SURGICAL PROCEDURES IN GENERAL PRACTICE

This is one of a series of articles contributed by invitation

AMPUTATION STUMPS AND ARTIFICIAL LIMBS

BY

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The war of 1914-18 added greatly to our experience of amputations, and even at that period many of the old textbook operations had become obsolete. In the last twenty years considerable further progress has been made: it has been shown that much of what was then done has not stood the test of time, and that many amputations, satisfactory enough in younger people, become impermanent as age advances and circulation becomes less adequate. Accordingly many changes of technique have been evolved, and fortunately these have coincided with a great improvement in the manufacture of artificial limbs, which are now made lighter and are simpler in mechanism. A man with a satisfactory below-knee amputation may expect to be able to walk five to ten miles in comfort, whereas he might well be unable to walk a hundred yards with a maimed leg. Where possible there should be co-operation between the surgeon and the limb-maker, the former aiming at the provision of an ideal stump and the latter being prepared to exercise his ingenuity in fitting one which is not so.

Emergency Amputations

Let us consider the duty of a surgeon confronted with a major limb injury in which part of the limb is irretrievably destroyed, say from a motor or an industrial accident. Unless it is absolutely certain that the intermuscular planes have not been infected and that the skin of the limb can be rendered aseptic, he should treat the case as a compound fracture, merely all dead or contaminated tissue being removed and the final stage left to a future date. In many cases it will be advisable to perform a "guillotine" amputation. This consists in dividing the limb in an absolutely circular manner, leaving as much as possible, tying vessels, and opening up no intermuscular planes. A non-adherent dressing is then applied. Suitable dressings are gauze soaked in flavine paraffin for the first two or three days, followed later by Dakin's oil sprayed on the wound. The latter has an agreeable odour and is highly antiseptic. The constituents of these two preparations are:

Flavine paraffin:

Acriflavine	...	...	...	...	gr. viij
Rectified spirit	...	...	...	...	3 vj
Liquid paraffin	...	...	...	...	3 xxxiv

Dakin's oil:

Dichloramine-T	...	...	...	...	2 parts
Chlorinated eucalyptol (Martindale)	...	...	...	...	20 parts
Chlorinated paraffin (Martindale)	...	...	...	...	80 parts

A large proportion of guillotine amputations remain permanently satisfactory if in the course of a few days traction be applied to the skin. Four pieces of adhesive strapping are attached at intervals round the stump, and by means of these extension is made to the end of an apparatus similar to a truncated Thomas splint. Heal-

ing will take place very rapidly and the resulting scar will contract to a surprising degree. Such a terminal scar is often quite satisfactory in the arm, forearm, thigh, and rarely, though occasionally, in the leg.

Should reamputation be necessary no attempt at the creation of a permanent stump should be made until the wound is covered with healthy granulations and there is no oedema in the stump. At the time of reamputation the granulations should be well painted over with pure carbolic, and no instruments, swabs, etc., allowed to come in contact with the open wound. Where amputation is performed for disease the final stage can of course be planned in advance.

Permanent Amputations

As regards general technique, a tourniquet should be used for the lower but not the upper limb, as in the latter it is unnecessary (the artery can be controlled by the digital pressure of an assistant) and also possibly harmful (the arm tolerates even temporary anaemia less well than the leg), a flat Esmarch bandage being alone permissible.

Flaps used to be made much too long, owing to the teaching of surgery classes where operations were done on the dead body, the skin of which is inelastic. In the living body the skin is elastic, and a total length of flap of one diameter of the limb is fully adequate. If the flaps are too long a pouch is left in which blood and serum can collect and become a nidus for infection; and, also, the final stump, though fittable, is likely to become sulcated and eczematous from the rubbing of the artificial limb. Only a part of the muscles should be retained sufficient to ensure the blood supply of the flaps.

The best stumps for limb-fitting are the thin and conical. The ideal flaps will be described below, but it must be remembered that in many cases their shape and length will be determined by the skin available and the nutrition of the limb. It would be absurd to employ the same length of flap in a case of arterial disease as in one of an injury to a healthy person. It may well be right to preserve length in a stump at the cost of placing the scar in a relatively unsatisfactory position. In dividing the bone it used to be thought necessary either to remove the periosteum from the last half-inch or to retain a cuff of periosteum from the bone removed that could be made to cover the sawn end. Actually no special treatment is required and the periosteum is divided at the same level as the bone.

At one time it was considered correct to shorten nerve ends and even to inject them with alcohol. The latter practice leads to an alcoholic neuritis and must be abandoned. A nerve bulb must form on the end of a cut nerve, and all we can do is to place the bulb where it will receive a minimum of pressure. This site will generally be the end of the stump, on which the socket does not press. Nerves should therefore not be shortened. Tying off with catgut is perhaps permissible, but the nerves should not be crushed; the less trauma they receive the less trouble they give later. Haemostasis should be performed with the greatest care and no drainage employed. On the question of drainage I am aware

that some surgeons will disagree, but I must speak from my own experience.

An amputation which bleeds but slightly at the time is always suspect and tends to bleed later when the blood pressure rises. In such cases it is as well to massage the limb above and to wait long before finally suturing the wound. It is best to ligature every bleeding point, however small. A copious dressing, firm bandaging, and the control of the knee or elbow by a splint for forty-eight hours will complete the operation. The splint should be removed as soon as possible, as it is important that the voluntary use of neighbouring joints should be preserved.

Amputation of the Arm

It is a fairly safe rule that as much as possible of the limb should be preserved. The possession of one perfect digit is preferable to the best artificial arm, as a prosthesis can be made to which this digit is opposable. Also, much can be done by tendon transplantation to improve a damaged hand. Amputation of the fingers has been considered in a previous article in this series, and it will suffice to say that the temptation to operate for the removal of tender digital nerve bulbs must be resisted, as this nearly always makes matters worse. There occurs an ascending neuritis which may lead to progressively higher amputations, with no benefit to the patient.

The ideal sites for amputation are eight inches below the acromion for the arm and six to seven inches below the olecranon for the forearm. The skin is very elastic, and short equal flaps from the flexor and extensor aspects of the forearm should be employed. Similar flaps should be used for the arm. The arm is a sense organ, and its sensation is far more extensively represented in the brain than is that of the leg. Accordingly, "phantom" limb is far commoner in the arm than in the leg. A patient will often feel the effects of an injury that occurred even a considerable time before the amputation. Pain is often agonizing, and for this reason also amputation of a part of the arm must never be undertaken lightly, even when the limb is useless, especially if the patient is of a "neurotic" type. Removal of nerve bulbs is worse than useless, as the pain is central in origin and the removal only adds extra trauma. The only treatment is by nerve sedatives, the wearing of an artificial arm, and occupation of mind.

Artificial Arms

Sockets are made of block leather, metal, or certalamid. Artificial hands operated by the patient have generally proved clumsy and unsatisfactory, but they are used occasionally, and are moved by the action of appendages and cords attached to the shoulders. Where no mechanical hand is to be fitted, forearm amputations are provided with a hinge at the elbow and a simple corset round the arm. The patient is supplied with a "dress" hand having a thumb working on a spring, with which, say, a book or paper can be held. In addition other appliances are supplied suitable to the occupation of the patient, all being made to be snapped in in place of the hand. A C-hook is very useful as it can be used for pulling, pushing, or torsion. Where the arm is weak it is advisable to fit an adjustable lock at the elbow to enable the joint to be fixed at any angle desired and to avoid strain.

For above-elbow amputations shoulder harness is used; the elbow is flexed by moving the shoulders forward and so pulling on a cord. There is also a mechanism which enables the patient to lock the elbow at any angle and release the catch at will. This is operated by the patient

forcing the stump down into the socket and so pulling on a second cord attached to the shoulder harness.

In above-elbow amputations the bisection of the forearm prosthesis, which allows of pronation and supination of the hand, is placed as near the elbow as possible in order to throw a minimum strain on the elbow-flexion cord. Instruments are snapped in to this short forearm, the dress-arm being of normal length.

Amputation of the Leg at or near the Hip-joint

Where this operation is performed for disease the eradication of the diseased tissue is the primary consideration, and in not more than half the cases will the patient ever wear an artificial limb. In these cases the amputation will be through the hip-joint. Where, however, the hip-joint is intact one should contemplate the wearing of a "tilting-table" limb (see below) and make the best stump for this purpose. At least the head of the femur should be left, the neck being sawn through, as its presence prevents the stump from sinking in. If possible, however, the amputation should be made just below the lesser trochanter. The ilio-psoas flexes the stump and the patient's hip is in the sitting position. The retention of the great trochanter and the flexed stump provide points to which the socket can be fitted closely, helping to prevent the stump slipping out of it, a principle which we shall meet again when considering the leg. Flaps will be planned according to circumstances, being of the same shape but shorter or longer according to the level of the bone section.

The old operation by equal lateral flaps is quite satisfactory, but by far the best is as follows: From the anterior superior spine to the adductor longus tendon a short anterior flap is made and turned up. Double ligatures are placed on artery and vein and the vessels divided between them. From the above points a large posterior flap is made composed of the whole gluteal region. This flap is well nourished by the gluteal vessels, which expend themselves in the flap, and bleeding is slight. The tuber ischii, which must bear the weight, is well covered, and the patient sits comfortably in the socket.

Amputation through the Thigh

Except in the rarest cases a stump measuring less than five inches from the top of the great trochanter cannot be fitted with a limb giving hip control, and if this amount cannot be retained amputation as above should be performed. At a point below this a stump should never reach lower than four inches above the adductor tubercle, as a longer stump interferes with the mechanism of the artificial knee-joint and is ill nourished. The ideal length is ten and a half inches, measured from the top of the great trochanter. Equal flaps, lateral or antero-posterior, may be used, but the ideal is a long anterior and very short posterior, the scar being placed at the back. Hamstrings should be cut rather short, as if they become adherent to the scar the necessary action of bracing the stump back in the socket when walking may be painful from the involvement of cutaneous nerves. The sciatic nerve should be left untouched for the reasons stated above.

In practically every case a bony spur will grow from the postero-internal aspect of the bone end. This does no harm, is not preventable by any special treatment of the periosteum, and operations for its removal are not necessary unless the spur is adherent to the scar, which, if the flaps are well planned, should never be the case.

The Stokes-Gritti operation is quite obsolete. The stump is too long and the patella often becomes displaced forward. The Stephen-Smith amputation through the knee-joint is retained only for certain cases of arterial disease. The necessary prosthesis is clumsy, as it is impossible to fit a neat knee-joint.

Below-knee Amputations

In the last century an amputation allowing for the fitting of a peg-leg on which the patient knelt was rightly in favour, and such is still our only method of obtaining a good natural weight-bearing end to a stump. For this a stump of under three inches of tibia should be left. Occasionally, even, one has to supply legs which differ only slightly from those in use in Nelson's day, but generally a somewhat more sightly limb is possible. It is clumsy but will solve many difficulties. From 1920 to 1930 we regarded a tibial length of seven inches as ideal, but it has been found that as the patient grows older this stump becomes ill nourished and that one of five and a half inches is better. Equal lateral flaps are to be avoided, as the antero-posterior scar tends to be drawn up between tibia and fibula, leaving a stump resembling a pair of "shorts."

The best amputation is as follows: A one-inch anterior flap is turned up composed of skin only and a posterior flap made shelving from skin at the extremity to the full thickness of muscle at the base. The bones are cleared and the fibula divided first with bone-forceps three-quarters of an inch above the intended section of the tibia (to prevent cross-union). The tibia is then divided and the anterior edge bevelled. Nerves are left untouched. The advantage of the posterior flap is that should, as rarely, the anterior end of the tibia tend to press through the skin a reamputation can generally be done without further sacrifice of bone. The head of the fibula should always be retained. As in the case of hip-joint amputations the socket can be fitted closely to it, and its presence helps to retain the stump therein.

Syme's Amputation

This still has its advocates. The operation originally described by Syme is obsolete, as the heel-flap was too voluminous and the stump left too little room for the fitting of an artificial ankle. The modern incision is an elliptical one crossing anteriorly just above the ankle-joint and posteriorly half an inch to one inch in front of the point of the heel. The foot is removed from above downwards after disarticulation of the ankle, and the bone is divided half to three-quarters of an inch above the ankle-joint. The posterior tibial artery should be respected, and in this case the nerves should be shortened as it is intended that the stump should be end-bearing.

I have performed this operation many times on natives in the East, mainly for shark-bite, and the results have been very satisfactory. No artificial limb has been worn, of course, and the patient has got about very well. The same applies to the wearing of an "elephant boot"—a simple leather bag with a sole; but where the patient is fitted with an artificial limb encasing the leg, and with a foot, the operation is not permanently satisfactory. Circulation is impeded, and there are traction on the muscles and friction of the skin. The heel flap is drawn up posteriorly and there is periostitis and ulceration of the stump end.

The mid-tibial amputation is far more satisfactory for civilized man. The Chopart and Lisfranc operations are

obsolete, as in the former the os calcis becomes displaced backwards by the pull of the tendo Achillis, and in the latter it is difficult to preserve an adequate arch to the foot.

After-treatment of Amputations

The splints applied to control knee or elbow should be removed after forty-eight hours and free movement allowed. As soon as the wound is soundly healed active exercise of the limb should be encouraged. Massage is of doubtful benefit. At this time treatment should be begun, directed to obtaining shrinkage of the stump to its final size before limb-fitting is attempted. The stump should be kept bound either by a simple bandage or preferably by elastoplast.

In above-knee amputations, and less often in those below the knee, "pylons" are used. These are temporary sockets, made of plaster-of-Paris, to which are fixed wooden ends similar to the lower ends of crutches. They are cheap, can be reapplied, and the patient, by being enabled to get about, retains movement in his joints and encourages the shrinking of the stump. A patient should not wear a pylon till up to three months after the amputation and his stump is in a condition to permit the fitting of a permanent limb.

Artificial Legs

For an amputation near the hip a "tilting-table" limb is fitted. The pelvis rests in a socket, and below this the leg is attached by a simple hinge, capable of being locked or released by a catch easily operable through the clothes. The catch is released for sitting and fixed for walking, in which the hip is rigid and progress made by a swing of the pelvis.

For thigh amputations there are really only two types of prosthesis, the choice between these depending on the patient's power of bracing back the stump and so controlling the extension of the knee. If strength is good the limb is suspended from the pelvis and the knee movement checked by an adjustable brake at the knee. In other cases the limb is suspended from the shoulders and knee extension is performed by means of a roller cord activated from the shoulders and working on an eccentric in the knee-joint. If the stump is very weak a rigid pelvic band can be added.

For below-knee amputations in which the stump is very hard and healthy a socket, knee hinge, and thigh corset may suffice, weight being taken on the heads of tibia and fibula and the lower edge of the patella; but experience has shown that this is rarely possible and that it is better to take some of the weight on the pelvis by fitting a limb with a bearing on the tuber ischii. This is certainly the case in growing children, as there is a danger of hyper-extension deformity at the tibial epiphysis. The ankle works on a simple hinge with roller bearings, movement being checked in front and behind by rubber buffers. In cases where there is a tendency for the knee to shoot forward increasing the thickness of the anterior buffer will help.

Sockets for above-knee amputations are made of duralumin or wood, those for below-knee amputations of block leather or wood.

Frontal and Ethmoidal Sinusitis.—Patterson advocates the external operation for severe cases of frontal and ethmoidal sinusitis. The site of the incision is discussed.—External Operations on Frontal and Ethmoidal Sinuses. N. Patterson. —*J. Laryng.*, May, 1939, 54, No. 5, 235.