WAR WOUNDS AND AIR RAID CASUALTIES

The following is one of a series of lectures on the Treatment of War Wounds and Air Raid Casualties recently delivered at the British Postgraduate Medical School

AMPUTATIONS UNDER WAR CONDITIONS

BY

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There was a time when amputations formed the major part of war surgery, and they still represent a very important section of this work. In the pre-antiseptic period gross suppuration was the rule, and the art of the limb-maker was but poorly developed. In consequence the experience and methods of the older surgeons have but little bearing on our practice to-day. The intensive experiences during the great war and the subsequent study in this country of some fifty thousand amputés under the Ministry of Pensions authorities have provided us with evidence from which we were able to mould our current practice. We have experimental evidence, both in regard to the technique of amputations and as to the value of stumps of various types. It may be admitted here, however, that the problems of the phantom limb and the development of painful nerve bulbs remain to be solved.

The indications for amputation cannot be considered in detail in this paper. The decision will always rest on the judgment of the individual operator. Some general observations, however, on the factors which govern this important decision will not be out of place. In the pre-antiseptic days any compound fracture of a limb due to a missile was regarded as an indication for prompt amputation. Under modern conditions this is by no means the case, and primary amputations in the war were only carried out when there was gross injury, not only to the bone but to the soft parts as well. In the case of missile wounds of the lower limb, particularly those below the knee-joint level, I cannot help thinking that our optimism in regard to conservative treatment carried us too far. Anybody who worked in a pensions hospital for five or ten years following the war must have been struck by the large number of compound fractures which required surgical treatment over a period of years. The end-results may sometimes have been brilliant. More often they left an indifferent limb, which remained liable to break down at intervals under stress. The result in this class of cases should, in my opinion, be considered not only in relation to the wound treatment but to the general effect on the mentality of the patient. Long hospitalization and repeated operations will disintegrate the initiative and enterprise of any but the most robust constitutions. I believe that a primary amputation should be carried out in those cases where, from a missile injury, comminution of the bone is such that prolonged bone infection and delayed union are likely to occur, especially in those instances where the damage is done in the lower half of the leg. I do not think the same attitude towards compound fractures of the upper limb is justified. In the lower limb a good stump in which suppuration has not occurred can be early fitted with a most satisfactory prosthesis. In the arm nothing can replace satisfactorily the loss of the hand.

General Principles of Amputation

The principles which should guide us in carrying out an amputation will vary according to whether section is

made through infected tissue or whether first-intention healing can be anticipated. When dealing with the latter state of affairs the result obtained should be a final one, and great care should be taken so to carry out the primary operation that the stump may be durable and suited to the modern artificial limb. I will now consider the general technique of amputation under the headings of flap formation, section of bone and nerves, and control of the major blood vessels.

Flaps.—If the nutrition of the flap be the first consideration the simple circular flap is most satisfactory in this respect. In general, therefore, flaps should be planned on this basis. There can be little doubt that long flaps tend to be unsatisfactory from the point of view of nutrition and innervation, although they may sometimes be employed with success. Though the circular flap in its exact form may be seldom used, it should remain the ideal of all flap design. In practice the circular flap will often be cut obliquely, and vertical cuts may be made in it to make it more manageable when the bulk of the limb requires it. Such side cuts will convert a circular flap into antero-posterior or lateral ones of approximately equal size. The total length of flap cut, whether circular or not, as measured on two opposed aspects of the limb, should not exceed in length a diameter and a half of the limb at the level of section. Fascia and muscle should only be included in the base of a skin flap so far as is necessary to maintain its nutrition. In the final stump, muscle and fascia, owing to their wasting and shrinkage, are not present at its termination, nor is their presence desirable. The end of a stump which is to carry an artificial limb should be covered by skin and subcutaneous tissue that is just mobile on the healed bone. The termination of a stump should be tapered and not bulky. The striking exception to the modified circular flap generally employed is particularly noticeable in the Syme amputation. Some critical observations on this are made below.

Bone Section.—Bone should always be divided so as to give an even and more or less rounded-off end to the stump of the maximum diameter possible. Projection of a bone of small diameter, such as the fibula, is a very undesirable feature in a stump. Occasionally a good-sized artery is divided in the bone, and this can usually be occluded by crushing the bone on to it. Suture of muscle over the end of the bone is sometimes practicable. Alternatively a small amount of bone wax may be used. I believe the employment of wax as a routine to be unnecessary. In order as far as possible to avoid the formation of bone spurs the periosteum should be cleanly cut before the bone is sawn through and scraped away distally so as to expose the compact bone for section.

Nerve Section.—There is no means by which the formation of some type of end bulb can be prevented. Pain in end bulbs most often occurs when suppuration has been present in a stump and when the cut ends of the nerve are so situated that they are exposed to pressure. In larger nerve trunks the latter tendency can be avoided by cutting the nerve an inch or so above the line of section of the muscle. I do not think severe traction of a nerve trunk or very high section is desirable. It is generally accepted that the nerve should be divided clean across

with a sharp knife after crushing. I do not favour ligaturing the nerve, except so far as this may be necessary to control bleeding. In order to prevent post-operative pain the stump of the nerve may be injected with 90 per cent. alcohol before closing the flaps. Prevention of post-operative pain is most desirable: in a sensitive patient its occurrence may well be the starting-point for the development of a painful and troublesome stump later.

Control of Major Vessels.—The old authorities advocated the isolation of the main vein or artery before ligature. There is not much to be said against the practice, but it is possible that in infected cases the local upset in the blood supply may favour secondary haemorrhage. I can say, from a practical standpoint, that the ligature of the two vessels together gives satisfactory results.

Amputations in Presence of Sepsis

If the amputation is through a septic field, or if there is active sepsis below the line of section to which the patient is showing little resistance, suppuration in the stump is to be anticipated. In such circumstances it is most probable that the primary amputation will be followed by a later final one. In this case the primary amputation will be designed so as to minimize the risk of spreading infection and to leave enough tissue for a satisfactory stump to be formed at the secondary amputation.

At one period during the war the simple guillotine operation was advocated. In the case of a virulent spreading gas infection this may well be sound practice. In my opinion, however, in its crude form it is seldom necessary. The guillotine stump is a depressing one to the patient; it is painful for dressing, and is more liable to secondary haemorrhage than the more protected type. In these circumstances I advocate the use of a short circular flap the length of about half the diameter of the limb and cut slightly obliquely so that one flap overhangs the bone end. Few, if any, sutures should be employed, and the cavity is packed with paraffin gauze. This pack should be left *in situ* for four or five days, or longer if the general condition is satisfactory.

Drainage.—It is customary to drain amputation wounds, whether carried out under clean or septic conditions. When sepsis is not present the drainage is merely to prevent the development of a haematoma, and for this purpose a rubber dam may be left in for twenty-four or forty-eight hours. Some surgeons prefer to dispense with drainage altogether in clean stumps, but it is certainly difficult to control oozing by pressure in the loose wound at the end of an amputation stump.

Regional Amputations: Lower Extremity

The ideal types of final amputation may now be discussed. By final amputation is meant one carried out as a primary measure when healing by first intention is anticipated or when a second reamputation is carried out after the infective process has been controlled. In these circumstances a durable stump suited to the standard artificial limb should be the aim. In the lower extremity, where prosthesis is of the greatest importance, the most satisfactory amputations, giving good functional results, are: (1) the Syme amputation; (2) below-knee seat of election; (3) above-knee seat of election; (4) amputation at the hip-joint. Amputations at other levels for one reason or another may be carried out, but none of them

gives full functional value, and some, I think, should be definitely condemned as either crippling or unlikely to stand long wear. Into this group fall the Chopart and Lisfranc amputations and below-knee amputations with more than seven inches of tibia. If the views and methods of the English limb-maker be considered, any thigh amputation longer than ten inches must also be condemned. It is true that in America and Germany the Stokes-Gritti amputation is still considered to give a useful stump; English experience, however, is not in its favour.

THE SYME AMPUTATION

The value of this amputation has been the subject of a good deal of controversy, and I will limit my remarks on it so far as possible to observed facts. If completed cleanly and neatly with a firm well-fitting heel flap it gives excellent service in children. It provides a true end-bearing stump which is very convenient at this level. It will carry an effective if not elegant prosthesis. If the bone section is carried out at the classical level (a quarter to half an inch above the ankle-joint) it does not allow of the fitting of an artificial limb with a symmetrical ankle. This objection is important to women from a cosmetic standpoint, and is partly overcome if the amputation is modified by using a small heel flap and cutting the bone one inch above the ankle-joint level.

In men the average results of this amputation during the war were unsatisfactory. The Ministry of Pensions circulated in 1934 an analysis of fifty-four Syme amputations. It was found that thirty-eight of these cases had undergone reamputation between 1920 and 1933. In a group of twenty-two cases, investigated in relation to their durability, it was noted that only six took full end-bearing for ten years or more. The average period during which end-bearing could be tolerated was seven and a half years.

This failure of the Syme carried out under war conditions was put down in about 25 per cent. of the cases to the presence of sepsis at the time of operation. Displacement of a bulky end flap was another cause of trouble. The development of callosities and ulceration, especially in relation to the anterior scar, was often noticed. Painful nerve bulbs are as common and as troublesome in this amputation as in stumps at other levels. Nutritive disturbance from a poor circulation was often met with. The above complications are sometimes overcome without reamputation by fitting an artificial limb bearing on the tibia or even the tuber ischii.

I advocate the Syme in children, and it may be worth while in young men and women provided there is no sepsis. It should be noted that in children this amputation involves the removal of the lower epiphyses of tibia and fibula, and so affects subsequent growth of the stump. At operation great care should be taken to maintain full nutrition of the heel flap; that flap should be shorter than the classical form, and the bone section should be made about an inch below the ankle. As many nerves as can be recognized should be cut short in the flaps. In the presence of sepsis and in the elderly the amputation is to be condemned. It is also unsatisfactory when oblique weight-bearing is imposed by the presence of a bow leg.

BELOW-KNEE SEAT OF ELECTION

This amputation can now be clearly defined. Ideally the bone section should leave six inches of tibia in the average adult and seven inches in a tall person. The measurement is taken from the upper border of the tibia

at knee level. Longer stumps give no increase in functional value and are liable to nutritional trouble. The shortest below-knee stump of functional value is about three inches. If less tibia than this must be left an above-knee amputation should be performed. The design of the flaps for this amputation may often be governed by the conditions for which it is carried out. They should always be planned with the idea of maintaining so far as possible good blood supply and a normal innervation.

ABOVE-KNEE SEAT OF ELECTION

It is customary to measure this stump from the crutch or pubic bone. The ideal length is nine inches for short and ten inches for tall patients. Greater length than this has no functional value and impedes the fitting of the best type of modern symmetrical limb. The shortest length of an above-knee amputation that is of functional value in controlling an artificial limb is about three inches. Less bone than this, however, should be left, as some bone in the stump facilitates the fitting of a tilting-table type of prosthesis. Modified circular flaps amounting to approximately equal length antero-posterior flaps give a satisfactory result and are generally practicable.

AMPUTATION AT THE HIP-JOINT

This amputation is seldom carried out, and it is only necessary to advise that it should be planned to leave a convex and not a concave surface for the fitting of a limb. To this end, unless there is some contraindication, the head of the femur should be left in the acetabulum, the neck of the femur being sawn through.

After-treatment of Leg Amputations

After above- and below-knee amputations flexion at hip or knee should be avoided. The development of fixed flexion at either of these joints prevents limb-fitting till deformity has been corrected. The prevention of habitual flexion is particularly necessary in septic cases, where treatment in recumbency is prolonged. The thigh or leg stump should lie straight while the patient is confined to bed, and when healing has progressed far enough exercise of the stump should be carried out. As soon as the wound is soundly healed the stump should be prepared for the fitting of an artificial limb. In the thigh a temporary pylon applied a month or so after amputation is a useful measure to this end. In the leg this method is not so easily applied. Active exercise, massage, and elastic pressure applied to the stump will, however, reduce the oedema and render the stump ready for the fitting of the final artificial limb in a month or so.

Regional Amputations: Upper Limb

In the upper limb the prehensile value of the hand is irreplaceable by any prosthesis hitherto invented. In consequence a conservative attitude in regard to amputations in either the hand or the arm should always be adopted. When amputation is decided on the determination of the ideal level for section is not so rigid as in the lower extremity. I will, however, give such details as to useful levels for division of the bone as meet with general acceptance.

Forearm.—Disarticulation at the wrist-joint or bone section immediately above it gives an unsatisfactory stump, difficult to fit with a prosthesis. The ideal is to retain six to seven inches of the radius and ulna. The minimum length of these bones which allows a good-fitting

and useful substitute is from two to three inches. If two inches of forearm bone cannot be left the patient will be better off with a supracondylar amputation. The flaps for amputations in this area may conveniently be approximately circular. The central scar overlying the bone, if mobile, is satisfactory in the upper extremity. The ingeniously devised so-called kineplastic stumps have

FIG. 1.

FIG. 2.

FIG. 1.—Diagram indicating satisfactory levels for bone section in amputations of lower extremity. Section of bone in the shaded areas leads to unsatisfactory stumps. a = Ideal level for above-knee amputations—9" to 10" of femur measured from the crutch. b = Ideal level for below-knee amputations—5" to 7" of tibia. c = Level of bone section for a modified Syme—the most useful amputation about this level.

FIG. 2.—Diagram showing useful levels of bone section in upper extremity amputations. Section of bone in the shaded areas leaves unsatisfactory stumps. a = Section above this level leaves a stump to which an artificial limb cannot be fitted. b = Most useful level for forearm amputations.

proved a failure. Their intention was to use the forearm muscles independently to act on an artificial hand.

Upper Arm.—Disarticulation at the elbow, like similar operations at the wrist and knee, does not give a useful stump. The best upper-arm stump is one in which the humerus is divided some two inches above the epicondyles. Any length of humerus, however, less than this should be left, if only for cosmetic purposes; anything less than four inches of humerus measured from the tip of the acromion cannot be fitted with a useful artificial limb. Even circular flaps are ideal for upper-arm amputations, a central scar being most satisfactory.

Conclusion

It may appear that the directions for lower extremity amputations are somewhat dogmatic. But I would emphasize that they are based on the opinions of most of those surgeons and limb-makers who have had under observation the large amount of material provided by the war.

I would like to acknowledge my indebtedness to the medical staff of the Pensions Ministry for some statistical information, especially in relation to the Syme amputation. I should also like to thank Mr. Desoutter for valuable advice on the best levels for lower extremity amputations in relation to the fitting of artificial limbs.

WORK OF THE BRITISH RED CROSS SOCIETY

The report for 1938 of the British Red Cross Society opens with an account of the sixteenth International Red Cross Conference, held in London, which was attended by representatives of more than sixty Red Cross Societies, Governments, and kindred organizations. Later in the year the international crisis caused a considerable increase in the work of the Society. Some 3,000 members were warned for duty at short notice, while others were actually mobilized with anti-aircraft units. Throughout the country branches have actively co-operated with local authorities. Many courses of lectures have been given to the general public, while Red Cross instructors have also been occupied in teaching A.R.P. officials, air raid wardens, and fire brigades, and in demonstrating the nature of air raid precautions. The Society was responsible for the dispatch of large quantities of warm clothing, blankets and rugs, cocoa, chocolate, milk foods, and cod-liver oil for the use of Czech refugees. In Spain co-operation continued with the International Red Cross Committee, resulting in the establishment, in the chief centres of the contending parties, of bureaux responsible for the receipt and distribution of hospital supplies, drugs, and surgical instruments. An Information Card Service was also set up, whereby many thousands of people were able to secure news of friends and relatives. The Society continues to co-operate with the British Fund for the Relief of Distress in China. In addition to large quantities of medical supplies some forty bales of clothing and comforts were sent out each week during the period under review, several shipping companies carrying the goods free of charge.

The Joint Council

The annual report of the Joint Council of the Order of St. John and the British Red Cross Society contains nine departmental reports and two sections devoted to financial matters. The former group includes the hospital library report, which records an increasing demand for books from all kinds of hospitals. Requests are frequently made for technical books, many patients wishing to study in hospital with a view to improving their chances of employment on discharge. There is also a continuous demand for foreign books, especially French, German, Italian, modern Greek, Hungarian, Spanish, and Yiddish. The report stresses the importance of collaboration between architect and library expert in planning hospital libraries, citing the case of the new Westminster Hospital, where this procedure has been advantageously adopted. Another new development is the institution of a band of voluntary librarians at the Central London Ophthalmic Hospital, which, it is believed, is the first eye hospital in England to have a voluntary service of librarians to read aloud to the patients. The report mentions the special need on the part of mental hospitals for adequate libraries, for in these institutions properly directed reading may have a definite therapeutic value. With regard to hospital libraries in general it is maintained that organization and inspection by experienced librarians are matters of importance, and that the appointment of an inspector for each county, or at least for several groups of counties, would ensure a higher and more uniform standard.

Nova et Vetera

THE OLDEST MEDICAL MANUSCRIPT WRITTEN IN ENGLAND

It is claimed in the Press, though not in the auction catalogue, that the Latin MS. to be sold by Messrs. Sotheby on July 12 on behalf of the Penzance Library is the oldest medical treatise written in England. This interesting relic consists of eighty-nine leaves of vellum written in red and black in extremely careful and beautiful Gothic script in the Latin tongue. The MS. is full of the contractions which make the deciphering and translation of such documents a job for scholars and not for amateurs; but the actual lettering is a masterpiece of meticulous care and penmanship. The auctioneers regard the date of the manuscript as roughly A.D. 1250; they do not offer an opinion as to the date of the binding of tooled black calf leather over old oak boards, which may conceivably be as old as the book, but seems more likely to be about two or three centuries later. On the inside of the front cover is the book-plate of Thomas Dawson, with an autograph note: "Presented to me by my late brother-in-law G. Aspinall about 1836. T. Dawson."

The work contains six separate treatises, of which the first and most important is the *De Chirurgia* of Albuhasim (Albucasis, Albucasin); this occupies forty-four leaves, three of which are missing. The initial letters of every paragraph are illuminated in red and blue, and many of them are heightened with gold also. These are most carefully and artistically executed; but the illustrations of the text are very crude in comparison, virtually nothing more than outline diagrams in red. There are two human figures (back and front views) showing how and where a surgeon may apply the cautery for various diseases, and a very large number of drawings of surgical instruments, including (besides the inevitable cauteries) cannulas, scissors, catheters, specula, spatulae, vulsella, bistouries, scalpels of many kinds and shapes, hooks, fistula knives, and so forth.

Albucasin, it will be remembered, was a Moor of Cordova (1013–1106), whose textbook of surgery was the leading mediaeval authority up to the time of Saliceto. He in his turn was deeply indebted to Paulus Aeginetus (625–690), whose sixth book was the foundation on which Albucasin built up his own treatise. He is said to be the first medical man ever to write about the treatment of deformities of the mouth and dental system; and Dr. Herbert Spencer quotes him as having anticipated Walcher in the discovery of the obstetric posture now known by the latter's name.

The other treatises look as if they are all by the same scribe as is the *De Chirurgia*, though the quality of the ink and of the vellum seems to vary somewhat. That next after Albucasin's work is the *Chirurgia Rogeri*, composed about 1170, and re-edited by his pupil Roland about 1230–40—that is, quite shortly before the probable date of the Penzance manuscript. Ruggiero Frugardi Roger was a surgeon of Palermo, and Roland came from Parma; they were among the earliest teachers in Europe to free themselves from excessive dependence upon Arabian sources. Roger described cancer and (possibly) syphilis; ordered seaweed ashes (iodine) for goitre and scrofula; used mercurial inunctions for chronic parasitic infections; performed suture of the intestines over a hollow tube; used sutures, styptics, and ligatures for haemorrhage; and described the healing of wounds by second intention.

Then follow six leaves concerning equine surgery, and lastly there are three treatises devoted apparently to obstetrics and gynaecology, entitled respectively "*De passionibus mulierum*," "*Liber sanitatis salernitanae de passionibus mulierum*," and "*Hippocras de passionibus*