SURGICAL OPERATIONS
WITH
LOCAL ANESTHESIA
BY
ARTHUR E. HERTZLER, M.D.
SECOND EDITION
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SURGICAL OPERATIONS
WITH
LOCAL ANESTHESIA
SECOND EDITION

BY
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PREFACE.

In the first edition of this little book I had in mind the needs of the general practitioner in the role of an "occasional operator." In harmony with this plan the simpler operations alone were described, confining myself to those operations which any one should be able to do with certainty without a great amount of experience in the use of local anesthetics.

Contrary to my expectations many surgeons of standing expressed an interest in the work and made the suggestion that its scope be widened to meet the need of surgeons. In conformity with this wish the present work takes in most of the major operations.

In acceding to the demands of a wider scope I have not departed from the original plan of presenting to the reader a multitude of detail which seeks to arm the operator with a broad range of procedure which makes it possible to select that which is best for the given condition and patient. In order to attain this aim it has been necessary to outline the entire course of the operation in many instances. This is necessary, for in but few procedures is any technic absolutely certain in the hands of all classes of operators. For instance, the skilled operator in a hernia operation is able to block off the nerve supply with certainty before the operation is begun. The less experienced will find that in the course of the operation some detail has failed to work out according to schedule. It becomes necessary to supplement his preliminary injections. This book attempts to tell the operator just how to help himself out in these little perplexities.

The literature bearing on local anesthesia has been collected with diligence and has played an important part in the development in the procedures as here set forth, and I gladly acknowledge my indebtedness. The operations as presented, however, are the result of my own experience and I stand sponsor for their efficiency if performed as advised. For this reason the literature has been specifically cited only in instances where the procedure is as yet not fully satisfactory. This is done in order
that the reader may refer to the original papers in order to secure first-hand the original conception of the operation.

The purely practical scope of the book absolves me from any obligation to note the history of local anesthesia. Furthermore, those who have been most interested in local anesthesia will agree with me, I am sure, that we are as yet only constructing an alphabet and that until the fundamentals are more completely worked out the writing of the story is not profitable.

I have omitted, too, any discussion of the theory of the production of local anesthesia. This involves a discussion of the nature of pain and the problem of osmosis. I am forced to with- go such a discussion because I know nothing about it, and there is not available to me any presentation of the subject which would in any way enhance the art of local anesthesia.

The attempt has been made throughout the book to emphasize the need of the utmost gentleness in technic. This is necessary if satisfactory results are to be obtained in operating on our sensitive and self-assertive American patrons. There is a vast range of difference between the patients bearing the pain and being operated upon painlessly.

For this reason I believe that it is worth while to modify the technic as advised by our Teutonic brothers, with the idea of avoiding as much as possible any unnecessary strain on the sensibilities of the patient.

The operator must approach his task imbued with the spirit of gentleness in the fullest measure. He must have an accurate knowledge of the anatomy of the region he is about to operate upon, and above all he must have in his mind’s eye the full scope of the required operation.

It is in the constant emphasis of the above factors that I have hoped to find a sphere of usefulness for this little book in the dignified companionship of larger and more pretentious works.

It is a pleasure to acknowledge my great indebtedness to Tom Jones for the interest he has shown in the preparation of the illustrations.

A. E. H.,
1310 Rialto Building.
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CHAPTER I

DRUGS EMPLOYED

Surgeons who use local anesthesia have long searched for a drug that would be efficient and yet safe in any amount, but such a one has not yet been discovered. There are, however, several the dangers of which can be avoided, and some that are perfectly safe and efficient if used with judgment and discretion. The former group is represented by cocaine, the first drug widely used, which is eminently efficient but sometimes causes ill effects in surprisingly small quantities. Novocain, which is equally efficient when used by injection and much less toxic, has come to replace cocaine for this purpose. In quinine and urea hydrochloride we have a drug which is entirely safe in any amount and is efficient when properly employed. Experience is required to get as good results from it as from cocaine and novocain, and in some conditions it is less easily employed than either of them. By the judicious selection of the drug best suited for the purpose at hand any condition may be safely and effectively met. These substances will be discussed seriatim together with a number of less used drugs.

COCAINE.—On account of its dangers the use of this drug by injection has been almost discarded, but it is still extensively used by topical application. The danger can be reduced to a minimum if its application is limited to the area to be operated upon, as in eye work, and if it can be injected directly into the nerve sheath, for which purpose a very small amount suffices, its action is safe, speedy and certain.

EXTERNAL APPLICATION.—All mucous surfaces may be anesthetized by the application of cocaine. For operations about the eye and nose this means of anesthesia is almost universally employed, and because of the small amount required in these re-
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gions cocaine is comparatively safe. It is more dangerous when used about the genito-urinary organs and rectum because the extensive surfaces require more of the solution. Numerous fatalities have followed its use in these regions, and few operators at the present time care to risk its use.

**Strength of Solution.**—For local applications, particularly about the eye and nose, a 4 per cent. solution is most frequently used. In the nose a solution half that strength gives a very satisfactory anesthesia, particularly when combined with epinephrin, and is preferable on account of greater safety. In the eye, stronger solutions, up to 10 or even 20 per cent., are sometimes employed, and because of the small amount absorbed they are relatively safe; but they are probably unnecessary since weaker solutions give perfect anesthesia if properly used.

**Methods of Use.**—A weak solution thoroughly applied usually gives a better result than a stronger one used timidly because of anticipated danger. With either weak or strong solutions, all surfaces to be anesthetized must be touched and time must be allowed for absorption to take place. The conjunctiva is effectively anesthetized by dropping the solution into the eye with a medicine dropper. A 4 per cent. solution dropped into the eye 4 or 5 times at intervals of two or three minutes usually gives complete anesthesia. Care must be taken that it is allowed to come in contact with the entire surface to be operated upon. In local operations, as for the removal of a tumor, it may be advantageous to apply the solution with a pledget of cotton. In the nose the anesthetic may be introduced by means of a syringe or with a pledget of cotton. The former is the more convenient method inasmuch as all regions of the nose can be easily and quickly reached, but the latter is more certain because the drug can be allowed to act upon the exact spot until the desired degree of anesthesia is obtained. Many rhinologists apply to the nose of operation, after a cleansing spray, a pledget of cotton which has been dipped first into epinephrin solution and then into powdered cocaine. When a local anesthetic is applied to a mucous
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Surface it must be remembered that a secretion may be excited which tends to dilute the fluid used. The mucus may form a viscid coating over the cotton which prevents further diffusion of the anesthetic. For this reason the cotton pledget should be frequently changed. The spray gives sufficient anesthesia for the parts which are not directly attacked in the operation and is useful in inhibiting the irritability of the mucosa should it be touched during the operation. It is usually desirable, therefore, in extensive operations to combine these methods.

It is hardly possible for enough of the chemical to be absorbed from the eye to give constitutional symptoms, but in the nose this danger is always present, though it can be minimized by using weaker solutions and limiting the quantity. It is likely that intoxication has resulted in most cases from an excess of solution which flowed into the pharynx and not from absorption from the nasal mucosa. In the use of the spray only enough to moisten the mucous membrane of the nose should be used. If the spray continues until the fluid runs into the pharynx the danger of absorption is greater and there is no corresponding increase in efficiency. In applying the stronger solution by means of a cotton pledget the excess of fluid should be pressed out beforehand in order to avoid its escape into the pharynx. The pledget, too, should be no larger than necessary to cover the field of operation. With the very strong solution (10 to 20 per cent.) recommended by some rhinologists for special purposes, constitutional effects of an alarming character may be produced. These strong solutions should be used only in individuals in whom it is known from previous use of weaker solutions that no idiosyncrasy exists.

By Injection.—Because of the slow rate of absorption from surfaces other than mucous membranes it is necessary to inject the anesthetic beneath the surface in order to bring it into contact with the nerve endings. Since one must expect complete absorption, the amount used should not exceed the safe maximum of 34 gr.
STRENGTH OF SOLUTION.—When cocain was first used as a local anesthetic, 4, 5 or even 10 per cent. solutions were commonly employed and a number of fatalities resulted. These high percentages are no longer used. A 1 per cent. solution produces quite as efficient an anesthesia with proportionately less danger. To Schleich belongs the credit of having worked out a plan whereby very much weaker solutions can be used. He employed solutions as weak as 1:1000. In order to enhance the anesthetic effect of the cocain he combined it with morphine in small amounts and sodium chloride in 0.2 per cent. solution. In a series of experiments he determined that if used in large quantity these substances give a fair degree of anesthesia with safety. His method causes an artificial edema in which the pressure upon the nerves and their endings aids very materially in the production of the anesthesia. The following formulas are those recommended by Schleich:

1. Cocain Hydrochlorat ......................0.2 3 gr.
   Morphine Hydrochlorat ..................0.02 ⅛ gr.
   Sodium Chloride (sterilized) ..........0.2 3 gr.
   Aq. Dest ..................................100.0 3½ oz.

2. Cocain Hydrochlorat ......................0.1 ½ gr.
   Morphine Hydrochlorat ..................0.02 ⅛ gr.
   Sodium Chloride ........................0.2 3 gr.
   Aq. Dest ..................................100.0 3½ oz.

3. Cocain Hydrochlorat ......................0.01 ⅛ gr.
   Morphine Hydrochlorat ..................0.005 ⅓-12 gr.
   Sodium Chloride ........................0.2 3 gr.
   Aq. Dest ..................................100.0 3½ oz.

METHODS OF USE.—In superficial operations cocain may be used by endermic infiltration. In strengths of ⅛ to 1 per cent. it is efficient in small quantity and may be used either with or
without epinephrin for small operations, particularly in plastics about the eye. Anesthesia is complete as soon as blanching of the skin appears. It may be used by direct injection into the shafts of nerves as in Cushing's operation for hernia. Some operators use submucous injections as a supplement to topical application in intranasal operations.

Anesthesia by edematization with cocain solutions, as introduced by Schleich, consists in the use of large amounts of weak solutions. The anesthetic effect is produced perhaps as much by pressure and by the 0.2 per cent. salt which it contains, as by the cocain itself, particularly in the No. 3 formula. The No. 2 solution of Schleich is usually employed when large areas of slightly sensitive tissue are to be injected. A syringe holding several drams is most convenient. Matas has employed a special apparatus operated by compressed air. A large amount of the solution is injected into the region of the proposed operation so as to produce a veritable edema. The more tense the edema, the more perfect the anesthesia. It is safe to use in this manner two ounces of solution No. 2 and a pint of solution No. 3. This method is effectual and simple, and is extensively used. It has the advantage of being applicable where the exact distribution of the nerves is not known. The tissue so infiltrated admits of rougher handling, which is of advantage to the operator of limited experience. The distension produced by the edema some operators find objectionable, and it certainly is undesirable where identification or exact coaptation of structure is of importance, as in hernia operations. In certain operations, as in enucleation of encapsulated tumors, this edema may be a positive advantage.

ACTION UPON THE TISSUES.—When applied to mucous surfaces it at once produces blanching of the surface without preliminary burning or dilatation of the vessels. It causes no pain when injected into the tissues unless it is done very briskly so as to cause tearing of the tissue before anesthesia can take place. The healing process is delayed about an hour, after which
it proceeds in the usual way. The effect on wound healing is therefore of purely theoretical interest.

TOXICOLOGY.—A word as to dangers or fatal results from very small amounts of cocain may not be amiss in this place. Ten drops of 4 per cent. solution used hypodermically have produced death. Eight drops of a 2 per cent. solution produced violent symptoms in a girl of 12, and 4 minims of a 3½ per cent. solution produced convulsions followed by mania in a strong man. These instances are sufficient to show that very minute quantities may produce alarming symptoms.

In many instances in which toxic symptoms occur it is, of course, impossible to estimate the amount of drug actually absorbed. Because of this uncertainty the amount used should not exceed that which may safely be thrown into the circulation, notwithstanding the employment of methods intended to limit its absorption, such as prompt incision, the use of constricting bands, the addition of epinephrin, etc. Wood recommends that a total of three-quarters of a grain be not exceeded and that no more be used locally upon mucous membranes than would be used by hypodermic injection. If these amounts are not exceeded unpleasant results will rarely ensue.

The symptoms of cocain poisoning manifest themselves without warning. They are pallor or slight cyanosis, often with restlessness and sometimes with a sense of impending disaster. More rarely sudden collapse is the first symptom. These conditions may extend into unconsciousness.

In some instances fainting may follow the sight of blood or the thought of the operation may cause the patient to become pale, which may excite in the mind of the operator the fear of cocain intoxication. To distinguish between the two conditions is not always easy. In simple syncope the subject's condition rarely assumes any other form than pallor, limpness and loss of consciousness. If cyanosis, dyspnoea and a sense of fear or great excitement appear it is safest to assume that cocain intoxication has taken place.
The treatment of cocain poisoning is principally prophylactic. Not much can be done after symptoms appear. The patient should, of course, be laid down if not already recumbent, the clothing loosened and the respiratory action freed as much as possible from impediment. Strychnine in small doses may be used, although its value is questionable. Morphine, except for delirium, is of no use. When employed before the cocain is used it appears to have a certain prophylactic effect. For convulsions, chloroform may be used. Ether, administered by the drop method, on a mask has recently been tried and is believed to have a direct antidotal effect (J. E. Engstadt, Jour. A.M.A. 1910, March 19).

**QUININE:**—**SALTS EMPLOYED.**—All the soluble salts of quinine act as local anesthetics when brought into contact with nerve endings or nerve trunks. I have employed quinine and urea hydrochloride almost exclusively in my operative work and chiefly in my experimental researches. According to Schaefer (The Druggists’ Circular, Feb., 1910), this salt is a combination of one molecule of quinine hydrochloride and one molecule of urea hydrochloride. The preparations upon the market are the powdered crystals and the tablets. It is soluble in an equal quantity of water forming a strongly acid solution. Quinine and urea hydrochloride has been used chiefly because of its ready solubility and because it is easily obtained. Other soluble salts of quinine are equally efficient. Some of the insoluble salts will dissolve if faintly acidified, and can then be used with good effect. A knowledge of this simple fact is sometimes of value when other means of producing anesthesia are not available.

**ACTION UPON THE TISSUES.**—A study of the action of quinine upon the tissues is of interest because certain of the changes which occur are liable to misinterpretation. When a soluble salt of quinine is injected into the tissues it causes an exudate which is at first amorphous, but which, if the solution remains confined in the tissues, soon coagulates forming granular fibrin. The coagulation begins after a few minutes and
is complete in from 12 to 24 hours. The skin so infiltrated is thickened and has a reddish color, so that it suggests a cellular infiltration. It is not tender to touch as would be the case in an inflammatory reaction, and sections show no round cells. The fibrin occupies the spaces among the connective tissue fibrils, displacing them but leaving them for the most part unchanged. In the midst of such fibrin the connective tissue fibres seem to lose their specific tinctorial reaction to a slight degree but much less than in reactive processes of like extent. This granular fibrin is not replaced by adult fibrous tissue as is the fibrillar type of fibrin, as described in another place, but is absorbed after one or two weeks and the tissues resume the state in which they were before the infiltration was made.

When quinine solution is injected into the nerve sheaths the action is similar. Granular fibrin forms among the nerve fibres, displacing and compressing them, but producing no apparent changes in the fibres themselves. This observation is of interest because it indicates that the solutions are harmless when injected into mixed nerves for the relief of pain. The exudate produced by the action of quinine upon the tissues has been referred to as an edema. This is incorrect because it is spontaneously coagulable and forms a substance capable of reacting to specific fibrin dyes. Furthermore, in the presence of a true edema, a tissue is incapable of making the first step toward wound repair. The exudate produced by quinine, on the other hand, is itself a first step toward repair, although a misdirected one. This tendency of quinine to produce an exudate is not to be looked upon as necessarily pernicious, although it may do harm if improperly employed. On the other hand, if used with intelligence and care it can be made to meet almost any demand upon local anesthesia.

The importance of keeping these changes in mind is, in part, that the reddened infiltrated condition of the skin will not be thought due to an inflammatory reaction. Much more important, however, is the fact that a knowledge of the method of action of the drug enables one to use it much more intelligently and ef-
fectively. If the skin is injected and at once incised the quinine solution escapes into the wound and the fibrin formation described above takes place to a slight degree only; anesthesia lasts for some hours only and wound healing occurs as though no local anesthetic had been used. This is the result to be aimed at in skin incisions where a short anesthesia and prompt healing of the wound are desired. If, on the other hand, primary union is not possible and prolonged anesthesia is desirable, it is important that the solution be allowed to remain in the tissue as long as possible in order that the exudate which later forms the granular fibrin may appear. The pressure exerted by this exudate prevents the oozing which follows certain wounds, and limits the hemorrhage of the operation itself to a degree depending upon the amount of exudate, which in turn depends upon the solution used and the length of time it is allowed to remain in the tissue. When infiltration with granular fibrin takes place anesthesia lasts from several days to two weeks or longer. This is a very desirable effect when primary union is not to be secured and when pain following operation is a prominent feature, as in operations about the anus, in the opening of abscesses and in less degree in operations about the throat.

In order to use quinine with satisfaction these actions of the drug must be kept in mind. That degree of reaction which is most desirable for the requirements of the given case may nearly always be obtained. The action of quinine may be modified by the addition of epinephrin. This substance by virtue of its vasoconstrictor action lessens the preliminary dilatation of the capillaries produced by the quinine. The exudate is lessened and the duration of the anesthesia is correspondingly shorter. By altering the amount of epinephrin I have been able to vary the duration of anesthesia in experiments on myself from two hours to several days.

EXTERNAL APPLICATION.—Quinine has not been as extensively used by topical application as it deserves. It acts less promptly than cocain, it is true, but it is of value on account of its absolute
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Safety and prolonged effect. It is more efficient applied locally than novocain and is much cheaper. Late oozing is less likely to occur than after cocain; it is rarely necessary to pack to prevent oozing after nasal operations when quinine has been used. I employ quinine universally in nasal work and never fail to secure anesthesia. Because of its irritating effect quinine is not desirable for use in the eye.

Strength of solution.—In strengths of 5 per cent. to 10 per cent. local anesthesia may be secured in mucous membranes by topical application. For making these stronger solutions powdered crystals are preferable to tablets, although the latter are usually employed because of their convenience.

Methods of use.—The nose is the most frequent place for the local use of quinine. It is applied upon pledgets of cotton as described for cocain. Any desired amount may be used. The duration of the anesthesia may be in great measure controlled by the length of time the anesthetic is allowed to remain in contact with the mucous surface. When applied for acute coryza or hay fever where the longest possible action is desired, it should be allowed to remain for 15 to 30 minutes, while as a preliminary to therapeutic applications a shorter time will suffice. For destructive applications or operations the longer period is required. Because of the bitter taste of the drug, care to prevent its running into the mouth will be appreciated by the patient, for as Brewster remarked “They complain of the taste bitterly.”

The action of quinine when applied to mucous surfaces is to produce first a slight burning sensation, and then an increased production of mucus. Frequent changes of the pledgets is even more necessary than when cocain is used because the initial irritation is greater. Pledgets as large as can be introduced should be employed so that the entire area likely to be touched by the manipulations comes in contact with them. Too great pressure, however, will lessen capillary activity and delay absorption. The pledgets should be changed at least three or four times.

After anesthesia has been secured a certain degree of shrink-
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ing of the tissue may be secured by using pledgets saturated with epinephrin solution. This facilitates the operation and does not interfere with the anesthesia. The degree of retraction of tissue is by no means equal to that produced by cocain-epinephrin solution, so that quinine has somewhat less immediate advantage where hemorrhage is annoying, as in work on the septum. On the other hand, because of the absence of late oozing and after-pain, quinine is indicated in turbinectomies and other operations where delicate manipulations are not required.

The urinary bladder may be satisfactorily anesthetized by the use of quinine. Any amount may be safely used, and it may be allowed to remain in contact for any desired length of time. Further experimentation will be required before it can be determined exactly what reliance can be placed upon the drug for this purpose. I have found sacral blocking so much more effective that I no longer employ topical application preliminary to intravesical manipulations and but seldom as a preliminary to operations on the bladder.

**BY INJECTION.**—Quinine has been used most extensively by injection. It is more likely than cocain to cause burning when first injected, but this lasts only a few seconds and can usually be entirely prevented by slow injection. A few trials in the operator's own skin will teach him the need and the art of gentleness.

**STRENGTH OF SOLUTION.**—Quinine being safe in any strength, one need consider only the amount of the drug that is necessary to produce the desired results. An extended use has proven that a 1 per cent. solution is sufficient to produce anesthesia under all conditions. Weaker solutions, \( \frac{1}{2} \) per cent. or even \( \frac{1}{4} \) per cent., give efficient anesthesia if skillfully used. When temporary anesthesia only is desired, and primary union with a minimum amount of scarring is important, as in operations about the face, and in loose tissue containing few nerves, these weaker solutions are to be preferred. Where prolonged anesthesia is desired as in nearly all extensive operations, or where the tissue
is involved in a reactive irritation, the stronger solution is preferable. I have never seen the advantage of the strong solutions recommended by Brown (3 per cent.), though in certain situations they are not particularly objectionable. The solution should be made fresh just before using. For ordinary use two 2-grain tablets may be dissolved in 1 oz. of water and the solution boiled. This makes approximately a 4-5 per cent. solution. I use this strength for all routine work. Instead of a watery solution normal salt, or a 1 or 2 per cent. CaCl₂ may be used as the solvent.

METHODS OF USE.—Quinine has found its most extensive use in endermic infiltration and for nerve blocking when the nerve can be directly injected, as during amputation. Where much after-pain is expected or where the cautery is used it is of particular value and is preeminently the anesthetic of choice, but may be used in any operation. Failure to secure anesthesia is due to faulty technic. Necrosis following its use is due to massive injections and can always be avoided by proper care. After an extended experience with quinine I have yet to see necrosis result from its use during an operation, except in one case, in which after the removal of a wart situated close to the nail-bed the tissue between the incision and nail became necrotic.

I produced necrosis experimentally in the skin of my leg by injecting two cc of a 1 per cent. solution at the same point under firm pressure. After a few days an area the size of a dime became black, and after two weeks separated leaving an ulcer which required three months to heal. I can testify to the fact, therefore, that it is possible to produce necrosis of tissue with quinine, but it can be done only by employing such an amount of fluid introduced under such a pressure as is never required in practice.

Quinine is employed for infiltration, for nerve blocking or for perineural blocking, which is a modification of nerve blocking. It is rarely used for edematization; first, because it is unnec-
necessary for the production of anesthesia; and, second, it is undesirable, because when quinine is thrown into the tissues the fibrinous exudate previously described may be formed in large amounts. This produces a swelling which lasts for a week or longer, and while it results in no permanent mischief it calls forth expressions of curiosity or alarm from the patient. These objections apply, let it be understood, only when large amounts, as several ounces, are injected into the loose cellular tissues. There are a few instances in which edematization with quinine is desirable. These will receive specific mention in the discussion of those operations where it is to be recommended.

RAPIDITY OF ACTION.—As soon as the endermic infiltration is completed the operation may begin, unless perineural blocking is depended upon for a part of the field, in which case anesthesia is sometimes not complete for 10 or more minutes. It is my practice not to delay the operation at any stage for the purpose of permitting the anesthetic to act, but to continue leisurely without interruption. By a little foresight it is possible to occupy the time as, for instance, in making ligatures, while some recently injected or slowly working area is being influenced by the anesthetic. Where prolonged anesthesia is desired to prevent post-operative oozing, the solution should be allowed to remain in contact with the tissue in order that the fibrinous exudate may form before the operation is begun. This is well established in a period varying from twenty to thirty minutes, and becomes much more complete if many times the period mentioned is allowed to elapse before the operation begins.

TOXICOLOGY.—Closson raises the question of the safety of quinine because he found it toxic to guinea pigs. However, there seem to have been no serious results from its therapeutic use, even in large quantities. Brewster used 100 grains in one patient for pernicious malaria with recovery both from the malaria and the quinine. Far larger amounts than are ever required in local anesthesia have been employed so many thousands of times
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without disastrous results that one may consider quinine as safe as a drug can be.

I have encountered but one case of idiosyncrasy in the use of quinine as an anesthetic. In this patient I used five minims of a 1 per cent. solution preliminary to the tapping of a hydrocele. The scrotal region and lower abdomen became covered with an extremely annoying eruption which lasted for a day or two. The patient knew that he possessed a quinine idiosyncrasy.

Necrosis following the use of quinine has come to my notice a number of times in the practice of my associates. The most distressing instance was the loss of a toe following a hallux valgus operation. Skin necrosis following the removal of tumors has occurred a number of times. A rim of necrosis about the foreskin after circumcision is the most common type of mishap.

These occurrences always result from technical errors. Because the drug is safe in any amount operators are too prone to use excessive amounts so as to make certain of anesthesia. It is never necessary to use enough to endanger the tissue.

Other salts of quinine.—A year and a half ago Prof. J. Morgenroth, of Berlin, placed at my disposal several new quinine preparations with the request that I study these products histochemically and clinically. It has been possible to date to study but one of these, namely, Isoamylhydrocuprein hydrochloricum.

Professor Morgenroth, (Berlin, Klin. Woch., 1912, No. 46 and Berlin, Klin. Woch., 1913, No. 8), has made a study of this and other preparations on the cornea. He states that this drug is twenty times the strength of quinine and is efficient in 0.1 to 0.125 per cent. solutions. In this strength an efficient anesthesia lasting forty hours was produced. In stronger solutions, 0.25 per cent., some clouding of the cornea of the rabbit resulted and in still stronger solutions chemosis occurred.

I have employed this drug in 1-10 per cent. solutions both in plain water and in normal salt. The action histochemically and as an anesthetic is about equal to quinine and urea hydrochloride.
of ten times this strength. My experiments have not yet been terminated and my clinical experience with it is limited.

Novocain.—Braun (Deutsch. med. Woch., 1905, xxxi, 1667; Beitr. z. Klin. Chir., 1909, LXII, 641), has contributed much to the advancement of local anesthesia by introducing the use of novocain with epinephrin. This combination has become the most widely used substance for the production of local anesthesia. Used by injection it is as efficient as cocain and much safer. It is stated that it is seven times less toxic than cocain and that fewer persons possess a susceptibility toward it. Cases have been reported where tonic and clonic spasms were produced, but no fatal cases have been reported. Because of its slight irritability and the rapidity of its action, together with the comparatively bloodless operative field produced by the added epinephrin solution, this drug is the most easily used and generally efficient anesthetic at present available and is to be unqualifiedly recommended to the beginner.

Local Use.—Novocain produces a slight initial burning and a dilatation of the capillaries when applied to mucous surfaces. For this reason it is less serviceable for use in the eye than cocain.

In the nose and pharynx it can be used with fairly good results in ten per cent. solution. It acts more slowly than alypin, is more expensive than quinine, and less efficient than either.

By Injection.—When injected into the tissues novocain causes a slight burning and an ephemeral dilatation of the vessels. If used alone the effect begins to disappear in about 15 minutes. If used with epinephrin the initial dilatation does not appear and the anesthesia is prolonged for an hour or more.

Strength of Solution.—Ordinarily a $\frac{1}{2}$ to 1 per cent. solution is used. To this may be added 4 to 8 drops of 1-1000 epinephrin solution. For infiltration of the skin and perineural blocking the 1 per cent. solution is usually best. For infiltrating loose tissue about tumors, the thyroid or a hernial sac, $\frac{1}{2}$ or even $\frac{1}{4}$ per cent. solution may be employed. The operator will do
well to calculate in the beginning the amount of fluid likely to be required. In extensive operations the weaker solutions may be used in situations where in smaller operations the stronger solution would be preferred. Occasionally in perineural blocking, as about the deep nerves of the skull and face, some operators recommend a 2 per cent. solution. Novocain bears boiling. It should be boiled in physiological salt solution and the epinephrin added after it has cooled to body temperature. Fischer (*Die lokale anesthesie in der Zahnheilkunde; Meusser, Berlin, 1911*) advises the addition of thymol both because it is in itself a local anesthetic and because it acts as a preservative. His formula is as follows:

\[
\begin{align*}
\text{Novocain} & \quad \ldots \quad 1.5 \\
\text{Sodium Chloride} & \quad \ldots \quad 0.92 \\
\text{Thymol} & \quad \ldots \quad 0.025 \\
\text{Distilled Water} & \quad \ldots \quad 100.0
\end{align*}
\]

This makes a $1\frac{1}{2}$ per cent. solution of novocain in normal salt to which 1-3 grain thymol has been added. It bears boiling and epinephrin may be added at the time of use. For dentists or for office use where small amounts are likely to be used at all hours of the day this solution can be highly recommended. For general use it has the slight objection that it causes more burning when introduced into the skin.

M. L. Harris praises very highly the addition of chlorbutanol in saturated solution—8 parts per thousand. He warns me that it must be made just right or it is spoiled in the making. The water is boiled long enough to insure sterility, 20 to 30 minutes. The novocain is then added and the boiling continued not over three or four minutes. It is then removed from the flame and is cooled to below 170 F. and the chlorbutanol added. Since chlorbutanol volatilizes above 170 F. the importance of the last precaution is evident. Epinephrin is added just before using.
Harris (Surg., Gyn. and Obst., 1915, xx, 193) now uses a solution of novocain-epinephrin to which calcium chloride in from $\frac{1}{4}$ to $\frac{1}{2}$ per cent. and 8-10 per cent. of chlorbutanol is added. He gives the following directions for making the solution: the water is sterilized by boiling, after which the novocain is added and the boiling continued for 2 or 3 minutes longer. When this has cooled to 160 degrees Fahr. 1 per cent. chlorbutanol is added. The calcium chloride solution is made and sterilized and after it has cooled the chlorbutanol is added the same as to the novocain solution. By diluting the first solution with the second a varying percentage of novocain and calcium chloride is readily obtained. The epinephrin, 4 or 5 drops to 30 cc. of the solution, is added just before use.

Hoffman and Kochmann (Deutsch. med. Wochenschr. 1912, xxxviii, 2264) add 2 per cent. of calcium sulphate to the novocain solution. They claim that by the addition of this substance the novocain is made more potent so that solutions of 1-10 per cent. are effective. After-pain is said to be lessened. My own experience with this combination has not been so favorable.

**Method of Use.**—When injected about the roots of nerves in 1 per cent. solution it produces anesthesia in the region supplied by those nerves in from 15 to 30 minutes. It is non-irritating when so used and the amount is limited only by the toxicity of the drug. For the injection of such loose tissues as the capsules about tumors, a weaker solution may be used, $\frac{1}{2}$ per cent. or even less if the operation requires a large amount of the solution as is the case in breast amputations. Endermic infiltration is readily accomplished by 1 per cent. or even $\frac{1}{2}$ per cent. solutions.

**Actions upon the Tissues.**—Novocain when applied locally causes temporary dilatation of the superficial capillaries. When injected into the tissues it produces a fleeting hyperemia associated with a moderate degree of burning. When used with epinephrin the preliminary hyperemia does not occur and the burning can be avoided by the injecting of the fluid slowly. Novocain with epinephrin, on account of the constringent action
of the latter, tends to delay wound healing more than cocain does. This fact does not seem to be of much importance except in case of cleft palate operations, in which I am convinced that although novocain-epinephrin is valuable in reducing hemorrhage, it also lessens the chance of healing.

TOXICITY.—No records of fatal cases have been encountered in the literature. Based upon the statement of pharmacologists that novocain is only one-seventh as toxic as cocain, operators have limited the use to 7 grains for the operation. Braun has used double this amount without bad results.

STOVAIN.—(Braun, Munch. med. Woch. 1905, LII, 1177; Kendirdjy, L'anesthesie chirurgicale par la Stovain. Paris, Masseon et Cie., 1906). This drug has been used chiefly in spinal anesthe-sia, but it has also been used by injection. It is less toxic and less efficient than cocain, but is said to give better results in inflamed tissue. In many cases it is reported to work well and in others without evident reason results are not satisfactory. One is justified in regarding such statements as reflecting more on the technic of the surgeon than on the efficiency of the drug. Stovain may be used in the same way as novocain. It has been added to alcohol for injection into neuralgic nerves.

OTHER DRUGS USED.—Because of the well organized dangers attending the use of cocain many substitutes have been introduced, but they are all inferior in efficiency, though safer. Novocain has been the most widely used of these. Several others have enjoyed a degree of popularity and may be here enumerated.

Beta-eucain may be used in quantities up to three grains, it is said, and as much as 15 grains have been used without alarming effects. It may be used in the same strength as cocain in Schleich solutions, or in 1 per cent. solution for infiltration. For local application in the eye or nose, solutions of 2 per cent. are used. Tropacocain has been used in similar strengths, and is said to be safe up to five grains. Among other drugs which have been used may be mentioned anesthesine, subcutin, and alypin. Of these the last has been much used, but is inferior to cocain.
Pure water has been made use of by S. G. Gant in operations about the rectum. It is necessary to inject the tissue so tensely that it becomes thoroughly blanched. The injection itself frequently causes acute pain, which may be lessened by pressing the tissue as it is being injected firmly between the thumb and finger. This means of securing anesthesia has an extremely limited field of usefulness and can be recommended only for operations of short duration when other means are not at hand.

**SEQUENTIAL COMBINATION OF LOCAL ANESTHETICS.**—I habitually employ novocain-epinephrin and quinine and urea hydrochloride during the same operation, using the one for one part of the operation, the other for another part of the same operation. This is done for the purpose of employing that drug in the particular part of the operation in which it is particularly indicated and for limiting the amount of the more dangerous drug required.

Thus, in rectal amputations, quinine urea is used in the skin and the sensitive regions of the terminal segment of the gut while the novocain-epinephrin is used in the loose para rectal tissue or in sacral blocking. In large umbilical hernias quinine is used in the extensive infiltration of the skin and the novocain is used in the fascial and preperitoneal tissue. In large goiters, too, the skin infiltration is made with quinine while novocain is used for the deeper tissue. If deeper nerves are reached, as in blocking the nerves of the thigh, quinine would be employed to block the nerve, while novocain may be used as a matter of convenience in the superficial tissues. By judicious combinations of anesthetics, operations of almost any magnitude may be performed without approaching a dangerous dosage of any one of them.

**COMBINATIONS OF SEVERAL LOCAL ANESTHETICS.**—Numerous attempts have been made to enhance safety and efficiency by combining the safe with the efficient. The only combination worthy of trial is that of quinine with novocain-epinephrin. By so doing the quick action of the novocain, the vessel constricting action of epinephrin with the prolonged action of quinine is ob-
tained in part. The result of this combination is that the full effect of neither is attained. The constricting action of epinephrin is compromised by the quinine and the prolonged effect of quinine is lessened by the epinephrin. Nevertheless this compromise may be very desirable in certain small operations where a relatively bloodless field with control of after pain is desired as in tonsilectomy and operations at the mucocutaneous border of the anus. Anesthesia is easier to attain by this combination by virtue of the novocain, the adrenalin secures a measure of anemia and the quinine controls the after-pain longer than where this drug is not employed.

The proportionate combination most useful depends upon the use to which it is put. In tonsilectomies the novocain should predominate, using:

Novocain ....................... gr. v
Quinine urea hydrochloride....... gr. ii
Epinephrin ....................... gtt. viii
Water ............................ oz. i

In operations in the anal region the following is more desirable:

Novocain ....................... gr. v
Epinephrin ........................ gtt. vii
Quinine urea hydrochloride....... gr. iv
Water ............................ oz. i

This combination may be employed for more extensive operations where these qualities are desired, but on the whole the ends are better served by using that drug which secures the definite result desired.

**THE USE OF EPINEPHRIN AS AN AID IN LOCAL ANESTHESIA.**—Perhaps more credit is due to Braun than to anyone else for having discovered the usefulness of epinephrin as an adjunct to anes-
thetic solutions. By means of this drug he hoped to lessen the rate of absorption of cocaine, and render it thus at once safer and more effective. Its chief value perhaps is in lessening hemorrhage. When used with novocain it also lengthens the duration of anesthesia from 4 to 10 times. Sickenburg denies that epinephrin makes cocaine either safer or more efficient. Usually from 5 to 15 drops of a 1-1000 epinephrin solution are added to an ounce of the anesthetic solution. Fischer believes that not more than 7 minims should be used at one operation, but the results of intoxication are not serious. Palpitation, cardiac spasm and dyspnoea may appear early in the operation but soon disappear and do not return. Toxic symptoms are more apt to manifest themselves if the solution is old, and if it is injected directly into a vein. Barker used epinephrin with beta-eucain with great satisfaction. It must be admitted that addition of epinephrin reduces hemorrhage and probably lessens the rate of absorption, and thus increases the effectiveness of the anesthetic. The action is but temporary, and it has seemed to me that the disposition to ooze when the effects of the drug have disappeared is greater than when it has not been used at all. Hematomas may form after the skin incision has been closed, or prolonged oozing may occur from exposed wounds, especially after operations upon the nose and throat.

Added to the quinine solution epinephrin has a very interesting effect inasmuch as it limits the amount of fibrin produced. For this reason it may be advantageously added for use in regions where the induration produced by quinine when used alone is undesirable. It should be noted that the duration of anesthesia is thereby much reduced and where after-pain is considerable the use of epinephrin is not advisable. When added to quinine it lessens the hemorrhage and prevents in a measure the primary dilatation of the vessels produced by that drug. Each region and operation has requirements peculiar to itself, and when modifications in the solution are required they will be mentioned in the specific
operations. Until the operator has become expert in the use of quinine he should not experiment with epinephrin.

**EPINEPHRIN.**—The unstable nature of epinephrin must be remembered and only fresh preparations used. If the anesthetic solution, usually novocain, becomes pink after the epinephrin is added the whole should be thrown away, and a new solution of novocain should be prepared and a fresh bottle of epinephrin secured. Often a fine granular deposit is formed in the epinephrin solution. When this occurs it is inert and a new supply must be secured. This granular deposit is most easily detected by withdrawing it from the container by means of a medicine dropper and observing this thin column by direct light.

**COMBINED LOCAL AND GENERAL ANESTHESIA.**—For a long time general anesthesia has been employed in particularly painful stages where local anesthesia is used for the major portion of the anesthetic. Thus, a few whiffs of gas-oxygen may be given in appendectomies when the adhesions are being separated, or when the bone is being sawed or chiseled in jaw dissection.

With the advent of quinine as a local anesthetic the association of local and general anesthetics has found a new application. Rogers first proposed (verbal communication, 1908) that when operations are done under general anesthesia, those areas likely to be attended by marked after-pain should be injected with quinine for the sole purpose of lessening the suffering after the patient comes from under the anesthetic, as when hemorrhoids are tied off in the course of a major gynecological operation, or when hemorrhoids are operated primarily under general anesthesia. Likewise nerves that have been severed in an amputation may be injected in order to limit the pain.

**SECONDARY EFFECTS OF LOCAL ANESTHESIA.**—A commonly overlooked accompaniment of local anesthesia is the zone of hyperesthesia about the anesthetized area. A space varying from \( \frac{1}{4} \) to \( \frac{1}{2} \) inch or more immediately beyond the anesthetized area ordinarily becomes excessively sensitive to touch though not to pain. The cause of this phenomenon is not understood, but the
importance of recognizing it is great. If it is overlooked, touching or pressure upon this zone may cause acute suffering and the operator may believe that anesthesia of the site of injection is insufficient or has already disappeared. This hyperesthesia often lasts a day or two or even longer.

FREEZING.—The usefulness of freezing in producing anesthesia is very limited, and furthermore the thawing causes severe pain quite independent of any pain which may be attendant upon the operation itself. It has a certain use, however, for operations of short duration upon the skin.

Fig. 1. Ethyl chloride container for freezing.

METHODS.—Cooling sufficient to make the skin insensible may be secured by pressing salt against the skin with a piece of ice, the size of a walnut, for a few minutes. This method has been used for simple punctures, as in thoracic paracentesis, in the absence of more suitable material. For timid patients it has the same advantage as all methods of freezing, that anesthesia can be produced without pain. The fact that the patient suffers more from the thawing than from the operation itself is not a contraindication sufficient to prevent its use in such persons.

The usual method of freezing is by the use of volatile substances. Ether spray used as with a freezing microtome may be employed. Ethyl chloride has been used most, however, and is the most convenient. It is placed upon the market in small containers (Fig. 1) fitted with a cap or valve which prevents evap-
oration when not in use. These containers are of such size and form as to fit the hand, the warmth of which causes the ethyl chloride to be projected against the desired spot. In this way a small area of skin can be frozen in a few seconds. The proper degree of refrigeration has been reached when the skin becomes frosty. Freezing beyond this stage does not increase the anesthesia and may lead to sloughing. The instruments for the operation should be previously arranged so that no time be lost because the duration of the anesthesia is very short.

The method is used chiefly for the opening of small abscesses or anesthetization of the skin preliminary to aspirations or injection anesthesia. Here it serves a very useful purpose, since it eliminates the initial pain of infiltration anesthesia; and conversely, infiltration anesthesia may be used to prevent the pain caused by the thawing out of the tissues after freezing. By the combination of these two methods it is possible to carry out painlessly procedures otherwise very painful. If primary union of an incision is expected, freezing anesthesia should not be used on account of its interference with the vitality of the tissue.
CHAPTER II

TECHNIC OF ADMINISTRATION

Suitable instruments kept in good condition are essential to success in local anesthesia. Dull knives cause pressure on distant nerves and give the patient discomfort at the outset when he is most open to suggestions of doubt. Dull scissors pinch, but do not cut. Badly working forceps pull unnecessarily upon the tissues. A dull and rusty needle and a leaking syringe will defeat the most expert operator.

APPARATUS.—The syringe must be well made and in perfect condition, and adapted to its purpose. The needle must be sharp and free from rust and long enough to reach the desired field. The beginner is likely to underestimate the depth of the sensitive tissue and use a needle too short to reach the sensitive area.

The most desirable syringe is one with a metal piston and glass barrel with metal mountings. All-glass syringes have the disadvantage that the tip upon which the needle fits is easily broken off. The Record syringe is the best on the market and can be obtained in any desired size. The piston is of metal and must be boiled separate from the barrel.

If the piston does not work smoothly within the barrel, fluid will be expelled unequally and cause pain by the sudden dilatation of the tissues. The most common fault of syringes is that the barrel differs in calibre in different portions. In the narrow portions the piston works with difficulty, while in the wider portions it permits the fluid to leak back. Nearly all my operations have been done with an ordinary 25 minim syringe (Fig. 2),
Surgical Operations with Local Anesthesia

which is the most desirable size for endermic infiltration, particularly in very sensitive tissue. In operations which require a large amount of fluid a syringe of greater capacity is convenient. For deep nerve blocking, as about the base of the skull, a syringe of 5 cc. capacity is convenient (Fig. 3). The greater

the diameter of the barrel the greater the pressure required to force the fluid out of the needle. The difficulty of gentle infiltration increases in proportion to the diameter of the piston. For this reason large syringes can be used only for the edematization of the loose areolar and muscular tissues, which indeed require no anesthetic.

Some operations require a special syringe. In deep cavities, as in operations on the cervix, an extension tube is desirable

(Fig. 4). For dental work a more powerful instrument (Fig. 5) is needed because of the density of the tissue to be injected. For this purpose all-metal syringes are preferable because the glass barrel will not stand the high pressure required.
Not less important than the syringe is the needle. A variety of sizes and lengths should be at hand for special purposes. For endermic infiltration a needle 2 to 4 cm. long with a diameter of 0.5 mm. is best. For infiltrating the abdominal wall a needle of this size is usually long enough, but in fat abdomens one 4 or 6 cm. long may be needed. For infiltrating the anal sphincter and the levator ani muscles a needle 6 or 8 cm. long and 0.7 mm. thick is desirable. For deep cranial injections needles 12 cm. long and 0.9 mm. thick are required.

The character of the point of the needle is of importance. For endermic infiltration it is important to have a needle with a sharp point because it is easier to penetrate the dense cutaneous tissue.

For deep injections about vessels a sharp pointed needle increases the danger of penetrating a vessel. For such injections, therefore, a needle with a point representing a more obtuse angle is demanded.

Special needles have been devised for special purposes. Curved needles for injecting about the base of tumors are superfluous. They are expensive, not easy to obtain and are easily broken. The angled needles for use in dental operations are very convenient. Appliances for marking the depth to which the needle is passed or needles marked with a scale are unnecessary. A bit of cork through which the needle can be passed serves quite as well.

With careful cleansing needles can be used repeatedly and when slightly damaged may be restored by polishing on emery
cloth and sharpening on a small stone. For operating on his friends the operator will do well invariably to use a new needle.

GENERAL PREPARATION OF THE PATIENT.—In carrying out operations under local anesthesia the most important factor is confidence on the part of the operator that the results will be satisfactory. If the operator is apprehensive the patient is sure to imbibe his lack of confidence. Nothing will more certainly make for failure than to have a general anesthetic in readiness and to assure the patient that he will be given ether if the local anesthetic fails. Stopping the patients ears with cotton or covering his eyes, unless required by the nature of the operation, serves only to disturb him. Besides, the expression of the patient’s face is the operator’s gauge of success in his anesthesia.

It is desirable that any patient about to undergo an operation should have his mental and physical equipoise disturbed as little as possible. This is doubly important if the operation is to be under local anesthesia. Unless some special indication exists no great departure from normal living is required. A full bath, a restful night’s sleep, and a normal bowel movement are helpful alike to both surgeon and patient. A patient who is confined to bed for a period of days should make his dietary harmonize with the enforced inactivity. I usually permit the patient a light breakfast just before the operation. Purgation and starvation are particularly to be avoided because they inspire apprehension and do no real good. If the patient is accustomed to enjoy an after breakfast cigar it should not be denied him.

SPECIAL PREPARATION.—After the full bath, if the operation is a major one, the region is washed and shaved. Immediately before the operation the field is painted with Tr. Iodine, either full strength, or diluted with an equal quantity of alcohol. In operations about the scrotum or anus this cannot be employed, and soap and water must be depended upon. The use of iodine has proven reliable, and where the nature of the skin permits its use is more pleasant to the patient than the vigorous scrubbing with soap and water. The use of soap is undesirable because it makes
the skin slippery and renders the necessary manipulation in skin infiltration more difficult. Simple cleansing with clear water lessens this inconvenience but does not entirely remove it. Where alcohol can be employed it will remove the soap entirely. About the labia and scrotum neither iodine nor alcohol can be employed because of the irritation produced; simple rinsing must be depended upon.

The preparation of the instruments and accessories is of course the same as when general anesthesia is employed. The syringe should be sterilized with the instruments. The receptacle in which the solution is made should also be boiled. Ordinary one ounce medicine glasses are of a convenient size and are sufficiently accurate for the purpose.

The preliminary hypnotic.—If the patient is restless and expresses fear of his ability to withstand the operation, or if the operation is to be one of magnitude, a preliminary dose of morphine may be given. This I have called “removing the hypertension from the apprehension.” The initial dose of morphine likewise lessens the pain produced by tugging on parts not anesthetized, especially in abdominal operations. The morphine should be given thirty to sixty minutes before the time of operation.

If the morphine cannot be given at least half an hour before the operation is to begin it should be omitted entirely, for in the first few minutes after its administration it often excites rather than quiets. The dose need not be large; 1-6 to 1-4 grain is sufficient. Many operators use larger doses than these or repeat them several times. This no doubt makes the operation easier, or at least makes a careful technic less imperative. Operating on a patient stupified with a hypnotic is not operating under local anesthesia however. The large dose of an opiate may be a greater menace to safety than a general anesthetic, this is particularly true in diseases of the kidneys.

Pantopon recommended by a number of German operators in twice the dose of morphine is effective, but is more stupefying
and the effect lasts longer and is therefore more objectionable. The addition of atropine, hyoscine or scopolamine to morphine enhances the action of morphine and may therefore be advantageous or harmful as the case may be. In operations about the mouth and trachea these drugs are useful, while in operations about the ano-genital region they are objectionable, because they increase the tendency to urinary retention.

When injection of the anesthetic solution is to begin the patient should be placed on the table in a comfortable position. A strained attitude may be more trying than the operation, as for instance holding the legs in the lithotomy position in rectal work. Pillows under the head and in the small of the back may aid in making the patient comfortable and assist in gaining his co-operation. He may be allowed to see the preparation of the instruments in order that he may become familiar with the sound of their manipulation. He may be engaged in conversation about some matter of common interest, or the operator may relate to his assistant the success of some similar operation. The advantage of faith in the success of the operation is incalculable, and the operator should spare no pains in acquiring the confidence of the patient. The operator should sit down, if possible, both to prevent fatigue and to permit more delicate and accurate manipulations.

Before the initial injection is made the patient should be told that the first prick of the needle will cause about as much pain as the giving of an ordinary hypodermic injection. One of my patients estimated the pain as about "two mosquito power." I have used this expression with advantage to the mental poise and comfort of other patients. This forewarning prepares him for the slight pain. It is remarkable how far such minute detail goes toward gaining the confidence of the patient and establishing his faith in the success of the procedure. If the initial prick causes the patient to bellow with pain the operator has an indication of the state of his mind and renewed efforts must be made to gain his co-operation.
METHODS OF INJECTION.—Before beginning the injection the operator must plan his operation in detail. The neural anatomy must be recalled in his mind's eye, and it must be decided by what steps the various sensitive tissues may be anesthetized.

The order in which the various steps are carried out depends on the anesthetic used, the nature of the operation and the character of the patient.

A number of methods are employed, depending on the size and accessibility of the nerves involved in the operation. In terminal nerve-endings the anesthetic fluid can most advantageously
be deposited in the tissue in which the nerve endings lie, namely, the papillary layer of the skin. This method is called *endermic infiltration*. In larger nerves the solution may be injected directly into the nerve sheaths. This is called *nerve blocking*. In large nerves this can be done without exposing the nerves as in case of the sciatic, brachial plexus, etc. In smaller ones, as in ilio-inguinal, radial, ulnar, etc., it is necessary to first expose the nerve. In most instances the infiltration is made in the region of the nerve and dependence is placed on diffusion of the fluid to reach the nerve fibres. This method is depended upon, for instance, in hernia, thyroid operations, etc. When the operator has no definite notion as to the location of the nerve supply the tissues are infiltrated diffusely. This may be called *edematization*.

These several methods may be described in detail.

**ENDERMIC INJECTION.**—This method seeks to anesthetize the end organs in the skin. Anesthesia is dependent in part on pressure within the tissues, but the chief action is a direct chemical

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*Fig. 7. Showing a wheal produced by endermic injection. The rings indicate the location of subsequent wheals as the needle is pushed forwards.*
one upon the nerve endings. The fluid should, therefore, be brought as nearly as possible in direct contact with the nerve endings, that is, in the papillary layer of the derma.

In beginning the injection, one picks up the skin between the thumb and forefinger of the left hand and makes a firm pressure (Fig. 6). This produces a local anemia rendering the skin less sensitive to the initial prick of the needle. As soon as the point of the needle has entered the epidermis, slight pressure on the

![Image](image_url)

**Fig. 8.** Endermic infiltration. The needle penetrates the papillary layer of the skin and follows along this plane.

piston forces out the solution which, displacing the blood in the capillaries, causes a blanching of the skin (Fig. 7). In this way, the fluid as it escapes from the needle comes in contact with the nerve endings in the papillary layer of the skin (Fig. 8). Anesthesia rapidly follows the blanching. If the fluid is introduced rapidly the stretching of the tissues causes pain before the anesthetic effect has had time to manifest itself. If the needle penetrates too deeply the fluid escapes into the loose subcutaneous tissue and edema is produced, but the skin is unchanged in color. In this case several minutes will elapse before the skin
loses its sensibility. Less skill is required to introduce the fluid subdermically, but the results are less satisfactory.

Blanching from the first endermic injection having appeared the needle should now be pushed forward nearly to the opposite border of the blanched area and the piston again pressed. A blanched area is produced extending for a distance in advance of the needle (Fig. 7). When the needle will reach no farther it is withdrawn and introduced again near the edge of the blanched area and the injection proceeds as before until the entire line of the proposed incision has been injected.

As soon as the skin line is finished the deep injections are made by passing a needle through it. If the skin only is to be incised it may be done very soon after the endermic infiltration is finished. If deep injections are required they can be made best before incising the skin. Care should be taken to note the line of infiltration, for if properly done the blanching has disappeared before the infiltration has all been made. It has been proposed that the line of injection be marked by drawing silver nitrate or tincture of iodine along it, provided the latter drug has not been used to sterilize the field of operation. Although the blanching may have disappeared the general direction of the infiltrated line can be retained in the mind's eye, and this aided by the palpable edema of the skin will enable the operator to follow accurately the infiltrated line.

All skin and mucous surfaces may be anesthetized by the endermic method. The advantages of this method are that it requires a minimum amount of fluid and that anesthesia appears as soon as the infiltration is complete. The surgeon's skill in the use of local anesthesia is better shown in this initial step than in any other. The needle passes just within the skin and a drop of fluid is expressed. Too much fluid produces a burning pain due to the distention of the tissue. This pain is of momentary duration to be sure, but it is often sufficient to shake the patient's faith in the efficiency of the method. Each time the needle is advanced to the edge of the infiltrated area, the same gentle pres-
sure upon the piston must be exerted. If the injection is properly done the initial prick alone causes pain. The width of the line to be infiltrated may be varied by the amount of fluid injected; the more fluid is forced out at each point the wider the area infiltrated by the fluid.

After the injection is completed, and before the incision is made, a test of the sensitiveness of the area may be made by pricking the skin with the needle of the syringe or the point of the knife. The experienced operator omits this precaution because he has learned by experience when anesthesia must be complete. An error commonly made is to extend the incision beyond the infiltrated area. When the unanesthetized skin is reached, the sudden pain startles the patient and surprises the operator and may mar the success of the operation.

![Subdermic infiltration](image)

**Fig. 9. Subdermic infiltration.** The fluid is injected into the loose tissue immediately beneath the skin.

**Subdermic Infiltration.**—When the skin or mucous membrane is very thin endermic infiltration may not be possible. The solution must then be injected immediately beneath the surface (Fig. 9). This applies not only to thin skin, as in circumcisions, but also to fascia, periosteum and peritoneum. This method requires more fluid and a greater length of time before anesthesia is complete because the fluid must traverse the sheaths of the nerve filaments. It is a hit or a miss method and should be employed only when more exact methods cannot be employed.
NERVE BLOCKING.—Some operative fields are supplied by terminal nerve trunks. These regions may be effectually anesthetized by injecting directly into the nerve sheath. In certain large nerves this may be done without exposing the nerve, but in most cases it is necessary to isolate the nerve trunk and to fix it carefully with the tissue forceps (Fig. 10a) before attempting to thrust the needle into it. The forceps here illustrated (Fig. 10b) enable one to pick up the nerve with the greatest gentleness. By grasping the nerve in the hollow portion of the forceps (Fig. 10b), and passing the needle within the grasp, the forceps form a constriction about the needle; the fluid injected distends the nerve sheath like a sausage and may be made to traverse some inches of the sheath. The entire area supplied by the nerve may then be operated upon without fear of producing pain. This is the ideal method of anesthetization when the trunk of the nerve supplying the entire region to be operated upon is accessible. It is the method employed in major operations upon the extremities and, combined with skin infiltration, it constitutes the method introduced by Cushing for inguinal herniotomy. Unfortunately this method is applicable only when the nerve trunks large enough

![Fig. 10. Method of picking up a nerve for endoneural injection. a. Method of grasping the nerve. b. Hollow tip of forceps is shown natural size.](image-url)
to be directly injected are exposed during the course of the operation or are easily reached by a preliminary incision.

In most cases the operator must depend upon the accuracy of his anatomic knowledge to inject the fluid into a deeply lying nerve trunk or at least into its immediate vicinity. This is illustrated by regions such as the foramen ovale, the inferior maxillary canal, and the intercostal and abdominal nerves. If the nerve is directly injected anesthesia takes place instantly. In these deeply lying nerves direct injection is not often possible unless their locations are fixed by reason of their exit from some foramen or notch. Ordinarily the best the surgeon can do is to place the solution as near the nerve as possible. The fluid then reaches the nerves by diffusion.

The more recent marked advances in local technic have been in the direction of blocking deep nerves, and have made possible many major operations which heretofore had been done only under general anesthesia. This is true notably of operations upon the jaw. For these deep blockings novocain and epinephrin is the anesthetic of choice because of its more rapid diffusibility. The addition of chlorbutanol apparently hastens the diffusion because this substance is a lipoid solvent. It is in addition slightly anesthetic. When the nerve is exposed quinine can be used because of its more enduring effect.

**Edematization.**—(Schleich’s method). The distension of the tissues with fluid was introduced by Schleich in order to secure anesthesia from solutions of cocain too weak to act by infiltration. The fluid is injected into the loose tissue irrespective to the position of the nerves. The weak solutions were used because stronger ones were dangerous. The method is, therefore, a makeshift to overcome the dangers of the drug employed. It was first used with cocain solutions and is described in connection with that drug.

The method is properly used only in loose tissue which contains but few nerves; in regions particularly sensitive or where larger nerve trunks are involved it is inefficient. With increased
experience and the use of safer drugs the method has gone largely out of use, but it is still useful where tissues are to be dissected, as in the ligation of vessels, in the search for nerve trunks for the purpose of nerve blocking, and particularly to facilitate the separation of tumors from their capsule, as in thyroidectomy, etc. Where tissues are to be accurately united again, as in the operation for hernia, the method is objectionable since it interferes with the coaptation of the wound edges, though most of the fluid escapes when the incision is made. The method is particularly useful to the novice and may be used for many purposes in the absence of a finished technic. Quinine is seldom used by this method. An undesirable infiltration of the tissue follows.

THE SEQUENCE OF ENDERMIC INFILTRATION AND NERVE BLOCKING.—Generally two or more of these methods are combined in one operation. Nearly always endermic infiltration is employed for the skin and nerve blocking in some of its forms or edematization is added to anesthetize the deeper tissues. Which of these shall be done first is a matter of election.

Two general plans may be described. The method employed almost universally in my own work and the one described in these pages seeks to anesthetize the skin first. After the line of skin infiltration has been made the deeper tissues are infiltrated by passing the needle in the line previously infiltrated. This method has the advantage that only the initial prick is perceived by the patient while all other punctures are made in anesthetized skin. It has the disadvantage that the operator must determine the direction and extent of the operation before the injection is begun. This is the most delicate method, and I believe, is the one best adapted to the sensitive nervous American.

The other method is the one generally employed by German surgeons and those Americans who have followed the German lead. This method seeks to reach the chief nerve trunks as the first act in the operation. This necessitates the plunging of needles of sufficient length deeply into the tissue. Two or more of these punctures are necessary. After the deep infiltration
is made the skin is infiltrated. This method has the advantage that niceties of planning and of technic are not demanded and that the solution is brought at once in contact with the chief nerve supply of the part. The chief disadvantage lies in that several unanesthetized points must be punctured with a relatively heavy needle and the needle must be passed for some depth into the tissue. Both these acts are more or less disturbing to the patient in the earlier stages of the operation before his full confidence is gained.

**INTRANOVESOUS ANESTHESIA.—** (Bier, *Berlin, klin. Woch.*, 1909, No. 11). The following is quoted from Hartel (*Wien, med. Woch.* 1909, No. 35): “The patient is prepared in the usual manner for operation. The affected extremity is completely disinfected and protected with sterile dressings. The following instruments are held in readiness for the anesthetization: a glass receptacle, filled with carbolic acid solution, containing at least three bandages, from 3½ to 6 meters in length, made of thin rubber (the kind of rubber used for constriction-bandages), and provided with strings at the rolled-in end. A graded Janet syringe holding 50 to 100 grams is boiled, rinsed in physiological salt solution, and completely filled with a fresh ½ per cent. sterile novocain solution (0.9 natr. chl. 100.0 aq.), at about body temperature. To the syringe is attached a tube of rubber or a Nelaton catheter about as thick as a lead pencil. With this tube is connected a canula 1.5 to 2.0 mm. thick and provided with a stopcock; the connection being made through an inserted segment with bayonet closure. The end of the canula is blunt and has a few indented grooves for the fixation of the vein. We also need a Pravaz syringe with ½ per cent. novocain solution, 1 scalpel, 2 small three-pronged sharp hooks, 3 Deschamp’s needles with silk, 1 pair fine pointed scissors, 2 small hook forceps, a few clamps, ligature threads, needle holders, and a few silk sutures.

The first and indispensable preliminary requirement for the success of the anesthesia is complete ischemia. No satisfaction
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with venous anesthesia is possible, unless this is carefully attended to. The limb is raised by the assistant, the operator wraps it from the fingers or toes with rubber bandage No. 1, pressing the blood out carefully and thoroughly until a short distance above the site of the injection; the expulsion bandage is then temporarily fixed in place. Immediately above it, the permanent Esmarch bandage is applied as tightly as possible in turns, only partly covering each other, so that the result is not a constricting strand, but as wide a constricting surface as possible. Expulsion bandage No. 1 is then removed, as far as the point above which the lower ischemia bandage No. 3 is to be applied. As bandage No. 1 is being removed, the limb should appear clear white in color; if it is still red or bluish, the prospects are poor for a satisfactory anesthesia. While the expulsion bandage is still in place at the peripheral end, the lower Esmarch bandage No. 3 is applied in a similar fashion as bandage No. 2, and the expulsion bandage is entirely removed. The entire procedure is more easily accomplished, in fact, than described in words.

There are now two constricting bandages around the ischemic extremity. The principle of venous anesthesia consists in filling the segment between the two bandages with a novocain solution, by way of a skin vein, and in this manner to bring all the nerve terminals situated between the bandages in contact with the novocain solution, by the natural route of the vascular supply, constituting direct anesthesia. In the second place, all the nerve trunks passing though this region toward deeper parts of the limb are in the same way made incapable of conduction-indirect anesthesia. The space between the two bandages should not be narrower than about 10 cm. and not wider than about 25 cm. (1 to 3 hand's width). In the case of peripheral segments of limbs, direct anesthesia may be carried out under application of a single bandage, but this should never be placed higher than the middle of the forearm, or lower leg.

It is dangerous to select other veins for the injection than the well-known large subcutaneous veins, which should be looked
for according to their topographical relations. Often enough, a large blue vein will shimmer most temptingly through the skin at some other point, turning out to be nothing but a narrow membrane, when exposed under ischemia, which does not permit the introduction of the canula. Hence, the course of the skin veins should first be studied. The position of these vessels is usually described rather superficially, and often inaccurately, in the textbooks of anatomy. As a rule, the vein can be felt as a rolling strand under the skin by very gentle palpation; in fat and youthful individuals, the examiner must depend on his topographical knowledge. The large saphenous vein lies at the inner aspect of the thigh, far backward on the abductors, behind the sartorius muscle; at the knee joint, it should be sought for about a thumb's width behind the posterior margin of the femoral condyle; in the leg, the vein will be found lying upon the calf muscles at the mesial margin of the subcutaneous tibial surface; farther downward, it lies in front of the internal malleolus. The small saphenous vein enters more rarely into consideration. The basilic vein of the upper arm lies in the internal bicipital groove and is frequently concealed under the fascia after a short course. It is usually more serviceable than the cephalic vein which lies on the anterior external side of the upper arm, almost in the midst of the muscular ridge of the biceps.

The veins at the bend of the elbow and of the forearm take a variable course, and are usually visible under the skin. Only the middle ulnar vein, or the basilic vein of the forearm should be selected, avoiding all side branches. It should further be kept in mind that the basilic vein is accompanied by the middle cutaneous nerve of the forearm, and the large saphenous vein in the leg is accompanied by the saphenous nerve; these structures should be carefully preserved. In order to be sure to find the vein, it is advisable to study its course prior to the expulsion of the blood from the limb, marking the site for the injection of the needle by a needle prick, or similar device, or possibly by exposing the vein while it is still filled with blood.
Immediately below the upper Esmarch bandage, the transverse skin incision which is to serve for the exposure of the vein is rendered anesthetic for a distance of 2 to 3 cm. by the intra and subcutaneous injection of \( \frac{1}{2} \) per cent. novocain solution; the skin is then divided and is pulled forcibly apart with two sharp hooks by the assistant. As a rule, this causes the vein to appear, but in case it fails to present itself, it is necessary to go deeper into the layer of fat down to the fascia. This illustrates the superiority of the transverse incision which guards against missing the vein by passing on its side into the depth of the tissues. As soon as the vessel appears it is grasped with Deschamp's No. 1 and tied as high as possible at the central end. The sharp hooks are removed and the vein is lifted up by the ligature thread. The vessel is held with Deschamp's No. 2 under the peripheral end; the thread is left untied, and serves to raise the vein at the other end. The full syringe with the canula, stopcock closed, is lying near the limb ready for introduction. An oblique lateral incision is made with the pointed scissors, in the vein which is stretched out and flattened, until the lumen gapes; the lower corner of the gap is held with the small forceps and the canula is introduced deeply into the lumen, in a peripheral direction. The assistant ties the second thread, while the operator slowly withdraws the canula until the thread slips into the groove: the canula is thus held in place. The assistant holds the canula exactly in the direction of the vein, which is put on the stretch by the central thread; the operator opens the stopcock and slowly injects the fluid, sometimes under considerable pressure. In case some of the solution oozes out from small vessels in the wound which have been divided, these should at once be caught by clamps. If the injection is successful, the superficial veins of the segment will now be seen swelling up and becoming very prominent for a short time, after which the entire segment becomes still whiter in color than heretofore. Sometimes a valve is found to close and oppose a strong resistance against the flow, but this is soon overcome by continuous pressure, and the valve yields. The
quantity of the solution to be injected amounts to about 80 cc. for the leg, and about 50 cc. for the arm. A few c. cm. more than necessary should always be injected, in view of the loss incurred by escape of fluid from the wound. The stopcock is now closed, and the tube is removed from the canula, by means of the bayonet closure. The withdrawal of the canula, which is either done at this time, or postponed until the end of the operation, in view of possible further injections, is accomplished in such a way that a Deschamp's No. 3 is placed under the vein, peripherally from the canula, the vessel is tied, thread 2 is divided, and the canula is withdrawn. The wound is closed by sutures.
CHAPTER III

LOCAL ANESTHESIA IN THE PREVENTION OF AFTER-PAIN AND SHOCK

AFTER-PAIN.—After-pain is prevented by local anesthesia just as long as the anesthesia lasts. After the effect of the anesthesia has passed off the patient is conscious of the same sensations in the region of the wound as though no anesthesia had been used. The duration of control is therefore a question of the action of the drug employed.

The degree of after-pain is dependent upon the region operated upon and upon the manner in which the operation is done. The amount of complaint one hears from any given patient depends upon his sensitiveness to pain and upon his ability to give vocal expression to his sensations. The failure of correlation of these two factors makes judgment difficult in a given case or in a series of cases.

After-pain is dependent largely upon constriction of the nerve-bearing tissue by ligatures or sutures and only in a small measure by the actual division of tissues. The incision of the skin produces a burning pain which lasts a number of hours only, and is not intense, described usually as a burning, but ligation of painful masses is intense and lasts until the ligature begins to absorb or cut through the tissue or the constricted tissue begins to undergo an anemia necrosis. Those who have not had the opportunity of studying the effect of gentle and firm ligation upon themselves will hardly fully appreciate the truth of these statements.

If one fully appreciates the importance of care in technic as a factor in the avoidance of after-pain, operations under local anesthesia furnish him a good opportunity to study the relative sensitiveness of tissues. In his early efforts at producing local anesthesia his imperfect technic affords him abundant opportunity to learn which tissues are sensitive and which are not. This
information will be valuable after he has so perfected his technic that he no longer produces pain, for he then knows which tissues must be avoided in making ligations. Even then operations under the most perfect local anesthesia make it possible to study the effects of a technic on the production of after-pain much better than do operations under general anesthesia. The reason for this is that the patient operated upon under local anesthesia retains his general sensibilities and consciousness, and is able to give a good account of the beginning and degree of the after-pain, an estimate which the disturbed brain of the recently etherized patient is incapable of doing. Given a large number of individuals operated upon in the same way one gets a measure of comparison to a like number operated upon in a different manner for the same affection. The larger the number of patients operated the less the individual idiosyncrasies impress themselves. For instance, if a hundred patients are operated upon for hernia without giving attention to extreme delicacy in ligation and suture, and a like number of patients in which every attention is given to gentle technic, one gets a general impression of the importance of care in technic.

It is more difficult to determine the difference in after-pain when operating under ether because the reaction of the patient is so different. The patient as he awakens from the anesthetic has a disturbed sensibility, and his expressions of pain are more apt to be dependent upon his loquacity than upon his sensitiveness to pain. Again, he may be nauseated to such a degree that his time is so occupied with the emesis basin that the after-pain suffered is relegated to a secondary place in his memory.

It is, therefore, the student operating under local anesthesia who has the best opportunity to study after-pain in its purely physical relations. Far too little attention has been given to this problem. The enthusiast in his delight with having performed operations without pain is too apt to ignore or minimize what the patient has to endure after he returns to his bed. Yet this phase is quite as important as the performance of a painless operation.
The problem has become somewhat confused by surgeons because of the fact that most operators give a preliminary dose of morphine before beginning the operation under local anesthesia. The after-pain will then be modified by the morphine to a degree dependent upon the amount of the drug given and the patient's sensitiveness to it. For this reason patients operated upon under a general anesthetic will suffer more unless they too receive a like amount of morphine. When this point is kept in mind it will be observed that the degree of after-pain suffered after local anesthesia and after general is not very great. At any rate, patients who have undergone like operations, for instance, hernias or block dissections of the neck, once under general anesthesia and once under local, praise the latter because they escape the ether, after-pain being seldom mentioned.

The above remarks are based upon observations made with cocain and novocain and drugs of that class. Quinine and urea hydrochloride is the only drug available for local anesthesia which has a notable influence upon the control of after-pain. Properly used this drug is capable of a very decided amelioration of pain after operation. By the use of this drug it is possible to control the after-pain for some days. Unfortunately it requires a considerable experience with the use of this drug before these results can be secured with any degree of regularity. An injudicious use of the drug may fail to secure these results and after-pain may actually be increased or wound healing may be disturbed. The factors upon which the successful use of this drug depends can best be set forth in the specific operations in which it is indicated. This detail will be found in the succeeding chapters.

The foregoing remarks have to do with the summation of after-pain following an operation without any attempt to separate the pain produced by the mechanical acts of the operation and that due to the introduction of the foreign substance, the novocain-epinephrin or quinine solution. That the use of the local anesthetic is itself productive of after-pain has seldom been re-
ferred to in the literature, but that it adds something to the sum
total of after-pain must be evident to experienced experimental-
ists. The degree of after-pain the anesthetic produces is depen-
dent upon the anesthetic used, the method of its use, the amount
used and particularly upon the character of the tissue in which
it is used. Unfortunately there are great individual variations
which contribute to an inconstancy of results which seems to
defy analysis. The personality of the individual, the degree of
local reaction and the technic of operation enter here to confuse
the final analysis.

The after-pain which results from the use of the local anes-
thetic results in the first place from the injury produced by the
needle itself. If the needle is large and the tissues are sensi-
tive this will be considerable. About the fingers and toes par-
ticularly a sensitive area lasting several days is produced. The
chief factor, however, is the anesthetic solution itself. Cocain
leaves but little after-pain when used without epinephrin. No-
vocain when used alone is followed in 15 to 30 minutes by a
very distinct unpleasant tingling which amounts to actual pain
in the more sensitive regions. In many instances this is followed
by a very distinct hyperesthesia lasting for several hours. These
sensations, though delayed from one to three hours, are aug-
mented by the addition of epinephrin. This increase in after-
pain is due to the secondary dilatation of the vessels after the
constricting action of the epinephrin has disappeared. This
dilatation is accompanied by an actual exudation of serum aug-
mented sometimes by the escape of erythrocytes. The changes
are therefore parallel with a low degree of acute inflammation.
These conditions are restored to normal within a few hours.
They are, as one might expect, most severe where the tissues
are abundantly supplied by nerves and are dense. These con-
ditions are met by the anatomic structures of the fingers. The
lateral and palmar surfaces exhibit this to a greater degree
than the dorsal surface. The loose tissues about the front of
the neck and inner surface of the thigh exhibit it but little.
The local effect of quinine and urea hydrochloride presents a different variety of problems. The long duration of the anesthesia produced by the agent makes it possible for the reactive processes produced by the chemical irritation of the drug to run their course before sensation is restored. This is true only for the region in which there is a fibrin exudate produced by the drug and does not hold for the region made anesthetic but in which no infiltration has occurred.

The marginal hyperesthesia that often accompanies local anesthesia has been briefly referred to elsewhere but may be mentioned again at this place. If an area a cm. in diameter is anesthetized there will be a border beyond the area actually infiltrated which is more sensitive than the surrounding normal skin. The degree reached by this hyperesthesia is sometimes astonishingly great. It is most readily observed on one's own person, but may readily be recognized upon patients. For instance, a patient complaining of pain following a hernia operation will find relief if an irritating bandage is removed and will note a return of his pain if the region beyond the wound, say a cm. on either side, is gently irritated.

When novocain-epinephrin is used the area previously anesthetic becomes hyperesthetic when the effect of the drug has worn off. I am led to conclude from my studies that the sensation produced after the effect of the anesthetic has worn off is due to the reaction already referred to, namely, the vascular dilatation and serous exudate, and to some toxic after effect on the nerves. The evidence of this is found in the fact that the hyperesthesia extends beyond the area acted upon by the drug and in this area the sensation is one of simple hyperesthesia, while that in the area acted upon by the drug the sensation is a combination of superficial sensitiveness and deep soreness. The latter is accounted for by the reaction of the tissues to the epinephrin above mentioned.

With quinine the area upon which the drug acts does not become hypersensitive and the problem of after-pain concerns itself with the hyperesthetic border zone only.
The practical problem resolves itself into a question of simply avoiding irritation of the region anesthetized when the novocain-epinephrin is used and sparing the zone about the actual region of infiltration after the use of quinine. This resolves itself, in practice, in avoiding nerve-bearing tissues in making ligatures. This requires that vessels be isolated before ligation and that coaptation sutures be applied as loosely as is compatible with the proper closure of the wound. In the use of quinine for the control of after-pain the ligation suture must be applied in tissue actually infiltrated by the drug and not to tissues near that directly acted upon by the drug. Thus in the ligation of hemorrhoids the quinine must be introduced into the tissue at the actual site of ligation and not some distance beyond the point of operation. In the anesthetization of the peritoneum, if the after-pain is to be ameliorated, the infiltration must be made in the actual line of incision and suture. If the infiltration is made lateral to this line, after-pain will be increased.

The reader may, if he has had abundant clinical experience, believe he discovers paradoxes in the above statements. It is possible that the regional anastomosis of nerves plays a part. Waldeyer explained early restoration of sensation in peripheral regions when a nerve is severed by the supposition that a neighboring trunk takes up in part the innervation of the injured companion through anastomosing nerve plexuses not ordinarily functioning. In the same way it is possible that an area made anesthetic by blocking with quinine recovers sensation through these anastomoses before the original trunk which has been blocked recovers its function. It is only in this way that hyperesthesia can be explained in regions at one time anesthetic before the nerve has recovered from its block.

To the pain produced by the local action of the anesthetic we must add that due to the trauma of the operation. If the problem were one of simple addition we might represent the sum total of the after-pain present by x, which would be as the sum of a, the pain produced by the anesthetic, and b, the pain pro-
duced by the operation. We would then have the following equation, \( a + b = x \). Self-experimentation and careful clinical observation leads to the conclusion that under some conditions the after-pain is greater than the simple sum of \( a \) and \( b \). Then the formula would read, \( a + b = x^n \), the power of \( x \) representing in itself an unknown quantity.

This latter point can be illustrated by comparing operations done by trunk blocking and those done by local infiltration. A familiar example is seen in amputations of the fingers. An amputation done by regional infiltration may be followed by more pain than one done under general anesthesia or by nerve trunk blocking, and is greater than the pain produced by infiltrations made in these regions which are made experimentally for the purpose of determining the amount of pain produced by the operation and are not followed by an operative procedure. In many of these cases, therefore, it would seem that the infiltration, when followed by operation, results in pain greater than both of these factors combined. This may be explained by the fact that the epinephrin, when its effects have worn off, leaves the vessel walls in a state capable of responding more readily to the reactive processes in the healing wound. This excessive reaction may be avoided by securing the anesthesia by infiltrating the nerve at some distance from the field of injury, thus avoiding the local effects of the epinephrin in the field of operation. As an example may be cited the familiar operation of the amputation of a digital distal phalanx. If the nerves be blocked in the region of the metacarpo-phalangeal joint, instead of infiltrating directly the region to be operated on, the after-pain will be less. As a fundamental principle, therefore, it is desirable to block the nerves supplying the part at some distance from the field of operation rather than to inject the actual site of therapeutic attack. The foregoing remarks apply with double force when areas already the site of inflammatory reaction are to be attacked.

On the other hand, if the pain following operation is of but
short duration, the local anesthetic may outlast the after-pain. The smarting pain from a simple skin incision lasts only a few hours and the novocain lasting two hours reduces the total pain by so much.

But if ligations or tight suturing is necessary the after-pain lasts much longer than the anesthetic effect of the novocain-epinephrin and the local anesthetic may actually add an element to the sum total of after-pain. Before attempting to control after-pain by means of local anesthesia, one should consider the problems in all possible phases. On the whole by avoiding those factors which are known to produce after-pain the operator will accomplish more than by instituting means to prevent it.

Fortunately structures that are sensitive do not require ligatures or firm sutures and those that do require ligation and firm sutures do not have nerves. For instance, in the closure of an abdominal wound the peritoneum should be very gently coapted with fine sutures. The fascia, if the nerve-bearing fat be pushed back, is without nerves and may be firmly sutured without the production of after-pain. The skin is the structure most prolific of after-pain and the gentlest means possible of holding it in apposition should be used.

SHOCK.—Enthusiasts are apt to declare that in painless operations under local anesthesia there is no shock. If the profound depressed states observed after severe injuries or prolonged unskillfully performed operations under a general anesthetic are in mind, this opinion may be accepted. Nevertheless states of exhaustion do follow operations properly done under local anesthesia. There is no rapid pulse or perspiration, to be sure, but the patient lies flat in bed without any considerable interest in his environment and is apt to express great satisfaction that the operation has been completed. These states may be exemplified by examples. One patient operated upon for a large umbilical hernia climbed off the table, walked to her room and climbed in bed. Some hours later she was found reading the morning paper, which occupation she interrupted long enough to berate
herself for having so long endured her affliction. Another woman of the same age and physical make-up was operated on for a large goiter. She climbed off the table unassisted and remarked to her husband that the operation was altogether painless. As she walked out of the room she inquired if it would be necessary to go to bed. I assured her she could go anywhere she pleased. I was quite sure where I would find her in a few hours. She was in bed quite flattened out, looked exhausted and expressed satisfaction that the operation was completed. Neither pulse nor blood pressure were affected. She did not sit up again until the afternoon of the following day.

Still a more pronounced degree of depression is illustrated in the following: a block dissection of the neck was done, removing the jugular veins, external carotid and the pneumogastric nerve together with all the muscles of the antero-lateral quadrant of the neck. He at no time admitted pain. As the operation approached the base of the skull it was evident that his general body muscular tonus was relaxing, a state best described as flattening out. When asked if he was being hurt, he assured me that he was not, but came back with the inquiry as to how soon the operation would be completed. This patient was quite willing to ride back to his bed on the cart and lay heavily upon his pillows for the remainder of the day, and expressed no desire to sit up until the fourth day. His pulse was fuller and more bounding after the operation and was increased in rate some ten beats.

The problem is to so operate that the two patients last mentioned shall experience no more depression than the first one detailed. There is but little that can be offered at present which will enable one always to achieve the desired result. The extent of the operation, its location, the patient's general condition, his mental attitude and general nervous state, and lastly, the drug employed are all matters of importance.

The extent of the operation naturally enhances the importance of all the other factors and therefore is difficult to consider as a separate factor. Generally speaking this seems to be the least
important factor, for, if the other factors can be controlled, the amount of tissue involved seems to make but little difference.

The location of the operation is of greater importance. The neck is more vulnerable than the inguinal and perineal and anal regions, though less difficult to operate upon painlessly. The more important structures involved furnishes an adequate explanation. The depressing influences can be avoided only by preserving as much as possible the more important structures. Thus, one may think twice before ligating the external carotid or cutting the pneumogastric nerve. The bloodless field secured by the local anesthesia often makes preservation of important structures possible, when they would be sacrificed if operating under general anesthesia.

The mental attitude of the patient is of the greatest importance and is the factor most capable of amelioration. Nervous patients show the depression more readily than those who are composed. This applies less to the neurotic than to the apprehensive. The neurotic may be calmed with bromides and the preliminary hypnotic, and sometimes by judicious advice to quit her foolishness. Those possessed by real fear can be best reassured by talking with a patient who has undergone a similar operation. A judicious mingling of the convalescent with the candidate usually secures the results. Of course, this contact must be apparently unpremeditated, but one need not worry about the results; the convalescent will bring the candidate to a proper state of mind. Sometimes a brief explanation of the details of the operation on the part of the surgeon produces the desired results. A quiet, expeditious personnel in the operating room is of great importance. The talking should be left to the surgeon, and if he is experienced he will confine his remarks to an occasional inquiry as to the comfort of the patient. His armamentarium will be confined to such instruments as he actually needs. If the patient notes that but a few instruments have been prepared she is very apt to conclude that she had an exaggerated notion of the gravity of her operation.
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Those afflicted with grave constitutional diseases feel the depressing influence of operation under local anesthesia as well as under general. Those in the last stages of malignant disease are particularly likely to feel the depressing effect of the operation and but little can be done to ameliorate the condition. Diabetics too are apt to be easily depressed. Codein given regularly for a week before the operation is of the utmost importance in conjunction, of course, with the usual diatetic treatment.

The drug employed is a matter of much moment and is perhaps the most potent factor. Novocain often produces a slight depression before the operation is begun, which, however, is quickly recovered from. I have never seen even mildly alarming symptoms, nor have I noted such in the literature. Nevertheless, this slight depression caused by novocain is suggestive to those who have had experience with cocain. I have never used the large doses employed by some. My plan is to use novocain in loose tissues where hemostasis is important and employ quinine for the remainder of the operation. By following this plan I rarely find it necessary to use more than five grains of novocain for any operation. However, a number of operators have used as much as fifteen grains without serious results.

Local anesthesia has a limited use in preventing after-pain when used in conjunction with general anesthetics. In operations about particularly painful areas, quinine infiltration very materially lessens after-pain. Ford Rogers first proposed the use of quinine for the control of after-pain in hemorrhoids when this operation is performed as a terminal act in more extensive operations done under general anesthesia. Used in this manner the method is very useful. The same applies to any painful area where quinine can be used. I employ it regularly when the cautery is applied. When large nerves are to be severed as in amputations, it is worth while to inject the main nerves with quinine.

In the control of shock when general anesthesia is used, local anesthesia has a limited application. The chief shocking agent
in major operations unquestionably is ether. Recent investigations by Sweet and Corbett indicate that possibly the reduction of the epinephrin content caused by ether may be the cause of it.

Whenever it is possible to block efferent impulses, it is well to do so as in major amputations. Whether it is the action of a large nerve or nerves, or the loss of so large a part of the body that makes these operations serious, is not known. Statistics capable of making a conclusion possible are not available.

That shock is the result of the action of painful impulses upon the brain, has not been proven. Certain changes in the brain cells have been noted in association with shock, it is true, but like changes follow fatigue and even normal exercises of function without fatigue. Most of these studies have been concerned with Purkinje's cells in the cerebellum. We do not know what areas of the brain are concerned with the reception of painful impressions, but most likely the cerebellum does not perform this function.

Even if we grant this hypothesis that the organic changes observed in the brain cells, as studied by Dolly and others do occur, and that we could prevent these changes by blocking the transmission of painful impulses by means of local anesthesia, we would be as yet unable to meet the indications. Shocking impulses do not arise from the skin, but from the structures lying deeper. In abdominal operations it is the adherent masses from inflammation or new growths that are the most likely to produce shock. Theoretically these impulses could be blocked by reaching the rami communicantes. Practically, however, blocking of these regions consume too much time and is too uncertain in its results to be of much value.

If local and general anesthesia are to be combined, it is best to go as far as expedient with local anesthesia and then employ general through the more painful part of the operation. This method must be used with very fine judgment lest more harm than good result. The operation under local must not be continued until the patient has become excited from pain. If this
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state is reached the amount of ether required is likely to be greater than if general anesthesia has been used from the beginning.

If the painful stage of the operation is very short, just a little ether may be given and the operation may be completed under the local anesthetic. If the patient has been completely anesthetized, he is apt to be unruly as he wakens and thus hamper the manipulations of the operator. Unless there is a direct contraindication against ether in operations too great to be performed under local anesthesia alone, the entire operation had best be done under the general anesthetic.

Where a general anesthetic must be combined with local, gas is a much more valuable agent than is ether. This combination is desirable in abdominal operations. If the abdominal wall is well infiltrated there will be satisfactory relaxation of the muscles when the patient is under gas. The painful part of the operation may be performed under gas, and when this is completed the patient is allowed to awaken and the operation then completed with local. Patients awaken quickly from gas and are amenable to reason at once, and are not dazed and unruly as they are after ether has been given.

As generally employed in conjunction with ether, local anesthetics are improperly used and are incapable of producing local anesthesia. In fact the hurried injection of the solution, often with big needles, is calculated to increase rather than limit the afferent impulses. If the anesthetics are to be combined, the local anesthetic should be used with the same care as if the operation were to be done under local anesthesia alone. Unless this is done the whole procedure is a sham and a pretense.

Clinical experience teaches that in ether itself often is found the most potent agent in the production of shock. Any means that will lessen the use of this anesthetic will lessen depression following operations. For this reason local anesthesia and gas in conjunction or in sequence, will make operations more safe.

On the whole the combination of local and general anesthesia
is not productive of much good. A careful use of a general anesthetic, with the expeditious completion of the operation, will produce less harm than the delay incident to the use of the local anesthetic in conjunction with the general, in so far as the prevention of shock is concerned.
CHAPTER IV

GENERAL OPERATIONS

THE OPENING OF ABScesses.—Localized abscesses are easily anesthetised by freezing the surface or by injection of one of the more easily diffusible anesthetics, such as novocain. If the abscess is "ripe" the stage of hypersensitiveness has passed and a line may be infiltrated over its summit by beginning at the border in or near the normal skin. In more acutely inflamed areas it is best to infiltrate, first, the normal skin about the base and then the summit. If the abscess is on an extremity, the nerves supplying the part may be blocked in their course. For instance, in case of a felon the nerve supplying the digit may be blocked at some distance from the infected area. Novocain acts more readily, but quinine may be used. The latter has the advantage of saving the after-pain. The skin over a deep-seated abscess may be entirely unaffected, and can be anesthetized as usual. Thus, in case of renal or appendiceal abscess the parietes are infiltrated as for any other operation.

It is difficult to anesthetize inflamed tissue because the exudate interferes with free diffusion of the solution. On account of the extreme sensitiveness of such tissue both to pressure and to puncture, one should begin the injection in the unaffected skin. If the diseased part is so large that this is not practicable, the case is not one for local anesthesia. When the incision indicated can be quickly and surely made, nitrous oxide is sufficient but if it is extensive and the extent of the operation cannot with certainty be foreseen, ether will probably be the best anesthetic. Venous anesthesia in the region of inflammation can hardly be regarded as other than a measure of necessity to be resorted to only in the face of distinct contraindications to general anesthesia. For such cases nitrous-oxid-oxygen is the anesthetic of choice.

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Not only are there great technical difficulties to be overcome in treating suppurative processes, but the problem is complicated by the disposition of the patient. Patients with chronic pus infections are peevish and bear pain poorly. Such difficulties may render a general anesthetic greatly to be desired even in the hands of operators who are experienced in the use of local anesthesia.

The Removal of Tumors.—The removal of benign tumors usually furnishes the first lesson for the student of local anesthesia. The encapsulated tumor demands little more than a linear skin injection, perhaps with infiltration about the base. Adherent or diffuse malignant tumors are the final task for the master in the use of local anesthesia. An operator's qualification for the surgery of such tumors under local anesthesia, is an accurate estimate of his own skill. It is only when he is satisfied that his ability is equal to any demand, is he warranted in undertaking the operation of a malignant tumor under local anesthesia. Yet, when this condition is fulfilled, the surgeon may undertake under local anesthesia by election many major operations for the removal of tumors, and almost any tumor operation may be

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Fig. 11. Showing the line of infiltration over the summit of a wen.
performed, in the face of grave contraindications to ether, by this method. The general problems involved can be presented best in the discussion of specific tumors.

![Fig. 12. Showing method of edematization of the base of a tumor.](image)

**CIRCUMSCRIBED BENIGN TUMORS.**—Small subcutaneous lipomas, wens and similar tumors may be removed after infiltrating a line over the summit (Fig. 11), with additional infiltration beneath the base (Fig. 12). In larger tumors it is well to circumscribe an ellipse about the base (Fig. 13), and also to inject solution be-
neath them (Fig. 12). They can then be readily shelled out and the redundant skin can be used to cover the defect.

Infiltrating Localized Tumors.—In some varieties of tumors the skin may be involved, but the process is yet localized, and requires local excision only. Among these may be mentioned papillomas, nevi, endotheliomas and some slowly growing sarcomas. To remove these the skin surrounding the tumor and the deeper tissues are infiltrated, and the entire growth excised. The elliptical defect in the skin can be closed by sutures or by skin grafting.

In such operations quinine or novocain-epinephrin may be used with equal satisfaction.

Metastasizing Tumors.—Tumors predisposed to regional metastasis force additional obligations upon the operator. The removal of the tumor itself is the minor part of the operation. The chief problem is the removal of the regional lymph glands. Unfortunately many operators practice local removal of known malignant growths and thus invite recurrences in the adjacent lymph glands.

In all operations for malignant growths the technic when operating under local anesthesia should be identical with that employed when operating under general anesthesia. The lymphatics should be removed first, and the primary growth afterward at a second operation if necessary. If the local growth is removed first and the operator finds himself unable to complete the operation, the patient being relieved of the primary growth almost always fails to return for the removal of the neighboring lymph nodes. In case of cancer of the lip, if the operator dissects out the neck first the patient will submit to a subsequent removal of the tumor on the lip, but if the lip tumor is removed first he will not return for a dissection of the neck until too late.

Operations for malignant tumors resolve themselves, therefore, into the technic of lymph gland dissection, and if the surgeon is not equal to this difficult procedure he should not attempt to operate metastasizing tumors.
Inasmuch as operations for malignant disease require a different technic for each region involved, they can be considered best in discussing the operative surgery of the various parts.

**THE SEARCH FOR FOREIGN BODIES.**—Many a beginner has failed to find fragments of needles under local anesthesia. The trouble is not with the anesthetic, but because of difficulty in the search. No special directions are needed for the production of anesthesia, any of the usual agents being efficient. The common error is to underestimate the length of the incision required. A preliminary x-ray plate is useful to indicate the extent of infiltration required, as well as to aid in the subsequent search for the foreign body. Sometimes after the parts have been anesthetized the wire mandrin which accompanies some of the larger hypodermic needles may be made to follow the channel traversed by the foreign body. Sometimes, too, in making the injection the needle comes in contact with the foreign body and thus aids in finding it after the incision is made.

**SKIN GRAFTING.**—Local anesthesia can be used effectively in the preparation of the bed as well as in anesthetizing the part from which the graft is to be taken. Grafts may, of course, be placed upon fresh surfaces without previous preparation. If the wound is covered by recent granulations the surface may be curetted or better still cut off on the flat with a knife after anesthetizing the surface by compresses soaked in quinine or cocain. If granulations are not over four weeks old and free from incrustations, exudates and notable infections, grafts may be placed upon them without previous preparation.

The region from which the skin is to be removed is best anesthetized by infiltrating a horseshoe line with the open end of the shoe pointing toward the distal end of the extremity. The infiltration should be made not only endernically but also subcutaneously, in order to block off the nerves. Sometimes I have failed to secure anesthesia promptly in this way. I have then resorted to subdermic infiltration of the entire region from which the graft is to be taken. It should be emphasized that the injec-
tion should be made into the subdermic tissue and not into the skin itself. If the latter is done, the healing of the graft will be materially interfered with. After anesthesia is secured the operation proceeds in the usual manner. In this way grafting can be done with the least inconvenience, and the operator is often encouraged to graft small areas not large enough to justify the use of a general anesthetic. It is easily carried out without any assistance, and should, therefore, commend itself to the general practitioner.
CHAPTER V

OPERATIONS ON THE CRANIUM

The cranium offers a particularly favorable field for operations under local anesthesia, because of the constant location and accessibility of the nerves supplying the scalp. This method is practicable for all operations in this region and for certain conditions it is mandatory. It is especially satisfactory for the excision of the numerous tumors which involve the soft parts, and for the treatment of injuries of the soft parts which require trimming and preparation. Injuries of the bone may be conveniently treated whether they require the elevator or the trephine. Vigorous use of the chisel and mallet is not well borne because of the unpleasant jarring, particularly if the patient is suffering or has previously suffered from headache. In severe accidents in which the cranium is injured, together with the mouth, pharynx, throat or diaphragm, the use of local anesthesia for the management of the cranial injury is important because of the great danger from pneumonia after any form of inhalation anesthesia. The method is particularly desirable if the head injury is accompanied by shock due to injury of other parts, such as crushing of the extremities.

For deliberate operations for cranial and intra-cranial disease local anesthesia is an optional method, but is not to be advised if the mentality of the patient has suffered because of the disease, as in post-traumatic epilepsy with associated mental weakness, or if the patient has been a sufferer from severe headaches due to increased tension from tumors. It is particularly likely to succeed in exploratory operations for tumors where local motor symptoms are the chief guiding sign or where decompression is demanded because of developing choked disk.

OPERATIONS UPON THE CRANIAL SOFT PARTS.—When extensive operations are to be done upon the cranial soft parts it is conve-
twigs from other than the typical nerve may necessitate infiltration of the skin. The operator should distinguish between the sensation caused by these twigs and pain from inadequate blocking of the principal nerves. When anesthesia has been secured the operation may proceed as under general anesthesia. In small wounds of the scalp it is often more convenient to pass the needle from the cut edges of the scalp when making the infiltration. The danger of carrying infection into the deeper parts by so doing is theoretical speculation. In a neglected wound less pain will be caused by infiltrating an ellipse about it than by entering the skin from the injured edges as recommended for fresh wounds.

THE REMOVAL OF TUMORS.—PAPILLOMAS.—This term may be made to cover those tumors which are a part of the skin and project from it. They can be removed through the entire depth of the skin by infiltrating an ellipse about the base and injecting a few drops beneath. If the operation be in a very vascular area such as the scalp, the bleeding from the base or the edge of skin is often profuse. A deep suture, preferably figure-of-8, usually controls the hemorrhage, this being the only operation for tumors in which it is permissible to make a coaptation suture serve for hemostasis as well. If quinine is used as the anesthetic the placing of sutures thus tightly is not followed by after-pain as is the case if novocain is used. With the papillomas may be classed the melanomas which are usually somewhat elevated. In removing them a wide margin of skin should be included and in injecting the base the needle should be passed well beneath the tumor and not into it. Other small endermic tumors may be removed in a like manner.

WENS.—Atheromatous cysts are common upon the scalp. They are sacculated sebaceous glands and are free from the skin except at their summit. When small they may be exposed by an incision over the apex and the sac then removed. Larger wens should be circumscribed by an elliptical incision about the base. In the first instance the skin is infiltrated over the summit
and from the ends of this line injections are made beneath the tumor. In large growths an ellipse is injected surrounding the tumor and all tissue contiguous to and beneath the tumor is abundantly infiltrated. This infiltration loosens the tumor from its surroundings and facilitates its removal. After hemostasis the skin is closed by sutures.

**DERMOIDS.**—Dermoids are found about the great fontanelle and in the temporal and mastoid regions. The skin is free but the tumors are often intimately associated with the periosteum, so that the latter structure requires careful infiltration, which may be accomplished by passing the needle immediately over the bone. A straight incision over the summit or an elliptical incision as in wens, may be employed. It is easy to deflect the skin from the tumor, but an elevator may be necessary in order to elevate the base of the sac from the bone upon which it lies.

**ENDOTHELIOMA AND BENIGN CYSTIC EPITHELIOMA.**—These tumors project from the surface of the scalp and do not tend to infiltrate the depth. Infiltration about the base and between the base and the bone renders their removal easy. The bare surface of the skull which is left may require a preliminary drilling of the outer table. Usually fairly thick Thiersch's grafts are successful in filling in the defect, particularly if the scalp incision is made on the bevel and the Thiersch graft is allowed to extend over the surface (Figs. 15 and 16). The difficulty arises in keeping the scalp from pulling from under the graft. Adhesive strips over vaseline smeared gauze usually solve the problem.

**CARCINOMA.**—Malignant epithelial growths are often of a slow development and involve large surfaces of the scalp. They remain free from the bone for a long time and form metastases late. Such growths are satisfactorily removed under local anesthesia. If necessary the surface of the bone may be removed with a chisel. Skin grafting may be undertaken at once if the surface is favorable or the formation of granulations may be awaited either with or without multiple drilling of the outer table as the case demands.
ANGIOMA.—Blood vessel tumors frequently occur upon the scalp and offer ideal objects for operation under local anesthesia because of the vascular constriction which can be secured by epinephrin. These tumors are usually either venous cavernomas or mixed venous and arterial tumors. The most frequent site is on the forehead. The best procedure for their removal is as follows: one infiltrates a line 1 cm. about the base of the tumor and makes an incision down to the bone three-fifths of the circumference of the tumor on the side where the scar will show least. After hemorrhage is controlled the tumor together with

Fig. 15. Incision about a hemangioma. The beveled incision furnishes a broad surface for the Thiersch graft.

the skin covering it is lifted from the skull, using the two-fifths of the circumference not incised as a hinge. The uncut vessels are now ligated beneath the hinge. The tumor may now be dissected from the overlying skin and the flap so remaining is returned to place and sutured. Large tumors may be treated by multiple preliminary ligation with subsequent excision.

Fig. 16. The tumor shown in the preceding figure has been removed and a graft has been placed.
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OPERATIONS ON THE SKULL.—INJURIES.—The region of a fracture of the skull is circumscribed by a line of infiltration from which the surrounding soft parts are injected. In order to decompress, if an opening large enough is already present the loose pieces can be pried up by an elevator without further preliminary manipulations. If there is no such opening a trephine opening is made through uninjured bone as close as possible to the line of fracture. From this opening the bone is snipped with a Dahlgren forceps until the dislocated fragments can be elevated. Before the bone is elevated it is worth while to tell the patient that it is going to "pop"; this prepares him for the sensation of lifting experienced in the brain when the fragment is raised. The subsequent treatment follows accepted principles.

EXPLORATION OPERATIONS.—In the desired region, usually over the motor area, a horseshoe-shaped figure is infiltrated one cm. beyond the line in which it is proposed to sever the bone. It is well to infiltrate the skin directly and likewise to edematize the tissue between the bone and scalp. From this line injections are made beyond the line of infiltration, beneath the flap and beyond its base (Fig. 17). An incision is now made down to the skull in the line infiltrated. The scalp is elevated toward the center of the flap and slightly beyond the outer border of the infiltration line. Trephine openings are made at two points at the upper margin of the flap in the classical way. Before the buttons loosened by the trephine are elevated the patient should be told that he will hear a popping noise. An intelligent automobile engineer upon whom I operated compared this noise with the back-firing of an engine, but did not complain of any pain. The two trephine openings are united with a Gigli saw in the usual manner. The passage of the protecting director is painless and requires no anesthesia after the skull is opened. The patient before mentioned felt no pain from the use of the saw, but felt the sensation of heat when the saw became warm from friction, and was able to tell me when it was time to cool the saw. He was able, therefore, to differentiate between the heat and pain sense.
The lateral limbs of the flap are made in the usual way with a Dahlgren forceps. A large powerful instrument should be used in order that the bone may be cut without imparting movements to the patient's head. The base of the bone is broken in the usual manner, the patient being warned that there will be a loud pop-

Fig. 17. Primary infiltration line with secondary subdermal lines for the typical cranial flap operation.

ping noise when the flap is raised. The patient above quoted compared the noise to the bursting of an automobile tire. The flap being raised the operation may proceed in the usual manner. The meninges and brain are quite insensitive. This is equally true if quinine or novocain has been used as the anesthetic for the soft parts. My experience with quinine makes me feel cer-
tain that the meninges and the brain are insensitive because when the skull is opened by endermic and subdermic infiltration there is no sensation of pain. The argument that these structures are made painless by the diffusion of the anesthetic is untenable when quinine is used.

DECOMPRESSION OPERATIONS.—The general procedure for both occipital and temporal decompression operations is the same as the preceding. The small bites from a powerful Dahlgren imparts less unpleasant movements to the head than the usual rongeur forceps, and for that reason the former is preferable. Patients who require decompression because of headaches do not bear local anesthesia well. Even if not suffering from headache at the time of operation they complain that the sawing of the trephine causes a pain distributed over the entire head.

OPERATIONS UPON THE CRANIAL CONTENTS.—When lesions within the brain are to be dealt with it is probably prudent to do a two-stage operation because of the changes in intracranial pressure likely to be produced. Dural cysts and blood clots can be removed and even ventricular puncture can be made without ill effect at the time of the primary operation; but so far as I know no one has attempted the removal of a tumor at the primary operation when working under local anesthesia. Cushing has shown that this can be painlessly done at a second sitting.
CHAPTER VI

Operations on the Face and Jaws

The most frequent operations about the face and jaws are those required for malignant disease. Nowhere in the body do tumors bearing the same name present such different degrees of malignancy. Carcinoma of the face, for instance, scarcely is malignant, while carcinoma of the lip is exceedingly so, and sarcoma of the jaw (epulis) is of low malignancy, while the periosteal osteo-sarcoma is malignant in the highest degree. Because of this local anesthesia has done much mischief in malignant tumors of the face by giving to the inexperienced a means of tinkering with grave diseases which would be beyond his field if general anesthesia was required. This is particularly true of carcinoma of the lip and tongue. The novice finds their removal easy under local anesthesia, but leaves the glands undisturbed.

However, the fault is with the individual operator and not with the method. Any operation about the face may be properly done under local anesthesia, but it is necessary to individualize. The life tendency of a tumor must be predicted and the operation planned accordingly.

Local anesthesia has the advantage of enabling one to secure consent to earlier operation, permits more readily two-stage operations, makes dissection less bloody and frees the region of the operation from the presence of the anesthetist and in a large measure prevents deglutition pneumonia. That the advantages are real is attested to by the fact that operators who have once familiarized themselves with the technic do not abandon the method for general anesthesia.

Operations upon the Orbit.—Operations upon the orbital soft parts can be done under regional infiltration. Novocain should always be used. If the operation is to be extensive the
respective nerves may, as a preliminary, be blocked within the orbit, according to the methods to be described (p. 107). All tumors, including those of the bones, can be satisfactorily removed in this way. The operation of enucleation requires an additional injection into the muscle sheaths. Lowenstein (Klin. Monatbl, f. Augen heilk, 1908, XLVI, 592), introduces the needle at the external border of the orbit, passes between the capsule and the eyeball and attempts to strike the optic nerve when the needle has reached a depth of 4½ cm. Sidel (Klin. Monatbl, f. Augenheilk., 1911, XLIX), edematizes the sub-junctival tissue at four points, injects the tissue behind the eye and deposits 1 cc. of the solution deeply in the retrobulbar space.

For operations upon the frontal sinus the skin and periosteum must be infiltrated at the site of the proposed incision, which

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Fig. 18. Nerve supply of upper jaw, palatal surface (Modified from Toldt)
depends upon the precise operation intended. If Killian's operation is to be done, the infiltration can be made along the lower border of the ciliary ridge and down the lateral border of the nose. This, together with the blocking of the ciliary and supraorbital nerves and the use of cocain or quinine tampons within the nose, enables the operator to proceed painlessly.

Fig. 19. Nerve supply of the upper jaw, external surface. (Modified from Toldt).

Rhinoplastic operations of the soft parts can be done with local infiltration, but when the bones at the upper portion are to be dealt with, one must block the ciliary and supraorbital nerves and anesthetize the nasal membrane by means of tampons.

**Neural Anatomy of the Face and Jaws.**—Sensory impressions from the face and jaws are carried by the two lower
branches of the fifth cranial nerve and by branches of the auricularis magnus.

The upper jaw.—The upper jaw is supplied by the second branch of the fifth nerve. After its course from the gasserian ganglion into the pterygo-palatine fossa, it gives off the sphenopalatine and the superior alveolar branches and passes through the infraorbital canal and foramen as the infraorbital nerve.

The sphenopalatine branch traverses the palatine canal. One portion escapes to supply the mucous membrane of the palate (Fig. 18). Another portion continuing along the floor passes through the foramen incisivum to supply the mucous membrane of the anterior portion of the hard palate and gums.

The superior alveolar branches are given off from the infraorbital nerve posterior to and within the canal. They traverse the superior maxilla and supply the teeth of the upper jaw after freely anastomosing with one another (Fig. 19).

The infraorbital divides into branches which supply the skin of the face, the buccal mucous membrane, the floor of the nose and the incisor and canine teeth.

The lower jaw.—(Fig. 20). The lower jaw is supplied by the third branch of the fifth nerve. Originating in the gasserian ganglion, it escapes from the cranial cavity through the foramen ovale and divides into a motor portion supplying the muscles of mastication, and a sensory portion, which is of interest in this connection, divides into the auriculo-temporal, the lingual and the inferior alveolar branches, the last of which supplies the lower jaw. It descends in front of the internal pterygoid muscle to enter the mandibular canal, which it traverses, giving off branches which supply the gums and lip. The mucous membrane on the lingual surface receives a branch from the lingual nerve.

Operations on the soft parts of the face.—Because of the multiplicity of origin of the nerve supply to this region infiltration of the soft parts about the lesion is necessary. This may be supplemented by blocking the infraorbital nerve at the foramen if the operation is extensive.
OPERATIONS UPON THE UPPER JAW.—EXTRACTION OF TEETH.—
In the extraction of teeth pain is caused when the tooth is torn from the gum, when the root is separated from the periosteum and when the root nerve is ruptured. Pain from the gums is readily controlled by submucous injection with either quinine or novocain-epinephrin. Pain from the initial prick of the needle may be prevented by the application of cocain or of the carbol-
menthol-cocain mixture of Bovain. With or without one of these preliminary measures the needle is thrust obliquely into the gum, at a point over the alveolar border of the bone (Fig. 21) and not at the free edge of the gum. In this way one may anesthetize by diffusion the free edge of the gum which comes in contact with the instrument and may also reach more readily the periosteum about the roots of the teeth.

A special syringe is advised for the purpose, since the pressure required is greater than can be secured with an ordinary instrument. The needle is introduced just beneath the mucous membrane and a few drops of the fluid are injected. The needle should be passed so that the beveled edge of the point faces toward the bone (Fig. 22). The needle is then made to penetrate the periosteum and the solution is deposited under pressure. Some writers recommend that the fluid be deposited upon the periosteum and allowed to reach the nerve by diffusion. There can be no question, however, but that subperiosteal infiltration gives more prompt and certain results. The needle should be introduced where the bone is smooth so that it may pass readily between the bone and the periosteum.

The technic must vary somewhat with the region operated upon because of the differing thickness of the bone and the corresponding variation of time required for the fluid to reach the nerves. For instance, the thin plate of the upper jaw permits diffusion through it, blocking the nerves where they enter the roots, while in the lower jaw the thickness of the bone is such that the nerve can be reached only before it reaches the lingula or at the roots of the teeth by diffusion of fluid injected about the necks of the teeth.

In addition to local infiltration nerve blocking may be resorted to, particularly when a number of teeth are to be operated on at one time. The posterior superior alveolar and the infraorbital nerves are accessible for blocking. These nerves enter the alveolar process and supply the three molars. They are blocked by introducing the needle at the fold of the buccal and alveolar mu-
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cous membrane above the second molar and passing it along the bone for about an inch. One or two cubic centimeters of fluid should be deposited here. In addition to this, Fischer recommends a submucous injection in front of the first molar and likewise an injection over the posterior palatine foramen. This should anesthetize all the upper molar teeth.

The anterior superior alveolar nerves are given off from the infraorbital just before it escapes from the canal. In order to block them the fluid should be deposited at the foramen, which is usually ¼ inch from the orbital border over the first premolar. The needle is entered at the point where the mucous membrane of the lip curves to the gingival surface. By raising the lip the needle can be made to approach the foramen at an angle. One cubic centimeter of fluid is deposited under as much pressure as possible. The nerves at the incisive foramen must also be injected. If the operation is to approach the median line the nerves of the opposite side should be injected in a like manner. Instead of injecting the infraorbital foramen from the buccal surface it may be reached more directly by penetrating the skin directly over the foramen and introducing the needle ¼ inch into the canal. By this means the nerves are more certainly reached. The injury to the skin made by the needle is negligible.

The anesthetics of choice for this region are novocain-epinephrin and quinine; the former for extraction of teeth, the latter for operations of magnitude, such as the resection of the alveolar process.

TUMORS OF THE ALVEOLAR PROCESS.—For the removal of small tumors, such as granulomas or epulides, local infiltration is sufficient. If the tumors are larger or within the alveolar process, blocking of the second branch at the foramen rotundum, according to methods already described, is necessary. In this case one must block the nerves in the pterygopalatine fossa and infiltrate beneath the mucosa along the anterior surface of the upper jaw. Such submucous infiltration may be sufficient in itself if time enough be allowed, but in this case the mucous membrane of
the antrum may remain sensitive. One may then inject directly into the antrum through the inferior nasal fossa. This will not be effective if the antrum is infected. The usual instruments employed for such operations may be used. A biting forceps is preferable to a chisel.

Fig. 23. Line of skin infiltration in resection of the upper jaw.

INFECTIONS OF THE ANTRUM.—The external surface may be anesthetized by infiltrating fully between mucosa and bone and in the nose by local application of quinine or cocain. The mucosa lining of the antrum still remains sensitive to a degree depending upon the nature of the pathological process. Usually the diffusion through the bone is sufficient to make this pain
negligible. Any of the standard operations may be carried out with satisfaction.

**RESECTION OF THE JAW.**—For this operation blocking at the foramen rotundum or the Gasserian ganglion itself is desirable. If the nerve is blocked within the foramen rotundum complete anesthesia is secured. If perinural blocking through the orbit is depended upon the sphenopalatine had better be blocked within the sphenopalatine fossa because of the uncertainty of reaching these nerves when perineural infiltration of the trunk of the second branch is depended upon. In addition, the skin must be infiltrated along the line of incision (Fig. 23). Because of the free anastomosis with the nerves of the opposite side, the palatine nerves of the opposite side must be infiltrated.

**OPERATIONS UPON THE LOWER JAW.**—Any of the standard operations may be done. With care and experience these operations become astonishingly simple. Before attempting excisions of the jaw, I hesitated lest the mental effect of the removal of the jaw would prove a source of shock. This anticipation was not fulfilled. Patients bear the saw without complaint and speak as calmly with the tongue rolling out of the wound as though they were not being subjected to any unusual experience.

The lessened hemorrhage and the freedom from the interference of the anesthetist makes local anesthesia less annoying to the operator than general anesthesia. The effect on the patient is most gratifying. While they may flatten out somewhat during the course of the operation, they are pretty sure to be sitting up before many hours. The advantage of this in the prevention of post-operative pneumonia will readily be understood by those who have done much work of this character.

**EXTRACTION OF TEETH.**—The alveolar process of the lower jaw being thicker and more dense than the upper, is less easily anesthetized by subperiosteal infiltration. However, for simple tooth extraction a careful subperiosteal infiltration (Fig. 24), and infiltration about the roots of the teeth (Fig. 25), relieves all the pain except that produced by the rupture of the nerve, and
often, particularly if the fluid has been allowed to act for some minutes, this part of the operation also may be painless. Novocain is the anesthetic of choice.

For extensive operations nerve blocking should be resorted to. The jaws, being supplied by nerve trunks which maintain definite anatomic relations to fixed points, are suitable regions for nerve blocking. The inferior alveolar nerve offers the most promising results. The lingula, which is usually palpable through the mouth, marks the entrance of the nerve into the bone and indicates its most accessible portion. The injection is made at a point \( \frac{1}{2} \) inch above the surface of the molar teeth, and the needle should penetrate slightly more than \( \frac{1}{2} \) inch and less than \( \frac{3}{4} \) inch beyond the anterior border of the ascending ramus (Fig. 26). This point may be best located by placing the index finger of the left hand behind the last molar and by resting the tip on the internal oblique line. By passing the needle through the mucous membrane, just above the finger, and penetrating \( \frac{1}{2} \) to \( \frac{3}{4} \) inch in depth, the nerve will be reached. It has been well emphasized by Fischer (Die Lokal Anesthesie in der Zahnheilkunde Fischer, Berlin, 1911), that owing to the obliquity of
Fig. 25. Point of injection for the premolar teeth.

Fig. 26. Relation of the tip of the needle to the lingula when the injection is made.
the ascending ramus the needle must be passed not in the line of
the teeth but from the canine tooth of the opposite side (Fig. 27).
Passed in this line the needle tip comes to lie in the vicinity of
the nerve, where an injection of 2 cubic centimeters should be
made. By injecting a few minims as soon as the needle has
penetrated the mucous membrane, and depositing a few drops
from time to time, the entrance of the needle can be made pain-
less. If this technic is properly carried out anesthesia will be com-
plete in about 20 minutes. All the teeth, as far as and including
the premolars, are anesthetized. In order to reach the teeth
beyond this point toward the median line the nerve must be
blocked at the opposite mental foramen, which lies at the base
of the alveolar process beneath the first and second premolar
teeth. To reach the second premolar tooth, the injection should
be made below it between the buccal and gingival mucous mem-
brane (Fig. 25).

TUMORS OF THE ALVEOLAR PROCESS.—Granulomas and small
cupulides can be removed by local infiltration. Larger tumors

Fig. 27. Showing the relation of the syringe and needle to the jaw in
making the injection for blocking the nerves at the lingula.
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require the blocking of the nerves at the lingula, and also local submucous infiltration (Fig. 28). If the tumor is situated near the median line, the nerve of the opposite side must be blocked at the mental foramen. The necessity for infiltrating the mucous membrane about the tumor comes from the fact that there is free anastomosis from other nerves the exact source of which may be difficult to understand. This is no great disadvantage, for after infiltrating about the nerve trunks at the lingula some time elapses before these nerves become anesthetized, and the operator may employ this time infiltrating the mucous membrane.

Excision of the Cervical Lymph Glands.—The first step in all operations for malignant disease about the jaws, tongue, mouth and lips must invariably be the removal of the regional lymphatics. Extensive gland infiltrations in the neck from malig-
nant metastasis where soft tissues and vessels are matted together are not suitable for operation under local anesthesia, and, of course, removal by any method is useless.

I have never secured a permanent cure in carcinoma of the mouth or jaws in which the cervical lymph glands were not removed at the primary operation and later became palpable. If the glands are palpable before an operation has been done upon the primary lesion there is some prospect of at least prolonged relief. In lymph gland involvement, following tumors of the parotid, whether previously operated on or not, offers a good prognosis. The chief use of the removal of the
cervical lymph glands, however, is purely prophylactic. The unaffected glands are small and difficult to see. It is necessary, therefore, to remove all connective tissue within which they may lie. The tissue intimately associated with the internal jugular vein is particularly likely to harbor them, and for this reason this vessel should always be removed.

Fig. 30. Points of infiltration in front of the carotid sheath and between the carotid sheath and trachea in removal of the cervical lymph glands.

Because of the vessel-constricting action of epinephrin, this agent associated with novocain should always be used. The vessels show up more sharply than when using quinine or operating under general anesthesia, and therefore facilitate thorough work.

A convenient incision for gland extirpation is one beginning at the point of the chin and extending backward beneath the border of the jaw beyond the angle. Joining this line at about its midpoint one infiltrates a second along the anterior border of the sterno-mastoid (Fig. 29), and through it injects the deeper
tissues. Through the horizontal line one infiltrates the loose tissue about the submaxillary fossa and at its posterior extremity the digastric fossa anterior to the sterno-mastoid. In this way one blocks the cervical nerves, which are the chief supply to the lower part of this region. The deep regions of the neck can be infiltrated by passing the needle behind the artery, as described in the operation for the removal of the thyroid gland. It is easy to locate the artery by palpation and thus avoid it. This is best done by passing the needle behind the sterno-mastoid muscle, which brings the needle behind the carotid sheath and avoids the internal jugular vein. No ill effects come from the deposition of the anesthetic solution about the pneumogastric nerve.

When a large packet of glands are to be removed, as in tuberculosis or Hodgkin's disease, wherein the carotid is displaced outward, it may be advantageous to pass the needle in front of the carotid sheath (Fig. 30). This has the advantage of bringing the anesthetic fluid directly into the field of operation. The edema and muscular constriction so produced greatly facilitates dissection. The tissue between the gland packet and trachea (Fig. 30), should be infiltrated in order to make the patient less sensitive to traction upon the trachea. By passing the needle lateralward and backward, the roots of the cervical nerves may be reached.

If in the course of the operation for the removal of lymph glands the deeper tissues are found to be still sensitive when exposed, edematization by dilute solutions quickly reduces the sensitiveness. The point most likely to give rise to pain is beneath the base of the skull when the jugular is ligated high up. Undue anxiety on the part of the operator may cause him to include the vagus nerve in his ligature.

The dissection is commenced below. If the external jugular is to be removed it should be isolated below and doubly ligated. Dissection upward is then easily and rapidly accomplished. If any pulling must be done it should be from below upward, because tugging laterally or downward transmits a pull to the
pharynx and trachea and may give the patient a feeling of suffocation. In fact, blunt dissection should give way to sharp dissection, particularly when removing the submaxillary glands. When this dissection has been accomplished, any operation for the removal of malignant tumors may follow.

Quinine may be advantageously used for the skin infiltration, but novocain is best for deep infiltration.

**Excision of the Jaw.**—This is required for carcinoma of the
alveolar border and for sarcoma. Other tumors admit of conservative operations. A skin incision, somewhat modified from that used in the removal of the cervical glands, may be used to advantage (Fig. 31). It extends from the clavicle upwards along the anterior border of the sterno-mastoid but passes near the parotid instead of over the mastoid process. The deep structures are anesthetized as for the removal of the cervical glands. At the level of the hyoid bone a second line extends over the point of the chin. From this line the mental foramen of the opposite side may be reached. This incision gives good access to the tongue and floor of the mouth, as well as to the jaw.

It is well to block the nerves at the lingula before the preliminary neck infiltration. In addition, the mucosa in the floor of the mouth must be infiltrated. If the cautery is to be used for incising the mucous membrane, quinine should be used for this infiltration, because of the long duration of its effect.

The operation proceeds in the usual sequence. When the jaw has been separated from the floor of the mouth it may be sawed. If the section is made near the median line the nerve from the opposite side should be blocked at its exit from the mental foramen. Section of the bone is best made with a Gigli saw, and the bone should be supported by a bone-holding forceps in order to avoid imparting unpleasant movements to the head of the patient in the process of sawing. The floor of the mouth is repaired as may please the operator.

If the entire half of the jaw is to be removed the third branch must be blocked at its exit from the foramen.

Operations on the tongue.—Limited lesions, such as cysts, can be excised under local infiltration. More extensive lesions require blocking of the nerves at the lingula, or the lingual nerve alone, according to the method of Skillern (Surg. Gyn. & Obs., 1913, XVII., 114). This writer palpates the nerve where it lies close to the bone near the wisdom tooth. If one projects a line from the last molar tooth to the angle of the mandible, the nerve crosses this line half an inch below the tooth. It is easier to block the nerve here than at the lingula.
Surgical Operations with Local Anesthesia

If the operation will involve a lateral half of the tongue, the blocking on only one side is sufficient, but if both sides or the tip are involved, or if the extent of the disease is uncertain, bilateral blocking is required. If it is large or situated near the root of the tongue, deep infiltrations are required (Fig. 32). In all malignant growths the submaxillary glands require removal and the skin infiltration is required as for typical excision of the jaw.

In addition, the periphery of the lesion may be infiltrated with quinine and excision begun with the cautery knife. By the time this is completed, effective blocking will have taken place in other regions.

The most important recent advance in the treatment of tumors of the tongue is that proposed by Bloodgood. He blocks out the neck at the first operation and allows this to heal before opening into the mouth for the actual removal of the tumor at a second

Fig. 32. Blocking the base of the tongue.
sitting. This avoids infection of the large wound of the neck by secretions from the mouth. This plan of operation is particularly suited to operations under local anesthesia.

TUMORS OF THE FLOOR OF THE MOUTH.—Ranulas and other benign tumors may be removed by local infiltration. Removal of a malignant lesion, though small, should be preceded by blocking at the lingula. Though the growth itself can be satisfactorily removed by infiltration, if the cautery is used the transmitted heat to the tongue and jaw is unpleasant or even painful to the patient, unless the nerve has been blocked. In these cases, likewise, one must remove the cervical lymph glands.

The location of tumors at the floor of the mouth is such that metastasis may take place on either side of the neck. In that event the neck dissection must be made on both sides of the median line. For this purpose a collar incision is useful. A line below the edge of the jaw is infiltrated from sterno-mastoid to sterno-mastoid. In this manner the upper lymph nodes on both sides can be removed. This having been accomplished, the primary tumor may be severed, preferably by the cautery knife, after a preliminary use of quinine.

TUMORS OF THE BUCCAL SOFT PARTS.—Tumors of the cheek and lip can be removed by local infiltration, whether malignant or benign. The removal of the cervical lymph glands is necessary in all cases. The extent to which the glands must be removed depends on the size and location of the tumor. Small tumors situated near one angle may be preceded by the dissection of one side only. If large, or near the median line, both sides must be cleaned out. When the tissue of the lip requiring removal is at all extensive it is advantageous to remove the glands as a preliminary operation and complete the operation after healing of the neck wound has taken place.
CHAPTER VII

Operations on the Ear and Mastoid

The external ear and auditory organs have such a complex nerve supply that local infiltration only can be employed. The external ear is supplied by the auricularis magnus and the auriculo-temporal chiefly. The latter nerve also supplies the skin and mucous membrane of the external auditory canal. The organs of hearing are supplied by the auricular branch of the vagus. The middle ear and the Eustachian tube by the tympanic branch of the glosso-pharyngeal. The mastoid cells are supplied by the mandibular nerves through the spinosus.

Furunculosis of the External Meatus.—This exceedingly painful affection is difficult to anesthetize, but the following methods employed for the tympanic membrane give at least partial results. Complete anesthesia may be secured by beginning the infiltration in the unaffected skin at the periphery of the affection and gradually circumscribing it. The greatest gentleness is necessary in order to avoid pressure pain from the fluid before anesthesia takes place. Cocain is the most effective for this operation.

Paracentesis.—Various means have been employed to lessen the pain of this operation on the drum membrane. Most of the solutions used for this purpose contain carabolic acid and cocain. The one recommended by Hechinger is as follows:

<table>
<thead>
<tr>
<th>Acid Carbolic 95</th>
<th>gr. vii</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocain</td>
<td></td>
</tr>
<tr>
<td>Menthol</td>
<td>aa</td>
</tr>
<tr>
<td>Alcohol</td>
<td>gr. xxx</td>
</tr>
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<td></td>
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A bit of cotton is saturated with this solution and pressed
against the tympanic membrane for a few minutes. Bonain uses an even stronger solution of carbolic acid as follows:

Phenol chrystals
Menthol
Cocain aa 1 gram

To this may be added several drops of epinephrin.

Usually no attempt at injection is worth while since the operation of incising the membrane is no more painful than the injections used to produce anesthesia.

THE MASTOID OPERATIONS.—Operations upon the mastoid are not infrequently required as emergency operations in the course of general diseases, notably scarlet fever, typhoid and respiratory diseases. My own experience in this operation has been limited to those cases in which a general anesthetic was contraindicated or when it was necessary to treat ambulant patients. Kulenkampff advises against the use of local anesthesia in acute cases. My first patient was such a one operated in 1903 in a case of mastoiditis following typhoid fever. I have since repeated the experience in a number of cases, and I am led to believe in consequence of this experience that it is in just such cases that local anesthesia finds its most gratifying field.

When simple palliative drainage is desired the preliminary infiltration need not be elaborate. A simple line of infiltration over the most prominent part of the mastoid, followed by infiltration of the deeper parts from this primary line, permits a linear incision through the soft parts and an adequate opening of the cells for the purpose of drainage.

For the radical mastoid operation a more elaborate anesthetization is required. The following plan has given me good service: beginning over the tip of the mastoid, a curved line is infiltrated, extending from the point of beginning to a point above the meatus. This line may be half an inch or more
from the ear (Fig. 33). From the primary line the deeper parts are infiltrated by passing the needle forwards and backwards. First, that below the skin infiltration is injected, and then the tissue on either side of this line (Fig. 33). Braun has shown that attempts at injection beneath the periosteum are unnecessary since the periosteum, together with the bone and cells, receive their nerve supply via the soft parts and are, therefore, effectually anesthetized by infiltration of the soft parts.

![Fig. 33. The rings indicate the endermic infiltration and the arrows the direction of the deep periosteal infiltration in the radical mastoid operation. The x indicates the point of exit of the facial nerve.](image)

From the point of beginning a line is now infiltrated in front of the ear to the point of termination of the line previously infiltrated back of the ear.

The skin of the meatus is now infiltrated by passing the needle behind the ear between the skin and the cartilaginous canal, and as much farther as possible (Fig. 34). Care must be taken lest the needle puncture the thin skin lining the meatus (Fig. 35).
Fig. 34. Points of deep infiltration into the auditory canal.

Fig. 35. Cross-section of the auditory canal showing the passage of the needle between the bone and the soft parts.
This error is made manifest by the escape of the fluid out of the external ear. By care the needle can be made to follow the desired plane for an inch or more.

From the auditory canal an additional injection is now made (Fig. 36) according to the suggestion of Neumann. The needle passes between the lining of the canal and the bone. By employing gentle pressure, 1 or 2 cc. of the anesthetic fluid can be made to diffuse in this plane and reach as far as the tympanum. It is imperative to employ for this purpose a syringe of small barrel calibre in order that a slow gentle expulsion of fluid will be possible.

By the time the injections have been completed the infiltration over the mastoid will have produced an effective anesthesia and the operation may be proceeded with without delay. Any operation may be done. The bloodless field assured by the epinephrin facilitates the operation very much.
Kulenkampf (Beitr. z. klin. Chir., 1913, LXXXIII, 446) advises against the use of local anesthesia in sinus thrombosis, or temporal abscess. I have found no contraindications in these diseases. In fact, it is in just these cases that one is often most anxious to avoid inhalation anesthesia.

Of course, the increased extent of operation demanded by these operations must be anticipated by a corresponding extent of primary infiltration. If the sinus is to be opened, care must be taken that a sudden gush of blood does not cover the face of the patient and frighten him. In searching for temporal abscess the trephine may sometimes be used to replace the chisel. The jarring of the chisel is most likely to be annoying to the patient. This may be lessened or obviated by using sharp instruments and proceeding slowly and making the cuts as obliquely as possible. A water bag makes a more comfortable pillow than a sand bag or blanket.
CHAPTER VIII

Operations on the Gasserian Ganglion and the Trifacial

The Gasserian Ganglion.—This ganglion was removed by Krause under local anesthesia, (Centralbl f. Chir., 1912, XXXIX, 385). He injected 50 cc. of novocain-epinephrin solution at the upper and lower borders of the zygomatic arch and at both its extremities, first subcutaneously and then subperiosteally. From the midpoint of the arch he then infiltrated the entire area including in the flap ordinarily used in this operation, injecting both subcutaneously and subperiosteally. The temporal fossa was infiltrated by passing the needle into this region through the mouth at the level of the temporal process of the mandible. There was some pain when the dura was raised from the base of the skull. As soon as the middle meningeal artery was exposed the dura at the base was infiltrated with 2 cc. in front, at the middle and behind in such a manner that the roots of divisions II and III were injected. There was some pain when the ganglion was shelled from its bed and the roots severed.

I have performed this operation in but a single case. Krause's technic was followed in the main. I made no injections through the mouth, but injected about the II and III branches from the temple. There was considerable pain when the dura was elevated from the base of the skull. The ganglion was injected as soon as exposed. This was followed by vomiting. In order to facilitate access, I resected the zygomatic arch after the method of Lexer. This patient had previously been operated on and a considerable scar was situated directly over the arch and a resection of the arch was deemed the easiest way to get the scar out of the way of the newly-formed flap.

Except for the pain produced when the dura was separated, and the nausea that followed injection directly into the ganglion, the operation was entirely satisfactory. In my next operation I
shall inject the ganglion through the cheek as a preliminary step. This should effectually anesthetize the ganglion and control the pain when it is twisted out.

**DIRECT INJECTION OF THE GASSERIAN GANGLION.**—The injection of the Gasserian ganglion itself offers greater possibilities of usefulness than any other nerve blocking operation. Attempts at this procedure were made by Schlosser (*Verhandl d. Kong. f. innere Med.*, Wiesbaden, 1907, XXIV, 49). Ostwalt (*Berlin, klin. Woch.*, 1906, XLIII, 10), and Harris and Offerhaus (*Arch. f. klin. Chir.*, 1910, XCII, 47; *Deutsch med. Woch.*, 1910, XXXVI, 1527), all of whom reached the ganglion through the mouth, which is obviously objectionable because of the danger of infection. Hartel (*Arch. f. klin. Chir.*, 1913, C, 193) perfected a method whereby the needle is made to traverse the cheek without entering the buccal cavity. The same author likewise carefully studied the anatomic relations of the ganglion, and pointed out many difficulties that may be encountered, and indicated a few dangers that must be avoided. This operation may be considered to be the standard.

The ganglion lies in Meckels' fossa in the superior lateral plane of the petrous portion of the temporal bone. Internal to it is the cavernous sinus and the internal carotid artery. It is approached for blocking through the foramen ovale. Viewed from the base of the skull from which direction the needle must approach it, it is seen at the base of the lesser wing of the sphenoid, and at the posterior border of the external pterygoid plate (Fig. 37). Internal to it is the foramen lacerum medium and behind it is the spina angularis, containing the foramen spinosum for the transmission of the middle meningeal artery.

There is considerable variation in size and shape of the foramen. Hartel found a variation in length from 5 to 11 mm. with an average of 7 mm. and a width of 2 to 8 mm. with an average of 4 mm. Sometimes the foramen is continuous with the foramen spinosum and with the foramen lacerum medium. Sometimes the foramen is multiple.
The foramen presents a canal nearly a centimeter long extending from below upwards, backwards and inwards. The planum infratemporale is a smooth surface which slopes gradually toward the foramen, and furnishes a guide to the needle which approaches it at an acute angle. This plane, bounded behind by the spina angularis and medially by the external plate of the pterygoid process, defines the limits within which the needle must search for the foramen.

If the needle enters the cheek so that it comes to lie midway between the second molar tooth and the malar bone (Fig. 37).
and is thrust along a line to a point midway between the occipital and parietal fontanellae in the midline (Fig. 38), it will enter at the front of the foramen or will strike the smooth surface of the bone anterior to it. Should the needle strike the bone

![Fig. 38](image.png)

*Fig. 38. a. Needle is passed into the ganglion through the foramen ovale.
b. The needle reaches the ganglion by way of the foramen ovale.*

the foramen is almost certain to be farther posterior, and can be entered by advancing the point of the needle along the bone. This is accomplished by elevating the distal end of the needle. This has the effect of depressing the point and bringing it into the foramen (Fig. 39).
Hartel introduces the needle into the cheek 3 cm. and back of the angle of the mouth at a point previously anesthetized. Viewing the patient from the front, the needle passes in a plane which bisects the pupil on the side being operated upon (Fig. 40).

Fig. 39. Position of the needle when the foramen is not struck when passed in the line of the second molar tooth.

Viewing the patient from the side, the needle is passed along a plane, which bisects the auricular tubercle (Fig. 41). This brings the point of the needle to the planum infratemporale and thence to the foramen. If the spina angularis is struck it will
be perceived by its rough surface, and the needle must then be directed farther upward.

A method quite as accurate and more simple is to mark the parietal eminence with the thumb and the external occipital protuberance with the second finger. The index finger marks a point midway between these two, which marks a point 2 or 3 cm. above the posterior fontanelle. The needle grasped in the free hand enters the cheek opposite the second upper molar and is passed directly toward the index finger of the other hand (Fig. 42). If this misses the foramen the point of the needle is too far medial and must be directed lateralward, and it may be too far posterior and must be directed more anterior.
By this method the operator soon learns to strike the foramen with astonishing accuracy.

When the needle has entered the foramen it should be thrust 1 to $1\frac{1}{2}$ cm. farther and the solution deposited. Hartel has found that the distance between the upper border of the petrous portion of the temporal bone and the lower posterior portion of the foramen varies between 1.4 cm. and 2.3 cm. The needle should be passed only to the minimum distance. If it goes too far it may puncture the posterior petrosal sinus or the cysterna pontis, in which case their respective contents will escape through the needle.

Two cc. of one per cent. novocain-epinephrin solution are injected into the ganglion. If injected too rapidly vertigo and nausea or even vomiting may take place. This soon passes off. Anesthesia in the region supplied by all of the branches comes on at once and lasts two or three hours.
This method of approach has been employed for the injection of alcohol in neuralgia. Injection of alcohol directly into the ganglion is sometimes followed by vertigo and vomiting, as is true of novocain and epinephrin.

OPERATIONS ON THE FIRST BRANCH OF THE FIFTH NERVE.—This branch supplies the contents of the orbit and the region about it. It passes along the lateral wall of the cavernous sinus and enters the orbit through the sphenoidal fissure, immediately after dividing into its three branches. Of these the lachrymal supplies the lids and the conjunctiva of the outer part of the eye and the skin of the forehead; the frontal nerve passes along the roof of the orbit and out through the supraorbital notch and supplies the skin of the forehead; and the naso-ciliary supplies the

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Fig. 42. The thumb marks the parietal eminence and the second finger the external occipital protuberance. The tip of the index finger lies midway between these two points. The needle entering over the second molar tooth is directed at the tip of the index finger.
mucous membrane and the skin of the upper part of the nose, after passing through the anterior ethmoidal foramen and the ethmoid plate. These branches may be effectually blocked either by injecting the ganglion itself or by injections outside of Tenon's capsule. The latter is the simpler method for the beginner. By following the bony plate of the orbit, injury to the orbital con-

![Fig. 45. Needle passed for blocking the nerves within the orbit. (Redrawn from Braun).]
point of injection is half an inch above the inner canthus of the eye. The point of the needle is made to follow the bone for 4 or 5 cm. Here 5 cc. of the solution are deposited. Peuckert recommends that the needle be passed 3 cm. deep. This depth is to

![Diagram](image)

**Fig. 44.** *a.* Needle passed into the Gasserian ganglion by the orbital route. *b.* Passed through the foramen ovale from the cheek. *c.* Needle passed for blocking the ethmoidal nerves. *d.* The same for blocking the frontal and lachrymal nerves (Hartel).

be recommended in operations upon the appendages of the eye, but for resection of the supraorbital nerve the depth suggested by Braun is the more certain.

**RESECTION OF THE SUPRAORBITAL NERVE.**—This nerve is the only branch of the first division which is attacked surgically in
tic douloureux. It is reached through an incision along the orbital border after blocking the nerve within the orbit as above described. The orbital contents are pressed downward with a spatula and the nerve exposed. If a true foramen exists it is converted into a notch and the nerve loosened as far back as possible. Should any sensation remain in the nerve it may be directly injected in its course. The nerve should be cut off as far back as possible and the peripheral portion twisted out as far as possible. The most effective way to secure a severance far back is to use a nasal snare as recommended for the second.

Fig. 45. Needle passed through the orbit to reach the foramen rotundum.
branch. This usually secures a longer piece of nerve than if twisting is depended upon as recommended by Thiersch.

**Operations upon the Second Branch.**—The main trunk of this nerve can be blocked at its exit from the foramen rotundum. This may be accomplished either by passing beneath the malar bone through the masseter, or by passing through the orbit. In the former case the needle passes beneath the malar bone at about its middle and extends upward and backward at an angle of about 25 degrees. After passing the masseter muscle the needle may strike the superior maxillary bone. The posterior surface of this bone is then followed with the needle until it glides over the rounded posterior border, when it is passed 2 cm. deeper. If the needle is directed too far back it will strike the lesser wing of the sphenoid. In that event the needle must be directed farther forward until this obstruction is passed. The needle will then freely pass deeper, and should reach the nerve at a depth of 5 or 6 cm. Upon contact, the patient will feel pain in the region supplied by the nerve. An actual puncture of the nerve is not necessary for the success of the anesthesia, though when this is achieved the effect is more quick and certain. Braun recommends that 5 cc. of a 2 per cent. novocain-epinephrin solution be deposited in this region. While the needle is being introduced several cc. may be deposited with advantage along the tract.

The orbital route is recommended by Payr (Arch. f. klin. Chir. 1903, LXXII, 284), and Bockenheimer. The needle enters the external inferior angle of the orbit and is passed downward, backward and inward at an angle of 25 degrees (Fig. a, 44 and Fig. 45). The point of the needle follows the floor of the orbit until it reaches the fissure, and is then dropped to nearly a right angle in its anterior posterior plane while the angle inward is maintained. The point of the needle should reach the foramen rotundum at a depth of about 5 cm. Care in directing the needle is necessary in order to avoid penetrating the orbital contents. If the direction of the needle is not changed as soon as the fissure is reached, the needle passes a cm. or more below the fora-
men. On the other hand, fear of injuring the orbital contents often causes the operator to pass too far laterally to the nerve. If the needle enters the nerve, the patient feels pain in the region of distribution of the nerve and anesthesia follows at once when the fluid is injected. If the fluid must reach the nerve by diffusion 10 or 15 minutes elapse before anesthesia begins, and if the needle is too far laterally complete anesthesia may not take place at all.

Resection of the infraorbital nerve.—This nerve is to be blocked at the foramen rotundum. If the needle actually penetrates the nerve anesthesia follows quickly in the entire area of distribution. Usually one must wait 15 or 20 minutes for anesthesia by diffusion to take place. During this interval the operator may infiltrate a line along the lower border of the orbit and over the edge of the floor of the orbit, and may also inject the nerve at its exit from the foramen. This insures painless incision of the skin and isolation of the nerve even though infiltration of the nerve at the foramen rotundum be incomplete or tardy. The orbital soft parts should be elevated by a retractor, and the infraorbital canal found by passing a small probe (a stylet from a needle) into the infraorbital foramen. The canal should be exposed by a small chisel, and the nerve lifted out, and injected as far back as possible, if there is any pain. In this manner it is possible to secure complete anesthesia, even if the attempt at blocking at the foramen rotundum has failed. The nerve should then be fixed by a ligature and cut distally to it. This gives an anchor to the portion of the nerve between the point of severance and the foramen rotundum. A Jarvis, or similar nasal snare, is now threaded over the anchor string and segment of nerve, and pushed back as far as possible. The nerve is cut off, or the loop may be drawn taut, and the nerve torn loose from the ganglion. The distal part of the nerve should then be pulled into the cheek through the infraorbital foramen and windlassed out of the cheek as far as possible by winding about a pair of forceps.
OPERATIONS ON THE THIRD BRANCH.—Offerhaus (Deutsch, med. Wchenschr, 1910, XXXVI, 1527), has devised an elaborate system of measurements designed to locate accurately the foramen ovale. Simpler and quite adequate is the method of Braun (Deutsch, ztsch. f. Chir., 1911, CXI, 321). He passes the needle directly inward for a distance of 4 to 5 cm. at the lower border of the middle of the zygomatic arch. The pterygoid process should be encountered at this depth, which should be measured accurately. He then withdraws the needle until

Fig. 46. Direction of passing the needle from the middle of the lower border of the zygomatic arch toward the base of the mastoid process of the opposite side.
the point reaches the subcutaneous tissue, and then reintroduces it to an equal depth, but in a direction slightly farther back. This describes, according to my experience, an imaginary line passing 2 or 3 cm. above the mastoid process of the opposite side (Fig. 46). When the needle reaches the depth at which it had previously touched the pterygoid process it should be in contact with the nerve. If pain or paraesthetic sensations are not felt by the patient in the region of the distribution of the nerve, the needle may be cautiously passed a few mms. deeper. Here several cc. of a 1 or 2 per cent. novocain-epinephrin solution are deposited. In order to mark the required distance upon the needle, Braun places a cork disc upon it. In lieu of this a small forceps or serrefine, or a Crile vessel clamp, may be attached to the needle to mark the depth. Such apparatus has the advantage that is more easily sterilized than the cork, and is more likely to be at hand when needed. If the needle is near the length required the eye of the operator is sufficiently accurate to mark the distance.

The third branch is best reached by an opening through the ascending ramus of the lower jaw. A modification of the classical operation can be performed as follows: after blocking the nerve in question at its exit from the foramen ovale, or by blocking of the ganglion according to the method already described, the skin and deeper tissues are infiltrated, from a point beginning below the lower angle of the malar bone, extending backward along the lower border of the zygoma to the posterior border of the ascending ramus and then downward for 5 cm. The triangular flap is then raised downward and forward, keeping close to the bone. The perpendicular limb of the incision at its lower half should pass through the skin only, dependence being placed upon blunt dissection for the deeper tissues, thus avoiding injury to the facial nerve and parotid gland. When the flap is raised the loose tissue below the ramus is infiltrated by injecting 3 to 5 cc. of fluid. This injection may be made at the time the
roots of the nerves are blocked, or when the skin infiltration is made by passing the needle obliquely downward as much as possible. Instead of trephining an opening through the ascending ramus and enlarging the opening upward, time can be saved and the sensibilities of the patient spared by enlarging the notch from above downward with a Dahlgren forceps.

The external pterygoid muscle is then located, and the nerve will be found at its lower border, lying on the internal pterygoid, buried in loose tissue, which may be removed by forceps. The nerve is grasped with forceps, the external pterygoid retracted upward and the nerve resected at its exit from the foramen ovale. The lower portion of the nerve is wound about a forceps and the nerve divulsed from below. After the removal of the nerve the external and internal pterygoid muscles may be coapted, where they come in contact, with silk sutures in order to hinder the passage of the redeveloping nerve. This in a measure closes the channel which the regenerating nerve would otherwise traverse.

The nerve may, likewise, be reached at the point where it enters the mandible. The overlying soft parts are infiltrated in a line along the lower border of the angle of the jaw, beginning below the point where the facial nerve crosses the maxilla and extending around the angle of the jaw over and parallel with the horizontal ramus for an inch. The incision is made down to the bone and all soft parts are raised from the bone and sharply retracted upward. By means of a burr or a trephine the bone is removed at a point midway between the anterior and posterior borders of the ascending ramus on a line parallel with the free border of the teeth of the lower jaw, which exposes the canal in which the nerve lies. By raising the nerve from its bed it can be severed at its upper part and the lower end pulled from the canal below. The canal thus emptied may be filled with some non-absorbable material, preferably soft paraffin, or the disc removed by the trephine replaced.

This operation can be done without first blocking the nerves
at the foramen ovale, and can be carried out by those whose experience with local anesthesia would not warrant them in undertaking the more formidable operation described.

The lingual nerve may be reached at the side of the root of the tongue, operating through the mouth. The nerve may be blocked at the lingula or may be blocked where it lies close to the bone at the root of the wisdom teeth, according to the method of Skillern (Surg. Gynec. and Obst., 1913, XVII, 114). He projects a line from the last molar tooth to the angle of the mandible, the nerve crosses this line half an inch below the tooth.
CHAPTER IX

OPERATIONS ON THE TONSILS AND ADENOIDS

Operations on the Tonsils.—In young children general anesthesia is still required for the removal of tonsils. In adults the infliction of general anesthesia is a demonstration that the operator is unacquainted with the technic of local anesthesia. The technic of tonsil removal is made vastly easier, because the upright position enables the operator better to observe the relation of tonsil and pillars, and when novocain-epinephrin is used the bloodless field further simplifies the operation enormously.

This is particularly true in operations in the acute stage. Most operators, it is true, refuse to remove tonsils when in a state of acute inflammation, but my observation of the results obtained by the pioneer in this work, Dr. T. L. Higginbothon, of Hutchinson, Kansas, has fully convinced me that the operation will soon be done as a matter of routine in the acute stage of inflammation. The material placed at my disposal for pathological study makes it obvious to me that the same problems are repeated in acute tonsilitis which we have already come to recognize in the acute inflammation of appendicitis.

Two agents are at our disposal for inducing local anesthesia for the removal of tonsils—novocain and quinine. Novocain-epinephrin has the advantage, in that it gives a bloodless field, thus rendering the operation much more simple. It has the disadvantage that after the effect of the epinephrin wears off, oozing sometimes occurs. In order to secure the full hemostatic effect of epinephrin the injection should precede the operation by at least fifteen minutes. At least eight minims of epinephrin should be used in one ounce of 1 per cent. novocain solution. The full action of the epinephrin is particularly desirable when removing tonsils in the acute stage of inflammation.
Quinine and urea hydrochloride controls the after-pain effectively, but the hemorrhage at the time of operation is greater. It has the advantage, however, in that when the hemorrhage has once ceased, oozing does not recur. When patients are to be treated ambulant this drug is therefore to be preferred.

Dr. W. R. Dillingham combines these two anesthetics. This results in the sacrifice of some of the advantages of epinephrin when this is used with novocain alone; hemorrhage by this combination being greater than when novocain-epinephrin is used without the quinine. This combination adds materially to the after-comfort of the patient, however.

Whichever drug is used the technic is the same. The solution is injected about the capsule of the tonsils with or without a pre-
liminary swabbing of the surface of the pillars. The needle is passed through the pillar as indicated in Fig. 47. The distance from the edge of the pillar at which the needle is made to enter depends on the type of tonsil. In submerged tonsils the injection must be made farther from the edge of the pillar. At least two points of injection should be made over the body of the tonsil and one at the upper pole and one at the lower pole. This latter injection is the most important and is the one most difficult to make. Tonsils frequently project deeply down beneath the pillars toward the root of the tongue. The injection must reach below the tonsillar tissue. If this is done the pain complained of when the snare is tightened will not be experienced. The posterior pillar is injected in a like manner. This may be made difficult if the tonsil is very large and protuberant.

Both tonsils should be injected before the operation is begun. In this manner the tonsil first injected is being acted upon by the anesthetic, while its fellow is being injected. This reduces very materially the time necessary to wait on the anesthetic.

Instead of using solutions of 1 per cent. strength, one of half this strength may be employed and the tissue about the tonsil edematized. This makes the tonsil stand out more prominently and in a measure facilitates removal.

ADENECTOMY.—It is difficult to anesthetize this region. Sprays into the vault of the pharynx, or application on a carrier, may be employed, but application through the nares is most usually done. Carriers armed with cotton are carried through the nose to the vault of the pharynx, and are frequently renewed until anesthesia is obtained.

This operation is most often needed in childhood, when any type of anesthesia is difficult. The operation requires but a moment and is not painful and is well borne. General anesthesia may be employed, but is vastly more dangerous than the operation itself, because of the possibility of blood aspiration—an accident not certainly obviated even by operating in the hanging head. I prefer always to operate with local anesthesia or with no anesthesia at all.
CHAPTER X

Operations on the Thyroid and Larynx

The structures in the anterior region of the neck requiring surgical treatment are relatively superficial and have a well defined nerve supply. For these reasons they are particularly well adapted to operation under local anesthesia, and fortunately so, for operations upon both the thyroid gland and the trachea are usually required under conditions in which general anesthesia is inconvenient or hazardous. Tracheotomy is often required when the operator is working alone, and the patient finds his supply of oxygen limited enough by his disease without having it diluted with a general anesthetic. The operation, too, is much simplified by the use of the local anesthetic, because not only is the congestion reduced by the epinephrin, but the additional hyperemia from the inhalation of a general anesthetic is absent. It is to the removal of the thyroid gland, however, that local anesthesia is most frequently applied. Danger from pulmonary and cardiac collapse are eliminated, and compression of the trachea is easily prevented or managed. Here even more than in tracheotomy the relatively bloodless field is to be appreciated, because it facilitates the avoidance of the parathyroid glands and the recurrent laryngeal nerve. The operator is much less likely to hurry the operation when working under local anesthesia than when he is apprehensive of the general anesthetic and is able to work more carefully. In hyperthyroidism all these advantages are of maximum value. Hyperthyroid patients may require some primary treatment on account of their nervous state, but in this, as in most other operations done under local anesthesia, they are apt to show as much poise and confidence as the operator does. With proper technic thyroidectomy becomes an ideal operation for local anesthesia.

Neural Anatomy.—The nerves to be anesthetized in opera-
tions upon the anterior portion of the neck are confined largely to the superficial structures. The chief are the cutaneous colli, which spring from the second and third branches of the cervical plexus, pass beneath the sterno-mastoid muscle, and curve over its posterior border (Fig. 48), and then extend forward under the platysma, supplying the skin of the anterior surface of the neck from the chin to the sternum. The auricularis magnus springs likewise from the second and third branches of the cervical plexus, passes around the posterior border of the sterno-mastoid and supplies the skin in the region of the angle of the jaw. These nerves also send twigs to the muscles in this region. The muscles in addition receive twigs from the Spinal accessory and the Glossopharyngeal. These latter nerves supply the fascia. The two principal nerves curve around the posterior border of the sterno-mastoid muscle near together at the level of the thyroid cartilage and can be blocked with ease and certainty.

Fig. 48. Superficial nerves of the anterior region of the neck.
The deep nerves of the neck are of importance because they must be shielded from injury. They are the inferior or recurrent laryngeal, the superior laryngeal and the hypoglossal. The two recurrent laryngeal nerves after springing from the vagus on the right side, in front of the subclavian artery, and on the left, in front of the aortic arch, wind beneath these vessels from before backward, and are then directed upward and inward to the groove between the trachea and esophagus. They reach the larynx by passing under the lower border of the inferior constrictor of the pharynx. In their passage upward they come in contact with the inferior thyroid artery, passing sometimes over it and sometimes between its branches when this vessel undergoes early division. The superior laryngeal nerve springs from the ganglion of the trunk of the vagus, passes downward and inward and reaches the larynx by passing behind the carotid vessels. Its high position keeps it out of harm's way, except where the thyroid is very large, and the thyroid vessels are displaced upwards, when it may be exposed in searching for the vessels. The hypoglossal is of importance only because of its descending branch. This nerve may be encountered in the depth of the wound and may give the operator fright lest he has severed the inferior laryngeal nerve. The interior of the trachea is supplied by twigs from the vagus mostly through the recurrent laryngeal and the sympathetic.

**Tracheotomy.**—Local infiltration is sufficient to produce anesthesia in this operation. The line of the proposed incision is first infiltrated, then the subcutaneous tissues, and from the same line the tissues about the trachea are injected by directing the needle laterally and posteriorly (Fig. 49). By slipping the skin laterally it is possible to infiltrate the space between the trachea and esophagus, thus reaching the nerves supplying the mucous membrane. The effect that might be produced by anesthetizing both recurrent nerves is not known. One nerve may be blocked without unpleasant effects, and it is a matter of experience that the vagus of one side may be resected in malignant
disease with impunity. If intratracheal manipulations are required it is probably safer to use topical application to the mucous membrane, though probably no undesirable results need be feared if all the nerves supplying the larynx are simultaneously blocked. At any rate if trachectomy is the operation at hand the relief for closure of the glottis is readily applied.

When the infiltration has been completed the operation is carried out in the usual manner. The question of hemorrhage is much simplified by the use of epinephrin. Careful hemostasis must not be neglected lest bleeding occur after the effect of the epinephrin wears off.

When the low operation is to be done it is well to infiltrate the isthmus of the thyroid down to the trachea so that the separation of these two structures will not be painful. If necessary the isthmus may be partly or completely severed in order to ob-
tain room for the tube. This latter may be desirable, particularly in extensive involvement of the larynx by malignant disease.

LARYNGOTOMY.—Infiltration of the soft parts for this operation does not differ materially from that for tracheotomy. By passing the needle along the upper border of the cartilage the mucous membrane can be effectually anesthetized. All the tissue about the larynx can be readily infiltrated with a straight needle by sliding the line of skin infiltrated first to one side, then to the other. The mucous membrane will need to be anesthetized either by topical application or by injection with a small needle. This is particularly necessary when the removal of tumors is the object of the operation.

EXTIRPATION OF THE LARYNX.—This operation is nearly always done for carcinoma before obstructive symptoms develop and may be performed in one or two stages. The plan of Berard and Surgnon may be adopted. In the first stage they did a tracheotomy, and delayed the extirpation for a week or ten days until the patient had become accustomed to the new way of breathing. Removal of the cervical lymph glands, if necessary, should be done in the first stage, in order that the wound may heal before it is exposed to the pharyngeal secretions.

In addition to the blocking, as done for laryngotomy, it is necessary in extirpation of the larynx to infiltrate the constrictors of the pharynx and the tissue between the larynx and pharynx. The needle should be introduced at a point lateral to the pharynx in order that all the tissues may be reached. For deep infiltration ¼ per cent. novocain is sufficient. If a transverse incision is to be made the lateral injection may be made from the extremity of the line of the skin infiltration.

THYROIDECTOMY.—The curved incision of Kocher is now used by most surgeons. It is of particular advantage in operating under local anesthesia, because it gives free access to the gland without tugging.

The skin line is infiltrated first. For goiters of medium size
the line begins over the sterno-mastoid of the side opposite the lobe to be removed, extends horizontally across the neck over the center of the isthmus of the thyroid, curving slightly upward to reach the outer border of the opposite sterno-mastoid at the level of the thyroid cartilage (Fig. 50). It is then continued upward toward the angle of the jaw (Fig. 51) or as far as required for the particular goiter. The fascia and platysma are then infiltrated through this line. In very large goiters the muscles of the region have usually been pushed to one side so that they require no special attention. In moderate sized and smaller glands the muscle layers should be infiltrated.

The chief nerves of the region are now blocked where they lie beneath the sterno-mastoid muscle. The line of infiltrated skin is pulled laterally until the needle can be passed through it behind the muscle, and the anesthetic solution is deposited at this

Fig. 50. Skin infiltration for removal of thyroid.
point. The cervical nerves pass around the sterno-mastoid muscle at this point (Fig. 48) and are readily blocked with certainty. The tissues behind the gland are now infiltrated by introducing a long needle through the same point, behind the cartoid sheath (Fig. 52), and as far as the esophagus, if possible. In large goiters the sterno-mastoid muscle and the carotid sheath are displaced far outward and backward. In that advent it is necessary to pass the needle anterior to the muscle and carotid sheath, but behind the parotid. With care this can be readily accom-

![Fig. 51. Lateral view of skin infiltration.](Image)

plished, even when the gland presents many irregularities and bossilations. Many goiters present very long extensions, upward. In one of my patients the tip of the lobe was plainly visible in the mouth beside the epiglottis. In such cases the infiltration behind the gland must be carried as high as possible. If the infiltration is carried as high as the superior thyroid vessels, any portion extending above this point can be shelled out without pain without further infiltration.
Failure to secure reliable anesthesia is usually due to a too timid infiltration of the deeper tissues of the neck. The carotid artery and the structures accompanying it can easily be avoided by noting the pulsations of the vessel.

The tissue about the isthmus is then infiltrated by dislocating the line of skin infiltration first upward and then downward. The isthmus is next directly injected.

By the time these infiltrations are completed the original skin infiltration has produced an effective anesthesia, and the blood vessels have become contracted from the action of the epinephrin. This is an advantage which emphasizes the value of making the skin infiltration first instead of afterward, as the German school has advocated. With the vascular constriction the small vessels are invisible, and the larger veins stand out in
bold relief, and are to be carefully separated from the surrounding tissue, doubly ligated and cut. The platysma is then severed and if any bleeding points appear they are caught up and ligated at once before the incision is extended. The muscles in front of the thyroid are then severed, unless they have been pushed out of the way by the enlargement of the gland. If any bleeding points appear, and usually there are none, they are ligated at

once. If the incision is found too short to expose the gland without undue traction it is to be enlarged.

The capsule of the thyroid is now carefully exposed, taking care to sever each fascial layer covering the gland. Often there are more layers than one expects. Care should be taken not to injure the vessels in the true capsule lest troublesome hemorrhage

Fig. 52. Secondary blocking about the superior pole of the thyroid.
ensue. Too much attention cannot be paid to keeping the wound free from blood so that every structure may be recognized before it is handled. The success of the operation may depend upon this.

The finger is now slowly and gently introduced between the lateral border of the tumor and the sterno-mastoid muscle. If the patient feels pain the operator must admit that he is still a novice to the art of local anesthesia, and must resort to infiltration immediately about the tumor (Fig. 53). By gradually insinuating the finger between the tumor and the surrounding tissue, the gland is dislocated and the superior thyroid vessels located.

Fig. 54. Ligation of superior thyroid vessels.
They are separated from the surrounding tissue, doubly ligated (Fig. 54) and severed. Less traction is produced by this means than by clamping, cutting and then ligating as most operators do when operating under general anesthesia. Often acces-

Fig. 55. Ligation of inferior thyroid vessels.

sory lobulations confuse the operator either before or after the vessels are located. The upper part of the tumor is now separated from the surrounding tissue.

The tumor is now isolated toward the lower pole, a procedure which is much easier because of the vessel-constricting action of the epinephrin. By care the para-thyroid glands may be avoided, even if they are imbedded in depressions within the
gland. As the gland is elevated the inferior vessels come into view (Fig. 55). If the separation of the lower pole is painful, infiltration may be made about the gland before proceeding. The vessels must be isolated before being tied so that the recurrent nerve is not caught in the ligature. This accident is less likely to happen with the use of a double ligature than with clamps. Sometimes when the lower pole extends far down behind the sternum and clavicle, one may have difficulty in reaching the vessels. Having the patient cough, as recommended by some German writers, in order to force the gland upward, I have found astonishingly effective. When the goiter is thus propelled out of its deep seat, the vessels are easily secured and ligated.

It now remains only to remove the gland from the trachea. In order to minimize the almost unavoidable choking sensation, the gland should be separated by using some blunt instrument rather than by forcible rotation of the tumor. The gland then remains attached only by the isthmus, which if large is crushed with forceps and ligated, and if small may be ligated without crushing.

If the technic has been carefully carried out the removal of the gland leaves a dry bed and a wound unincumbered with forceps. To close the wound, the muscles are sutured into place and the superficial structures united in any manner that may suit the operator.

In ordinary goiters no preliminary preparation is necessary, except a hypodermic of 1-6 gr. of morphine. The skin is painted with iodine after the patient is on the table. Novocain-epinephrin is the anesthetic of choice. For blocking of the nerves a 1 per cent. solution is preferable, while for the deeper infiltrations ½ per cent. or less is adequate. In very large goiters, I use quinine and urea hydrochloride in the skin and fascia, reserving the novocain for the deeper structures. Quinine, when used in the muscles and loose tissues of the neck, produces a thin reddish exudate, which interferes with healing and may produce an annoying woody induration of the surrounding tissues which may last for
weeks. It sometimes produces slight disturbances in healing of the skin wound. By employing both drugs, I have never been obliged to use more than two grains of quinine and urea and five grains of novocain with eight drops of epinephrin.

Patients suffering from hyperthyroidism are more difficult to operate upon than those who have simple goiters. This is due in part to the fact that the glands, being usually small, are dislocated with difficulty, but chiefly to the nervous state of the patient. The former difficulty is met by infiltrating more carefully about the gland. In order to minimize the latter disadvantage, the patient must be properly prepared. Very nervous patients are placed in bed and proper rest secured by some means, moderate doses of bromides usually producing the desired result after a time. When the patient has become composed, the question of the relative pleasantness of local and general anesthesia is discussed with her. Danger is not mentioned. After the patient has been convinced that local anesthesia will save her from nausea, the time of the operation is fixed. If she is not sleeping well she receives ten grains of veronal the evening before the day selected for the operation. On the morning of the operation she receives morphine, 1-6 with atropin 1-150. If the patient has a friend who has been operated upon under local anesthesia, there is no need for parley, for she comes convinced of the advantages of the method.

No primary scrubbing or dressing is used. The patient is placed on the table in a comfortable position with the head tilted back, if she finds this comfortable; if not, the operator accepts the more difficult position. The trunk is slightly elevated. The operator sits comfortably beside his patient, neither being handicapped in conversation by mask or face covering.

The operation should be simply arranged. Noise should not be permitted. The fewer assistants the better, a single assistant for the surgeon and a nurse to run errands being all that are required. The easiest place to operate is in the patient's kitchen, with the bread pan as a sterilizer and the kitchen cabinet as an
instrument table. Six artery forceps, a knife, a pair of scissors, two needles and a perfect syringe with needles, are all the equip-

ment the surgeon needs. If he has no more apparatus than this, there is less tendency to allow instruments to hang about the wound, tugging upon it and annoying the patient. The knowl-

dge that he has but a limited number of forceps, compels the operator to acquire the habit of starting but few points of hemor-

rhage at a time and ligating as soon as the vessels are caught up. Retractors are not needed and are objectionable, because of the inevitable traction they cause on tissues outside of the field of operation. This method of operating may require a little more time, but it prevents the loss of blood. Blood which trickles over the side of her neck and shoulder and finally beats a tattoo in the sponge pan, is very apt to elicit interrogatory remarks from exophthalmic patients.

The secret of success in thyroidectomy under local anesthesia is that the surgeon must not hurt the patient. The field must be completely anesthetized, and must be kept free from blood. The latter is impossible unless the former is realized, because if the patient suffers pain the necessary delicacy in technic required to perform a bloodless operation is not possible. With all details mastered thyroidectomy under local anesthesia becomes an ex-

ceedingly satisfactory and simple operation.
CHAPTER XI

Operations on the Mammary Gland

Because of the great extent of the wound required in the radical removal of the breast and its diversified nerve supply, this operation does not lend itself readily to performance under local anesthesia. Nevertheless, the radical operation may be satisfactorily done if there are contraindications to general anesthesia. In thin women this is readily accomplished, but in fat, muscular patients the tax on the operator’s time and resources is considerable. It is just these women that a particularly radical operation is required, for the vigorous woman in midlife gives a much poorer prognosis than the feeble aged woman. Nevertheless, I find myself urged by patients more and more frequently to undertake the operation under local even in the more difficult cases.

The simpler operations, such as the removal of fibro-adenomas and the removal of the entire breast for interstitial mastitis and the like, may well be done under local anesthesia as a matter of routine.

Nerve Supply.—The skin in the region of the mammary gland receives branches from the cervical plexus through the sterno-clavicular and acromial nerves, and some twigs from the intercostal nerves. The breast itself is supplied by branches from the fourth, fifth and sixth intercostal nerves. None of these nerves admits of blocking at its source. Therefore, infiltration about the field of operation must be depended upon.

Opening of Abscesses.—Chronic abscesses of the breast may be opened by simple infiltration of the skin in the affected area. Acute abscesses are so wide in extent and the parts so sensitive that no form of local anesthesia is satisfactory. Here gas or ether “rauch” finds an ideal application.

Benign Tumors.—The entire adeno-fibromatous and mixed tumor group is readily managed under local anesthesia. When
the tumor is small a simple line of infiltration over the summit with infiltration beneath makes its removal a simple matter. With large tumors one makes a circular infiltration about the base and then by means of a long needle infiltrates the tissue between the tumor and chest wall (Fig. 56). In this manner the tumor may be removed with more or less of the breast tissue. The operation may be performed on ambulatory patients, no matter how large the tumor.

**DIAGNOSTIC INCISION IN SENILE PARENCHYMATOUS HYPERTROPHY.**—The most difficult problem in breast tumor surgery is the differentiation between the malignant and benign states of the breast in women at or near the menopause, when the breast is more or less hypertrophied. For this it is advisable to infiltrate the entire breast area so that if desired a part or all of the breast may be removed.
An ellipse may be infiltrated about the nipple, or a simple curved line about the lower border of the breast (Fig. 57). When the lesion is localized, and the question is one of local hypertrophy with or without cyst formations, the elliptical infiltration in the skin may be followed by an elliptical infiltration of the mammary gland itself. The gland, particularly when the interstitial tissue is increased, is a difficult tissue to infiltrate. It is dense...
and elastic, resists the passage of the needle and offers great resistance to the expulsion of the fluid. Syringes with narrow barrels will be convenient here. The "feel" of the tissue to the needle alone is sufficient to differentiate between malignant and non-malignant foci in many instances. When the area of involvement is more diffuse a single long semilunar line of infiltration along the lower border of the breast is more convenient (Fig. 58).

Fig. 58. By sliding the skin over the breast the area may be infiltrated without puncturing unanesthetized skin.
57). From this line the tissue between the breast and skin and between the breast and thoracic wall must be infiltrated. This is readily done by sliding the breast about beneath the skin (Fig. 58). The incision is then made through the skin down to the gland and the inferior edge of the gland exposed. The gland is then loosened from the thoracic wall. The gland may now be cut into and a search made for malignant areas. If the operator does not have confidence in his clinical diagnosis, he may excise a suspected area and pass the responsibility up to an interne or to a pathologist, if one be available. With the breast so exposed, however, the "feel" of the breast to the finger and to the knife will leave few cases in which there is any doubt. If not malignant a part or all of the gland may be excised and the operation terminated.

If a malignant focus is discovered ether had best be given and the operation terminated in the usual manner. It is my practice in cases in which there is a suspicion of malignancy to state to the patient that there is probably no malignancy, but that an exploratory incision under local anesthesia will settle the matter. The patient is told that if no malignant area is discovered, she can go home at once if she desires, but should malignancy be encountered ether will be given and the operation performed in a radical manner. With such an understanding many women consent to a definite solution of their problem who would hesitate to accept without parley a more radical procedure.

The objection raised against breast explorations under local anesthesia is that if the operation turns out to be more extensive than was at first expected, an incomplete operation results. The indictment is against the operator. It implies that he is unable to foresee the possible extent of the operation or that, seeing the requirements, has not the courage to fulfill them. If he will in every instance bear in mind the possibility that a radical operation may be required and be fully prepared to meet it no expenditure of courage will be required to meet the indications.

THE RADICAL BREAST AMPUTATION.—As already stated this oper-
Surgical Operations with Local Anesthesia

Operations may be performed under local anesthesia on any kind of a patient. Because of the labor entailed, I volunteer it only in women with pulmonary or cardiac diseases and in slight, elderly persons.

Fig. 50. Lines of infiltration for radical operation upon the breast. The ring line indicates the skin infiltration and the arrow lines indicate the direction of the deep infiltration. These lines reach the pectoral fascia.

The infiltration is begun by making an ellipse about the nipple, circumscribing the extent of skin it is deemed necessary to sacri-
Surgical Operations with Local Anesthesia

This ellipse is extended along the lower border of the Pectoralis major muscle to the axilla, thence down the bicipital groove and upward just below the clavicle (Fig. 59). This infiltration in the region of the clavicle is made extensively, for it not only anesthetizes the skin, but blocks the sterno-clavicular and acronial nerves.

From these primary lines the deeper tissues are infiltrated both about and beneath the gland, about the brachial vessels and into the tendons of the pectoral muscles, and by passing the needle through these tendons, the loose tissue beneath them is reached.

In operations of this extent the operator must, well calculate the extent of his resources. It is in such operations that a friendly relation with quinine is particularly important. This anesthetic may be used in sufficient amount in the extensive skin infiltration. The thick skin of the chest bears this anesthetic well. I do not recall having noted delayed union after quinine in this region. If the axillary infiltration requires a large amount of fluid, I use quinine about and beneath the mamma as well. In small spare women novocain-epinephrin may be used for this part of the infiltration. In large, powerful patients the novocain should be saved for infiltration of the axilla. This drug is very much preferable in the loose axillary tissue because of the bloodless field it procures. By palpation the axillary artery can be located, and from this by calculation the veins can be avoided. The regions requiring particular care in infiltration is the sub-scapular and infraclavicular regions. Because of the looseness of the tissue a 1/4 per cent. solution is sufficient.

Even with abundant infiltration of the axilla the operator must be on the look-out for the long thoracic, the intercostohumeral and the axillary nerves, for the weak solution above recommended will not anesthetize these relatively large nerves. They should, therefore, be blocked by infiltration directly within their sheaths. They may then be avoided or resected as the operator's temper prompts him.

The operator need not deviate from the type of operation he
is accustomed to perform. I prefer to allow the pectoral muscles to remain. The tendons may be severed, to facilitate dissection, and subsequently reunited. The removal of a wide area of skin, it seems to me, is the most vital factor in this operation and the removal of any extent is easily accomplished. In fact, the removal of skin coextensive with the breast area facilitates the infiltration of the retroglandular tissues and therefore encourages a radical procedure in this part of the operation.

In cases where the breast tumor has been removed by paste, or otherwise without attention to the axillary glands, the latter can be satisfactorily removed under novocain-epinephrin.

Many of the late recurrences in the skin can be removed under local anesthesia. There is often much scar tissue about these recurrent nodules, and it is therefore necessary to infiltrate extensively about them in order that the nerves may be blocked before they enter the scar area.
CHAPTER XII

OPERATIONS ON THE THORAX, LUNGS, SPINE AND KIDNEYS

During my student days it was my misfortune to witness three deaths upon the operating table of patients being operated upon for empyema or lung abscess. Because of this my early efforts were directed toward the perfection of a technic for all operations involving the thoracic cavity. From this experience I believe one is justified in saying that general anesthesia is not required in operations upon the thorax.

When one considers the state of the patients demanding such operations, it is readily understood that in no class of operations is a general anesthetic more often contraindicated. The displacement of the heart in intrathoracic accumulations, the embarrassment of respiration and the general septic condition of the patient, all make inhalation anesthesia hazardous.

The demands on the resources of the operator are sometimes great, though fortunately the majority of operations are simple. Simple rib resection requires little skill, the drainage of lung abscesses decidedly more and complex rib resections with the associated scar formation may try the skill of the experienced.

NERVE SUPPLY.—The skin in the region of the spine and the subjacent muscles are supplied by the primary dorsal division of the spinal nerves. The lateral and anterior portions of the thorax are supplied by the intercostal nerves. These represent the anterior division of the thoracic nerves (Fig. 60). They travel, in the first part of their course, immediately beneath the parietal pleura. In the axillary line they pierce the internal intercostal muscle and travel in the space between the two muscles to near the sternum. At about the middle of their course they give off a cutaneous branch which supplies the skin in the lower part of the chest, while in the upper part of the chest
Fig. 60. Nerve supply of the abdominal wall.
the clavicular and acromial nerves supply the skin. The nerves terminate over the sternum and supply the skin in this region.

OPERATIONS UPON THE SPINE.—Because of the danger or embarrassment to respiration likely to ensue when operating upon injuries to the vertebra in the upper dorsal region, local anesthesia is particularly to be desired. The depth of the object of the attack furnishes the chief difficulty. The physical build of the patient permits us, therefore, to predict the difficulties to be encountered. The freest access possible must be aimed at.

![Fig. 61. Infiltration of the deeper layers in laminectomy.](image)

This may be achieved by infiltrating with quinine a line for six inches over the spinous processes in the region affected. Through this line the muscles about and lateral to the spinous processes are extensively infiltrated with a weak solution of novocain-epinephrin. This blocks the posterior root of the thoracic nerves (Fig. 61) and the action of the epinephrin secures a relatively bloodless field. The needle should be gradually pushed forward until the ligaments are reached. These can be infiltrated
without injuring the cord. The usual operations may then be performed, since, like the brain, the spinal cord and its coverings are not sensitive.

Like the operations upon the brain, too, the patient may be annoyed by the manipulations of the bony parts. For this reason the chisel must be eschewed and cutting forceps substituted.

A large, powerful Dahlgren forceps is most suitable. In order to avoid even so much jarring I have devised a trephine for cutting the arches (Fig. 62). The spinous processes are removed and the arches are then cut, first on one side and then on the other. When this has been done the arch may be lifted out. This method has the advantage in that the spinal roots are not interfered with, as is the case when cutting forceps are used.

**Thoracoplasties.**—When a considerable area is to be re-
moved, as in rib tuberculosis or thoracoplasties, it is best to block the intercostal nerves in continuity. This is best done at the angle

of the ribs. The rib is located with the tip of the index finger and the needle pushed through the skin just above the guiding

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*Fig. 63. The line of circles represents the skin infiltrations; the marks \( \times \) indicate the points at which the intercostal nerves are blocked.*
finger into the interspace. The nerves lie upon the parietal pleura, and the nearer the point of the needle lies to this region when the solution is expelled, the more prompt and certain the anesthesia. The trained finger can usually feel when the needle has reached the resistance offered by the pleura. Usually the patient experiences some pain expressed by contraction of the spinal muscles when this region is reached. Two cc. of the anesthetic solution, preferably a 1 per cent. novocain-epinephrin, is deposited at this point. The number of nerves that must be blocked is dependent upon the extent of the operation. In thoracoplasties, usually five or six must be blocked. In the removal of a diseased rib two usually suffices.

In thoracoplasties the skin is now infiltrated in the line in which the skin incision is to be made (Fig. 63). Additional blocking in the intercostal spaces are made through this line to avoid pain through anastomosis with nerves not previously blocked.

The thoracic wall may now be attacked in any manner desired. The visceral pleura is not anesthetized, and if decortication of the lung is to be added a general anesthetic must be resorted to. These are formidable operations at best and only the experienced technician is warranted in attempting them.

Rib resection.—Inasmuch as the less experienced in technic are likely to be called upon to do limited resections of a single rib, this technic may be described in detail.

Inasmuch as the resection of a rib presupposes an accurate knowledge of the character of the exudate, the technic of exploratory puncture may be given. Simple as the procedure is, unnecessary pain is too often inflicted. This may be a matter of importance with patients who must be subjected to repeated punctures.

An ordinary hypodermic syringe fitted with a standard needle is sufficient if the thoracic wall is thin, but in many cases a longer needle is required. The caliber of the needle required is dependent upon the character of the exudate. In fresh exudations a
fine needle is satisfactory, but in long standing exudates or purulent effusions a larger bore is required. A syringe capable of being boiled with the needle should be employed, but if such cannot be obtained, the needle should be boiled and the syringe chemically sterilized, preferably with formalin or iodine. The skin may most conveniently be prepared by painting with tincture of iodine or by washing with soap and water followed by alcohol. Many practitioners use no anesthetic in making the puncture; a local anesthetic removes the pain during and after the operation. Freezing effectually prevents pain in the skin from the initial prick, but the effect is evanescent and it is followed by after-pain. Salt and ice pressed against the skin for a minute or two lessens the sensibility to a considerable degree. Neither of these methods produces an anesthesia lasting long enough to permit careful exploration. Injection anesthesia is, therefore, preferable because it not only permits the operator to study the character of tissue through which the needle passes, but if therapeutic measures are to follow, the operation may proceed at once. Quinine, because of its efficiency and the duration of its effect, is the most suitable substance. Ten or twenty minims of 1 per cent. solution is drawn into the syringe, a fold of skin over the intercostal space in which the puncture is to be made is caught up between the thumb and forefinger so that it becomes anemic and thus less sensitive. The needle is made to penetrate the skin at a slight angle and a few drops of the fluid are deposited in the skin. The needle is then gradually forced inward immediately above the next rib below in order to avoid the intercostal vessels which lie in the groove of the upper rib. As the needle reaches the pleura the resistance is increased or the patient experiences slight pain. The remainder of the anesthetic fluid in the syringe is deposited at this point. An interval of a few seconds permits anesthesia to become effective and the needle may then be pressed into the pleural cavity, whereupon the resistance is suddenly lessened. The syringe is then steadied with the left hand while the right gradually withdraws the piston. If
fluid is present it should appear in the barrel of the syringe. If no fluid appears, it is either absent or the needle may be too short to enter the thoracic cavity, or the fluid may be too thick to pass through the needle. If no fluid is present the needle can be felt to strike the visceral pleura and usually the patient complains of pain. If there is doubt about the needle entering the cavity, a longer one should be employed. If the physical findings for fluid are definite and the case is of long duration, the possibility of a fluid too thick to pass the needle must be entertained and a needle of larger caliber employed. Adhesions at the site of puncture may give a negative aspiration. In that event the same procedure must be repeated in other likely situations. If the site of an adhesion is punctured, the needle enters the lung, which is manifest by the entrance into the syringe of bubbles of air covered with blood.

THORACENTESIS.—The correctness of the diagnosis having been demonstrated by exploratory puncture, the question of the removal of the fluid must be decided. This may be best undertaken at the time of the exploratory puncture for it saves the patient a second annoyance and the doctor a second preparation. The clinical diagnosis should be sufficiently accurate to determine the character of apparatus which will be required. The exact point where fluid will be obtained is known. A tract for the aspirating needle in case aspiration alone is needed is already anesthetized, the interval between the puncture and the aspiration permitting perfect anesthesia to take place.

In the absence of more suitable apparatus a syringe holding a few drams, and fitted with a stop-cock may be employed. It is a slow method and is trying to both patient and operator, but it is possible to remove large accumulations with this simple apparatus. The most suitable apparatus is the Potain aspirator.

All apparatus which comes in contact with the patient should be prepared by boiling. The hand of the operator should not touch that portion of the needle which is to enter the tissue. The needle is passed along the tract of the exploratory puncture
already anesthetized, and this may be accomplished without pain. If the needle is none too sharp, it is often desirable to nick the skin with a scalpel so as to avoid an annoying degree of pressure. The preliminary use of the scalpel is particularly indicated when a trocar is used. When the parietal pleura is passed aspiration may begin.

Whether all the fluid obtainable is to be withdrawn at the first aspiration depends on circumstances. In neglected cases when a considerable amount of fluid is withdrawn, a temporary irritation indicated by coughing may attend the expansion of the lungs, or the replacement of the heart to its normal position may cause a sense of faintness. Either of these sensations if at all marked should be a signal to the operator to desist. In early cases the first evidence of discomfort is shown when the fluid is nearly all removed and the expanding lung causes the visceral pleura to come in contact with the end of the aspirator. This pain can often be relieved by withdrawing the needle or by tilting the tip downward. When the operation is ended the aspirator is withdrawn and the wound is closed with gauze and collodion or adhesive plaster. If it is necessary to interrupt the aspiration before the fluid is all withdrawn, the operation should be repeated after an interval of a few days.

**PERMANENT DRAINAGE.**—Purulent fluid requires a permanent exit. In children this is satisfactorily accomplished by the introduction of a fair sized (say 26 F) soft rubber catheter through a simple intercostal incision. Sometimes the catheter is pushed through the sleeve of a large trocar, after which the latter is withdrawn. It is often possible to employ this method under local anesthesia in quite young children. It is especially efficient also when permanent suction is to be applied to the drainage tube. Permanent suction has been accomplished in various ways. The simplest method is by the permanent application of a Potain aspirator, the negative pressure in the receiving bottle being kept at the point of easy tolerance.

**RIB RESECTION.**—In empyema in older persons, the resection of
a rib is necessary, in order to secure satisfactory drainage. The diagnosis is less certain than in case of serous effusion by physical means alone. Before operation it is always advisable to verify the diagnosis by puncture.

The resection of a rib is a simple operation, but since it is always done upon a dyspneic patient, the complications are often annoying. Instruments sufficient to meet all possible emergencies should always be at hand. Aside from the usual syringe and solution for local anesthesia, a rib shears or a bone cutting forceps, a periosteal elevator, knife, scissors and a number of hemostats and a needle threaded with catgut should be provided.

Fig. 64. Injection of intercostal nerve. The needle passes close under the lower border of the rib.

The latter may be needed should the intercostal vessels be inadvertently severed.

The site of operation is selected, usually the 7th or 8th rib at the mid-axillary line. A line of skin 3 inches long is injected
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over and parallel with the rib selected for removal. The area immediately beneath the rib at both ends of the line of injection is infiltrated in such a manner as to deposit a pool of fluid about the intercostal nerve (Fig. 64). Next the periosteum over the rib is freely injected. A wait of a few minutes permits anesthesia to take place. An incision is made through the skin the length of the line infiltrated. The muscle over the

Fig. 65. Partial elevation of the periosteum.

Fig. 66. Elevation of the periosteum completed the rib is removed and the parietal pleura incised.
rib is next incised. All hemorrhage should be controlled at this point. The periosteum over the rib is then incised for a distance of two inches. The periosteum is elevated from the rib about its entire circumference, care being taken to remove it from the groove containing the intercostal vessels (Fig. 65). The pleural surface of the periosteum must not be perforated. The periosteum being loosened for the entire distance of the incision, the rib may be cut. At least an inch should be removed. The opening thus made has for its floor the parietal periosteum. If the intercostal vessels have been cut they may be controlled by mass ligatures through the muscle. When all hemorrhage has been checked the drainage tubes are made ready, the periosteum is quickly incised (Fig. 66) and the tubes passed into the opening. The tubes must be sutured to the skin in order to prevent their slipping into the thorax. Many operators permit the pus to flow out before a dressing is applied, others prefer to apply a large snug dressing quickly and permit the pus gradually to soak into it.

If the parietal periosteum is inadvertently opened the pus flows at once and the cutting of the rib and the control of any hemorrhage that may ensue must be done in a puddle of pus.

The duration of the quinine anesthesia is such that nothing is required for post-operative pain. The dressings must be removed as they become soiled. After the flow has lessened the tubes are gradually shortened and can usually be removed in from 2 to 6 weeks, depending on the nature of the infection, the earlier period if the pneumococcus or influenza bacillus is the infective agent, the longer if the empyema is secondary to some infection of the abdomen or pelvis.

DRAINAGE OF LUNG ABSCESSES.—There is no operation that demands so much of the operator as the drainage of lung abscesses. The greatest difficulty lies in locating them. This can be proven only by exploratory puncture. Pus macroscopic in amount may not be encountered and cultures must be made from the serum obtained. Every provision must be made for a bacterial examination.
The abscess is located as nearly as possible by the physical signs. At the most accessible point the skin is infiltrated as for puncture of the pleura. When the tract has become fully anesthetized a needle of sufficient size and caliber is used to search for the abscess. When the parietal pleura is reached the resistance is appreciated and its thickness is determined by the resistance offered. If pain is perceived a few drops of an anesthetic fluid may be injected when the visceral pleura is penetrated. This makes the subsequent procedures more satisfactory if repeated punctures are required.

The actual search for the abscess in the depth of the lung is now begun. The increased lung resistance is often a clue that the abscess is being approached. When a cavity exists and the needle enters, the sudden lessened resistance is perceived. If pus is present it may be withdrawn. Often no actual cavity is entered but the needle may penetrate pus infiltrated tissue. In that event a few drops of bloody serum may be all the operator obtains. Bacteriological examination may reveal the presence of pus microbes. Often repeated punctures must be made before the abscess is located. The needle must be redrawn each time until the point is just within the visceral pleura and then introduced with a change of direction. Only in gross interpretations of the physical signs is it necessary to entirely withdraw the needle.

Fig. 67. Author's dilator for widening the tract to permit the introduction of the drainage tube.
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When the pus is located, the exploring needle should be left in situ and a rib resected as explained above. When the pleura has been opened the needle may be followed by a closed artery forceps in order to secure an opening large enough to admit a drain. Better still is the instrument devised by me for this purpose. The needle is straddled with the instrument (Fig. 67) which is then forced through the lung until its tip enters the abscess. The blades are then separated, the needle withdrawn and a drainage tube substituted and the instrument withdrawn. This permits the tube to be introduced more quickly than if the dilatation is made with forceps.

If the pleural space is not obliterated by the adhesions of the parietal and visceral pleura, the area must be packed for a few days until obliteration does take place. It is often possible to determine if the visceral and parietal pleura are adherent by the sensation imparted to the needle when it is passing from the one to the other. If there are no adhesions the movement of the lung will be felt by the tug upon the needle. This method is by no means a certain test and is only after a rib has been resected and the pleura opened that any reliable information is obtainable. If there is a free space the opening in the parietal pleura is packed with plain gauze in such a manner that it comes in contact with the visceral pleura, thus exciting adhesions. Reliable adhesions will have formed in 3 or 4 days. The method of obliterating the space by suture is not suited to local anesthesia and is objectionable because immediate suture does not protect the pleural cavity with certainty from infection if the abscess be drained at once.

The opening of lung abscesses following pneumonia offers no difficulties under local anesthesia. Those following prolonged suppurative processes in the pelvis or abdomen in which the patient is often pus soaked for many months and usually more or less accustomed to the use of morphine, are not favorable cases for local anesthesia. Unless the operator is experienced both in the treatment of lung abscesses and in thoracic operations
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under local anesthesia, he will do better to place the additional burden of a general anesthetic upon the patient.

DRAINAGE OF SUBDIAPHRAGMATIC ABScesses.—The technic required does not differ from that described for lung abscess. A rib must be resected and the pleural cavity protected if pleural adhesions have not already taken place. After the necessary opening has been made in the chest wall no further anesthetization is required. The abscess is located with a needle and the drainage tube introduced as in lung abscess. On the whole the location and drainage of these abscesses is much more easily accomplished than drainage of lung abscesses.

OPERATIONS ON THE MEDIASTINUM

The recent advances in the diseases involving the thymus make operations in this region a matter of practical interest. A bloodless field, which the use of epinephrin assures, is particularly desirable, in order that the operators' orientation may not be disturbed when operating in a field so full of important structures. Fortunately, the nerve supply to this region is such that the technic of local anesthesia is relatively easy.

The mediastinum is best approached from one side rather than through the body of the sternum. By removing the cartilages of as many ribs as may be necessary a wide opening may be secured. To approach the mediastinum by deepening the suprasternal notch is inadvisable, since at best it gives inadequate room, and it compels the operator to approach important structures without an adequate chance for the proper determination of their relations.

The technic I have employed is as follows: the preliminary line of skin infiltration is made horseshoe-shaped, with the open end upward (Fig. 68). One limb of the horseshoe is placed just lateral to the sternal border on the side opposite that to be attacked. The limb on the side from which the mediastinum
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is to be entered is placed over the line where the ribs are to be severed which is usually at the costo-chondral junction. This infiltration is made with quinine for the purpose of limiting the use of the novocain-epinephrin solution. Novocain-epinephrin is used for infiltration of the mediastinal space itself, and for the blocking of the intercostal nerves.

From this primary line the intercostal nerves are blocked and the periosteum of the ribs is anesthetized by injecting the solution about them. It is not necessary to inject the fluid beneath the periosteum, because if the fluid is injected about the periosteum the nerves will be blocked before they reach this structure. Each intercostal space in turn is so injected (a, a, Fig. 68). The operator must remember that the nerves lie just below the border of the ribs. Usually the line of section of the ribs is at the costo-chondral junction, and the

Fig. 68. Line of skin infiltration: a, a, points for blocking the intercostal nerves; b, d, infiltration of the suprasternal space and blocking of the cervical nerves; c, infiltration of the upper retrosternal tissues; and e, infiltration of the mid-retrosternal tissues.
skin line is made here. By passing the needle through the primary line and directing it outward and backward the nerve may be reached, as it lies beneath the rib.

The periosteum of the sternum is blocked by injecting fluid over it from the primary line of infiltration. This is readily accomplished if a sufficiently long needle is used. The cervical nerves must receive special attention. These may best be reached by making extensive subcutaneous injections from the upper end of each limb of the primary lines of the infiltration (b, d, Fig. 68). This blocks all nerves coming from the cervical plexus. While this is being done, it is convenient to infiltrate the loose tissues of the jugulum (c, Fig. 68). At the upper limb of the horseshoe on each side the needle is passed cautiously behind the sterno-clavicular articulation. The tissues in this situation are little sensitive, but several cc. of the \( \frac{1}{2}\% \) novocain-epinephrin solution should be used in order to secure complete constriction of the small vessels in this region. The retrosternal tissues behind the body of the bone may be reached by passing the needle close to the bone from each of the intercostal spaces (e, Fig. 68).

In making these deeper injections, when large vessels are approached, it is well to use as fine a needle as possible, and to introduce it carefully with the empty syringe attached in which the piston has been drawn partly back so that a vacuum is created. If a vessel is perforated, blood at once appears in the syringe. If none appears the operator may feel safe in injecting the fluid as soon as the needle has reached the desired depth. This maneuver is repeated as often as is necessary to infiltrate the entire area.

The parietal pleura comes close to the border of the sternum, and the operator must hug the parietal fascia in order to reach the mediastinum without entering the pleural cavity. The operator's sense of touch must guide him in this maneuver.

If the needle, such as is used for this purpose, does accidentally perforate the pleura, the puncture is not large enough
to admit air. If the needle perforates a vein some oozing occurs when the needle is withdrawn, but it soon stops. If an artery is perforated a tiny geyser forms for a few seconds, but this soon ceases.

The incision is made down the line of infiltration, on the side from which the mediastinum is to be approached, and extended across the sternum below. If the upper portion of the sternum and the jugulum is to be reached the incision may be extended across above (Fig. 68). The flap is loosened and reflected. The cartilages and sternum are carefully separated from the parietal pleura. The use of epinephrin lessens the oozing to a surprising extent, and with care the entire series of cartilages and sternum may be so separated before the rongeur is used to remove the osseous structures. The internal mammary vessels are pushed out of the way and do not require ligation.

Should the pleura be inadvertently opened, the hole may be compressed with pledges of gauze until the operator is prepared to close the opening. If an abscess is to be attacked, it may be well to pack gauze into the pleural cavity and await the formation of adhesions before the operation is completed. This procedure could be desirable only in the presence of suppurative processes.

It has been my experience to open the pleura in several instances, but the patient experienced but little inconvenience and no distress. The opening can be sutured or packed at once.

**Operations on the Kidneys and Ureters.**

The essentials in the operations on the kidneys and ureters consist of an effective blocking of the XII thoracic and the first three lumbar nerves. The field of operation receives aberrant twigs from nerves lying above and below this region. It is well, therefore, to anticipate their presence by infiltrating the skin about the limits of the field of operation (Fig. 69).
The trunks above indicated are best reached by passing the needle about midway between the spinous processes. This point is reached by passing the needle forward and medially from a line 4 or 5 cm. lateral to the midline opposite the upper
edge of the spinous process corresponding to the nerve sought. The nerves lie about on the level of the lower border of the transverse processes (compare Fig. 70), and from 1 to 1½ cm. deeper. It is well to deposit 5 cc. of a 1% novocain-epinephrin solution in this region. In addition, the tissues of the abdominal wall may be infiltrated by a weaker solution (½ to ¼%) along the line of the proposed incision. If the blocking of the nerves above indicated is well done, this step would not be necessary, but the operator's marksmanship may be defective, particularly in fat patients. The loose perirenal tissue may be infiltrated with a weak anesthetic solution, though this is scarcely necessary.

Traction on the kidney causes some pain. It is well, therefore, to have an incision long enough so that complete dislocation of the organ will not be necessary. Incision into the kidney is not painful, but exploration of the pelvis is painful. In the case of palpable stone, it is well, therefore, to make direct incision into the pelvis after infiltrating the wall.

The ureter may be followed from the kidney by raising the peritoneum the required distance. When the stone is palpated, it is well to infiltrate the ureter before the extraction of the stone is undertaken. The chief requirement in ureteral operations is an adequate incision through the abdominal wall, in order to avoid undue tugging on the peritoneum. For this reason the v. Bergmann incision, downwards and forwards, is preferable, even when the kidney alone is to be attacked. Skill in renal surgery is the prime requisite in performing this operation.
CHAPTER XIII

Abdominal Operations

Operations upon the abdominal wall may now be said to belong definitely to the domain of local anesthesia. Operations upon the abdominal contents belong distinctively as yet to the domain of general anesthesia. There are, however, many surgical conditions within the abdomen which may be regarded as belonging on the border line and may under special indications be satisfactorily performed under local anesthesia. The unfitness of local anesthesia for most intra-abdominal operations is due in part to the multiplicity of the nerve supply, in part to inaccessibility of the actual field of operation; but chiefly to the fact that on account of the various manifestations of reactive processes, it is impossible to predict the condition in which the organs will be found, and consequently to foresee the extent of the operation. An adequate nerve control of the abdominal contents would involve blocking all the vertebral nerves. Kappis (Munch. Med. Woch., 1912, No. 15) has proposed the blocking of the V to XII dorsal nerves and the I to III lumbar nerves. The principle is correct, but difficult in practice. Such extensive blocking would have to be done with exceeding accuracy to avoid the use of a dangerous amount of anesthetic solution. Furthermore, blocking the spinal nerves does not interfere with the conductivity of the sympathetic nerves. Attempts at blocking nerves to individual organs at the roots of the mesenteries have not met with success because of the thinness of the surrounding tissue which increases the technical difficulties very greatly. The results attained in this way are not constant because sensibility varies considerably in different individuals and under different conditions. For this reason enthusiastic reports published on the basis of a few cases of mesenteric blocking will usually be discounted by operators with a more extended experience. So far as present knowledge goes, success in abdominal operations under local anesthesia depends upon the proper selection of cases and upon gentleness of technic after the abdomen is opened.
Generally speaking, operations upon organs coming naturally in contact with the abdominal wall or those which may readily be brought into contact with it may be readily performed under local anesthesia. Organs which normally lie deeper and require much traction upon their mesenteric attachments are less readily operated on. Superficial organs which have become abnormally attached as the result of some past inflammation are even less suited to local anesthesia, for adhesions may be more sensitive and are always less readily influenced by anesthetics than are normal attachments.
These conditions may be illustrated by the citation of three cases of gall bladder trouble in old women. The clinical pictures of these were quite identical and indications for local anesthesia were presented by advanced age, chronic pulmonary affections and uncertain kidney function. In the one patient when the abdomen was opened the fundus of the gall bladder presented at the incision. Cautious palpation showed the common duct to be free from stones. The operation was easily terminated by the removal of the stones and drainage of the gall-bladder. The second patient likewise had a common duct free from stones, but the gall-bladder was small and deeply situated, and could not be brought near the surface. It was opened in situ and a tube fastened in the opening. In the third case, after the abdomen was opened, a mass of adhesions presented, and careful palpation and inspection failed to disclose the location of the gall-bladder. Ether was given at once before the patient was hurt by an attempt to locate the gall-bladder by the separation of the adhesions.

These difficulties are naturally greater in inflammations in which the sensitiveness of the organs is increased. The statement of Braun that sensitiveness is not increased is true for parts in the hyperemic stage of inflammations, and for adjacent regions which are only reflexly hyperemic. In the later stages of inflammation in the presence of fibrous exudate sensitiveness is not greater than normal and may be less. During the early exudative stages the tissues are acutely sensitive. For example, the placing or removal of abdominal sponges, which is always painful, is particularly so in the presence of acute inflammation. For this reason operations in acutely inflamed regions not adjacent to the abdominal wall, which require a safety packing, are not ordinarily suitable for local anesthesia. However, where there is a secondary attachment of the diseased part to the abdominal wall, as in appendiceal or gall bladder suppurations, local anesthesia finds one of its most gratifying fields.

In operations upon abdominal organs the operator must be an
opportunist. He should approach his patient prepared to use the method of anesthesia most appropriate to the conditions and not predetermined to see if the operation can be done under local anesthesia. If an organ which is ordinarily readily accessible is found, when the abdomen is opened, to be firmly bound down, general anesthesia should be resorted to at once before an attempt is made to loosen the adhesions. Such an attempt would have no other effect than to hurt the patient and destroy his equanimity. Similarly, if an abscess is adherent, it can easily be drained; but if the free peritoneal cavity must be traversed general anesthesia is indicated. Introduction of a protective tamponade under local anesthesia should not be attempted. Nitrous oxide can be easily and quickly administered and serves perfectly in most cases. If a more protracted operation is required, or if a greater laxity of the abdominal muscles is demanded than can be secured by gas, the switching to ether in the hands of a skillful anesthetist is a matter of but a few minutes.

**NEURAL ANATOMY OF THE ABDOMINAL WALL AND THE CONTAINED ORGANS.—**The abdominal parietes receive branches from the seventh to the twelfth intercostal nerves and from the ilio-inguinal and ilio-hypogastrics. The thoracic nerves after leaving the spinal canal pass to the posterior surface of the intercostal membrane, which they pierce, and in company with the intercostal vessels, pass forward between the intercostal muscles (Fig. 70). The ilio-inguinal and ilio-hypogastrics are concerned chiefly in the operations for inguinal hernia and are described in that chapter.

The intercostal nerves reach the anterior region of the abdomen by passing superficial to the transversalis muscle. At their midpoint they give off branches which supply the more superficial structures, including the skin and external oblique muscle at the lateral surface of the abdomen. Other branches are given off at the border of the rectus which supply the superficial structures of the anterior surface of the abdomen.

Branches are given off near the semilunar line, which per-
forate the transversalis muscle or run in its substance and form a plexus superficial to the peritoneum. In this manner the peritoneum receives branches from the lower six thoracic nerves and from the ilio-inguinal and the ilio-hypogastric.

The plexuses are formed by the reunion of branches of the same or neighboring nerves. Branches are given off from these loops which supply the muscle itself. It is from these loops, too, that branches are given off to supply the peritoneum. Some of these nerves pierce the fascia at once, while others run for some distance to reach the semilunar line and perforate the fascia at or near this line to reach the peritoneum.

Within the preperitoneal tissue these nerves undergo renewed plexus formation, and branches from this plexus may assume a recurrent direction so that they may reach a point near their primary origin from the intercostal before breaking up into their endorgans. On the whole, however, the general direction of the terminal branches is toward the median line. In harmony with the developmental change of position of the abdominal muscles the terminal filaments are directed upward. This upper tendency of the terminal filaments is emphasized by the hypogastric branch of the ilio-hypogastric.

It is important to note relative to nerve blocking at the point of origin of these nerves that while in general the nerves supply the region of their respective muscle segments, because of the free anastomosis and general upward direction of the terminal branches the nerves in the segments below likewise require blocking.

Ranstrom has studied particularly the relation of the intercostal nerves to the diaphragm and of the phrenic to the peritoneum. He denies the correctness of the teaching that the diaphragm receives motor fibers from the intercostals and conversely that the peritoneum receives sensory fibers from the phrenic. Numerous dissections of my own cause me to accept with confidence these conclusions of Ranstrom.

It is beyond the purpose of these paragraphs to enter minutely
into the study of the termination of the endorgans into the peritoneum. It is worth noting, however, that the terminal fibers given off from the plexuses above mentioned are for the most part non-medullated with an intermixture of a small number of variously sized medullated fibers. These latter divide at the nodes of Ranvier in such manner that in most terminal meshes medullated fibers are found. The non-medullated fibers terminate in plexuses about the vessels, showing here and there sympathetic nerve cells singly or in groups, while the medullated terminate in the subserous and serous layer in special endorgans. These endorgans, it is sufficient to note, do not differ from the Vater-Pacini bodies found in other regions of the body.

The neural anatomy of the viscera is much less satisfactorily worked out. Auerbach’s plexus, situated between the muscle layers of the intestine, and a finer one, Meissner’s, situated in the submucosa, are well known. These form a complete web about the gut and from them filaments have been traced to the mucosa. Nerves have not been demonstrated in the peritoneal or subperitoneal layer.

Sympathetic nerves have been traced into the solid viscera, but of their ramification within them little is known. The presence of medullated fibers within the visceral plexuses is pure hypothecation.

Much discussion has arisen relative to the sensitiveness of the organs involved in abdominal operations. Much discussion has been due to a disregard of the anatomy of the region in question and still more to an attempt to transfer data, always necessarily unreliable, derived from animal experimentation. The abdominal surgeon can use only real facts. The patient, and not the scientist, sits as the judge of the correctness of his deduction.

Broadly speaking, it may be stated that pain is caused whenever a sensory nerve is exposed to experiences of an irritating character to which it is not accustomed. To this may be added that the stimuli which excite pain must be in the direction of an exaggeration of their physiological function.
The parietal peritoneum is not separable in surgical practice from the transversalis fascia, and for practical purposes it is convenient to regard the fascia and parietal peritoneum as one structure.

The parietal peritoneum, as above noted, contains medullated fibers. This need not occasion surprise when it is remembered that the prime function of the parietes is to protect the viscera within from external violence. The parietal peritoneum is much less sensitive than the skin, but is sensitive to section or stretching because none of these manipulations can be carried out without involving endorgans or involving the nerves in continuity.

The response elicited from a nerve injured in continuity depends upon the degree of trauma inflicted. It is possible to pierce nerve sheaths with a fine needle without pain, while a large or rusty needle excites pain. Even a relatively large needle may be thrust into the sciatic nerve or brachial plexus without the production of noteworthy pain. In picking up and deliberately irritating exposed nerves, pain is caused, no matter where the nerve is located. If fatty tissue is picked up with it, as usually is the case in manipulations of the peritoneum, less pain is caused than if the bare nerve is grasped.

The parietal peritoneum, therefore, like any other tissue bearing medullated nerve fibres and endorgans, is sensitive to trauma of such character as excites pain in other regions supplied by similar nerve structures, the differences being dependent upon the projection of the surrounding tissue and the degree of injury.

It is necessary to treat the peritoneum just as one would treat the skin if one were working from within the abdomen outward toward the skin. In other words, one might turn his patient wrong side out and not alter the fundamental problems in technic.

The visceral peritoneum does not contain, so far as is known, any medullated nerve fibers. It is safe to conclude, therefore, that either sympathetic nerves can bear painful stimuli or there are medullated fibres in the abdominal viscera, for pain may be
experienced when these nerves are irritated, as every small boy learns during the green apple season.

The abdominal viscera are sensitive to trauma only when such trauma produces an exaggeration of their normal function or threatens the integrity of the nerve. Because of the width of the meshes of the intestinal plexus, needles of considerable size may be thrust into the wall without disturbing the nerves, or at most but pushes them aside. Light pinching does not cause pain, because the nerves are well padded by surrounding tissue. Severe pinching which crushes the organ is painful. Clamping the appendix or catching the gall bladder with forceps in order to draw it forward is painful. Grasping the stomach preliminary to a gastrostomy is painful. That traction on viscera is painful is attested to by all operators. This is due largely perhaps to the stretching of the nerves in the mesentery.

Why crushing and stretching is painful while cutting is little or not at all painful is open to speculation. Colicky pains likely are due to an undue sudden stretching of the contained nerves. Cutting, if it strikes no endorgans, gives no pain. In opening a gall bladder, for instance, if its summit is caught up by two clamps, pain is felt when each forceps is tightened. No pain is felt when the top of the viscus is cut into. If now the operator attempts to enlarge the opening by dilatation, severe pain is caused. While the patient does not complain when the summit is cut, he objects to the use of the stone scoop inside and the nearer the duct the more the complaint.

The diseased peritoneum suffers quite as many deviations from the normal in its response to stimuli as it does in anatomic structure. A dropsical peritoneum (having been infiltrated by nature) is little or not at all painful. The same applies, of course, to the skin.

Inflammation, as already intimated, influences the peritoneal sensibility greatly and the variation seems to follow the same general laws that govern the sensibility of the somatic system. Simple hyperemia does not increase the sensibility. This is true
whether the vascular dilatation is caused by an irritant or reflexly.

With the beginning of exudation, sensation is much heightened. This applies to both serous and cellular exudates. So far as my studies permit me to judge, that stage of inflammation, when the connective tissue is swollen but retains its specific tinctorial reaction, is characterized by the greatest sensibility. This corresponds to the height of tissue reaction against injury. This stage once passed sensation lessens. If regression begins the normal is approached. If the process becomes subacute the connective tissue loses its specific reaction to dyes and approaches the fibrin reaction. Tissue in this state may be relatively free from sensation. If organization begins sensation increases and may equal or exceed that of acute inflammation. If a severely toxic process develops sensation may be lessened. This may be due to a soggy edema. No effort on my part has revealed any changes in the nerves to account for these variations in sensibility in the various stages of inflammation.

In order to give concrete form to these observations, I may hypothecate a case of appendicitis running through these various stages. In the acute stage the appendix and immediately adjacent portion of the cecum is inflamed and the pain is heightened. Farther up the ascending colon is hyperemic, due to reflexes from the inflamed area and is not abnormally sensitive. With the increase of the process the walls of the appendix become swollen and adhesions are formed. This stage is marked by excessive sensitiveness. If this stage exists for some time the changes in the tinctorial reaction above noted take place and sensitiveness is reduced. Guts in this stage may be separated with impunity. If restitution begins and permanent adhesions form, the tissues become more sensitive again. The pain produced by carcinomatous invasion corresponds to this stage of the reactive process.

These data here tentatively presented were gained by noting the patient’s interpretation of the sensitiveness when the tissues
were handled. If the operation was productive of specimens these were religiously examined in the laboratory. Similar states were produced in animals and these studied. Studies of nerve changes in these conditions were fruitless. I regard as utterly useless attempts to study sensation on lower animals. An interpretation of the gross changes in the viscera above noted often gives the operator the clue as to whether or not he shall call for general anesthesia. These studies, I am aware, have been but a rattling of the dry brushes of the valley, while the timber-covered mountains lie unexplored before. Nevertheless, knowledge must supplant speculation in abdominal anatomy and pathology before we can discuss intelligently the problems of local anesthesia.

EXPLORATORY OPERATIONS.—Not infrequently local anesthesia finds a useful application in exploratory or confirmatory abdominal section, especially in cases where a lesion, usually a malignant tumor, is believed to be inoperable, yet the patient demands the benefit of the doubt. In such patients an exploration under ether is an operation of some magnitude, while with local anesthesia it is no more than an inconvenience. Should an operable lesion be discovered its removal may be undertaken at once under local or a general anesthetic may be administered. If, for instance, an operable pyloric tumor is present a gastro-enterostomy may be done under local if the patient’s condition demands it, and the removal of the tumor may be undertaken at a later date. Not infrequently it is difficult to distinguish between simple stenosis and constriction due to malignancy. Local anesthesia offers a simple solution of the problem by inspection and gives opportunity for establishing permanent drainage, or, in cases where the tumor is operable, for a complete removal of the growth. Dr. E. D. Twyman employs local anesthesia in probable gall-stone cases. He proposes to the patient that he will make an inspection under local anesthesia and if no gall-stones are found the patient will be spared the inconvenience of the general anesthesia, but if stones are present a general anesthetic
will be given and the operation completed. Frequently when the gall bladder is exposed and the stones demonstrated it is possible to complete the operation under local.

Local anesthesia is suitable for exploration only when the surgeon has in mind a definite condition to exclude or confirm. When he has only a vague notion of some abdominal lesion, local anesthesia will not be satisfactory, because it does not give opportunity for aimless wandering about in the abdominal cavity.

The technic of an exploratory incision does not differ materially from that of any other incision. If the operator expects the patient to remain in bed for a day or two only, as in operations for confirming a diagnosis, the incision will be planned in position and length so as to admit of the firmest immediate closure of the wound. Thus, in case of carcinoma of the stomach a short incision high in the epigastrium will settle the question of glandular metastasis and operability through an incision that admits at most two fingers. The same rule applies in cases of chronic jaundice, with suspected tumor about the gall ducts, and over the sigmoid or pubes in malignancy of these regions. With a short incision firmly closed the patient need not go to bed at all. Consequently the surgeon gains the patient’s consent for early operation and the patient gains the surgeon’s consent for late exploration. The former often, and the latter occasionally, results in vast good to the patient and much satisfaction to the surgeon.

Abdominal exploration under local anesthesia will, however, not give much information to an inexperienced surgeon. Many indeed explore the cavity under ether and fail to clear up the diagnosis.

The method of infiltration for exploration in any region is the same as that for typical operations and will be discussed in connection with the respective regions. The method of closure and the material should be chosen according to the site and type of incision and with respect to the condition of the patient. If the condition of the patient is such that he should not be in bed
long, the wound must be securely sutured. When the patient is to be allowed to be up at once the wound should be sutured with chromic gut. If in addition the patient offers conditions which make a disturbed wound-healing probable, as in diabetes or jaundice, figure-of-8 silkwormgut sutures in addition to the catgut sutures furnish additional security.

**THE ABDOMINAL INCISION.**—General rules apply to the infiltration of all abdominal incisions. Two methods have been em-

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**Fig. 71.** Elliptic infiltration of the abdominal wall.
ployed in anesthetizing the skin. In one the skin is infiltrated in the line in which the incision is to be made, and the deeper parts are then anesthetized through this line. In the other, an ellipse or a rhomboid or some other geometric figure is described about the line of proposed incision (Fig 71). By this method the skin contained within the figure is anesthetized and may be incised in any part. My preference is emphatically in favor of the former, for the reason that a single prick in sensitive skin suffices, the subsequent injections beginning at points which are already anesthetized. The deeper parts can be reached by passing the needle directly downward through the linear infiltration (Fig. 72). The trained operator is thus enabled to anesthetize the muscular layer and the transversalis fascia and with it the peritoneum before the skin incision is made. Meanwhile the skin has lost its sensation and while the incision is made and hemostasis secured the deep infiltration is becoming effective.
By this plan it is unnecessary that the operator wait for the action of the anesthetic in any part of the operation. What is of even greater importance in extensive operations is that the linear skin infiltration requires much less anesthetic solution.

The rhombic method not only requires multiple points of primary infiltration, each of which adds to the discomfort of the patient, but also necessitates the use of several times as much fluid to produce anesthesia of the skin. If it is desired to inject a definite line in the deeper tissues, the rhombic figure on the skin from which the injection is made prevents any great accuracy, and the amount of fluid used is likely to be excessive. The single advantage of the method is that the operator is permitted to handle the tissue more roughly. Those who are accustomed to handle all tissues with the greatest delicacy whether obliged to do so or not, will not regard this as an advantage. In outlining the figure on the skin it is necessary to reach all nerves supplying the skin within its confines. If nerves reach the area from a depth greater than that to which the infiltration has reached anesthesia will of course be incomplete. The rhomboid method is unavoidable for lesions which must be circumscribed, such as post-operative, and umbilical hernias, and tumors which are large or extensively adherent.

Sometimes, particularly in fat subjects, when it is not possible to infiltrate the muscle and fascial plains before the skin is incised, these structures must be injected after the incision is made through the skin and fat. The inexperienced will find a resort to this method necessary in most cases. The reticular tissue immediately overlying the fascia should not be disturbed before the latter is infiltrated, because it contains nerve filaments and will give pain.

The fat layer as a rule is not sensitive, but the heavy fascial bands which sometimes traverse it often contain nerves. The operator can often divide the tissue parallel with these bands and by pushing them aside avoid even the slight sensation their division causes. Only in certain areas, to be mentioned specifically
later, is the infiltration of fatty layers to be undertaken. It is to be avoided, if possible, because fat at best heals badly and the addition of anesthetic fluid places an additional burden upon the reparative process, and because the increased amount of anesthetic fluid may be a factor of importance in extensive operations.

PREPARATION OF THE PATIENT.—Usually, when the surgeon sacrifices the convenience of general anesthesia in abdominal operations, the condition of the patient is such as to demand special thought as to preliminary treatment. For operations which are done by choice under local, especially upon the abdominal wall only, the ordinary routine of preparation is sufficient. For emergencies, such as may arise in intestinal obstruction, where enterostomy alone is indicated, special preparation is neither convenient nor necessary. Sterilization of the skin with iodine usually constitutes the preparation, the preliminary injection of morphine not being generally needed. Careful preparation is desirable before exploratory operations for chronic conditions, especially malignant disease. To secure the best cleansing of the digestive tract dependence is to be placed upon a reasonable diet and simple laxatives and enemas rather than upon starvation and purges. The patient should be kept upon a diet suited to his condition up to the very time of entering the operating room. By careful attention to this detail his power to withstand an operation can be materially augmented, and the abdominal contents can be placed in a much more favorable condition to tolerate the necessary manipulations. Patients with advanced pulmonary disease should have heroin or codein in order to prevent coughing during the operation. The dietetic preparation of patients with diabetes or nephritis should be carried out for as long a period as possible before the operation. In diabetes the use of codein for several days before the operation often improves the patient’s condition with astonishing rapidity.

GASTROSTOMY.—As a rule, this operation is required for carcinoma of the esophagus, and is usually performed when the stomach can no longer be entered by sounds or tubes. Reliable
evidence as to the size and position of the stomach is difficult to secure, but it may be assumed that in such a condition the stomach is much contracted. An operation should, therefore, be selected which may be performed with the least possible traction upon the stomach.

A line four inches in length is infiltrated over the middle of the left rectus muscle beginning an inch or two below the costal margin. The deeper parts are freely infiltrated through the unopened skin. Before the fascia is incised the transversalis fascia should be infiltrated for an inch or more on each side, so that the stomach may subsequently be attached to it without pain. The incision in the abdominal wall should be long enough to allow the stomach to be distinguished from the colon by inspection.

Witzel's or Senn's operation is the preferable one when the stomach is much contracted. When it is not contracted any operation desired may be selected. The stomach is not sensitive to suturing, but is very sensitive to the traction of the sutures. Therefore, when it has been fixed by forceps or by the fingers of the assistant the wall should be gently infiltrated with quinine solution. Care should be taken that the infiltration be not too intense or it will interfere with plication of the stomach walls, and will cause annoying contractions of the stomach after the operation has been completed. The operation is finished in the usual way.

An elliptical infiltration of the skin with a corresponding injection of the deeper parts offers certain advantages. It allows a wider range of operative choice and is especially adapted to thin abdomens where a proper fascial infiltration can be made through the unopened skin. It is the method of choice when Frank's operation is to be done.

GASTROENTEROSTOMY.—The preliminary blocking may be made either as an ellipse or in a straight line. The important thing is to have the incision of sufficient length and far enough down in relation to the inferior border of the stomach in order that traction upon the viscera may be reduced to a minimum. Inasmuch
as the operation is usually done for pyloric obstruction, the lower border of the stomach must be previously determined either by insufflation or better by the x-rays.

The line of infiltration in the skin should be six inches long, so that the incision in the fascia may be at least five inches long. A longer incision is required than when opening under ether in order that the jejunum can be located and coapted to the stomach without too much tugging. This is the most important point in the planning of the operation. When the operation is done for inoperable carcinoma of the pylorus the posterior operation should not be attempted, because tugging on the stomach is particularly likely to be painful on account of the infiltration of the walls. The stomach is also often unnaturally fixed. Since the operation is at best but palliative, ultimate results are of less importance than in cases of benign stenosis. The anterior operation is, therefore, the method of choice. In cases of benign stenosis the posterior operation is indicated and is likely to be easily carried out, particularly if considerable dilatation is present.

If a cholecystectomy is to be undertaken under local anesthesia, it is necessary to make an infiltration between the gallbladder and liver. This is best begun where the peritoneum deflects from the liver over to the gall-bladder. The tissues about the cystic duct are easily infiltrated by passing the needle beneath the peritoneum, parallel with the duct, and a cc. of fluid injected.

In either operation the use of clamps depends upon whether or not the parts can be brought upon the surface of the abdomen. If the operator is compelled to work in a measure within the abdominal wound, long clamps may exert a continuous tugging. In such cases, short clamps like the Bartlett clamp may be used with advantage. They can be used in any position and are preferable to the fingers of an assistant.

Feeding may begin soon after the operation in most cases, because there is little or no tendency to vomit. This is often a matter of importance in patients who are much reduced by starvation.
COLOSTOMY.—Permanent drainage of the colon in the region of either the cecum or the sigmoid is frequently best performed under local anesthesia. It may be a palliative operation or pre-

liminary to operative removal of a tumor. Because of the permanency of the wound the best method is to describe an ellipse with quinine about the region to be operated upon and to infil-

Fig 73. Linear infiltration with secondary deep infiltration lines for the incision for acute appendicitis.
trate the muscle layers freely with novocain-epinephrin. The operation requires cutting across massive bundles of muscle, which are more or less richly supplied with blood vessels. The thorough infiltration by novocain-epinephrin gives a relatively bloodless field and permits the retraction required to secure the gut. The length of the incision should be from three to five inches, depending on whether or not it is desirable to explore the abdomen in order to find out if the lesion causing the obstruction is operable. The segment to be drained is brought into the wound and held by a row of sutures surrounding the proposed opening. If the gut comes well into the wound it can be retained by passing a glass rod beneath it. If the indications are not urgent the gut should be exposed for from 24 to 72 hours before it is opened.

APPENDECTOMY.—Either rhomboidal or lineal infiltration (Fig. 73) of the skin can be made, followed by massive infiltration into the muscle. The muscle injections block the nerves effectually and permit considerable manipulation of the tissues medial to them. One-half per cent. novocain-epinephrin is the preferable solution. It is better to make the incision lateral to the semilunar line so as to avoid the network of nerves near this line. Otherwise some of the nerve fibers, which may have escaped the area of infiltration will cause pain if cut.

The ease with which the appendix can be removed depends upon the location and mobility of the cecum. When this can be brought into the wound but little difficulty will be experienced in the operation, but when the cecum is fixed by inflammatory adhesions the operation may be by no means easy. Difficulty is particularly likely to arise in the period of subacute inflammation 3 to 6 weeks after the acute attack. It is this uncertainty as to the local conditions which contraindicates the use of local anesthesia in all cases. Fortunately, however, these patients are usually in good condition and the operation is short, so that general anesthesia is not objectionable.

In acute suppurative lesions where the abscess is well walled off, I have many times slid the patient to the edge of his bed, in-
filtrated the abdominal wall as described, opened the abscess, introduced the tube, and allowed the appendix to remain for a second operation. There are many situations, I am sure, where patients would be better off if so managed rather than transported to more favorable conditions. All that is essential for this operation is a good syringe and a diagnosis.

GALL BLADDER DRAINAGE.—When the gall bladder is long enough to reach the parietal peritoneum, drainage can easily be secured under local. A line in the skin and deep layers, three inches long, parallel to the costal border and an inch below it, is infiltrated and incised. The gall bladder may then be grasped and pulled out into the wound and anchored either before or after a drainage tube has been placed. This method is particularly desirable when the condition of the patient is unfavorable and when the gall bladder is much distended and can be palpated through the unopened wall.

When the gall bladder is to be drained for stones, or when the common duct or pylorus is to be explored, a long vertical incision is preferable. It should extend from the costal border downward for at least five inches, and should be preceded by infiltration of the skin and deeper layers. A long oblique incision parallel to the costal margin and below it gives better access to the gall bladder than the longitudinal incision, but is not as well suited for reaching the pylorus and does not permit an examination of the appendix. The chief objection, however, is that it cuts the nerves which supply a considerable part of the abdominal muscles.

The operation does not differ from that done under general anesthesia, if the gall bladder is long enough to reach the incision. If traction is necessary the operator has the choice of supplementing local injections by inhalation anesthesia, or draining the gall bladder deep in the abdomen and allowing the drainage tube to supply the distance between the gall bladder and abdominal wall. The chief difficulty in this plan is the proper protection of the environment while the stones are being removed.
Unless strongly contra-indicated a supplementary general anesthetic will be preferable.

Superficial abscesses about the gall bladder may be blocked by infiltration, through an incision parallel to the costal border, which also permits satisfactory drainage. If, however, as is usually the case, there is a perforation or escape of infective material nearer the base of the gall bladder, dense adhesions form which cannot be removed without great pain. In general, for the present, operations upon the gall bladder are not to be encouraged under local anesthesia. Careful exploration and finished operations are more difficult than under general anesthesia, and generally speaking, operations in this region are now done with too little care.
CHAPTER XIV

OPERATIONS FOR UMBILICAL HERNIAS, HERNIAS OF THE LINEA ALBA AND SCAR HERNIAS

UMBILICAL HERNIAS.—This affection is most common in stout women past middle life, who are also poor subjects for general anesthesia. The following operation has been found uniformly satisfactory in all patients for hernias of any type or size:

An ellipse is infiltrated about the hernia at such a distance from the sac that it is easily accessible (Fig. 74). If it is desirable at the same time to excise superfluous fat, the ellipse must be correspondingly larger. I have in this way resected pieces of fat measuring a foot in one diameter and eight inches in the other, with a thickness of four inches. The fatty layer should be injected through the primary line of infiltration with a weak solu-
tion (say ¼ per cent.) of novocain-epinephrin or quinine. The fatty layer is not very painful and the amount of fluid injected should be small. Even without injection section of the fat is painful only when large fascial septa are cut. For small hernia, in which the amount of anesthetic required is not great, novocain-epinephrin may be used throughout the operation. I use quinine for the skin in all cases. In large hernias quinine is imperative, because the amount of fluid necessary exceeds the limit of safety of novocain.

If the operator is experienced and the abdomen not too fat, the abdominal walls may be anesthetized through the primary line of infiltration before the skin is incised. The fascia about the ring is freely infiltrated (Fig. 75). This gives complete anesthesia. If conditions are less favorable, the following plan is more certain: the skin is incised through the primary infiltration line and the fascia is exposed, as shown partly accomplished in Fig 76. The abdominal wall about the ring is then infiltrated (Fig. 76), fluid being injected just beneath the fascia, into the muscle and partic-

Fig. 75. Infiltration of the layers of the abdominal wall in umbilical hernia. The skin has not been incised. (Redrawn from Braun).
ularly just above the transversalis fascia. The distance from the ring at which the injections should be made depends upon the size of the opening. If it is large, or if extensive overlapping of the edges of the ring will be required, the injection should be made at least an inch from the margin. If the opening is small, the injection should be made close to the ring (Fig. 75.) By this injection the ring is effectually anesthetized for all future manipulations.

Fig. 76. Infiltration of the fascial layer of the abdominal wall in umbilical hernia. Half the circumference of skin and fatty layer has been incised and raised up showing the point of entrance for the needle in injecting the fascia, muscle and peritoneum.

The sac is now opened and adhesions of omentum and gut freed from the ring and from each other. Any excess of omentum is excised and the cut edges carefully inverted to prevent subsequent adhesions.

The flaps are now prepared for overlapping. Any degree of imbrication is possible and there is no rigidity of the muscles or increase in intra-abdominal pressure when the sutures are passed.
Fig. 77. The first row of sutures is passed and one of them is tied.

Fig. 78. The second row of sutures passed through the edge of the upper flap and into the fascia of the recti below the opening.
The usual Mayo technic may be followed (Figs. 77 and 78), or the overlapping may be done laterally. The epinephrin gives a bloodless field, which makes the technic easier, but all raw edges should be protected by suture to prevent oozing. The fatty layer is not sutured. The skin is closed with silk worm gut, which should be placed close to the cut edge so that the needle does not pass beyond the primary line of infiltration. It is well to allow the patient to walk back to the bed, for it gives her a sense of confidence and pride and lessens the labor of the attendants.

Hernia of the Linea Alba.—These small hernias nearly always occupy the mid-line and are exposed best through a line infiltrated directly over the summit. In the rare cases of hernia of the linea semilunaris, the line of infiltration corresponds to the lateral border of the rectus. It is well to make the primary infiltration much longer than the apparent need, so that if the hernia has a long pedicle, which is not uncommonly the case, it will not be necessary to make a second infiltration in order to reach it.

After the primary line has been infiltrated the external fascia is anesthetized by injecting the tissues immediately above it. The operator readily perceives when the needle touches the fascia, and if he does not, the patient will tell him. After the prefascial tissue is injected the needle passes through the fascia into the edge of the rectus muscle. This region is freely infiltrated so as to anesthetize the tissue external to the transversalis fascia. The entire region of the operation is then anesthetic. If the operator cannot find the fascia, the skin and subcutaneous fat may be incised first, and the fascia and deeper layer infiltrated when exposed.

Any operation desired may be done. As suggested above, it is well to make a fairly long incision into the abdomen so that the relations of the pedicle to the interior of the abdomen may be determined.

Scarf Hernias.—A bulging scar presents much the same problem as an umbilical hernia, but is likely to be more complicated.
Unless the operator is quite sure of himself, he should carefully consider beforehand the nature and extent of these complications.

A line is infiltrated circumscribing the old scar. If the wall is not too thick the fascial and muscle layers may be infiltrated through the primary line. At any rate the subcutaneous fatty layer should be infiltrated, because it is likely to contain thickened fascial bands resulting from the disturbed healing which caused the scar. If the fascia and muscle have not previously been infiltrated, this is done after the skin and subcutaneous tissue have been incised. It is well to make this infiltration an inch or so from the edge of the bulging scar, because there are certainly adhesions about the edge of the hernia, which sometimes extend a considerable distance, and unless this precaution is taken pain will be caused when they are separated.

From this point the problem is the same as when operating under general save that the abdominal wall is pale and flaccid from the novocain-epinephrin. For this reason the operator must use more than ordinary care not to cut an adherent intestine in opening the abdomen.

If, when the opening is exposed, it is found too large to allow direct apposition, a flap of the adjoining fascia must be loosened and turned over the defect. Additional infiltration must then be made in the area from which the flap is to be taken. If sufficient firmness is not secured by this means, a fascial transplant may be secured from the thigh after the technic of Dr. A. T. Mann. For the skin infiltration about the hernia and for infiltrating the thigh for a transplant, quinine is used. For the tissue about the hernial opening novocain-epinephrin is preferable.

In the repair of scar hernias, local anesthesia is especially gratifying to the patient, who has usually already been subjected to anesthetization by ether, and is in a position to know what he has escaped if a successful operation is performed under local anesthesia.
CHAPTER XV

OPERATIONS ON HERNIAS

Operations for hernia have been done under local anesthesia more frequently than any other operation of like magnitude. The reason for this is that this operation can be done with ease because of the definite anatomic relations of the structures involved. The patient is often desirous of escaping the general anesthetic, the disadvantages of which have been unduly magni-
Surgical Operations with Local Anesthesia

fied by those irregulars who pretend to produce a cure by non-operative means. Many patients indeed have refused operation until they find that it can be done without a general anesthetic. It is surprising, too, that many doctors who have long borne the inconvenience of their hernias submit readily to operation when they once observe the efficiency of local anesthesia. While the most frequent reason for employing local anesthesia is that it causes less inconvenience to the patient, in a few patients, particularly those of advanced years, operation may be advised where general anesthesia would be prohibitive.

All hernias may be operated under local anesthesia. Simple inguinal hernias furnish suitable objects for the introduction of the beginner into the use of local technic, while some of the large scrotal or interstitial ones furnish good exercises for the experienced technician. It becomes necessary, therefore, for the operator to measure his experience with the particular case before him if he is to avoid perplexities and disappointment for himself and pain to the patient. In the following description the operations are given in detail in order that the junior surgeon may anticipate the possible difficulties at the various stages.

Neural Anatomy.—The nerve supply in the region of inguinal and femoral hernias is furnished by the ilio-inguinal, ilio-hypogastric, and genito-crural nerves (Fig. 79).

The ilio-inguinal arises from the first lumbar nerve and passes across the quadratus lumborum muscle, pierces the transversalis muscle and, associated with the ilio-hypogastric, follows the curve of the crest of the ilium. It pierces the internal oblique muscle in front of and above the anterior superior spine of the ilium and reaches the inguinal canal by following Poupart's ligament under cover of the fascia of the external oblique. In the canal it lies upon the cord at its anterior and upper surface and is the first object to come into view when the canal is opened (Fig. 84). It escapes the canal at the external (medial) ring and supplies the skin of the upper inner part of the thigh and the upper part of the scrotum, and the root of the penis in the male and the ex-
treme upper part of the labium majus in the female. It usually lies as a white band the size of a thick darning needle upon the hernial sac. Occasionally it divides before entering the canal and is then spread out into a number of fine filaments.

ILIO-HYPOGASTRIC.—This nerve, like the preceding, arises from the first lumbar nerve and passes along the crest of the ilium in company with it. Before reaching the anterior superior spine of the ilium it divides into an iliac branch, which passes over the crest of the ilium and is of no interest in this connection, and a hypogastric branch which continues in company with the ilio-inguinal. At or near the anterior superior spine it parts company with its companion and reaching the under surface of the fascia of the external oblique, passes between this fascia and the internal oblique muscle to a point about an inch above the external (medial) ring where it pierces the fascia and is distributed to the neighboring skin.

The important point in the relation of these two nerves is that at a point 3 or 4 cm. above and medial to the anterior superior spine and over the crest of the ilium beyond, they lie close together and may be blocked at this point (Fig. 79) by an anesthetic solution.

THE GENITO-CRURAL.—This nerve, formed by the union of fibers from the first and second lumbar nerves, runs on the surface of the psoas muscle under cover of the peritoneum to reach the outer side of the external iliac artery. Here it divides into a crural branch, which, accompanying the iliac vessels, pierces the facia and supplies the skin about the saphenous opening, and a genital branch which accompanies the spermatic vessels through the inguinal canal and supplies the scrotal contents and after piercing the spermatic fascia supplies the cremaster muscle.

In many instances this nerve is fused with the ilio-inguinal. When such is the case the blocking of this nerve secures anesthesia of all the scrotal contents. Frequently the nerve divides into numerous filaments which are distributed to the cord. In most instances the vas secures fibers high up in the canal so that if the cord itself is to be attacked the whole cord must be blocked.
In addition to the above-described nerves, branches from the pudic and small sciatic nerves supply the posterior surface of the root of the scrotum. The upper part of the scrotum is probably supplied by nerves from the sacral plexus, as well as by the nerves above described. This arrangement of the nerves makes it necessary in large scrotal hernias, particularly in those containing strangulated omentum, to block the skin and fascia about the root of the scrotum as well as the nerves in the inguinal canal.

Novocain-epinephrin ½% is the most convenient solution to use. In extensive cases ¼% may be used for the deeper structures. In very large hernias this may be supplemented by quinine solution, or the latter may be used throughout.

**INGUINAL HERNIA.**—Either of two plans may be followed in the operation for the radical cure of inguinal hernia. I. The operation as first developed by Cushing (Ann. Surg. 1900, XXXI, i), consisted in the successive infiltration and division of the various layers, together with a direct injection of the ilioinguinal nerve after it was exposed. II. Preliminary wide infiltration of the field of operation, thus blocking off all the nerves before the operation is begun.

The first operation demands a more exact technic and requires much less anesthetic fluid than the plan of massive injection. The beginner will find that his attempts at massive injection will often fail at some point, and it is of importance at such times to know just how to supplement it by secondary injections. For this reason the operation as done by Cushing, with some modification in its various steps, will first be described, followed by the description of a technic more convenient to the experienced operator.

**INFILTRATION BY LAYERS.**—The skin incision should be planned in reference to convenience in operating and also to ease in retaining a dressing after the operation has been completed. The former demand is met by an incision in the line of the inguinal canal (Fig. 80), and the latter by one placed higher up in a
nearly transverse direction (Fig. 81). The former is to be recommended for the beginner.

The skin is infiltrated in the line of the inguinal canal, extending from the root of the penis to a point lateral to the internal ring. If the hernia extends into the scrotum the infiltration may extend downward upon the scrotum. This increases the ease of operation, but increases the liability to infection, because...
the skin of the root of the scrotum is difficult to sterilize. For this reason it should not be extended farther than necessary.

Usually there is a superficial nerve accompanying the superficial branches of the deep epigastric vessels and an injection into the subcutaneous tissue will block it (a, Fig. 80). Likewise over the external ring branches of the ilio-inguinal and the ilio-hypogastric reach the subcutaneous tissue and may be blocked by in-

![Diagram of skin incision](image)

Fig. 81. High skin incision for inguinal hernia.

filtration of the subcutaneous tissue at this point (b, Fig 80). In cases where the incision must be extended farther down on the root of the scrotum a third point (c, Fig 80) may be infiltrated.

The incision is now made to expose the superficial deep epigastric vessels (Fig 82). These are clamped, cut and ligated. If the incision extends down far enough to reach the pudic vessels these, too, must be identified before they are cut and clamped and
Fig. S2. Superficial deep epigastric vessels.

Fig. S3. The fascia of the external ring is exposed. a, point of infiltration about the internal (lateral) ring; b, point of infiltration about the external (median) ring.
ligated. This care is necessary in order to keep the tissues free from blood in order not to obscure the anatomic structures. These vessels having been secured the subcutaneous tissue is divided down to the fascia of the external oblique muscle.

When this fascia is exposed, the pillars (b, Fig. 83), and the muscle bundles at a point where they disappear to make the external oblique fascia (a, Fig. 83), are infiltrated. The infiltration at this point should be freely made so as to reach the cord and sac. This anesthetizes the area of the ring to which the sac is attached and prevents pain when the sac is ligated. The remainder of the fascia is not sensitive and may be freely divided. When divided it is well to pick up the free edges and retain them with forceps in order that they may be readily identified at any time (Fig. 84).
The cord and sac now lie in the bottom of the wound. If the parts have been kept free from blood the ilio-inguinal nerve is now seen passing over the center to disappear down into the scrotum. This nerve is now injected directly at the point where it emerges through the internal ring (a, Fig. 84). This injection is made more readily if the nerve is picked up with suitable forceps (Fig. 10). The sac, lying above and external to the cord;

Fig. 85. The cord is lifted from its bed with forceps. The sac shows above, and below is the cord including the vessels and fat. a Point for injecting the cord; b, deep epigastric vessels.

is now identified. It is grasped with forceps and raised up (Fig. 85). This carries with it the cord. The genital branch of the genito-crural nerve is now blocked by injecting the cord where it emerges from the ring (a, Fig. 85). The inferior deep epigastric vessels are seen in the depth of the wound beneath the cord (b, Fig. 85). If these vessels are identified they are not likely to be injured in suturing.
The sac is now separated, opened and ligated. If this causes pain, owing to previous imperfect injection, the sac may be injected about its base (Fig. 86). This is rarely necessary unless there are adhesions of viscera to the inside of the sac.

The closure of the wound is most easily accomplished by displacing the cord backward and uniting the conjoined tendon with Poupart's ligament in front of the cord (Fig. 87) or the typical Baccini operation may be done. The suture of the fascia of the external oblique (Fig. 88) and skin completes the operation.

It will be noted that the above directions advise the repeated injection of the same region. If the injection at Fig. 80, or a, Fig. 84, is properly made, the cord and sac will be completely
blocked. In that event the separate infiltration of the nerve a, Fig. 85, will not be needed. The same is true of the sac. But should the high separation of the sac still be painful after the filtration at a, Fig. 83, has been made, the plan shown in Fig. 86 may be followed. The same may be said regarding the separate infiltration of the cord at a, Fig. 85. No apology is offered for presenting these details. I have seen operators fail for the lack of knowledge of just such trifling details.

PRELIMINARY NERVE BLOCKING.—In this method the entire nerve supply is blocked at the point where they lie most closely together, namely above and medially to the anterior spine (Fig. 79).

The line of the skin is first infiltrated (Fig. 89). At a point medial to the anterior superior spine the deep infiltration is made. The needle is passed obliquely upward and outward (a, Fig. 89). The fascia of the external oblique is felt as a definite resistance

Fig. 87. The sutures are being passed through the conjoined tendon and Poupart's ligament. The cord is behind this line of sutures.
to the needle. Usually, too, the patient feels a slight pain when the point of the needle passes the fascia. If the operator is not certain of the position of his needle he can determine the position of the point of the needle by moving it about. If the point is still imbedded in the fatty layer it will move about readily, but after it has passed the fascia it cannot be so moved. The needle having penetrated the fascia is passed for a centimeter or two along the muscle and the anesthetic solution deposited. By passing the needle first more obliquely upward and then downward toward the spine, all the nerves in this region are sure to be reached.

It is well now to infiltrate the muscle about the internal ring (b, Fig. 89 and Fig. 90). This anesthetizes the attachment of the peritoneum at the ring and makes the subsequent high separation and ligation of the sac painless. It will likewise block off the
Fig. 89. Nerve blocking for inguinal hernia. a, Deep infiltration into the abdominal muscles to block the ilio-inguinal and ilio-hypogastric nerves; b, infiltration about the internal ring to anesthetize the attachments of the sac; c, infiltration about the pillars to block accessory and aberrant nerve filaments.

Fig. 90. Schematic transverse section of the inguinal canal. Needles correspond to a, b, c, Fig. 89, reaching the ilio-inguinal and hypogastric nerves, the structures about the internal ring, and the structures about the pillars respectively.
genito-crural nerve and make the manipulations of the cord painless. Ordinarily the blocking so far as described anesthetizes the tissue about the external ring as well. Sometimes, however, this region receives branches from the twelfth dorsal and from the pudic. In order to make sure of complete anesthesia it is well to deposit a small amount of the fluid above and below the pillars of the external ring (Fig. 90).

The time required for making this infiltration is about six minutes. In order for anesthesia to be complete it is necessary to wait five or ten minutes longer. Skin anesthesia is already complete, however, and if the operator begins at once and carefully exposes the superficial vessels and ligates them, by the time the fascia is reached the blocking will be complete and a wait on the anesthesia is not necessary.
So planned the time consumed is no greater than operating under a general anesthetic. A moderately skillful operator should turn out a hernia operation every 30 or 40 minutes. What little time is lost in the infiltration is made up by the expedition with which the patient gets out of the way. He walks out of the operating room, thus consuming less time than would be required to haul him out with a cart.

So injected any operation desired may be done without further thought as to anesthesia. If through inexperience the operator fails to secure satisfactory anesthesia in any stage of the operation he can supplement it after the plan first described.

Under unusual conditions the experienced operator may be compelled to supplement his primary infiltration. In very fat patients it is sometimes difficult to reach the plane of the nerves beneath the external oblique, because the distance is difficult to estimate, or the needle available may be too short.

In persons who have worn a truss for a long time or have suffered many strangulations, the connective tissue planes may be so thickened as to lead the operator into mistaking them for the fascia of the external oblique, and in consequence he deposits the solution above instead of beneath that structure. Sometimes, too, in these persons the layer of fat between the skin and fascia is surprisingly thin. In such instances the needle may be passed entirely through the abdominal wall by mistaking the transversalis for the external oblique fascia.

In lipomas of the inguinal canal associated with hernia failure to secure anesthesia is a common occurrence. They usually have wide attachments in the preperitoneal fat, which necessitates infiltration through the abdominal muscles coextensive with the tumor. If the extent of the tumor is accurately judged, however, anesthesia can readily be secured before the skin is incised.

With nerve blocking as above described hernial sacs of any extent can be dissected out with ease. If the sac is extensive it may be allowed to remain, precautions against hydrocele being taken by means of obliterating sutures.
The large rhomboidal infiltration, as advised by Braun, obviates the necessity of delicacy in manipulation and saves time. It is satisfactory in plethoric subjects, but in nervous patients is less likely to produce satisfactory results than the more delicate procedure above recommended.

![Diagram](image)

Fig. 92. Skin infiltration about a femoral hernia. a, Point of entrance for infiltration about the neck of the sac. This point reaches the crural branch of the genito-crural; b, point for infiltration medial to the sac reaching the pudic nerves.

**STRANGULATED INGUINAL HERNIA.**—In cases of strangulation the problems depend upon the degree of inflammatory reaction present. In early cases the operation differs in no wise from
operations on patients in which strangulation has not occurred, save that the infiltration is made about the inguinal canal and not into it for fear of puncturing the gut.

In cases in which the tissue is very edematous the action of the anesthetic is interfered with, and it is preferable to infiltrate layer by layer according to the first plan recommended. After the sac is exposed the tissues about the internal ring are separately injected (Fig. 91), and may then be incised with impunity. Strangulated loops of gut are not sensitive and may be handled without pain. Above the line of strangulation sensitiveness may be heightened.

Strangulated omentum, if it has retained its vitality in good measure and has become adherent to the sac, produces pain when manipulated. Topography is apt to be distorted so that accurate localization is uncertain. The entire field about the internal ring must, therefore, be blocked off preferably with \( \frac{1}{4} \) % novocain-epinephrin solution.

The use of local anesthesia does not alter the surgical problems involved. If the gut is viable it is returned and the operation terminated by complete or partial closure. If necrotic the gut is fixed in the wound to be resected at a later date or the resection and anastomosis may be proceeded with at once.

FEMORAL HERNIA.—The neural anatomy of femoral hernia is such that nerve blocking cannot be employed, and dependence must be placed upon infiltration without regard to the nerve distribution.

An elliptical skin line is infiltrated about the hernia with a linear extension upward and outward parallel with Poupart’s ligament (Fig. 92), or downward parallel with the saphenous vein. The former is suitable for the performance of Selig’s operation and the latter for conventional operations with or without strangulation.

From the initial infiltration line in the skin the tissues about the tumor are injected (a and b, Fig. 92). The medial side can be infiltrated with impunity, but the close proximity of the fem-
oral vein to the lateral side demands caution in passing the needle. Anesthetization of the neck can usually be accomplished by passing the needle through the lower edge of Poupart's ligament. If Seelig's operation is to be performed anesthetization of the inguinal canal as described for inguinal hernia should be added.

Fig. 93. Infiltration of the tissues about Poupart's ligament

Infiltration being complete, the sac is exposed. Sometimes the manipulation of the sac is still painful and renewed infiltration of the tissues about it is required. With the sac exposed no difficulty is experienced in securing anesthesia by edematizing the surrounding tissue. The sac is ligated close to the ligament and the wound closed in the usual manner or Selig's operation may be performed.
In cases of strangulation the surrounding tissues are often edematous and a more extensive infiltration is required. These often are usually small and it is usually most convenient to edematize the tissue about the tumor independent of the surrounding structures. By infiltrating the tissues just beneath Poupart's ligament the tissues about the neck may be anesthetized (Fig. 93). It is best to pass the needle to the medial side of the neck of the sac in order to avoid the femoral vein. After the sac is exposed, if it is not yet sufficiently anesthetized, additional infiltration may

Fig. 94. Poupart's ligament is being cut with scissors before the sac is opened.
be done. In order to release the constriction about the neck of the sac Poupart's ligament may be cut through (Fig. 94). After the sac has been attended to the cut ends of Poupart's ligament are united to the underlying fascia. In addition to making the operation easier this method closes the hernial opening (Fig. 95). These recommendations will seem purile to the experienced operator, but the beginner will find them comforting.
CHAPTER XVI

Sacral Blocking

To Cathelin (Brilliere et Fills, Paris, 1903, also translations by Straus; Entke, Stadgart, 1903) belongs the credit for first investigating the feasibility of producing surgical anesthesia by introducing a solution extradurally. He used cocain and was enabled to induce anesthesia over the entire body of a dog by the use of 3 cc. of 1% solution. In the human subject he injected the solution through the hiatus sacralis into the sacral canal, but was unable to produce satisfactory results with safe quantities of the anesthetic. Stockel (Zentralbl. F. Gynäk, 1909, XXXI, 1) further developed the method by using the less toxic eucain and novocain. By the use of 30 cc. of 0.5% novocain solution he was enabled to reduce the pains of parturition materially.

In 1910 Läwen modified the technic of Cathelin and Stockel, and was enabled to produce constant results. It had previously been shown by anatomists and by the injection experiments of Cathelin and others, that the epidural space surrounding the dura from the hiatus to the foramen magnum comprised the area between the dura and the internal periosteum and ligaments of the canal. Läwen, desirous of confining the action of his solution to the lower part of this canal, injected his patients while in the sitting position, or made the injection in the lateral position and then allowed them to sit upright until anesthesia was induced. He increased the concentration of his solution and determined that less than 1½ to 2% solutions were not effective. In order to reach nerves high enough in the canal he determined that at least 20 cc. of the solution was required. Gros (Munchen. med. Wchnschr, 1910, LVII, 2042) showed that the efficiency of the solution could be increased by the addition of sodium bicarbonate.

TECHNIC.—The sacral canal terminates below in the hiatus sacralis, a triangular opening the sides of which are marked by the
sacral cornua. This opening varies in size. It may be greatly enlarged by the failure of one or more of the arches to close, and may be reduced in size by an osseous bar and even entirely closed by osseous changes in the membrane which covers it. The hiatus is normally covered by the posterior sacrococcygeal ligament. By passing the finger along the spines of the sacrum from above downward this membrane is usually readily palpated. Lawen has aptly compared the sensation this membrane produces when palpated with that of a fontanelle. Even in fat persons the

![Image](image_url)

Fig. 96. Position of the patient in sacral blocking. (Lawen).

depression can be noted with considerable distinctness. When this is not possible one can find the hiatus with the needle by gently feeling the way into the canal much as one searches for the foramen ovale when injecting the Gasserian ganglion. By this means the canal can always be found and one need not, as Lawen does, exclude fat persons from the use of this method.

It is most convenient to place the patient in the left lateral position with the knees drawn up (Fig. 96). The finger of the left hand locates the hiatus. A syringe armed with a small needle is then used to anesthetize the skin and to locate the hiatus accurately. It is not difficult to recognize the foramen. The needle
meets an elastic resistance quite unlike that offered by bone. A little increase in pressure forces the needle through, and it then passes without resistance. The sensation is like that produced by passing the needle through the pleura into a pleural exudate. When the foramen has been located the small needle is withdrawn and a larger and longer one substituted. If one regards the feeling of the patient less, the larger needle may be used throughout.

The depth to which the needle enters must be noted. The termination of the dural sac is at the 2d or 3d sacral vertebra, which is from 6 to 9 cm. from the hiatus. As soon as the needle passes the membrane it is in the canal. Inasmuch as the closure of the canal is not complete it is desirable to deposit the fluid as near the nerve roots as possible without endangering the dural sac. From the measurements above quoted a depth of 6 cm. would seem to be entirely safe. An ordinary needle may be used, but in order to avoid injury to the venous plexus which fills the canal, Schlimpert (*Zentral P. Gynak, 1911, XXXV, 477*) uses a needle constructed like a trocar. After the membrane is perforated the sharp point is withdrawn and the needle pushed upward. With such a needle the danger of wounding the dural sac is obviated.

Instead the needle may be introduced within the canal and the empty syringe attached. The piston is then partly withdrawn, so that a vacuum is produced in the barrel of the syringe, and the needle slowly passed upwards. If the spinal canal or a blood vessel should be entered, the accident is made manifest by the appearance of their respective contents in the barrel of the syringe. Should this occur, the direction of the needle must then be altered. After the needle has entered to a proper depth, the syringe is filled with the anesthetic fluid and reattached to the needle and its contents slowly injected. At least 20 cc. of the solution must be used.

When a sharp needle is used the dural sac may be avoided by directing the needle to one side or other of the median line (Fig.
Likewise, in order to avoid perforating the nerve roots, the outside end of the needle should be moved toward the body after the membrane is past, in order that the point may approach the posterior wall of the canal. In order to injure the vessels as little as possible, injection of the fluid begins as soon as the needle passes the membrane and continues slowly as the needle gradually passes upward. In this manner the veins are to a certain extent pushed away from the point of the needle. Should a vein be punctured only a small quantity of fluid would be injected into it before the needle passes on through it. In this way 20 cc of the fluid are injected in the course of two minutes.

**Solution Used.**—According to the investigations of Gros the addition of sodium bicarbonate causes the novocain to penetrate more readily into the nerve sheaths. Läwen, on the basis of abundant experience, recommends the following:
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Sodium bicarbonate 0.15
c " chloride 0.1
Novocain 0.6

This is prepared in a powder and is dissolved in 30 cc. of water. This gives a 2% novocain solution of which 20 cc. is injected.

He also uses a weaker solution as follows:

Sodium bicarbonate 0.2
c " chloride 0.2
Novocain 0.75

This is dissolved in 50 cc. of water to make a 1½% solution of which 20 to 25 cc. is injected.

The solution is prepared by dissolving the powder in the given amount of cold water and bringing it to the boiling point. This brief heating assures a sterilization, according to Läwen, and increases its efficiency due, according to Gros, to the fact that the heating converts a part of the bicarbonate into carbonate which is still more hydrolytic. After the solution has cooled, 5 drops of 1:1000 adrenalin solution is added. Strauss (Ztschr. f. Geburtsh. u. Gyn k, 1912, LXXII, 163) adds sodium sulphate to prevent a decomposition of the adrenalin.

**Extent and Duration of Anesthesia.**—Anesthesia becomes complete in about 20 minutes. It is first noted at the tip of the coccyx and extends over the perineum, and laterally over the gluteal region. The region of the clitoris and glans penis are the last to become anesthetic, and in partial failure it is these regions that fail to become anesthetized. In other words, the coccygeal plexus is the first to become anesthetized, then the hemorrhoidal and perineal, and lastly the dorsalis penis. The cause of the occasional partial failure to reach the latter is that they come from the pudendal plexus which sometimes derives roots from as high as the first sacral segment. In addition the middle hemorrhoidal, vaginal and inferior vesical nerves are usually anesthetized. The
extent of the anesthesia of the latter nerves is often difficult to determine since operations upon these tissues involves more or less traction which may produce pain in regions beyond. In operations upon the rectum, such as high fistula, or in amputations when no traction is produced, no pain is experienced by the clamping and cutting manipulations. The prostate also is insensitive to incision, but not to traction. Paralysis of the motor nerves aids materially in retraction. The sphincter and levator ani become lax and the parts above are reached with greater facility than when operating under general anesthesia, but even with this aid the higher operations in the pelvis may cause pain. By using the Trendelenburg position Schlimpert & Schneider (Munchen. med. Wehnschr., 1910, LVII, 2561), have secured anesthesia as high as the umbilicus. In this position anesthesia seems to begin sooner, but is less certain than in the sitting position.

Schlimpert & Schneider have found sacral anesthesia useful in securing relaxation during labor in old primipara. They have not found that the intensity of the labor pains is influenced by sacral anesthesia. They used 50 ccm. of a 1% solution.

The duration of anesthesia is from 40 minutes to 2 hours and often longer. Sensation to touch often returns before that of pain and the sensations may be confused by the patient. The anesthesia usually subsides in the inverse order of its beginning; that is, the glands and clitoris first regain their sensation and the ano-coccygeal region last.

Efficiency and Failures.—Läwen (Deutsch. ztschr. f., Chir., 1911, CVIII, 1) gives detailed reports of 80 cases among which there were 7 failures. His operations comprised hemorrhoids, melanomas of the anus, fistulas, hypospasias and phimoses. Schlimpert & Schneider (l. c.) reported 34 operations comprising perineal repairs, currettage of inoperable carcinomas, and rectoscopy, and cystoscopy. They recommend it for forceps operations and for the repair of obstetric lacerations. To these Schlimpert (Centralbl. f. Gynak., 1911, XXXV, 477),
adds 55 cases in which there were 11 failures. In 12 general anesthesia had to be added because of the long duration of the operation. In these cases the Trendelenburg position was used.

My own experience with sacral blocking has convinced me of the value of the method in perineal operations. It sometimes fails more or less, but if one is ready to supplement the sacral blocking by local infiltration the shortcomings of the method do not work much of a hardship. My plan is to use quinine in the sacral canal and novocain-epinephrin for local infiltration, or novocain in the canal and quinine for local infiltration. In this manner it is possible to meet all indications without using an excess of the novocain-epinephrin solution. By using this combined method I have never had to resort to general anesthesia.

The advantages of adding sacral anesthesia to any operation in the area supplied by the sacral plexus is apparent. It is particularly to be desired where extensive operations are to be done, such as the Freund-Werthheim operation, prostatectomy or the resection of rectal carcinomas.

I have found the method uniformly useful in the cystoscopic examinations of males or for the sounding of structures. For this purpose partial failures do not work as a great inconvenience and since the patient is in comparative comfort there is no disposition to hurry the examination. Retention of urine has not followed its use in my experience.

The usual cause of failure, aside from such gross errors as injecting the fluid outside the canal or into a vessel, results from the use of a too small amount of fluid. Two ounces of a $\frac{1}{2}$ per cent. solution gives more certain results than half this amount of twice the strength. In passing the needle higher up, under the precautions previously mentioned, and the use of a large amount of the weaker solutions, few failures will result.

Untoward complications are few and unimportant. The needle may be broken off by the sudden movement of the patient. This is unlikely to occur unless old rusty needles are used. Sometimes the patient shows a degree of restlessness.
but this soon passes off. The large nerve trunks of the legs may be anesthetized. This may result in complete sensory anesthesia and may affect the motor fibers to the extent that the patient is unable to walk for several hours. This soon passes off, however. This involvement of the leg nerves occurs only when the injections are made high and a large amount of fluid is used. In the use of quinine, therefore, not over 20 or 30 cc. should be used unless prolonged action is desired.
CHAPTER XVII

Operations on the Penis

CIRCUMCISION.—Removal of the redundant foreskin is usually the operation which furnishes the first lesson for the beginner in local anesthesia. Simple as the operation is, careful technic is required in order to avoid many annoyances during its course and afterward.

The foreskin is supplied by the dorsalis penis nerve which enters the dorsum at the root and sends branches which supply both the cutaneous and mucous surfaces.

A rich plexus of veins lies between the skin and mucous surfaces and at the frenulum is an artery which always requires ligation. Smaller and less constant arteries are found on the dorsal or lateral aspects.

The usual error in circumcision is that the skin is anesthetized but the mucous membrane is neglected. The frenulum, too, sensitive as it is, is often overlooked. The skin is too thin to permit endermic infiltration and subdermic injection must be depended upon.

With the foreskin in its normal position a line $\frac{1}{4}$ to $\frac{1}{3}$ inch wide is infiltrated just back of the corona of the glans (a, Fig. 98). Some care is needed in order that a perfect circle is described.

The foreskin is then fully retracted and a line is injected in a like manner in the mucous membrane about $\frac{1}{4}$ inch proximal to the corona glandis (Fig. 99). The frenulum is then injected from the line in the mucous membrane to the glans (Fig. 100).

The foreskin is then returned to its normal position and the skin is snipped through with scissors (Fig. 101). The skin alone is cut. The fluid injected raises the skin from the veins and it is possible to sever the skin without cutting the veins. The skin is now snipped from the vessels and subcutaneous tissue until the line of infiltration in the mucosa is reached (Fig. 102). By this means most of the veins retract with the subcutaneous tissue and
are not severed. The mucosa is then cut with snips of the scissors about ¼ inch from its insertion (Fig. 103). The frenulum is cut not more than ½ inch from the glans.

The artery of the frenulum and any other bleeding points are caught up and ligated. Exact hemostasis must be accomplished before suturing is begun. If this detail is not observed oozing in the loose tissue will cause swelling, discoloration and delayed healing. In some instances the hemorrhage may soak the dressings and be the cause of embarrassment to both patient and operator. The most certain way of securing all bleeding points is to catch them up the moment they are cut.

The mucosa and skin are then united with fine catgut (Fig. 104). The sutures should be placed close together so that there will be no gaping spaces. A little attention to this detail brings a smoother recovery and well repays the extra time spent. A simple gauze dressing completes the operation.

Complications do not arise if hemostasis has been carefully performed. The sutures occasionally become infected, but this delays healing for a few days only.

Quinine is the anesthetic of choice but novocain-epinephrin may be used with satisfaction. The latter by giving a bloodless field makes the operation simpler, but there is more after-pain and more disposition to ooze. Complaint has been made that quinine causes necrosis of the skin or fails to give perfect anesthesia. The first fault is due to the use of too great amount of fluid, the latter the failure to place the fluid in the right place. The in-
Injection must be made immediately beneath the skin or mucous membrane respectively. Merely throwing the solution aimlessly into the loose connective tissue of the foreskin will not produce satisfactory results. For those who must go about their business immediately after the operation, quinine is certainly the anesthetic of choice.

**Fig. 105.** Line of infiltration for amputation of the penis and removal of the inguinal glands. At the points x x, the tissue about the root of the penis is infiltrated.

**AMPUTATION OF THE PENIS.**—Carcinoma presents practically the only indication for this operation. The inguinal glands require preliminary removal in all instances. It is convenient, therefore, to begin the anesthesia by injecting the inguinal canals. This is accomplished by a line from a point a short distance internal to and below the anterior superior spine, continued along the direction of the inguinal canal, crossing above the pubes and describing a line along the opposite inguinal canal (Fig. 105). From
this primary line the deeper tissues are infiltrated as for hernia, also about the root of the penis (x, x, Fig. 105). The region of the external abdominal rings receives particular attention. The cord must be effectually blocked as in operations upon the cord.

![Fig. 106. Line of infiltration about the root of the scrotum. The deep tissues are injected at the points x, x. The transverse line shown in the previous figure is shown in the background.](image)

The scrotum is now raised and the skin across the root of the penis is infiltrated from one side to the other (Fig. 106). The root of the penis is now infiltrated by passing the needle medial to the pubic arch, reaching the dorsalis penis at the root of the penis beneath the arch (x, x, Fig. 106). This is the most important point of injection and several cc. of the fluid should be deposited in the vicinity of the nerve. This done the entire penis and scrotum, together with the contents of the latter, is anesthetized and any operation required may be done.
CHAPTER XVIII

Operations on the Scrotum and its Contents

The scrotum is supplied by the ilio-inguinal nerves at its upper part and by the perineal nerves at the lower portion. The scrotal contents are innervated by the genital branch of the genito-crural and the sympathetic nerves from the aortic, renal and hypogastric plexuses. Because of the abundant nerve supply to the scrotum, incisions into it are best preceded by injections into the line of the proposed incision. The nerve supplying the scrotal contents may be blocked in any part of the cord. This may be most easily done just below the external ring.

Varicocele.—Operations for varicocele have for their object the obliteration of the veins of the pampiniform plexus, varicosities of which constitute the prominent objective symptom of the disease. Prominent factors in the symptomatology are the backache and certain psychic disturbances preceding, accompanying or following the pampiniform dilatation. Relaxation of the scrotum, which permits the weight of the testicle to tug constantly upon the cord, is responsible in a large measure for the backache and perhaps for some of the psychic disturbances. The requirements of the operation in any given case will depend upon the conditions present. If the scrotal relaxation is marked this requires attention. If the vessels alone are affected the resection of these only will give the desired result. The ideal operative scheme must be such that each of these may be given the attention the conditions present demand. Any of the classical operations may be done with satisfaction under local anesthesia. The operation here proposed has the merit that both factors in the disease may be given attention through a single small incision.

Resection of the Veins.—Beginning immediately below the base of the scrotum a line is infiltrated in the general direction
of the cord (Fig. 107), extending downward 1½ inches. This anesthetizes the cutaneous nerves only, which, it will be remembered, are branches from the sacral plexus through the perineal nerves. The scrotal contents are supplied by the nerves accompanying the cord through the inguinal canal. At the point of operation they have divided into branches too fine to be infil-

Fig. 107. Line of skin infiltration.
trated directly. Perineural blocking must therefore be resorted to. This is done by grasping the cord between the thumb and finger at the base of the scrotum and making firm pressure (Fig. 108). The needle is passed at the upper end of the line already infiltrated into the tissues imprisoned between the thumb and finger. About 2 cubic centimeters (30 minims) is injected at this
point. This effectually blocks all the nerves leading to the scrotal contents.

The incision is then begun in the line already infiltrated.

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Fig. 109. The tunica vaginalis has been incised and is being held by forceps and the veins selected for extirpation are being ligated.

Branches of the external pudic artery are severed and should be ligated at once. The tunica vaginalis is identified and held by forceps (Fig. 109). The cord with the enlarged veins is sepa-
rated from its sheath and all structures identified. The vas deferens with its accompanying artery and several small veins are separated to be preserved. Included with these are a number of nerve filaments. The bundle of veins remaining is to be re-

Fig. 110. The severed ends of the veins are united by sutures.

sected. The veins are freed from the vas and its accompanying structures for a distance greater than the amount of tissue to be removed. The upper and lower limits are then tied with catgut
and the intervening tissue removed. The severed ends are then united by tying the ends of the ligatures together and additional security is assured by passing supplemental stitches through the stump (Fig. 110). The tunica vaginalis is now closed by a sep-

Fig. III. Closure of the incision in the tunica vaginalis in a transverse direction.

arate line of sutures (Fig. 111). The skin is closed in a longitudinal direction (Fig. 112) by either catgut or silk.

By closing the longitudinal incision in the tunica transversely a
shortening equal to the length of the incision is secured. By varying the length of the incision any degree of shortening may be secured. By this means a fascial support is secured for the testicle. The results are the same as those secured by scrotal amputation without the need of a skin resection.

Instead of injecting the cord through the unopened skin the cord may be separated after incision of skin and tunica and then
grasped between the thumb and finger and injected. This method is more easily accomplished, but the separation of the cord before injection is accompanied by some pain.

Either novocain-epinephrin or quinine may be used. The former gives a bloodless field, but is more apt to be followed by late oozing. Quinine has the advantage of freedom from late oozing, but if too much is used an induration is produced about the site of incision which may excite the curiosity of the patient. This always subsides after a few weeks.

**AMPUTATION OF THE SCROTUM.**—If preferred the classical amputation of the scrotum may be performed. Ordinarily the degree of shortening is estimated and the distance determined is clamped off with long-bladed forceps. Moynihan’s intestinal forceps are excellent for this purpose. The skin below the forceps is then infiltrated with quinine or novocain-epinephrin, and the amputation proceeded with, the clamps being still in position. Through and through sutures are then placed and tied.

Since the shortening of the tunica alone is of importance and the removal of the skin incidental and unimportant the clamps are best avoided, because when they are placed, the tunica is apt to retract and the purpose of the operation is defeated. The following method, therefore, is to be recommended as permitting the operator to remove with greater exactness the desired amount of the tunica.

The amount of the scrotum to be amputated is estimated by drawing the redundant portion between the fingers. If the operator doubts his ability to follow the imaginary line so formed it will be well to paint a line with tincture of iodine. This line is then anesthetized about the entire circumference of the scrotum. The skin is then cut through to the tunica with scissors. The tunica is then taken up and the amount to be removed estimated by drawing it between the fingers. The tissue is anesthetized while the grasp is retained. The portion representing the inter-testicular septum should receive special attention because nerves are abundant at this point. The excision of the tunica is then
completed, care being taken to secure the sac from retraction; any bleeding points are caught up and ligated as they are cut. Careful hemostasis should now be made in order to secure every bleeding point. Otherwise, post-operative hemorrhage into the sac will cause embarrassment during convalescence. The two layers of the tunica are united with catgut. The skin is then united as a separate layer, preferably by non-absorbable sutures. Since hemostasis has been accomplished by separate ligatures the skin sutures should be only tight enough to secure apposition of the skin. Care on this point will greatly shorten the period of convalescence from the operation.

**HYDROCELE.**—In the radical operation for hydrocele the same skin infiltration is employed as in the varicocele operation; but it is placed lower, and may be lengthened with advantage. The incision is made through the skin down to the tunica vaginalis. The cord is exposed above the tunica, and loosened carefully with finger and forceps until it can be grasped between the thumb and finger. The injection is then made as in varicocele. The cord may be infiltrated before making the skin incision as in varicocele if the tunica is not so large as to make the cord inaccessible to the grasp of the fingers.

With the infiltration of the cord the entire area becomes insensitive and the tunica can be separated with ease and the desired resection made. Care must be taken to make the separation just external to the tunica for, if the separation is made between the skin and the dartos, pain will result, because the skin of the lower scrotal region is supplied by the perineal nerves, which are unaffected by the anesthetization of the nerves accompanying the spermatic cord. For the same reason, if it is desired to drain the base of the scrotum, the skin must be anesthetized at the desired point of incision. For the ordinary hydrocele operation a drain is not required. An interrupted non-absorbable suture, after all hemorrhage has been controlled, should be used to close the wound.
CASTRATION.—The removal of the testicle is the simplest operation upon the external genitals to be performed under local anesthesia. The technic required consists merely in exposure and ligation of the cord. This may be accomplished at the base of the scrotum or in the inguinal canal. In the former location the technic is identical with the first steps of the operation for varicocele and in the latter situation the cord is approached as in the operation for inguinal hernia.

The site of the incision will be dependent upon the condition requiring castration. If the lesion is local, as in hematocoele, exposure of the cord at the base of the scrotum is to be preferred. Castration, however, is usually done for malignant disease.

In that instance, deep infiltrations about the inguinal canal, as for large inguinal hernias, gives the best access to the field. The entire thickness of the abdominal wall must be infiltrated, preferably through the unopened skin. If this is not possible the skin and subcutaneous tissue is infiltrated and the incision then made to the fascia of the external oblique. The remainder of the abdominal wall is then infiltrated. This latter plan is the more certain for beginners. The inguinal canal is then freely incised and the cord followed under the peritoneum. If the castration is being done for tuberculosis the vas may be followed to the bottom of the pelvis. The bloodless field secured by the epinephrin is particularly gratifying when working deep in the pelvis.

VASECTOMY.—The section of the vas is done to prevent the propagation of the species. It is now confined to the sterilization of criminals in some states, but the signs of the times seem to indicate that it may soon have a wider application.

The vas, being covered only by the skin and the tunics of the cord, is easily reached. Grasped by the thumb and finger, either in front or behind the scrotum, it is infiltrated with quinine or novocain-epinephrin. The vas is exposed with a few strokes of the knife. The vas is then infiltrated with a few drops of the quinine or novocain solution. This is necessary because of the density
of the coats of the vas; diffusion is slow and if the vas is not thoroughly anesthetized the patient is apt to feel a sickening sensation when it is severed. A section of the vas an inch long is resected and the ends allowed to retract. If the deferentia artery is cut it must be carefully ligated. The tunics of the cord are very vascular and careful hemostasis is required if annoying infiltration of the scrotum is to be avoided. The skin is closed with a suture or two of fine catgut. A small dressing is placed within a suspensory and the patient is allowed to go about his business. The quinine effectually controls the after-pain and if hemostasis is perfect there is no annoyance.
CHAPTER XIX

OPERATIONS ON THE URETHRA, BLADDER AND PROSTATE

NEURAL ANATOMY.—The sensory nerves of the genito-urinary organs are the same as those of the rectum and anus. They are so numerous that blocking of specific nerves is uncertain, and while in a general way the injection may be massed in the direction of the chief nerve supply, dependence must be placed upon infiltration of the entire region.

LOCAL ANESTHESIA PRELIMINARY TO CYSTOSCOPIC EXAMINATION.—Antipyrin and opium and, for local application, cocain were formerly employed. The first has been abandoned because of inefficiency, and the last because of its dangers. The most efficient safe anesthetics available at the present time are alypin and quinine, either of which may be introduced into the bladder half an hour before the proposed examination. The most efficient method, however, is the blocking of the sacral canal, which in nearly all cases gives complete anesthesia of the parts involved in cystoscopic examination. In intense cystitis with spasmodic contractions of the bladder sacral blocking is sometimes inefficient since it does not reach the bladder wall nor the peritoneum covering it. I have used quinine in the sacral canal, but its action is less prompt than novocain and the effect lasts an unnecessary length of time.

EXTERNAL URETHROTOMY.—When the stricture can be passed the bladder may be filled with an anesthetic solution, preferably 1% quinine or 1% alypin-suprarenin solution recommended by Braun. The penile urethra is filled with the same solution. If the stricture is impassable the part of the urethra distal to the point of stricture may be filled with the solution and retained with a tape. Too great an effort to secure the topical effect of the local anesthetic, and particularly the constricting band, may cause more pain than the anesthetic saves.
It is well to begin the anesthesia by infiltrating the skin in a line over the part of the urethra affected. This point is indicated by passing a sound down to or through the stricture. The parau-urethral tissue is then infiltrated through this line. By sliding the skin to one side the tissue of the penis dorsal to the urethra can be infiltrated. The operation then consists in resecting the constricted portion of the urethra, uniting the severed ends over a permanent catheter and closing the skin wound completely. The operation is more easily done under local than under general anesthesia on account of the smaller loss of blood. Hemostasis must be carefully secured and the bulbus must be protected from injury, on account of its tendency to ooze after the effect of the epinephrin wears off.

SUPRAPUBIC CYSTOTOMY.—Initial infiltration is made along the linea alba immediately above the pubic bone, or in the suprapubic fold transversely to the linea alba. The prevesical fat is infiltrated by passing the needle close beneath the pubic bone down to the bladder neck and laterally over the bladder wall, which can usually be recognized by careful palpation with the needle.

If the urethra is pervious to the catheter the bladder is filled with 5% quinine or with 1% alypin solution. This anesthetizes the bladder so that exploration will be less painful and raises the fundus of the bladder so that it is more readily accessible. Local anesthesia is very difficult in cases with impassible urethras, and particularly in those which have been drained by suprapubic puncture with a trocar. In such cases it is best to fill the bladder as well as possible through the trocar canal. Thorough infiltration must be made along this canal because the surrounding inflammatory tissue is not only painful, but also hinders diffusion of the anesthetic.

The incision is made along the line infiltrated first down to the bladder wall. If, as frequently happens, the wall is still sensitive, it should be fixed with tenaculum forceps and infiltrated separately. If the bladder wall is properly injected it may be
cut without pain. One may then proceed with the operation indicated, introduction of a drainage tube, extraction of a stone, removal of a tumor or of the prostate.

Extraction of Stone.—If the bladder mucosa has been anesthetized previously the stone may be searched for and removed without pain. If that preliminary has been omitted the act of grasping the stone will cause pain.

Removal of Tumors.—After the bladder has been opened as described, the location and extent of the tumor can be seen directly. If the tumor is removable the bladder wall about its base is infiltrated and the tumor removed by incision or cautery. The suppression of bleeding by means of the adrenalin makes this part of the operation simple.

Stone In the Pelvic Ureter.—Stones in the lower portion of the pelvic ureter can be reached by making a transverse incision as for suprapubic cystotomy. The prevesical tissue is then freely infiltrated beneath the peritoneum down to the bladder. Free injection of fluid about the bladder wall will facilitate separation of the paravesical tissues from it, so that the pelvic ureter may be exposed. Abscesses deep in the broad ligament may sometimes be reached in the same way.

Removal of the Prostate.—I have not removed the prostate through the bladder under local anesthesia. Allen (New Orleans, M. J., LXV 581) proceeds as follows: He opens the bladder under local anesthesia, brings the prostate into view, and at several points between the true and false sheath injects 2 or 3 drams of a $\frac{1}{2}$% novocain solution with 15 minims of epinephrin to the ounce. He also makes injections into the lateral walls of the urethra through the vesical opening.

Perineal Prostatectomy.—Two methods are available. The nerves may be systematically blocked about the prostate (Franke and Posner), or at the sacral foramina (Braun). Franke and Posner (Arch. f. Klin. Chir., 1912, XCIX, 139) proceed as follows: with the finger in the rectum as a guide the needle is introduced 2 or 3 cm. lateral and slightly ventral to the
anal opening. The coccyx is located by the rectal finger and the ligamentum sacrospinosum is followed to the spina num ossei ischii. The needle, which must be 12 to 15 cm. long, is passed upward until it reaches the levator-ani. Puncture of this muscle is detected by the patient by pain. A few cc. of the fluid are deposited here. The needle is passed farther until it is felt to impinge on the ischial spine. It is then slightly withdrawn and pushed forward again, but 1 or 2 cm. deeper than before, and 10 cc. of the fluid deposited. The needle is then withdrawn until the point lies only 2 or 3 cm. deep. Its direction is then changed under guidance of the finger upward and laterally to the space between the rectum and prostate. The needle is thrust 3 or 4 cm. deeper than this point and 10 to 15 cc. are deposited. The same process is repeated upon the opposite side. The dorsalis femoralis nerve is injected over the tuber ischii. Anesthesia comes after 10 to 15 minutes. Franke and Posner give morphine 0.01 gm. or twice that amount of pantopon before the operation.

Braun’s technic is as follows: with the patient in a lithotomy position the needle is introduced at a point 1 1/2 to 2 cm. lateral to the median line on a level with the sacro-coccygeal articulation, and thrust forward parallel to the ventral surface of the sacrum. The operator seeks the edge of the sacrum with the point of the needle, feels his way past this edge and pushes the needle along the flat ventral surface of the sacrum parallel to its median plane. The needle will strike the forward curve of the upper part of the bone at the second sacral foramen, 6’ or 7 cm. from the point of entrance. The entire distance from the second to the fifth sacral foramen is injected with 20 cc. of a 1% novocain-epinephrin solution. No injection should be made until the contact with the bone is felt. The needle is now drawn back to the edge of the sacrum and is directed at a small angle toward the innominate line, always pushing it parallel to the median plane. In this direction the needle penetrates deeper than before; until it again strikes the bone above the first sacral foramen at a distance of
9 to 10 cm. from the point of entrance, the soft parts not taken into consideration; at this point 20 cc. of 1% novocain-epinephrin solution are injected. The final injection of 5 cc. of the solution is made between the rectum and coccyx from the same point of entrance. A similar injection is made on the opposite side: altogether 100 cc. of the solution is required.

I have had better success aiming to surround the prostate directly with the anesthetic solution. From 4 to 8 ounces of a 5% quinine solution are introduced into the bladder as a preliminary. I infiltrate the skin with 1% quinine in a line shaped like an inverted U, for the usual perineal incision (Fig. 113). With the same solution I inject the region of the levator high up and lateral to the prostate, using about 15 cc. on each side. The immediate neighborhood of the prostate (Fig. 114) is now infiltrated with a 1% novocain-epinephrin solution, special attention being paid to the region about the urethra in front of the prostate, and to the periprostatic connective tissue. The parts overlying the prostate are now incised down to the prostate and all the bleeding points are caught up. With the prostate exposed it is infiltrated on all sides, along the urethra, between the urethra and bladder, and between the prostate and rectum, and into the prostate itself. In small prostates the lateral lobes may be traversed and the bladder wall reached. Hemostasis is now secured, the urethra is opened and the bladder explored. The retractor may now be placed into position and the enucleation proceeded with. This is facilitated because of the use of epinephrin. The degree of traction that can be applied varies, but traction always causes pain, so that knife and scissors must be used for enucleation in preference to the fingers. Generally the operator must work in a deeper cavity than when using general anesthesia. I have found a special retractor to facilitate the dissection. After enough of the prostate has been cut away the cavity it occupied is closed by sutures.

All operations above described place a heavy tax on the technical skill of the operator, and only those possessed of experience
Fig. 163. Superficial lines of infiltration for perineal prostatectomy; x, x, x, points at which the needle is passed in making the deep infiltrations.
Surgical Operations with Local Anesthesia

in the operations under general anesthesia of this region will find operations under local anesthesia satisfactory. Even then it is hard work.

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*Fig. 114. Injection of the periprostatic tissue. (Braun).*
CHAPTER XX

Operations on the Female Organs

The cervix and perineum present a wide field for operation under local anesthesia. In fact, no pelvic operation is beyond its range. From the patient’s standpoint the chief objection to work on these parts under local anesthesia is her embarrassment at being placed in the lithotomy position. This is best overcome by telling the patient beforehand that the position is the worst feature of the operation and that every precaution will be taken to guard her sensibilities. If she has been provided with leggings and is kept well covered with a sheet while the legs are being fixed into the stirrups, her embarrassment will soon pass away. Visitors disagreeable to the patient should be excluded.

The position is at best uncomfortable and may cause pain, particularly in fat women. If in the course of the operation the patient shows signs of restlessness, it is more likely to be caused by the position of the legs than by the manipulations of the operator. Cramping may be relieved by massage or by raising or lowering the standards. The foot may be freed from the stirrup and the leg held in a comfortable position by an assistant.

A much more comfortable position is attained by the use of holders which fit the popliteal space than by the usual foot straps. The comfort is further enhanced by having an angle (Fig. 115) in the standards which allows the leg a more comfortable position than the usual perpendicular standard. This position brings the legs in the way of the assistant, but this inconvenience is more than compensated for by the greater comfort of the patient.

From the operator’s standpoint the most difficult problem is the prevention of traction pain. Traction on the uterus causes pain from tension on the broad ligaments. Seizing the levator muscles may cause deep-seated pain, which must be overcome
by infiltration of the muscle and its fascia. Repair of the cervix and of the perineum are easily accomplished and are suitable operations for the beginner. Operations such as hysterotomy and the Freund-Wertheim fixation require considerable skill. Either quinine or novocain-epinephrin may be used. The beginner will find the latter preferable because it diminishes bleeding.

**Repair of the Cervix.**—The cervix is supplied by sympathetic nerves by way of the broad ligaments. It is not very sensitive,
as is readily demonstrated by the common practice of grasping it with tenaculum forceps when making office examinations.

The cervix is exposed by a suitable perineal retractor, fixed with a tenaculum and drawn down as near as possible to the vulva. The needle is introduced at the line of attachment of the vagina to the cervix, and is passed obliquely upward and medially so as to enter the base of the broad ligament and penetrates the substance of the uterine muscle just below the internal os (Fig. 116). Several cc. are injected on each side of the cervix, and the loose tissue between the cervix and bladder is infiltrated at several points. The vaginal deflection posterior to the cervix is infiltrated in the same way. If anesthesia is not complete an additional injection directly into the angle of the tear may be made, though this is rarely necessary.
A wedge of tissue corresponding to the depth of the tear is then removed with a knife. Enough of the cervical mucosa is allowed to remain to insure the integrity of the canal. The primary suture is placed at the upper angle of the incision, care being taken that it include all of the freshened surface lest a bleeding vessel escape and give rise to embarrassing hemorrhage after the operation. This precaution is particularly necessary when the parts are edematized by novocain-epinephrin. The remainder of the incision is then closed by interrupted sutures in the usual manner or by a figure-of-8 suture (Figs. 117 and 118). This suture is more quickly placed and prevents the conical point so apt to form after interrupted sutures when the amount of tissue removed has been large.

DILATATION AND CURETTAGE.—The use of the curet is not nearly so frequent as formerly among careful surgeons, and it is to
be regarded as fortunate that the operation is not readily accomplished by the tyro under local anesthesia. The difficulty lies in the density of the uterine muscle, which does not easily permit diffusion of the fluid in sufficient quantity to reach all parts including the peritoneum. In the recently pregnant uterus this difficulty does not obtain (one might almost say unfortunately) and curettage may be readily accomplished.

Infiltration should begin in the cervix as for repair of lacera-

![Figure 118. Figure of eight suture tied.](image)

tions (Fig. 116), using care to inject deeply into the muscle substance. In the non-pregnant, particularly in uteri long the subject of chronic inflammation, a special syringe, such as is used by dentists, is desirable. In the recently pregnant uterus satisfactory infiltration may be secured with an ordinary syringe. If the operator is careful to ascertain the position of the uterus it is
easy to inject the body of the uterus through the base of the broad ligament.

If after dilatation of the cervical canal the endometrium of the body is still sensitive, the cavity may be packed for five minutes with a five per cent. quinine solution.

Hysterotomy.—When there is something within the uterus that requires removal, splitting the uterus, which permits an examination by sight and touch, is better than simple dilatation and curettage. For this operation the anesthetic is injected as in

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Fig. 119. Line of injection of the cervix and in the interior fold together with the incision.
repair of the cervix and the tissue between the bladder and uterus edematized. The bladder is then lifted from the cervix as in opening the pelvic cavity in front of the uterus (Fig. 119). The substance of the cervix is then injected and an incision is made up to the internal os (Fig. 120). A renewed injection is

then made through the wound into the muscle of the body, and the incision is continued upward as high as necessary to permit an examination of the interior of the uterus (Fig. 121). Any pathological material discovered may then be removed after first infiltrating the uterine wall about it (Fig. 121).
Polypoid hypertrophies of the endometrium and submucous fibroids are the most frequent affections requiring treatment by this means. The area of the uterine wall which gave rise to these lesions would better be excised so as to insure against a return of this condition.

After the lesion has been excised the defect remaining is repaired with chromic gut sutures. The incision into the uterus is then closed from above downward so as to terminate below
where the incision began, as in a repair of the cervix (Figs. 121, 123 and 124). The incision into the uterine fossa is then repaired by uniting the vagina to the cervix.

This operation is easily performed and gives complete infor-

Fig. 122. Beginning closure of the uterine incision after hysterotomy.

mation as to the state of the interior of the uterus. Before undertaking it, however, the operator should make sure that the uterus is sufficiently movable to permit access to the fundus, if need be.

ANTERIOR COLPORRHIAPHY.—Removal of redundant portions of the anterior vaginal wall is easier to perform under novocain-
epinephrin than under general anesthesia, because of the lessened bleeding. If the cervix does not protrude from the vulva, the infiltration line is begun half an inch behind the meatus (Fig. 125), and extend nearly to the cervix (Fig. 126). From this primary lateral lines are infiltrated until the entire tissue between the bladder and vagina is anesthetized. If the cervix comes down into the vulva readily, the infiltration may begin at the cervix and extend nearly to the meatus (Fig. 126). From this primary line lateral lines are infiltrated as before. If other more extensive operations are to be done at the same time quinine may be

![Fig. 123. Second step in the closure of a hysterotomy wound.]
used for this part of the operation, or very dilute solutions of novocain-epinephrin. In either event an unnecessarily large amount of fluid should not be used because coaptation of tissue will be made more uncertain.

The operation as usually done may then proceed.

Fig. 124. Hysterotomy completed.

REPAIR OF THE PERINEUM.—When repair of the perineum is to follow any of the operations above described, it is well to begin by infiltrating the perineum. By so doing complete anesthesia of the perineum is assured by the time the cervical or other
operation is completed, and the latter is facilitated by the relaxation of the perineum so induced.

NERVE SUPPLY OF THE PERINEUM.—The nerves involved in the repair of the perineum are the same as those involved in rectal operations. These nerves may be blocked before their exit from the canal (Ilner, Zentralbl. f. Gynec., 1910, XXXIV, 699). by passing a needle at the posterior border of the tuber ischihi in

Fig. 125. Infiltration of the vaginal wall in anterior colporrhaphy.
a direction toward the foramen ischii. The nerves lie under the ligamentum sacrotuberosum. Sellheim (Zentralbl. f. Gynec., 1910, XXXIV, 897) prefers to reach the nerves after they have divided into branches by infiltrating the pararectal space.

Fig 126. Method of infiltrating the vaginal wall in anterior vaginal colporrhaphy when the cervix is prolapsed.

When large operations are to be done, such as extensive perineal repair, together with rectal operations, Ilmer's technic may be used. The objection to it is its uncertainty, for which reason local infiltration is usually required to supplement it. Sacral
blocking is more efficient in extensive operations. The nerves come from so many sources, however, that in most cases it is

Fig. 127. Infiltration of the perineum in perineorrhaphy. The infiltration begins at the point marked x. The needle shows the point of injection of the deeper tissues. By directing the needle more directly backward the levator may be reached. (Compare fig. 114.)

better to depend upon local infiltration, which is easily done in this region.

Infiltration is begun at the middle of the muco-cutaneous junction (Fig. 127), and continued along it to the caruncle of each side. The region of each caruncle is then grasped by a
tenaculum forceps. When moderate traction is made upon these the extent of the laceration becomes exposed. A line is now infiltrated from the point of beginning to the highest point (Fig. 128) of laceration, taking care that the needle is not pushed into the rectum. The entire area to be denuded is then infiltrated by a liberal injection of fluid between the vaginal and rectal walls. Either anesthetic may be used. Novocain gives less hemorrhage at the time of operation and is advised for the beginner.
Inasmuch as the chief source of discomfort is the pull on the levator muscle, infiltration of this muscle is a most important point. A finger in the vagina will locate the levator and deter-
and as much care should be exercised in injecting them as in infiltrating the skin.

An incision can then be made along the line of the first infiltr-

Fig. 130. The levator muscle is hooked up by the needle.

tration, or within it, wherever the operator may fancy. The vaginal flap is elevated either with knife or scissors. The beginner may even be permitted to push the vaginal wall loose with a bit of gauze. The levator muscle is now located and exposed with knife or scissors (Fig. 129).
The muscle is lifted up on the tip of the finger and the suture passed through it (Fig. 130). Gentleness in this manipulation is advisable, unless the operator is quite sure of his infiltration. The opposite side is hooked up in a like manner and the suture tied (Fig. 131). Additional sutures are passed in the same way.

Fig. 131. The opposite levator loop is hooked up and the sutures tied.

There is no difficulty of securing anesthesia of the deep perineal fascia and this layer may be united with confidence (Fig. 132). It should be done with especial care, because it furnishes the chief support of the parts above.
Every operator has his own ideas for the union of these structures and any whim he may possess need not be restrained be-

cause he is operating under local anesthesia. The foregoing technic is adopted from the work of Howard Hill.

The triangle of the posterior vaginal wall is now trimmed off as may be required, and a running suture applied to the entire extent of the wound remaining (Fig. 133). Care must be exer-
cised here that the needle does not sweep beyond the region which the anesthetic fluid has penetrated. This is particularly

likely to take place near the sensitive caruncles. The tendacula should mark the limit of efficient anesthesia.

The objection raised against the use of local anesthesia in plastic work that it interferes with healing, applies only when too much fluid is employed. Edematization of the tissue is unneces-
sary and harmful. The experienced operator will repair a cervix and perineum with the use of less than an ounce of solution, an amount which produces no edema and interferes in no way with the after-course of the operation. Twice this amount of fluid may be used without doing harm. If the operator has produced edema by the use of an excessive amount of fluid, a condition similar to that present after labor exists and may be met by the same modification in technic—the suture must be drawn more tightly so that the tissues are still held in apposition after the fluid is absorbed. Chronic catgut should be used for all sutures except the one for the vaginal mucosa where plain or pyoktanin gut is preferable.

OPERATIONS ON THE VULVA.—Any operation on the vulva, including tumors and incision of the skin for pruritis, may be performed with infiltration anesthesia. Either anesthetic may be employed; quinine, if the operator has in mind the after-comfort of the patient, or novocain-epinephrin, if he has in mind his own convenience. The same applies to operations upon the urethra.

THE FREUND-WERTHEIM OPERATION.—This operation is begun as for exploratory hysterotomy, with the addition that the anterior vaginal wall must be infiltrated and separated as for anterior colporrhaphy. Instead of splitting the uterus after the vaginal wall is elevated the base of the broad ligaments are widely infiltrated with novocain-epinephrin. The uterine wall is then infiltrated before an attempt is made to pull it into the vaginal wound. This makes it insensitive to the grasp of the forceps and to the subsequent passage of the sutures when it is fixed in the vagina. As the uterus is exposed and drawn into the wound, regions higher up may be infiltrated.

The only point in the operation presenting any difficulty is the pulling of the uterus into the vagina. This is facilitated by having the vaginal wound large enough to permit the passage of the uterus without undue traction. For this reason the bol'd operator will have less difficulty than the timid one.
Before beginning this operation the surgeon should make sure that the uterus is mobile. A uterus may be low in the pelvis and yet possess attachments that will make the operation difficult.

VAGINAL HYSTERECTOMY.—Up to a certain point this operation is identical with hysterotomy. The base of the broad ligament is infiltrated more widely lateral to the uterus than in the operations previously described. The posterior cul-de-sac likewise must be infiltrated.

Whether or not the perineum will require repair, it is worth while to infiltrate this region as for perineorrhaphy, so as to secure relaxation, and thereby facilitate very much the removal of the uterus. The manner in which the uterus is removed must be planned to fit the individual case. If the uterus is freely mobile ligation may begin at the base of the broad ligament. In more difficult cases the uterus may be bisected as for hysterotomy and removed in pieces. It is possible to remove the fundus, allowing the cervix to remain, performing in this way a supravaginal amputation per vaginam.

Hysterectomy under local is a difficult operation at best and the operator must be skilled before he undertakes it.

PALLIATIVE OPERATIONS FOR CARCINOMA.—Extensive infiltration of the tissue about the cervix is made preferably with quinine. Several ounces may be deposited about the affected area without much regard to direction, except to avoid the bladder and rectum. Any palliative procedure may then be employed, such as curettage with acetone after Gellhorn's method, or the actual cautery.

Curative operations for carcinoma of the uterus are beyond the realm of local anesthesia. It is worthy of note that in many cases palliation under local will procure a greater lease of life with less discomfort to the patient than attempts at radical operation under ether. This point is not sufficiently appreciated.

SHORTENING OF THE ROUND LIGAMENTS.—Any of the methods commonly employed in shortening these ligaments may be done.

ALEXANDER—ADAMS.—In very motile uteri without descensus
of the cervix this operation gives good results. The technic does not differ materially from that described for the anesthetization of the inguinal canal in hernia. The absence of the cord and hernial sac make care in injecting the canal unnecessary. The ligaments are more readily found than under general anesthesia, because of the bloodless nature of the field.

THE MONTGOMERY or any other intra-abdominal method that may be employed, is generally to be preferred to the operation just described, because the results are more certain and the time required to perform it is less. The operation I prefer is a transverse fascial incision with the fastening of the ligaments in both ends of the incision. To perform this operation a transverse line is infiltrated in the superpubic fold. The fascia and muscle of the abdominal wall are infiltrated through this line. In this way the entire thickness of the abdominal wall may be anesthetized. Should anesthesia be imperfect, the fascia, muscle and preperitoneal tissue be incompletely anesthetized, the preliminary infiltration may be supplemented after the deeper parts are exposed.

The same thing may be accomplished less elegantly by making a longitudinal incision into the abdomen.

URETHRAL CARUNCLE.—This little tumor is of frequent occurrence, and because of the sensitive nature of the surrounding tissue, the operator finds an interesting field for the exercise of technical skill. The simplest method of anesthetizing the site of the tumor and the distal half of the urethra is to place a tablet of 3/4 or 1/2 grain of cocaine or two grains of quinine just within the urethral orifice. The natural moisture of the parts dissolves the tablet sufficiently to bathe the affected area in a concentrated solution of the drug. After ten minutes complete anesthesia will have taken place and the tumor may be removed and its base cauterized.

Larger tumors in this region may be removed in the same way, by adding to the anesthetization above described an infiltration of the surrounding tissue by passing the needle through the area previously anesthetized by the topical application.
SACRAL BLOCKING IN PELVIC SURGERY.—Any of the foregoing operations may be done under sacral blocking. The technic of local infiltration above described has the advantage over sacral blocking, however, in that it is absolutely certain and the operative field is practically bloodless. Sacral anesthesia, on the other hand, occasionally fails in part and must be supplemented by local injections. This is particularly liable to occur in the region of the caruncles. The reason for this failure is that this region receives branches from the ilio-inguinal nerve which is unaffected by the sacral injection. In sacral blocking the vessel constricting effect of epinephrin is lost. Rougher handling is possible after sacral blocking. This is particularly true in dilatation and curettage.
Operations about the rectum under local anesthesia have not been popular with general surgeons but have found favor with patients. Specialists and general practitioners have been more ready to recognize the merits of local anesthesia than have surgeons. The anal region is on the whole the most difficult field for the employment of local anesthesia. Blocking operations, because of the abundant nerve supply from a number of sources, is difficult. The area is exceedingly sensitive and the position of the patient during the operation tends to make the technic difficult. Any apprehensive movement on the part of the patient adds materially to the difficulties of the operator. Nevertheless, when the fundamentals are mastered no other region permits operations of all varieties to be carried out with more satisfactory results to both practitioner and patient. No other class of operations deserves more to be done under local anesthesia. Patients are reluctant to submit to general anesthesia for the relief of a condition which does not endanger life and to the inconvenience of which they have by degrees learned to submit with more or less patience. Only when actually incapacitated do they readily submit to radical operations under general anesthesia. The result of reluctance of the general surgeon to employ local anesthesia has been to drive sufferers from piles to the advertiser, who has been more ready to accede to the demand for relief without general anesthesia. The general practitioner can prevent the defection of his patient if he will do these operations under local anesthesia. Most of the rectal diseases belong to the domain of minor surgery and should be quite within the province of the general practitioner. Certainly any man who can repair
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a recently lacerated perineum should be able to carry out nearly all the operations upon the rectum after he has once mastered the rudiments of anesthesia as applied to this region.

ANATOMY.—A knowledge of anatomy is a necessary preliminary, and that not alone of the nerves but also of the muscles and vascular supply, for nowhere else can complications affecting these tissues be more certainly avoided by anticipating them.

Broadly speaking the region in question consists of the termination of the gut canal, the group of muscles surrounding it and the associated vessels and nerves. The external sphincter, an elliptical muscle surrounding the outlet, is the most important muscle. Above it is the internal sphincter, which is merely a reinforcement of the circular fibres of the rectum. The integrity of these muscles must be retained lest an embarrassing incontinence result. Descending from above in the submucous layer are the hemorrhoidal arteries and veins. It is from these vessels that post-operative hemorrhage may occur if the technic has been faulty. The vessels which approach the anal region through the perirectal space are readily seen during the operation and are as readily controlled. The nerve supply, for the most part, is chiefly found in the perirectal space. Appearing from either side slightly behind the anal axis are the long perineal nerves and from the depth supplying the lateral and anterior portions are the hemorrhoidal nerves. The coccygeal nerve approaches from behind (Fig. 134). Descending from above within the wall of the gut are branches of the sympathetic nerves. These like sympathetic nerves in other regions of the intestinal tract are sensitive to traction. None of these structures are surgically fastidious yet they demand a certain respect if the surgeon’s relations in his dealings with them is to be at all times agreeable and harmonious.

Operations about the anus may be divided into those which may be done without dilatation of the sphincter and those in which dilatation is a necessary preliminary. In the former class are ischio-rectal abscesses, cutaneous and mixed piles and palliative
operations upon prolapsed internal hemorrhoids. Those demanding a preliminary dilatation of the sphincter are internal hemorrhoids, fistulas, fissures and all tumors within the gut. Although prolapsed internal piles may be operated without dilatation, there is most certain to be some that have remained internal to the sphincter which will likely give rise to trouble at some future date and a recurrence after operation is likely to be re-

Fig. 131. Nerves about the rectum.

corded against the efficiency of the surgical treatment. Therefore, even if one pile is prolapsed and easily within reach of ligation without dilatation, the sphincter should be stretched in order that all hidden nodules may be reached. Furthermore, if the prolapsed pile is so operated the pedicle slips back within the sphincter and should hemorrhage occur it is almost certain to be undetected for a long time.
DRUGS EMPLOYED.—Novocain--epinephrin gives a good anesthesia and the skill required in the use of this drug is but little, but the after-pain is prolonged and intense. For this reason I use this drug only for sacral blocking in extensive operations about the anus. Quinine, on the other hand, requires more skill in its use, but the prolonged relief from after-pain makes the

Fig. 135. Infiltration over surface of cutaneous hemorrhoid.

use of this drug imperative. Novocain may be used for para-rectal injection, but in the region affected by cutting and ligation the use of quinine is imperative.

EXTERNAL HEMORRHOIDS.—This variety is formed by the coagulation of blood within the veins of the anal region. They are covered by skin not materially changed, or at most but slightly inflamed. When the thrombosis extends into the veins of the mucous surface, a mixed variety, the mucocutaneous variety is
obtained. If the submucous veins are extensively involved a prolapsed internal pile may be diagnosed.

If the tumor is confined to the cutaneous surface and the skin over it is but slightly or not at all involved, a line may be infiltrated over its surface (Fig. 135). A simple incision is made into its substance and the clot turned out. A suture may be placed to control the bleeding; this may be removed after a day or two and healing by granulation permitted. In some instances the mere compression by a tampon for a few minutes controls the bleeding and a suture is not necessary.

If the skin over the pile is much inflamed or if the thrombus extends into the mucous membrane it is better to infiltrate the normal skin about the tumor (Fig. 136), circumscribing the painful area. Deep injections beneath the tumor are also necessary.
Incision may then be made into the mass and the clots turned out; or, better still, a flap of skin and mucous membrane may be raised up, and the venous mass ligated and dissected out. The edges of the flap may then be approximated by a few sutures. Infiltration of the mucous surface may be painful and the comfort of the patient is much enhanced by a previous topical application of cocain or novocain in 2 per cent. solution, or quinine in 10 per cent. solution. Water as hot as can be borne for a few minutes likewise makes manipulation less painful. These additional attentions to the patient's comfort are quite well worth the time expended, particularly to the operator of limited experience.

For prolapsed internal hemorrhoids, the cutaneous border is infiltrated as above; and infiltration of the base of the tumor either with or without preliminary topical anesthetization (Fig.
is sufficient to permit painless transfixion and ligation of the piles. The undesirability of removing the prolapsed pile alone has been sufficiently emphasized; but in many instances the practitioner and patient are satisfied with the relief the removal of the chief offender affords and are willing to risk the mischief its less conspicuous fellows may produce at a later date.

OPERATIONS WITH DILATATION OF THE SPHINCTER—INTERNAL

Fig. 138. A line of skin is infiltrated about the anal margin over the anal sphincter.

HEMORRHOIDS.—Operations demanding a preliminary dilatation of the sphincter may well be divided into two steps, the dilatation and the operation itself.

INTERNAL HEMORRHOIDS.—Operations demanding a preliminary dilatation of the sphincter may well be divided into two steps, the dilatation and the operation itself.

In order to dilate the sphincter it must be anesthetized and to reach the sphincter the skin must first be anesthetized. This is
most conveniently done by infiltrating a circle about the anal margin (Fig. 138). Beginning at the most convenient point over the coccyx a semi-circle is described on one side and then beginning at the original point the opposite side is infiltrated, the two lines meeting in the raphe in front of the anus. A needle is now thrust into the substance of the sphincter at the four points marked in Fig. 138. A needle of sufficient length to make sure of penetrating the muscle must be employed (Fig. 139). A finger introduced within the anus will assist in guiding the needle.
to the proper depth in order to infiltrate the sphincter (Fig. 140). The mucous membrane of the anus may be anesthetized by placing a small pledget saturated with a 10% solution of quinine or a 4% cocain solution within the grasp of the sphincter. By the time the skin about the anus has been infiltrated the finger may be introduced painlessly. I ordinarily omit this procedure, for

![Fig. 140. The finger within the anus determines the depth of the needle. (Redrawn from Braun).](image)

usually the infiltration of the sphincter permits the finger to be introduced without pain if it is done gently; and after the sphincter is infiltrated the mucosa may be injected from within the anal margin. The process of dilatation is facilitated by a special perineural blocking of the coccygeal nerves by depositing a syringe full of fluid immediately in front of the tip of the coccyx.

The dilatation of the sphincter may now be commenced. The index finger is placed well within the sphincter and is followed by the same corresponding finger of the opposite hand. Traction is now applied until the desired degree of dilatation is secured. If the muscle is properly infiltrated but little traction is required in order to secure the needed dilatation, since the anesthetized muscle loses its power to contract. This relaxation comes more readily with novocain-epinephrin, but the after-pain
is greater. It is worth while to take plenty of time in making the dilatation, because permanent relaxation is less likely to occur when done in this manner than when the dilatation is done bruskly. Pain from dilatation is usually due to the failure to properly inject the deeper layers of the sphincter. When the sphincter is dilated the pile nodules are sought and fixed with forceps. Not infrequently traction on the pile causes pain, due to stretching the sympathetic filaments coming down from above. This may be readily controlled by the injection of the pedicle above the proposed site of ligation (Fig. 141). The operation may now proceed in the usual manner. The method I prefer is ligation performed by passing a threaded needle eye-end first through the pedicle (Fig. 142). The ligature is tied without first incising the mucous surface as usually recommended. The larger
vessels descend from above and are effectually controlled by this method. The redundant portion may then be excised and the edges of the mucosa united by sutures. The usual method of forming a pedicle is to incise the mucosa above and doubly ligate the pedicle so formed. In many recent cases the mucosa may be elevated, the pile isolated and the pedicle ligated and the flap replaced and united with sutures. The number of masses which require ligation varies. Usually one on each side slightly behind

Fig. 142. The needle is passed eye end first through the pedicle.

the center and one anterior corresponding to the site of chief blood supply, will be sufficient. As few pile masses as possible should be ligated in order to lessen the liability to stricture.

If tags of skin remain they may be excised and the edges loosely approximated with fine catgut.

The cautery may be employed, but care must be exercised lest the heated instrument come too close to the thigh or the buttock. The hissing sound produced by the cautery is apt to produce a
disquieting effect upon the patient and the transmitted warmth to unanesthetized areas is apt to excite unpleasantly his apprehension.

There is no after treatment. Quinine properly employed gives anesthesia which lasts for several days or until healing is well established. The skill exercised in making the infiltration and in dilating the sphincter determines the after course. If the amount of fluid is excessive and a large amount of exudate is produced a sense of fullness may be felt in the rectum. This may be so great in some instances as to interfere with a free movement of the bowels, according to the patient's view. This is only temporary and disappears in a week or two, always resulting in perfect resolution. The patient's mind is set at ease if this result is explained to him.

**FISTULA IN ANO.**—The radical cure of anal fistula can be accomplished with surprising ease under local anesthesia. My own preference is for an excision of the fistula with the immediate closure of the fistulous tract. Many still prefer the simple incision and for the beginner this is certainly the operation of election.

**INCISION OF THE FISTULOUS TRACT.**—This operation merely aims at conversion of the fistula into an open wound which shall be allowed to heal by granulation. If the internal opening is within the sphincter the operation may be done without a preliminary stretching of that muscle. If it ends high within the gut the sphincter must be dilated.

The skin about the opening (Fig. 143) and a line from this point to the anal margin and up the mucous surface to the opening of the tract within the gut are infiltrated. Injections are then made in the deeper portions along the line of the fistula and anal sphincter, and then in the tissue about the fistula.

Because of the scar tissue present infiltration must be made with unusual care. The scar tissue itself cannot be injected and must in consequence be blocked off by infiltrating the tissue about
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it (Fig. 144). The scar tissue is sometimes very extensive, particularly if the patient has previously been treated by incision or by the injection of irritating fluids.

In extensive involvement of this region by fistulous tracts it is advantageous to make a sacral blocking with novocain and use quinine in the field of operation wherever it is needed to supplement the sacral blocking and for the purpose of controlling after-pain.

An incision is then made down to the director within the tract. Should the tract lead beyond the external sphincter the operation must be interrupted in order to infiltrate the deeper portions of the gut. Bleeding points should be picked up and ligated. A tampon should not be depended upon to control the bleeding. The bottom of the tract should be incised to permit new granulations to develop; the wound is loosely packed with gauze and allowed to granulate. This operation gives good results in simple straight fistulas though from 4 to 8 weeks are required for healing to take place.
EXCISION OF THE FISTULOUS TRACT.—The operation of choice in anal fistula is the excision of the tract or tracts and the immediate suture of the wound. It is true the method sometimes fails, but results will be secured in 90 per cent. of cases and should in-

![Image](https://example.com/image114.png)

Fig. 114. The tissue about the fistula is infiltrated throughout its length.

fection take place healing by granulation follows and nothing has been lost. If successful, healing is complete in a week or two as after the repair of a lacerated perineum.

If the tract is high or complicated the sphincter should first be dilated as already described. The fistulous tract is then infiltrated as for the simple operation by incision. A grooved direc-
tor is passed through the tract and the fistulous tract dissected out using the director as a guide (Fig. 145). The tract should be removed as an intact tube. If inadvertently cut into infection will be invited. It may be well to inject the tract with tincture of iodine before the operation is begun if the operator is not sure of his skill in removing it intact. If the opening in the gut

![Image](image-url)

**Fig. 145.** The fistulous tract is dissected out intact.

is high up the cut edges of the gut must be grasped lest they slip beyond reach and bleeding points cause embarrassment.

The tract being removed and all accessory tracts attended to in a like manner, closure of the wound is begun by suturing first the incision in the gut. Interrupted sutures of catgut are used and as the gut is closed it is allowed to retract into its normal position. The deeper portion of the wound is closed by buried catgut sutures (Fig. 146), after which silkworm sutures are used to close the skin (Fig. 147).

The rectum is lightly packed with gauze to protect the line of suture as much as possible. The bowels are kept locked with opium for four days and are then moved by a combined laxative and enema.
Fig. 146. Buried sutures of catgut placed through the severed ends of the external sphincter.

Fig. 147. Deep silk-worm sutures close the skin. Catgut in the lumen of the bowel.
A number of difficulties may be encountered in this operation. The accessory tracts may be difficult to find. Usually they extend about the anus horseshoe-fashion between the sphincter and skin. If the internal opening cannot be found great care must be exercised to find the highest point of the tract before opening is made into the gut. When accessory sinuses are present it may be necessary to stop the operation to permit renewal of the infiltration. There may be a temptation for the operator to abbreviate the operation if the sinus goes beyond his primary estimate of the extent of the disease. It is better, therefore, if the extent of the disease is not clearly discernible before the operation to make a sacral blocking at the beginning.

Fissures of the Anus.—In very small fissures a simple injection of the anesthetic about its base permits of excision. In the larger and more complicated it is better to do a typical operation, which requires the dilatation of the sphincter as advised for the removal of hemorrhoids. The affected area may then be excised and the defect closed by suture. Quinine is the anesthetic of choice because of the very intense after-pain when more ephemeral anesthetics are used.

Carcinomas of the Rectum.—Carcinomas situated low in the rectum, that is, when their upper border can be well circumscribed by rectal palpation, are easily removed under local anesthesia. Those situated higher up cannot be so removed because the necessary traction will cause pain in the upper part of the sigmoid. In such cases it is best to loosen the rectum and as much of the growth as is accessible from below under local anesthesia, and then to finish the operation under ether, either from below or by the abdominal route. This plan reduces very materially the duration of the general anesthetic.

The first part of the infiltration for carcinoma is done in the same way as for the removal of hemorrhoids, preferably with quinine. After this has been done the tissues higher up are infiltrated. The insertion of the levator is the essential area requiring infiltration and in the male the tissue between the
rectum and prostate. For this part novocain-epinephrin is preferable. It is not difficult to infiltrate the perirectal tissue if the needle is long enough to reach the sensitive area. A needle at least four inches long is required. The finger in the rectum gives the operator a definite notion of the presence of the point of the needle. It is possible in this way to anesthetize the pararectal tissue as high as the promontory.

The rectum is circumscribed either removing the sphincters or leaving them, depending upon the situation of the carcinoma. The levator is then encountered and should sensitiveness remain it may be infiltrated anew. With experience this necessity will not arise. If gentle traction is exercised after the levator has been cut it will bring the mesentery into view, and if this is cut high up it is possible to bring down tumors situated quite high. When the tumor has been delivered out of the perineal wound it may be excised without fear of causing the patient pain.

In high carcinomas it has been my practice to loosen the gut from below as high as the promontory under local anesthesia, and follow this by amputation through an abdominal incision with the establishment of a permanent inguinal fistula. This has given more satisfactory results than sacral resection.
CHAPTER XXII.

OPERATIONS ON THE EXTREMITIES

The subject of minor operations on the extremities under local anesthesia is of the greatest importance to the general practitioner, because most of his work will lie in this region. The parts are very sensitive and the possible lesions manifold, so that he must use the greatest care in the choice of methods and in their execution. Larger operations under local anesthesia have not met with uniform success, and their general employment is not at the present time advisable. The general principles concerning them are presented here because they are occasionally of great service and because it is desirable that they be developed further. Some of the procedures used for these larger operations are: injections into joint cavities for dislocations; infiltration about fractured bones; blocking of larger nerve trunks near their origin, and especially brachial plexus anesthesia, and blocking of the sciatic and anterior crural nerves.

INFECTIONS OF THE EXTREMITIES.—Localized infections may be anesthetized by circumscribing the inflamed area with a novocain-epinephrin solution. Very gentle pressure should be exerted for sudden increase in the tissue tension causes acute pain. In opening subcutaneous abscesses, where the skin is not directly affected, the line of incision may be injected directly, beginning in the healthy skin on one side of the lesion. Subfascial inflammations require deeper injections about the affected area. For the more serious infections about tendon sheaths and in the subfascial tissue local anesthesia should not be used indiscriminately. In such cases the extent of the disease often cannot be ascertained exactly before operation, and, at best, anesthesia in inflamed tissue is difficult to obtain. Furthermore, patients suffering from such infections are usually irritable, because of pre-
vious suffering. In all deep and extensive infections nitrous oxide gas is by all odds the anesthetic of choice. Only when gas is not obtainable, and when the patient has a special contraindication against ether should plexus anesthesia and nerve blocking of the large trunks be undertaken in deep infection of the extremities. When patients have pus-smereed extremities one should hesitate to make deep injections in the proximal parts.

**FRACTURES AND DISLOCATIONS.**—An American, Conway (N. Y. Med. Jour., 1885, II, 832), was the first to employ local anesthesia in fractures and dislocations.

The difficulty encountered in the reduction of fractures is due to the muscular spasm produced reflexly by the injured tissues. When the damaged area is anesthetized the spasm subsides, but may return as the anesthesia disappears. This fact must be kept in mind in placing splints, for apparatus which holds the fractured ends in place during the anesthesia may be inadequate after the anesthesia disappears. This applies particularly to fractures of the humerus. In most cases, however, fractures which are properly reduced and splinted remain reduced.

The first advantage of local anesthesia in the reduction of fractures is that the patient is saved the unpleasantness of ether. Further, unlimited time is allowed for the reduction of the fracture and with the same anesthesia the splint may be applied, examination under x-rays undertaken and the splint reapplied if necessary. The dangerous excitability of the etherized patient is avoided and the bandage is more easily applied. The great disadvantage lies in the injection itself, not because it is dangerous when ordinary care is used, but because the complications which are so numerous in fractures and dislocations may be attributed to the injection. Until the method is more commonly used the general practitioner will be playing on the side of safety to call in a colleague and make the reduction under ether. In fractures in which the skin has been bruised the needle should pass through uninjured skin, and if the injury to the surrounding
soft parts has been considerable the case should be considered unsuitable for local anesthesia.

From studies upon animals the following is deduced: in recent fractures the use of novocain-epinephrin solution will limit hemorrhage and exudation into the region of the injury and in so doing may limit the plastic material needed for repair. Quinine is unsuitable in fractures because of the excessive exudate of granular fibrin which interferes with the early processes of repair.

The technic is simple. The skin is sterilized with iodine and a solution of novocain-epinephrin, ½% is injected about the ends of the fractured bone. If there is displacement of fragments each fragment must be circumscribed with fluid. It is preferable to make the injection from two points diametrically opposite (Fig. 148) in order that the periosteum may be reached at all points. Thirty or more cubic centimeters are required. About 20 minutes is required for complete anesthesia to take place.
In dislocations injection is made directly into the joint cavity from the most convenient point. In hip dislocations Braun makes injections about the dislocated head and into the acetabulum by introducing the needle external to the anterior superior spine and following the bone into the acetabulum. In the knee Deutschlander (Zentralbl. P. Chir., 1913, XL, 377) injects ½% solution on each side of the ligamentum patellae, injecting each half separately. The infrapatellar region, the region of the crucial ligaments and the posterior recesses then receive attention (a, Fig. 149). The needle is withdrawn so that the point just remains within the joint cavity and is then passed upward under or to the side of the patella into the suprapatellar portion of the capsule (b, Fig. 149). After 10 or 20 minutes reduction may be accomplished. Pays used 80 to 100 cc. with the express purpose of distending the capsule in order to mechanically facilitate reduction.
Deutschlander warmly recommends joint injections for the manipulation of fixed joints and for operations. He regards a bloodless field as essential and employs the same technic to secure this as is recommended for Bier's venous anesthesia. My experience has been that the constriction required to secure the necessary anemia is intolerably painful to the patient. Intracapsular injections are not effective in adherent joints when there are extensive adhesions within or about the joint, but in recent adhesions gentle manipulation continued over a prolonged period is possible.

My own practice is to limit intracapsular injections to cases in which injections of formalin-glycerine are to be used. I aspirate the joint if it contains fluid, and inject 5% quinine solution. I allow this to remain 20 minutes, withdraw it and then

Fig. 150. Injections about finger into region of digital nerves.
inject formalin-glycerine after Murphy's method. The quinine produces a considerable degree of anesthesia, and in gonorrheal arthritis the quinine may have some effect on the disease itself. I have used quinine injections directly into the joint for the relief of pain in gonorrheal joints, and in those cases in which it was used the process ran a much shorter course than usual.

**OPERATIONS ON THE HAND AND ARM.—THE FINGERS.**—No region requires a more delicate technic if the patient is to be spared needless pain. A fine new sharp needle is indispensable. The
dull-pointed needles on the market expressly for use in local anesthesia are unsuitable. A small syringe must be used, preferably a glass one of 1 cc. capacity. The large syringes are unsuited, because very slow injections cannot be made with instruments of large diameter.

Fig. 152. Lines of skin infiltration on the palmar surface corresponding to the dorsal infiltration in Fig. 151.

AMPUTATIONS.—In amputations of the distal phalanx, or in opening abscesses in this region, the skin about the base of the finger is first infiltrated, beginning at the dorsum, because this is the least sensitive part, and proceeding toward the palmar surface. After a complete ring has been infiltrated the digital nerves
are blocked (Fig. 150). On each side of the bone the needle is passed downward and inward. The dorsal nerve is encountered near the central plane of the bone and the ventral opposite the flexor tendons.

When the first phalangeal bone, or the metacarpo-phalangeal joint, is to be attacked the line of skin infiltration begins on the dorsum of the hand an inch or two above the joint. Diverging lines are infiltrated, which terminate in the webs on each side of the finger (Fig. 151). When the web has been reached a similar triangle is described on the palmar surface in the reverse direction, terminating at a point opposite the point of beginning (Fig. 152). The nerves are now blocked by passing the needle downward from the dorsum on each side of the bone (Fig. 153), and upward through the web parallel with the nerves it is intended to block. If the metacarpal bone is to be attacked the periosteum must be infiltrated. This can be done most effectively by passing the needle along the bone from the web (Fig. 153). Each finger to be operated on is injected in the same manner. If several fingers are to be operated on at the same setting the skin lines of infiltration to the web should be made to bound the field of operation, but the nerves on each side of the metacarpal bones must be blocked separately (Fig. 151).

For operations upon the distal phalanx anesthesia may be attained by the method just described instead of by circling the base of the finger, but in limited operations the latter method is simpler.

Operations upon the carpal and proximal ends of the metacarpal bones must be preceded by blocking about or above the wrist. A circular line is infiltrated and from this the nerves supplying the region are infiltrated. The extent of this infiltration must depend upon the extent of the operation. If a single metacarpal bone is to be attacked injection about its base from the circular line will be sufficient. If more than one is to be attacked each in turn must be similarly infiltrated.

Instead of infiltrating about the bone to be attacked the nerve trunks may be blocked above the wrist. A circular line is first
infiltrated in the skin and subcutaneous tissues (Fig. 156). This blocks all superficial nerves in this region. Through this primary line the main trunks are injected (Fig. 157). This method of anesthetization is required for all extensive operations on the wrist and hand.

Fig. 153. Infiltration of the periosteum when the metacarpal is to be attacked.

For operations upon the metacarpal of the thumb this procedure may be modified. Instead of infiltrating a line entirely about the wrist this line is terminated over the carpo-metacarpal joint and the line continued to the web of the thumb, both fore
Fig. 154. Circular injection about the wrist. Needles showing direction of blocking the radial and ulnar nerves.

Fig. 155. Cross-section of the wrist showing the nerves to be blocked.
and aft (Figs. 156 and 157). From this line deep injections are made. This technic is useful also in certain dislocations of the thumb.

In lacerated wounds of the hand the skin injection is begun at one angle of the wound, and from this point the injured area
is circumscribed and the deeper tissue then injected. This method of injection causes less pain and is less likely to cause infection than if the skin is injected from the edges of the wound.

Fig. 157. Superficial and deep injections on the palmar surface for operations upon the metacarpal bone of the thumb.

INFECTION OF THE FINGERS.—Superficial infection may be injected directly in the line of the proposed incision, but in more severe infections it is best to block off the entire finger as recommended for amputation (Fig. 150).
If the operator will use judgment the patient may be saved many hours of acute suffering by using quinine for anesthesia in operating abscesses. If too much anesthetic fluid is injected the circulation is disturbed and the necrosis of the disease augmented.

*INFECTIONS OF THE PALM.*—Simple isolated infections may be incised through a simple infiltration line in the skin covering them. The diffuse infections should be done under gas or ether, or, if these are not available or are contraindicated, by blocking of the nerves above the area of infection, or by plexus anesthesia.

*Fig. 158. Circular injection of the arm with blocking of the nerve trunks above the elbow.*

Operations upon the forearm may be done following a circular infiltration above the elbow with subsequent blocking of the nerve trunks (Fig. 158). When for some reason local anesthesia is necessary for large operations, they are better done under plexus anesthesia. If the latter is incomplete it may be supplemented by local infiltration.

Bursae of the olecranon, or abscesses or exostoses resulting from them, may be attacked, infiltrating a line about them and injecting deeply beneath them from this line (Fig. 159). In thickened bursae the needle can readily be passed between the cyst wall and the bone, but in recent ones this may not be possible. In that event the border of the bursa is freely infiltrated, which secures ample anesthesia after a wait of ten minutes.
PLEXUS BLOCKING.—Crile first blocked the cervical plexus by laying bare the nerves above the clavicle. Herschel (Verhandl. d. Deutsch. Gesellsch. f. Chir. r., 1912, XLI, 348) attained the same result by passing the needle from the axilla, and Kulenkampf (Zentralbl. f. Chir., 1911, XXXVIII, 1336) by passing the needle above the clavicle. The last two methods will be described.

Herschel's Method. The patient is laid flat on the table with the arm in extension. The brachial artery is located by palpation. The needle is passed through the skin in a direction par-

![Fig. 159. Injection superficial and deep for operation upon the olecranon.](image)

allel with the artery, from a point over the insertion of the latissimus dorsi. The needle is passed parallel with the artery for ten centimeters, and 1 cc. of a 2% novocain-epinephrin solution is deposited in an area of 3 or 4 cm. The needle is withdrawn until the point is just beneath the skin and is then reintroduced lateral to the artery in order to reach the median nerve. The musculo-cutaneous nerve may be reached by passing the needle high into the axilla toward the first rib, but this is not needed in operations involving the hand only. If the nerves are directly penetrated, which is manifested by paresthesias, anesthesia is instantaneous. Ordinarily the anesthetic is deposited in the vicinity of the nerve and anesthesia is not complete for 20 or 30 minutes.
The objection to this method is the same that applies to any in which the anesthetization of large nerve trunks depends upon diffusion—irregularity in onset and uncertainty of effect. Lying as the nerves do in close proximity to the axillary artery and veins, these structures are liable to injury. Herschel states that such injury is of no consequence. I have tried puncturing large vessels with a needle when they are exposed during operation. The escape of blood is considerable. Cases are reported in which troublesome after-effects have followed on account of hemorrhage. Puncture of the vessels is unlikely if a puddle of the fluid is kept constantly ahead of the needle as it is being pushed forward. Troublesome paralyses have resulted from this method, but none so far as reported have remained permanently.

*Kulenkampf's Method*. This method probably is more certain in its action because its aim is to penetrate the nerves and it is less likely to injure the large vessels, because the vulnerable parts have constant anatomical relations and can easily be avoided. It is as follows: with the patient in the sitting position the artery is palpated. It is usually found about the midpoint of the clavicle (Fig. 160). A line uniting this point with the tip of the spinous process of the first dorsal vertebra (Fig. 161)
passes through the cervical plexus. In thin subjects the nerves may be directly palpated where they pass over the rib. From the point above given a needle is passed in the direction of the imaginary line, uniting the point to the tip of the first dorsal spine. Placing the tip of the left forefinger on this spine helps to maintain the direction. The plexus is reached at a depth of from $\frac{1}{2}$ to 3 cm. (Fig. 162). The penetration of the nerves is manifest by paresthesias in the region of distribution of the nerves affected. If the first attempt does not succeed the direction of the needle must be varied until the nerves are pierced. Infiltration of these nerves does not cause anesthesia in the upper portion of the arm, and when operations about the shoulder are to be performed infiltration of the skin and subcutaneous tissue is required. For the plexus injection, 10 cc. of a 2% solution are deposited when the needle penetrates the nerve, and a few more a short distance deeper. If anesthesia is not complete, an additional 5 or 10 cc. of a 4% solution is used. Novocain-epinephrin is always used.

In 100 cases recorded by Kulenkampf the method failed in four cases. In 19 cases some areas were not completely anesthetized. Kulenkampf regards accidental puncture of the artery as free from danger.

Injury to the nerves has resulted from puncture of the nerve roots, but in no case has there been permanent disability. Hirshler reports three cases in which circumscribed paralysis or sensory disturbances remained for a considerable time. He advises that those whose occupations require delicate manipulations with the fingers, such as fine mechanics, violinists, and pianists, be not subjected to this method of anesthesia.

Plexus blocking is applicable to all operations upon the arm and hand, and is particularly useful for individuals who are affected with other disorders, and in cases where thoracic injuries make inhalation anesthesia undesirable.

Hartel and Keppler (Arch. f. Klin. Chir., 1914, CIII, 1) report paralysis of the diaphragm on the injected side in 17 out of 200
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cases. This should warn against injecting both plexuses at one sitting. In 5 cases they observed severe pain in the chest and dyspnoea, which they believe was due to the puncture of the pleura. In the light of my recent experience I would suggest that it may be due to massive collapse of the lung due to paralysis of the phrenic nerve.
Because of the long duration of its effect quinine is distinctly the anesthetic of choice for this operation.

Instead of the method above described a circular line about the base of the toe may be injected and other nerves leading to the diseased area blocked by deep injections at the base of the toe, as shown for operations on the fingers.

Fig. 166. Dorsal line of infiltration for amputation of the toes.

AMPUTATION OF THE TOES.—The amputation of toes is accomplished in a manner similar to that described for amputation of the fingers. Since amputation of the toes is rarely performed distal to the metatarso-phalangeal joint, the triangular infiltration over the dorsum and plantar surfaces with deep infiltration from these lines is the method usually employed.
Near the base of the metatarsal joint an infiltration line descends to the web on either side of the toe or toes, which are to be operated upon (Fig. 166). From the point of termination of these lines at the web other lines are infiltrated upon the sole to terminate at a common point opposite the point of beginning on the dorsum. From the web line deep infiltrations are made along the bone, as shown in operations upon the fingers. From the point of beginning on the dorsum the deeper tissues are infiltrated, extending through the foot to the sole, as shown in operations on the hand. This gives an anesthesia which permits metatarso-phalangeal disarticulation or amputation through the shaft of the metatarsal, as is required in metatarsalgia. Amputations of the great toe may be done under the technic advised for bunion.

INJURIES TO THE FOOT.—Puncture of the foot, particularly the sole, by nails or other foreign bodies, is one of the most frequent surgical lesions encountered by the general practitioner. The frequency with which tetanus follows these injuries makes their proper treatment of the greatest importance. If the wound is fresh it is imperative that the entire tract be exposed immediately and that the entire area which came in contact with the foreign body be thoroughly cauterized and the wound packed. This procedure demands a careful anesthesia. If the wound be clean the needle may be introduced along the tract of the foreign body and the infiltration begun in the subcutaneous tissue. This method saves a preliminary puncture of the thick and sensitive skin, but it is open to the objection that infection present in the wound may be carried to the deeper structures. Some idea of the depth and direction of the puncture must be obtained from the history of the injury in order that an area large and deep enough may be infiltrated. If the wound is deep, extending to near the dorsum, it may be advantageous to begin the infiltration on the dorsum and gradually approach the site of the wound on the sole. The dorsum is less sensitive and the skin less resistant. Often by these means it is possible to operate children who
would not permit the operator to force the needle through the resistant plantar skin. This applies particularly in boys who have been going barefooted.

Wounds already infected can more frequently be satisfactorily opened under local anesthesia in the foot than in the hand, because of the lesser tendency for the infection to follow the tendon sheaths. The infiltration must begin in healthy skin and the infected area gradually be approached or circumscribed, depending on the degree and character of the infection. Infections following the tendon sheath, like those of the tendon sheaths of the hand, demand general anesthesia.

**Hallux Valgus.**—From a point two inches above the joint on the medial border of the foot to a point between the metatarsal bones to the web of the toes the skin is infiltrated (Fig. 167). From the same point a line is infiltrated over the inner border of the foot to a point on the sole corresponding to the point of beginning (Fig. 168). From the terminal point of the first infiltration on the web a line is now injected to the point on the sole of the foot. From the first point injected the interosseus nerves are blocked, and the periosteum is infiltrated. From the point on the sole of the foot the periosseous tissues likewise are infiltrated. This may be accomplished by injecting from the webs of the toes (Fig. 169). This operation deals with sensitive tissue, and a considerable amount of the fluid, usually 40 to 50 cc of a $\frac{1}{2}\%$ of novocain-epinephrin solution, should be used.

**The Tendo Achillis.**—Operative lengthening of this tendon is usually part of a serious operation not usually undertaken under local anesthesia. Rupture of the tendon offers a more frequent object for the employment of local anesthesia. It is desirable that the skin incision shall not fall directly over the repaired tendon. A curved line, therefore, is infiltrated from a point over the tendon, beginning two inches below the site of injury, curving outward over the tendon, beyond the tendon and terminating over the tendon two inches above the injury (Fig. 170). From the points of beginning and termination of the line the
Fig. 167. Superficial and deep dorsal infiltration for hallux valgus.

Fig. 168. Plantar infiltration for hallux valgus.
tendon is circumscribed with fluid. By sliding the skin both sides of the tendon may be reached by the needle without making a new puncture in an unanesthetized area. The area below the tendon can best be reached from a point in the original line where this crosses the furrow below the tendon. By making the incision along the line of the original infiltration a flap is formed which, when returned after the repair is made, places the line of incision outside from the recently repaired tendon.

In open injury of this tendon and others of the foot an ellipse should be circumscribed an inch or two from the site of injury
from which to infiltrate the deeper tissues. Should the injury involve or lie near a prominent nerve, the infiltration is made with the view of striking the nerve.

VARICOSE VEINS AND ULCERS.—Dilated veins and the ulcers resulting from them are frequent diseases in fat old women in whom ether anesthesia is to be avoided. They can be managed under local anesthesia by the exercise of patience and care in manipulation on the part of the operator.

It will be necessary to resect the veins below the saphenous opening and also some segments below the knee, the location of
which can be determined when the patient is on her feet. The skin over the vein is infiltrated in the usual manner (Fig. 171). The tissue about and below the vein can be infiltrated by sliding the skin first on one side and then on the other. For this purpose a considerable amount of weak solution, $\frac{1}{4}\%$ or less, is used in order to facilitate the dissection of the veins. The vein

![Fig. 171. Infiltration of skin over a varicose vein.](image)

should be dissected in plain sight so that collaterals may be seen before they are cut. They should all be ligated, for while they may not bleed at the time of the operation, they may do so later. If the vein from previous periphlebitis has become adherent to the subcutaneous tissue it is best to infiltrate an ellipse about the mass and excise it as a whole.

The removal of a varicose ulcer is more difficult, because it involves the periosteum and because the skin about it is often very sensitive. I have developed a typical operation, performed
as follows: the solution is injected about the border of the ulcer (Fig. 172) through approximately normal skin. From this line

the periosteum is infiltrated over the entire base of the ulcer, a procedure which is facilitated by the presence of a considerable amount of fibrous tissue. If the ulcer is large and consequently
curved it may be necessary to make some of the infiltration through the base of the ulcer. When the infiltration is complete, the skin is incised in the line of the first injection, and the ulcer is dissected from its base with its floor intact. The ulcer thus excised forms a flat saucer.

In preparing the bed of an ulcer for skin-grafting a small amount only of epinephrin, say two drops to the ounce, should be used, so as to produce the least amount of constriction of the vessels and allow a quicker recovery of their normal tone. One must depend upon the exudate from the vessels to supply the preliminary fixation of the graft. In operations of this kind it is well to prepare the ulcer as the first step. By the time the varicose veins have been resected and the area from which the new skin is to be secured has been prepared, the vascular tone in the bed of the excised ulcer has been to a certain extent restored. With all this precaution there will be a greater percentage of failures than if no local anesthetic at all is used.

The method of preparing the skin from which the graft is to be taken may be varied according to the size of the graft. If it is small, the area from which the graft is to be taken may be infiltrated subdermically and surrounded by a horseshoe-shaped endermic infiltration.

For anesthetizing the skin preliminary to removing the grafts quinine is better than novocain-epinephrin, because the former produces a preliminary capillary hyperemia which assures an abundance of serum which is necessary to assure ideal healing of the grafts. Novocain-epinephrin, on the other hand, by virtue of the anemia it produces, furnishes a blanched serumless graft. This is of more importance in where particularly thick grafts are required, as for covering defects on the tibia or skull.

For large grafts the same method may be used, or the nerves to the area may be blocked. The nerves concerned are the lateral cutaneous, femoral and the anterior cutaneous. The former emerges medial to the anterior superior spine and below the Poupart's ligament. In order to block it Loewen (Deutsch Ztsch.
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"Surg. Chir., 1911, LXI, 252) suggests that the most favorable point is two finger-breadths downward and inward from the anterior superior spine. Two or three cc. of the solution are deposited above and below the fascia, the needle being directed downward and outward. To reach the anterior crural nerve, Loewen gives the following directions: the femoral artery is located by the finger at its emergence below Poupart's ligament. The needle is passed one and one-half cm. lateral to this point perpendicular to the surface until it penetrates the fascia lata. While the needle is passing 5 cc. of a 2% solution are deposited. Puncture of the nerve, which should be done if possible, is manifested by a contraction of the rectus femoris. After the nerve has been penetrated the fluid is deposited.

When the nerves have been successfully blocked a large area is made anesthetic. This method has the advantage over direct infiltration of the skin that the capillary circulation is not interfered with. Its disadvantage lies in the fact that it is not always certain that the nerves will be effectually blocked, especially in fat persons.

Patellar Bursitis.—For the treatment of this common affection one injects first a line of skin around the base of the swelling and, second, through this line the periosteum beneath the bursa (Fig. 173). The second step is especially easy if the periosteum has become thickened by prolonged inflammation. In recent cases where the thinness of the tissue may make this uncertain, the fluid from the cyst is replaced by a 5% quinine solution. The bursa is then dissected out in the usual way.

Ganglia about the knee are removed by infiltrating the skin over them and the tissue surrounding them. Sometimes their deep attachments remain sensitive and require a secondary infiltration during the course of the operation.

Tumors.—Many tumors of the soft parts may be removed under local anesthesia. It is best to infiltrate about them without regard to the nerve supply. Tumors with deep attachment
should be undertaken with caution and the operator must be prepared to infiltrate periosteal or deep fascial attachments.

Blocking of the nerves of the leg in a manner analogous to plexus anesthesia in the arm is not possible because of the numerous avenues of exit of the nerves supplying the leg. The sciatic may be reached at a point slightly medial to the center of a line between the trochanter and the tuberosity of the ischium. The only purpose for which this nerve is likely to be injected is to control the pain in sciatica. By injecting 10 cc. of a 1% solution of quinine into the nerves, one can not only control the pain for some days, but can also bring about a cure in many cases.

Major operations about the knee may be performed under venous anesthesia. The indications for arthrotonomy are often
such as to make the case unsuited for venous anesthesia. Infected legs or joints preclude its use. In loose bodies or loose cartilages it finds ideal application. Unless the patient has had a full dose of morphine before the operation he is apt to complain bitterly of the pressure from the constricting band. All these disadvantages will prevent this method becoming popular.

Major operations on the leg and thigh under nerve blocking belong to the "stunts" in local anesthesia and are useful only for the purpose of demonstrating the spearing prowess of the operator. In major operations upon the thigh, one may employ spinal anesthesia where gas or ether cannot be used. Spinal anesthesia is less objectionable than the massive injections of the leg required for extensive operations under local. Loewen used 2.1 gm. novocain in order to make the whole thigh anesthetic. Such a quantity of the drug makes the procedure more hazardous than spinal anesthesia.
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