

War Surgery of the Extremities

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AMPUTATIONS

BY

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Comparison between a textbook of operative surgery produced before the war of 1914-18 and those published later shows that many amputations survive only as exercises on the cadaver and have no practical use. Also there has been increasing collaboration between surgeons and limb-fitters, to the advantage of the patient; and where, as in the case of young healthy people, it is contemplated that a limb will be worn, even the emergency surgeon should plan for this object.

Big advances were made during and just after that war, but during the last twenty years we have been able to watch the effects of age on amputation stumps and have modified our ideas accordingly. Artificial legs have improved enormously, and a good mid-tibial amputation is infinitely better than an incurably and severely painful foot. Artificial arms have improved too, but no prosthesis can equal the natural arm even when this is seriously maimed, and it must be remembered that the arm is a sense organ and is represented in the brain by a highly sensitive mechanism. "Phantom limb" is therefore much commoner in the upper limb, the brain cells working as a "racing" engine full of energy, with nothing to control on either the motor or the sensory side. These facts will easily explain the conservatism advised in the upper limb and the extreme importance, where amputation has been inevitable, of fitting a prosthesis as soon as possible to give the nerve centres something to do.

Emergency Amputations

A recent subcommittee of the War Wounds Committee of the Medical Research Council has published a paper (M.R.C. War Memorandum No. 5, H.M. Stationery Office) on this subject. It is clear that complete destruction of a limb will call for immediate amputation, often consisting in the mere removal of an already nearly severed limb. This is a simple matter, and can easily be performed while shock is being combated. Apart from this, there is really only one indication for immediate amputation—irreparable destruction of the blood supply of the limb. Retention of the limb under these conditions can lead only to extra shock from pain, sepsis, and the absorption of the products of dead tissue. Fractures open and closed, infection of joints, and destruction of muscle and nerve can be treated on orthopaedic lines, and extensive loss of skin by skin grafts, etc.

It has been a subject for discussion whether or not complete destruction of the main nerve to a limb is an indication for immediate amputation, as tending to save the patient prolonged treatment and disability. One has only to glance at the results watched for twenty years since the last war to decide against this. Hundreds of men had complete sciatic lesions which never recovered, and yet for many years they kept their legs, and only with advancing years did trophic ulceration sometimes demand amputation. They are no worse off in the end, and have had the use of the limb for many years. It is clear that occasions arise when the surgeon must act entirely on his own responsibility; but, where possible, he should always obtain a second opinion—the best available—before amputating.

The type of amputation suited to a particular case depends on: (a) the time that has elapsed since injury; (b) the level at which amputation is indicated; (c) the general condition of the patient.

During the First Six to Eight Hours after Injury.—Unfortunately this condition will rarely occur in field warfare, but will constantly arise in air raids on towns, where it is quite likely

that a patient will reach a proper operating theatre within this time. The same rules apply to amputations as to other surgical procedures. The tissues are infected, but infection has not had time to spread far. Amputation can then be done as for a permanent result, and for this reason it is desirable that emergency surgeons should be acquainted with the best sites and methods for the future fitting of artificial limbs. In such cases the wound may be stitched up, but, unless it is absolutely certain that haemostasis has been secured, drainage for twenty-four hours is advisable.

Eight to Twenty-four Hours after Injury.—If the injury be near the site of election it is justifiable to take a risk. A flap amputation is performed, but the flaps are not immediately closed. Mattress sutures are inserted through the edges of the flaps and prevented from cutting out by strips of rubber tubing, but are not tied. Skin traction will prevent skin retraction, and the sutures can be tied a few days later if all be well.

Later than Twenty-four Hours.—The tissues, and especially the intermuscular planes, are certainly infected, and maximum drainage must be afforded. This is best provided by a guillotine amputation or by that modification in which short flaps are left. Two conditions will arise: (a) The amputation can be performed well below the site of election, and the final amputation left till later: no skin traction will be needed. (b) Amputation must be performed at or near the site of election, and skin is so extensively damaged that the stump cannot be covered: skin traction is essential. Two illustrations will serve to define these points:

(i) The foot is destroyed and the leg uninjured. A mid-tibial amputation is contemplated and no more need be done than simple circular division of the limb at or just above the ankle.

(ii) The maximum amount of femur that can be conserved is five inches measured from the top of the great trochanter, and viable skin is deficient. Such a length is the minimum that can be fitted with a limb giving hip control, and every effort must be made to retain it.

Guillotine Amputation

In theory the guillotine amputation consists of a division of skin, muscle, and bone at the same level, and in practice this will be the case when used as a temporary measure. Otherwise it may be made to include such operations as (a) a modified circular amputation, each layer being drawn down and divided before being allowed to retract; and (b) amputation by short flaps. As much skin should be preserved as is consistent with safety.

Experience has shown that in most cases (though rarely in the leg) such operations are permanently successful, no further amputation being needed, a minor skin plastic operation at the outside being required. For this to be the case, and if a conical stump (the "sharpened lead pencil" of one author) is to be avoided, the after-treatment is all-important. After operation a flavine-paraffin dressing is applied, and, where needed, in twenty-four to forty-eight hours skin traction is begun. Four strips of adhesive strapping are applied to the skin—adhesion reaching as near the skin margin as possible—and secured by one or two turns of encircling strapping. To each of the four strips is attached a cord leading to a 2-lb. to 3-lb. weight suspended over a pulley at the end of the bed. Otherwise a Thomas splint (sometimes truncated) may be used, traction being made against the tuber ischii. Dressings must be infrequent, as in all modern surgical technique. Flavine-paraffin is good for the first three days; after which Dakin's oil or plain vaselined gauze is better.

In high guillotine amputation of the thigh it is safer to tie the femoral artery in its continuity below Poupert's ligament at the time of amputation, so as to minimize the risk of secondary haemorrhage.

Reamputation

In spite of past experience there is no doubt that the fundamental principles governing reamputation are not well understood, and patients have been subjected to a series of reamputations with no gain and a serious loss of limb length. In general, no reamputation should be performed until the wound surface is covered with healthy granulations, there is no oedema in the stump, and, where obtainable, radiographs have shown that there is no active periostitis. This means that every care must be taken to ensure that there is no latent sepsis in the stump.

Oedema especially shows that such infection still exists in the intermuscular planes, and therefore reamputation will be performed through infected tissues and the whole problem must be faced again. It is impossible to exaggerate the importance of this principle.

Permanent Amputations

It has been said above that a case seen soon after injury should be treated as for a permanent result, and it is therefore necessary to describe the methods designed to produce this. The general principles will be described first and the details applicable to various amputations later.

General Principles

Tourniquet.—Where the level allows, a tourniquet should always be used in the lower limb. If the section of the limb is so high that this is impossible, ligation of the common femoral artery at the time of operation can be done. No tourniquet should ever be used for the upper limb, as, although bad consequences are rare, they do occur and are avoidable: at most the bag of a sphygmomanometer is permissible. An assistant can easily control the artery by digital pressure for the few minutes needed, and in higher amputations the artery can be tied at operation, or the subclavian can be easily ligated through a separate clean incision. This is far more easy in the living person than in the cadaver, as the pulsation can be felt.

Flaps.—These should equal in length the diameter of the limb and not exceed it. The teaching that the length should equal a diameter and a half is derived from operations on the cadaver, in which the skin is inelastic. In the living body such flaps have a twofold disadvantage. They allow of the formation of a pouch in which serum or blood collects and is easily infected. Later on, the skin becomes infolded in the socket of the artificial limb and opposing sweating skin surfaces develop eczema intertrigo from contact with each other. Only just enough muscle should be retained at the base to ensure the blood supply of the flap. This will vary under different conditions, more being needed in cases of arterial disease than in those of the young and healthy. The best stumps for limb-fitting are the thin and conical, provided that adequate covering be obtained. The "lead pencil" type (see above) is of course objectionable. The best flaps for each operation will be indicated below, but flaps should always be planned according to the skin available.

Bone.—Bone should be sawn cleanly across and no spikes or periosteal tags left. Experience has shown that in certain situations, as on the postero-internal aspect of the femur, spurs will form in any case; but these are innocuous if they do not coincide with the suture line. There is thus no advantage either in removing a cuff of periosteum from the bone-end or in leaving one projecting beyond it.

Nerves.—These should be cut cleanly with a sharp scalpel or razor blade, but not shortened, crushed, or injected. They should not be shortened (except in Syme's amputation), as nerve-bulbs must inevitably form and pressure upon them is painful, whereas no pain is caused by pressure on the nerve-trunk. Reflection will show that the part of a stump least liable to pressure is the end, while at other points pressure will be caused by the socket of the artificial limb. Nerves should not be crushed or ligated, as they are very sensitive structures and dislike trauma either from crushing or from injection of alcohol or carbolic. The latter produces a neuritis which is very difficult to cure and which tends to spread up the nerve.

Vessels.—Main vessels should be carefully isolated from surrounding tissue and ligated with No. 3 catgut, the artery and vein being tied separately and care being taken not to include a nerve in the ligature. Haemostasis should be very complete, and most of the time of the operation should be thus employed. Where possible, arteries should be picked up cleanly and ligatured; but it often happens that a bleeding artery is in dense scar tissue, and in such cases there is no objection to its occlusion by a ligature passed round it on a curved needle. Again, periosteal vessels may be held in scar tissue and can be controlled, where necessary, by a ligature encircling the bone. Wax may be needed for medullary vessels.

Drainage.—This is optional. With complete haemostasis and firm bandaging it is unnecessary, and there is the disadvantage that it keeps open a possible route of entry for infective organ-

isms. At the same time, if it is thought that blood and serum will collect, drainage for at least twenty-four hours is advisable. Where no drainage has been employed the wound is inspected on the fourth day, or earlier if there are adverse local or constitutional signs. A small haematoma can often be released by sinus forceps or, at most, by removing one stitch.

Amputation of the Upper Limb

Fingers.—It is a good rule, in the first instance, to preserve as much of the finger as possible. Later on, when sepsis has been conquered, a reconsideration of the remaining function of the hand will be possible, and operation may be planned accordingly. Plastic surgery and tendon transplantation can do much. In any case it must be remembered that the possession of a single perfect digit which can be opposed to a prosthesis is better than the best artificial hand that can be provided. In amputation of the fingers consideration of the patient's occupation will decide whether the metacarpal head should be preserved. In the case of the index and little fingers an oblique removal of the head is usually preferable, unless it is felt that the preservation of the full width of the palm is industrially important. In the case of the central fingers such removal is seldom advisable, as, although the cosmetic result may be better, much weakness of the hand is inevitable. Tender digital nerves are a frequent complication of finger amputations, and the temptation to remove or inject them is great. Experience has shown, however, that this is dangerous, as it is apt to set up an ascending neuritis, which may lead to higher and higher amputations.

Wrist.—Amputation through the joint is sometimes advised, with the claim that thereby the power of pronation and supination of the forearm is preserved. Actually this is not the case, as the socket of an artificial arm that fits the stump will prevent this movement; if it does not do so, it does not fit. This point will be made quite convincing by the examination of an artificial arm. It is very occasionally worth while to preserve an amputation through the metacarpals with a perfect wrist, as the naked stump can be made useful, and the working hand be made with a fixed wrist as for a forearm amputation.

Forearm.—Equal antero-posterior flaps are best. The ideal length of the forearm stump is 7 inches below the tip of the olecranon; minimum, 4 inches (3½ inches is sometimes adequate); maximum, 2 inches above the wrist.

Elbow.—Amputation through the elbow leaves a clumsy stump very difficult to fit, and should not be considered as a permanent amputation.

Arm.—Equal antero-posterior flaps or a circular amputation. The ideal length is 8 inches below the tip of the acromion process; minimum, 5 inches (less than this can sometimes be used by means of a plastic operation to lower the axillary folds and enable a socket to grip the axillary side of the stump); maximum, 2 inches above the epicondyles.

Shoulder.—Where possible, the head of the humerus should be preserved, as providing a much better stump on which to fit a limb. The removal of the head allows the scapular processes to become prominent round an empty glenoid, and fitting is difficult. The classical anterior racket operation will be found generally applicable, the axillary artery being tied in the course of the operation.

The warning given above as to the avoidance of trauma on nerves is especially applicable to the arm. The temptation to remove large tender median and ulnar neuromata is great, but must be resisted. "Phantom arm" should be treated by bromides, anodal galvanism, and the wearing of an artificial limb; all operative intervention must be avoided.

Amputations of the Lower Limb

At or Near the Hip-joint.—In some cases this will be done for the cure of disease—as, for example, extensive tuberculosis of the hip-joint, sarcoma, etc.—it being very improbable that the patient will ever wear an artificial limb. The amputation will be through the joint. Where, however, it is expected that a limb will be fitted it is most important that the socket fit securely to the patient. The prosthesis will be what is called a "tilting-table," in which the stump consists of the pelvis. All who wear such an appliance agree that their chief fear is that the leg will fall off. It is obvious, therefore, that the more

bony points to which the socket can be fitted the better. First, at least the head of the femur should be preserved to prevent falling-in of the stump. Secondly, the retention of the great trochanter affords a good bony point. Thirdly, if the amputation be made just below the lesser trochanter the short stump is flexed by the ilio-psoas and the bone-end provides another bony point. Amputation at this level is therefore the ideal. The external racket incision of Furneaux Jordan is permissible, but far the best result is obtained by the formation of a large posterior muscular flap containing the glutei, and a short anterior skin-flap through which the main vessels are secured. The posterior flap is well nourished by the gluteal vessels, and the patient will sit in the socket on the tissues on which he is accustomed to sit. Haemorrhage will be slight, as the gluteal vessels mainly expend themselves in the gluteal muscles.

Through the Thigh.—The ideal flaps are a long anterior and a very short posterior: optimum length, 10 to 11 inches below the tip of the great trochanter; minimum, 5 inches; maximum, 4 inches above the adductor tubercle. The Stokes-Gritti operation, in which an attempt is made to fix the patella to the cut femur, is quite obsolete, as the stump is too long and the patella easily becomes displaced forwards.

Through the Knee-joint.—The Stephen-Smith operation is possibly a valuable one as an emergency (a saw might not be handy), but it is bad as a permanency, as the stump is bulbous and hard to fit.

Kneeling-stump.—Weight-bearing is possible at only three points—the tuber ischii, kneeling knee, and heel. In certain cases in which scarring, etc., prevents the use of the first, the second alternative must be considered. Amputation will be for a 2 to 2½-inch tibia, and the patient will be fitted with a limb on which he kneels, much as in the old "peg-legs" of Nelson's day.

Through the Leg.—A patient with an ideal below-knee amputation walks without a limp, and it is often impossible to tell that he has had an amputation. This applies to some on whom a double amputation has been done, and I know at least one man who can do a step-dance. Correct length is everything, but the ideal flaps are a short 1-inch anterior of skin only and a long posterior with muscle at the base. The fibula should be cut one-half to three-quarters of an inch shorter than the tibia to prevent cross-union (this destroys the compressive elasticity of the stump) and the anterior edge of the tibia bevelled. For many years 7 inches of tibia was considered ideal, but it has been found that with advancing years nutrition is inadequate and 5½ inches is better. Long leg stumps are very unsatisfactory, and generally develop a chilblain circulation.

Syme's Amputation.—The original operation with a large heel-flap dissected up before disarticulation is quite obsolete. The modern Syme is an elliptical one leaving less heel-flap, and the ankle is opened from above. The bones are divided half an inch above the ankle-joint, the inferior tibio-fibular ligament being preserved. The posterior tibial artery is respected and the nerves are cut short. The operation was originally devised to take weight on the heel-flap and to allow fitting with an "elephant-boot," a simple bag of leather with a sole. This is satisfactory, and natives may even manage to get about quite well with no boot at all. It is not, however, a satisfactory amputation for civilized man, although it may last several years, as the artificial limb is clumsy and tends to disturb the stump, the heel-flap being pulled back by the tendo Achillis and the stump becoming periostitic and non-weight-bearing.

Chopart's amputation is obsolete. *Lisfranc's* is nearly so, but it may be possible to fit an artificial foot, and the naked stump is, at any rate, weight-bearing.

After-treatment.—In the lower limb one must be on guard against flexion contractures. In the thigh the absence of the weight of the limb allows the psoas to contract, and the danger is increased if the patient is nursed in a sitting posture or the stump is supported on a pillow. The stump should be kept extended by two sandbags, with a strip of material between them. In leg amputations the knee should be kept splinted in extension for three weeks. As soon as the wound has healed active exercises are started. Massage is useless and serves only to irritate the nerve-ends. At the same time the stump is kept bandaged from below upwards to encourage shrinking. Plaster pylons may also be used for this purpose.

BRAIN SURGERY UNIT FOR WEST OF SCOTLAND

On May 15 Mr. Thomas Johnston, M.P., Secretary of State for Scotland, opened the first neurosurgical unit to be established in the West of Scotland. This marks an important development in the field of Scottish brain surgery and demonstrates the possibilities of united action on the part of voluntary, local authority, and State hospital managements. Neurosurgery calls into action a variety of specialists beyond the scope of any one hospital, while no single hospital receives sufficient cases to train the highly skilled staffs of nurses and assistants necessary and bring them to a high degree of proficiency. A committee representing Glasgow Corporation and the three City Infirmaries—the Royal, Western, and Victoria—considered the problem under the chairmanship of Sir Hector Hetherington, Principal of Glasgow University. The co-operation of the Department of Health for Scotland was invited, and the result of the combined deliberations is the establishment of a modern neurosurgical unit in one of the new hospitals built by the Department of Health under the Emergency Medical Scheme. The unit will have the services of the general hospital staff, including a whole-time anaesthetist, a pathologist with special experience of neuropathology, and part-time specialist consultants in ophthalmology, otology, radiology, psychiatry, etc. There will also be two part-time neurosurgeons, one part-time neurologist, and a whole-time surgical registrar and house-surgeon, while the unit as a whole will be supervised by the Regional Surgical Director of the Emergency Medical Service (Prof. C. F. W. Illingworth of Glasgow University). All types of neurosurgical patients will be able to benefit from the service which the unit can offer. Patients will be drawn from the West of Scotland both from the Services and from civil life. The authorities that have combined to provide the new unit have also joined in contributing the staff and equipment.

Correspondence

Mass Radiography

SIR,—In his letter published on May 16 Lord Horder rebukes me for misrepresenting the reasons which determined the Medical Advisory Committee against recommending mass radiography of those called up for service with the Forces. I was not referring to that committee, which, indeed, was not in existence at the time indicated in my letter of May 2. He goes on to contrast the serious administrative difficulties as against the low percentage of tuberculous individuals to be detected. Two of the difficulties stressed in the recent White Paper are the lack of suitable x-ray apparatus and of trained personnel to use it. The President of the College of Physicians tells me that before writing to the *Times* (March 21) on this subject he had received assurances from the Ministry of Supply that apparatus adequate for the purpose could be provided in six to nine months after it was ordered. He had also learned from Dr. Cochrane Shanks, President of the Faculty of Radiologists, that technical staff could be trained within this period and that a panel of experienced radiologists could be formed to interpret the films. This interpretation would occupy them only part-time, so would not prevent their performing their other duties.

Lord Horder says that the number of additional cases detected by this method would not exceed 1 or 2 per 1,000; but statistics published seem to indicate these as minimum rather than maximum figures. In any case they would amount to many hundreds of people yearly. The affected individuals would receive the benefit of early diagnosis, and, much more important, they would be prevented from acting as sources of tuberculous infection in the Forces.

It is good to know that the Ministry of Health has ordered a considerable supply of apparatus for the mass radiography of certain groups of civilians.—I am, etc.,

London, W.1.

GEOFFREY MARSHALL.

SIR,—The enthusiasm of the advocates of immediate adoption of mass miniature radiography for the detection of pulmonary tuberculosis and other diseases of the lungs is commendable; yet there is another side to the question which has received little publicity.

I believe that the committee appointed by the Minister of Labour and National Service to advise on medical questions