Original Communications.

AMPUTATIONS AND STUMPS.

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The following notes have no pretension to originality. They attempt to collect the present consensus of opinion on the subject of amputations, and will be found to differ rather considerably from the standard textbook teaching. Many points have been derived from experience at the Queen Mary's Hospital for Limbless Men at Roehampton.

I am much indebted to Major R. D. Kelham, M.D., of that Hospital, for his very helpful suggestions.

The staff of Queen Mary's Hospital have been dealing with amputations and limb fitting from the Great War up to the present time, and must have an almost unique experience in this work. They are therefore in a position to give authoritative views on the types of amputations that survive the test of time, and on all the very specialized points in regard to the fitting of artificial limbs.

ESSENTIAL FEATURES OF A GOOD STUMP.

1) The stump must be of suitable length for fitting an artificial limb. It should provide a lever of sufficient length and power for the attachment and use of an artificial limb at the level of amputation.

For above knee amputations the length of the functioning stump for limb-fitting purposes should be taken from the perineum. For below knee amputations, the limit of useful length is that amount of stump which can be retained in the below-knee socket when the knee is flexed at ninety degrees.

The usefulness of a short stump is in inverse ratio to the amount of redundant tissue present, i.e., a short, poorly covered stump is of greater functioning value than a fleshy stump of the same length, other things being equal.

2) The end of the stump should be covered with skin and subcutaneous tissue only. The skin must be healthy and well-nourished, and there should be no hyperesthetic or anaesthetic areas. Both skin and scar should be freely movable over the deeper structures.

3) The scar should be linear, non-adherent, and placed so that there is neither pressure nor traction on it.

4) The skin over the stump should be slack but not redundant. In this particular respect the success or failure to produce a satisfactory stump
Amputations and Stumps

will be influenced largely by the nature of the post-operative or convalescent treatment.

(5) There should be no disease of bone. Radiograms should be taken in two places at right angles to each other.
If bone disease is present, sinus formation will occur, with resulting adherence of scar, etc.

(6) There should be full range of movement in the proximal joint. Though full range of movement of the joint is desired and can be secured (if the joint is normal), provided post-operative treatment is correct, a limitation of movement at the hip or knee does not preclude limb-fitting or limb-wearing, provided the degree of flexion is not too great, and that in above-knee cases the stump is short.

METHODS OF AMPUTATING.

(1) Circular. Dissect up skin and fasciae. Pull up the muscles and divide in layers so as to form a cone with the bone at the apex.
(2) Modified circular, i.e., circular with short side cuts, which really equal flaps.
(3) Elliptical.
(4) Racket.
(5) Flaps. (Equal, unequal—antero-posterior, lateral, etc.). Generally speaking, the shorter the flaps the better their nutrition; avoid long flaps.
The base of each flap should be equal to one-half of the circumference of the limb at the point of bone section.
One and a half times the diameter of limb is usually advised for the combined length of flaps. This is too long and the combined length should be not more than the diameter of the limb at the level of bone section.

METHOD OF CUTTING FLAPS.

Flaps should be cut from without inwards. Skin and subcutaneous tissue only must be taken, except just at the base where a small amount of muscle may be included.
If any doubt exists as to the length of the flaps, these may be cut longer than necessary, as they can be shortened after the bone is divided, whereas if they are cut too short in the first instance, the bone will have to be redivided and the resulting stump will be shorter than was originally intended.
The old transfixion method is now obsolete; long knives are necessary, muscle is retained in the flap, and vessels and nerves may be lacerated.
The guillotine amputation, as performed at times in the Great War, was extremely wasteful, as the skin always retracted and a secondary high amputation was necessary. If this form of amputation is called for, always cut flaps of some kind and evert them. At the earliest possible moment.
bring these flaps down by skin extension, remembering that permanent skin stretching occurs in six weeks.

**TREATMENT OF STRUCTURES IN THE FLAPS.**

(1) **Bone.**

Commence the saw-cut by steadying the saw against the thumb of the left hand, and with a few light strokes from heel to apex of the saw cut a groove. The assistant must hold the limb steady—avoiding locking the saw-blade by upward pressure and splintering of deep part of bone by downward pressure on the limb.

Round off and cut away any spikes with bone forceps. Bevel off protuberant edges, e.g., crest of tibia.

(2) **Periosteum.**

(a) **Aperiosteal.** Divide periosteum with a knife half an inch above the level of bone-section and scrape the periosteum off the bone down to the level of the bone-section. The bone denuded of periosteum is then sawn through. This is said to leave the end of the bone hard and sclerosed and to avoid spur formation.

(b) **Periosteal Cuff.** Divide the periosteum half an inch distal to the proposed line of bone-section, then turn up a cuff of periosteum and, after sawing the bone, sew the periosteum over the cut surface.

(c) **Osteo-periosteal operation,** e.g., Pirogoff's and Stokes-Gritti's are not recommended.

Use an amputation shield or bandage retractor when sawing, to avoid bone dust flying on to cut muscle, etc.

Whatever method of treating the periosteum is adopted, it has been found that in above-knee stumps spurs seem fated to appear later, but unless they become adherent to overlying scars they produce no symptoms and do not interfere with limb-fitting, and a re-amputation has rarely to be performed for this reason alone.

(3) **Muscle.**

Consensus of opinion is that there should be no muscle in the flaps. A bulky flap is bad for fitting the prosthesis; also the muscle, if retained, turns into fibrous tissue which is often painful. A little deep muscle at the base of the flaps to ensure their nutrition is all that is required.

**NERVES.**

Bulb formation at the end of a divided nerve is the natural way of sealing the nerve trunk, and therefore must be expected with every divided nerve. The bulbs may be large, but so long as they are not inflamed, adherent to other structures such as skin, muscle, etc., or in a position where they are subjected to pressure by scar tissue, or by the artificial limb, they will usually give no trouble.

End bulbs of small cutaneous nerves, such as the communicans fibularis
Amputations and Stumps

in the leg and the internal saphenous in the thigh, are the most likely to be troublesome, as they are small and thus, being usually overlooked at the time of operation, become included in the scar.

Crush and cut all recognizable nerves about one inch above the level of bone-section, then inject absolute alcohol into the nerve-trunk above the cut end to block any painful impulses from the operation area.

Opinions differ as to the value of ligature of the divided trunk. Against this is the fact that ligature without alcohol injection is bound to cause pain, and a ligature is a foreign structure which may cause trouble. Pulling down large nerves and dividing them high up is not satisfactory (severe post-operative pain and traumatic neuritis).

Conditions in which the bulb nerves may become painful and troublesome:

1. When there has been long-standing infection prior to amputation.
2. Excessive addiction to alcohol.
3. Too early pylon- or limb-fitting, coupled with too early manipulative treatment of the stump after operation.

DRAINAGE.

This is advisable in all limb amputations for twenty-four to forty-eight hours, as it prevents haematoma formation, in which a low grade infection often occurs. Wilson (U.S.A.) and P. J. Verrall advocate no drainage.

AFTER TREATMENT.

1. Immediate.

Apply a firm bandage and Gooch splinting, especially in above-knee and below-knee amputations; this steadies the limb and avoids painful muscle spasm. Also steady the stump with a light sand-bag above it.

Keep all leg amputations in bed for three weeks. Nurse the patient with the stump in the normal position, i.e., avoid flexion contractures.

2. Later.

Massage and Movements.—Active joint movements by the patient are better than passive joint movements.

There should be no general massage to the stump for some time after the amputation, to allow the nerves to settle down. The less painful the convalescence the less likelihood there is of subsequent neuralgia from bulbs, which frequently occurs in cases where external irritation is permitted.

If massage is given at all, it should be limited to the purpose of keeping the scar tissue from becoming adherent—and probably active movement by the patient will be sufficient for this purpose.

Shrinking of Stumps.—The average time for shrinking is three months. Assist this by keeping a firm bandage on the stump. The scar should be rubbed with spirit every night when the bandage is taken off. A new socket for the permanent limb will be required within six months in primary amputations on account of shrinkage.
Pylons.—These are said to teach patients to walk earlier and to assist in shrinking of the stump (which they undoubtedly do), especially in above-knee amputations.

They teach balance but are of little value in teaching orientation. They induce a bad gait which has to be unlearned when the permanent limb is fitted.

In certain types of above-knee stumps, pylons are of some value in reducing them and shaping them up.

They are not good for below-knee stumps.

The full function of a stump depends on its normal position during convalescence and the maintenance of its musculature in good condition.

Amputations of the Lower Extremity.

There are three types for consideration: (1) Syme; (2) below-knee; (3) above-knee.

Generally speaking, in (2) and (3) the scar should be posterior, and two to three inches above the end of the stump.

(1) Syme's Amputation.

There is an end-bearing stump and the patient can walk on the stump without wearing the limb (in the house). It is an excellent amputation provided the stump remains in good condition.

It must be entirely condemned in infected cases. Roughly six to ten years seems to be the life of a Syme, and after that re-amputation is usually necessary:

Because (i) the end pad in many cases does not retain its position and gets forced laterally.

(ii) The stump is more liable to circulatory troubles than any other long stump, becoming blue, cold and painful.

(iii) The stump is liable to neuromata, very often pin-head in size, but very painful.

(iv) The scar is frequently keloidal and painful; the piston action of stump in the socket aggravates this.

(v) The formation of callosities is practically certain sooner or later; they often ulcerate, and even if this does not occur they become very tender, simulating soft corns.

(vi) The scar being anterior and transverse is liable to be dragged on and often ulceration results.

Certainly the number of Syme’s is gradually diminishing, and when patients have been fitted with the below-knee limb they are very thankful for the change.

(2) Below-knee Amputation.

The present site of election is distal to the line of the knee-joint, so as to leave six or seven inches of tibia.

(The old site of election, just below the tubercle of tibia, gives a short stump for the fitting of a peg-leg.)
Amputations and Stumps

Control of the knee can be obtained with as little as three to four inches of the tibia.

If the stump is longer than seven inches the skin is poorly nourished; ulceration and eczema are almost certain to result.

The general opinion is that the fibula should be divided one inch above the tibia. In short stumps the head of the fibula may be taken away altogether. If this is done the normal period of convalescence prior to limb wearing should be increased to give time for the site to settle down to take weight on the new surface.

Methods.

(i) Long anterior and short posterior flaps, bringing the scar on the posterior surface and well above the end of the stump.

(ii) Postero-external flap.

(iii) Equal lateral flaps; these should be avoided, the scar gets drawn up between the tibia and fibula.

(iv) Posterior flap.

Splinting of the knee is very important.

Do not amputate in the lower third of the leg; the flaps will be poorly nourished and unsatisfactory (e.g., Teale).

(3) Above-knee Amputations.

Amputations around the knee, e.g., Stephen Smith, Carden-Gritti and Stokes-Gritti, are unsatisfactory.

Taking the length of an average femur to be nineteen inches, the site of election should be four to six inches above the adductor tubercle for level of bone-section.

A stump longer than ten to twelve inches from the trochanter is very liable to circulatory trouble and usually comes to re-amputation.

A long stump, i.e., longer than ten to twelve inches, often fouls the knee-control mechanism. End-bearing thigh stumps give trouble sooner or later.

Few stumps nowadays are end-bearing at all.

(4) Hip Amputations.

An amputation may be performed at any point from just below the great trochanter up to the joint itself.

After amputations the patients are fitted with a tilting-table apparatus (tuber-bearing). The muscles must be cut short and the following methods have been employed:—

(i) Anterior racket.

(ii) Gluteal flap (leave sciatic nerve bulb unshortened—if shortened, patient sits on the bulb).

(iii) Furneaux-Jordan: this type is obsolete.

Total excision of the head of the femur is not popular since when it can be retained the head of the femur and the great trochanter form a good
anchor on which to fit the socket and tend to give shape to the stump, thereby aiding fitting. An amputation at the level of the lesser trochanter gives a very suitable stump for the fitting of a tilting-table leg.

The average length of a stump (from the tip of the great trochanter) which has to be fitted with a tilting-table leg is $4\frac{1}{2}$ inches; the longest stump fitted with such a limb is 6 inches. If the stump is more than this, a very bulky and cumbersome socket has to be made, adding weight and causing discomfort to the patient.

When from the surgical or mental point of view an above-knee stump is of such a nature that it is functionally useless for fitting an ordinary above-knee limb, a re-amputation for the purpose of shortening the femur is necessary to enable a tilting-table leg to be fitted.

THE UPPER EXTREMITY.

Hand.

Conservative surgery is essential. It must be remembered that a digit acts in two ways: (i) As a sense organ; (ii) as a mechanical contrivance.

(1) There can be no comparison between the value of a mechanical contrivance such as a hook, split pin, etc., which is at best a clumsy contrivance to aid in holding and carrying, and a finger or portion of finger with the skin and nerve supply intact. As stated above this is a sense organ and, as such, cannot be replaced by any artificial means.

(2) The thumb owing to its free mobility is worth half the hand, and as much as possible should invariably be saved.

Removal of the head of a metacarpal bone weakens the hand very greatly. It should be conserved for working hands. It can be removed for aesthetic effect.

Farabouf's flaps are recommended for the index and little fingers, as they avoid pressure on the scar.

Forearm.

The scar should be terminal, not on the flexor or extensor aspect, as this would cause friction against the prosthesis; the flaps should be equal, anterior and posterior or lateral.

The site of election should be not less than six inches and not more than seven inches from the tip of the olecranon. Disarticulation through the wrist-joint and long forearm stumps are unsatisfactory. If any portion of the forearm can be retained, this should be done. Even two inches of forearm if properly fitted with a limb gives a surprising amount of power and utility.

Amputation through the Arm.

The site of election is seven to eight inches from the tip of the acromion, or at least two inches above the epicondyle—with equal anterior and posterior flaps, producing a transverse terminal scar.
Amputations and Stumps

Through-elbow type of amputation is unsatisfactory (a) for surgical, and (b) for mechanical reasons.

(a) Surgical: Adherent scar tissue, malnutrition of skin, and presence of bony prominences.

(b) Mechanical: An awkward, unsightly and ill-fitting prosthesis predisposes the stump to inflammatory processes and impaired muscularity, and frequently necessitates a re-amputation.

If the neck of the humerus is intact, amputations through the shoulder are much more easily fitted with a limb than disarticulations at the shoulder-joint. With disarticulation through the shoulder-joint by anterior racket operation it is difficult to fit the stump with a prosthesis, but some results have been very good. Scar should be vertical in the middle of the subacromial cavity; axillary nerves should be free from pain; and the chest wall, where shoulder cap presses, should be free from any condition likely to cause excoriation.

Forequarter amputation is very rarely done. The inner end of clavicle should be removed and the subclavian vessels tied; this gives more room and there are no tributaries to the subclavian vein here. Injection of the brachial plexus with novocain diminishes shock.

Lastly, the mentality of the patient must be borne in mind.

However surgically good a stump may be, it is often rendered useless by the poor mentality of the patient, and this must be taken into consideration by the surgeon when amputating or re-amputating with a view to the subsequent fitting of a prosthesis.