War Surgery of the Extremities

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WOUNDS OF JOINTS

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Joints are mechanisms which permit movement between the various parts of the skeleton; the freest movement is needed between the segments of the limbs, and it is there that the largest and most complicated joints are found. I shall here deal only with the diarthrodial joints of the extremities, for wounds involving amphi-arthritis and synarthrodial joints are usually less important than the fractures which always accompany them. In the case of fractures we need immobilization of the limb in order to permit union to take place, but we have a different object when a joint is injured—i.e., to conserve as much movement as may be possible. It follows that different time periods are needed for the immobilization in the two cases. When a fracture does not unite we are disappointed and know that we have failed; when fixation occurs at a diarthrodial joint we know that we have failed to attain a perfect result, though we may have obtained the best one possible.

Before describing the different types of wounds we should recall the structure of a joint, which consists of the two cartilage-covered ends of two bones separated by a synovial sac and united by a capsular and accessory ligaments. Surrounding muscles and tendons support and strengthen the articulation. The most important parts of the joint are the synovial sac and the articular cartilage. If these can be kept intact or if they are only slightly damaged, then movement may be preserved; but if they are seriously injured mobility at the joint is always greatly impaired or is lost. That fact is of the utmost importance in directing our treatment of injuries of the joints.

The synovial membrane has a certain limited resistance against infection; but once infective organisms have gained a hold in the joint, mechanical drainage and antiseptic irrigation cannot be trusted to succeed in getting rid of the infection. Indeed, they may sometimes make matters worse by still further irritating the already damaged serous membrane, thereby leading to the formation of a further amount of granulation tissue. If we are to preserve mobility we must minimize the formation of granulation tissue, which will later be converted into scar tissue and limit movement at the joint. Thus the moral is that drainage tubes should seldom or never be inserted into the cavity of a joint.

For purposes of description we may classify wounds of joints into the following groups: (1) penetrating wounds of civilian type; (2) perforating bullet wounds (through-and-through type); (3) bullet, bomb, or shrapnel wounds in which the fragment is retained in the joint; and (4) severe wounds in which the articular surfaces are badly injured.

Diagnosis of Type of Wound

As a rule the type of wound is easily ascertained. One may see the small punctured wounds of entry and exit made by the high-velocity sharp-pointed bullet, or there may be only the one small puncture where it has entered. Remember that if the line of trajectory were oblique the exit wound might be found far from the joint in another part of the limb. With many cases in Group 3 and most of those in Group 4 there will be a lacerated wound of the soft parts and the skin. At the first dressing it will be impossible to tell exactly what damage has been done to the bones, but before any operative

treatment is undertaken an antero-posterior and a lateral radiograph should, if possible, be taken to show the extent of the injury.

First-aid Treatment

In all joint wounds the wound must be protected from further external infection and the joint immobilized. In addition it is usually necessary to give antitetanic serum and treat general symptoms such as shock and pain by the appropriate methods. Moderate haemorrhage may be controllable by local pressure produced by bandaging, but if the main vessel of the limb, such as the popliteal artery in the case of knee injury, is bleeding, then a tourniquet must be applied temporarily.

A first-aid aseptic or antiseptic dressing should be applied without unduly disturbing the wound. Immobilization should be attained by splinting, if possible. For the lower limb a Thomas knee splint is satisfactory, while for the upper limb a Jones or an angular splint may be used. Failing the availability of splints the upper arm can be bandaged to the body and the lower limb splinted by the adjacent good limb. No further treatment is needed until the patient is placed under good conditions for adequate surgical procedures. These procedures vary according to the type of wound.

One of the advantages or penalties of seniority is that during the last thirty years one has seen many changes in the treatment of open wounds of joints. Thirty years ago the importance of complete immobilization was not generally recognized, drainage of the joint cavity by rubber drainage tubes was thought to be efficient, and many believed that antiseptics had a more powerful action than they actually have in ridding infected tissues of microbes. Incision, drainage, and irrigation were the methods adopted at the beginning of the last war. In the *Official History of the Great War* Col. Frankau has well summarized the results of such treatment:

"The results of these methods were lamentable: the death rate for the larger joints was very high, the amputation rate was enormous—60% for knee-joint cases uncomplicated by injury to bone, and at least 80% where there was an associated fracture; and the functional results in those limbs that were saved were almost invariably bad as regards movement."

It was largely due to the work of the late Col. H. W. M. Gray that the new methods of immobilization, excision of infected soft parts, and lavage of the joint cavity, followed by closure of the capsule, led to great improvement in the results. After three years of war more than four-fifths of the joint wounds were healing by first intention without suppuration, and the amputation rate at the bases was down to 7%. Since the last war our resources have been increased by the discovery of the sulphonamide group of drugs, and our experience has been enriched by the work of Trueta, who showed that the technique of Winnett Orr could be applied to war wounds of joints.

We will now consider the treatment which may be applied to each of the types of wounds.

Penetrating Wounds of Civilian Type

When any blunt or pointed instrument pierces a joint there is almost always some infection carried in, but often the tissues can deal with this so long as they are not disturbed. Unless the instrument is known to be perfectly clean (as, for instance, when a sterilized scalpel accidentally punctures a joint) it is wise to excise the edges of the wound down to the synovial sac and to put a narrow drain down to but not into the joint. The limb should then be completely rested either on a splint or in plaster-of-Paris casing; if the temperature remains approximately normal and pain is absent the plaster may be removed in a few days and gentle movements of the joint encouraged.

If complaint of pain, onset of fever, and swelling of the joint make it clear that infection is developing, one of the sulphonamide group of drugs should be prescribed and aspiration of the joint performed to relieve tension and to obtain a culture of the organism responsible. It is important to know the nature of the organism, for it is well known that members of the sulphonamide group vary in their power of combating the different microbes, and, in addition, the surgeon may wish to have an autogenous vaccine made to help the cure. If these measures fail to stop suppuration in the knee-joint it will be necessary either to perform repeated aspiration or, preferably,

to make a free incision lateral to the patella, and sometimes postero-laterally in front of the biceps tendon or adductor magnus tendon, and immobilize the limb in plaster. A tube should not be put into the joint. Only in very rare instances will these measures fail to bring about cure. If they do fail, there ensues a condition similar to that which often follows the more serious wounds described below.

Perforating High-velocity Bullet Wounds (Through-and-through)

If a modern bullet travelling at a high velocity goes right through a joint without injuring the bony articular surfaces it may cause little disturbance and no appreciable infection, and, provided the limb be kept at rest, may result in rapid healing, with retention of good movement in the joint. If when rested pain, fever, and swelling remain absent there is no need to interfere. If seen soon after infliction the wounds of entry and exit may be excised down to the synovial sac and the tissues sewn up; if the case comes to hand many hours after infliction of the wound and no untoward symptoms have developed, then it is best to leave well alone.

When a bullet traverses the joint and seriously injures the bony articular surfaces there may be considerable effusion of blood into the joint cavity, and bony fragments may be loose in the joint. It is very tempting to open such joints with a view to removal of loose bits of bone, but I think we must here accept the teaching of Trueta, who has had great, and recent, experience of these cases. Speaking of a bullet wound of the knee-joint in which no foreign body has been retained in the joint, he says:

"Even when a bullet causes a comminuted fracture in the inferior articular surface of the femur the case follows an entirely favourable course when it is treated immediately in a plaster case from pelvis to toes. Healing is complete within three months; some mobility of the joint is usually preserved, and it is rarely that gross permanent stiffness of the knee persists."

Gunshot Wounds with Foreign Body retained in Joint

When a portion of bomb, bullet, or shrapnel is thought to be within the joint, either because there is only a wound of entry or because the radiographs show it to be there, then operative treatment is almost always indicated. An anaesthetic should be given, the wound of entry carefully excised, another clean scalpel used to open up the joint further, careful search for metal or bits of clothing made, all severely damaged soft tissue excised, and the joint cavity washed out with acriflavine (1 in 1,000) or with Dakin's solution and then closed by a few catgut sutures through the edges of the synovial membrane. The skin may be sewn up, leaving a drain down to the exterior of the synovial membrane. The limb is then immobilized in plaster. Knowing the local antiseptic properties of sulphanilamide one would be justified in insufflating a little of the powdered drug on to the interior of the joint, but this is not so important as complete rest to the limb after the operation. If, after this, infection should occur, it may be necessary to open up the incision to allow free escape of discharge from the joint, but the plaster should be reapplied and sulphanilamide given by mouth. If, in spite of this, infection progresses it will be necessary to consider amputation.

Severe Lacerated Wounds with Badly Injured Articular Surfaces

The most serious cases are those with a large open wound exposing the articular surfaces, which are in some instances broken into fragments and contaminated by debris of various kinds. There is often extensive damage to parts around the joint, and if the main vessels of the limb are destroyed and the joint badly smashed amputation may be necessary. If the main vessel be intact one should almost always give the joint a chance to recover. In these cases shock is often severe and soiling of the wound extensive. The limb is immobilized from the very first, and shock has to be treated before operation is undertaken. Antitetanic and anti-gas-gangrene serum should be administered. When the patient is considered fit enough an anaesthetic is given and toilet of the wound performed. This

consists in cleansing the surrounding skin, excising the edges of the wound down to the interior of the joint, complete opening up of the interior of the joint, and removing contaminated and separated pieces of bone, followed in some cases by irrigating the surfaces by an antiseptic which does not injure the tissues—e.g., acriflavine 1 in 1,000. If it be thought that infected tissues have not been thoroughly removed there would be justification for the local application of sulphanilamide powder. The synovial membrane is closed in part, but a portion should be left open for drainage. The whole limb should then be encased in plaster-of-Paris or, if plaster is not available, in a suitable splint.

This wound toilet, as I have described it, comprises several separate acts, and there is no one word which sufficiently describes the technique. The term "débridement" has lately been loosely, and I think incorrectly, used to designate the whole technique, but it would be a pity if this were allowed to become current usage. The word "débridement" (from the verb *débrider*, which means to incise or slit up) had, until the last war, been used by the French from the time of Larrey and by the Germans in their account of the surgery of the Franco-Prussian War, to indicate a slitting up of the wound in order to procure better drainage. In recounting some of the lessons of the war of 1914-18 Bainbridge (*Military Surgeon*, 1921, 49, 379) wrote as follows:

"It is more than likely that the Germans profited by the experience of French operators; . . . for the principle of extensive exposure of all wound angles, tracts, recesses, and cavities (the famous French débridement) with unobstructed drainage—in other words, the creation of physical conditions favourable to wound repair—was soon emphasized on the German as well as on the Allied side."

Lately several writers have extended the term "débridement" to include the excision of the soiled and damaged tissues of the wound. This was not previously included in the meaning of the word, and although one recognizes that the significance of words often changes with the passing of time, this change seldom does and never ought to occur with terms of definite meaning which are used by those who are trained scientifically. The term "wound toilet" would be a useful one for the whole process which I have described.

Further treatment depends upon the course of the infection, but in most cases repeated change of plaster is all that will be necessary. Only when all evidence of infection has disappeared should any attempted movement be permitted at the joint. If suppuration continues and extends it will be necessary to consider amputation of the limb.

When should Amputation be Performed?

There is no doubt that in the last war many lives were lost because surgeons often tried to save limbs when the patients were rapidly losing ground owing to the general effects of infection. When, in any joint, the suppurative processes continue to extend in spite of adequate drainage, and if the general condition of the patient as shown by fever, loss of appetite, wasting, sleeplessness, and general appearance makes it obvious that the infection is undermining the strength, then amputation will be needed. I can hardly recall a case in which I regretted amputation in these conditions, but I can remember, regretfully, one or more instances in which I delayed too long before performing it.

Excision of joints has little or no place in the treatment of joint injuries; it may be necessary to excise the head of the femur to produce better drainage of the hip-joint, or the head of the humerus the better to drain the shoulder-joint, and informal excision of loose contaminated fragments of bone may from time to time be required in the primary operation, but apart from these instances excision is more often needed to correct deformity at a later stage.

Prognosis

The outlook is better in the case of the joints of the upper extremity, for here the synovial sacs are not so complicated and drainage is rather more easily procured. Infected wounds of the hip and knee are most serious. At the end of the last war more than four-fifths of joint injuries of all kinds which were treated by early and free excision of the wounds healed

without suppuration—a truly remarkable improvement on the condition of affairs at the beginning of that war.

When it is seen that ankylosis must necessarily occur in a joint which has been injured, one should, so far as is possible, obtain that position which can be most useful to the patient. In the case of the elbow, the optimum position for ankylosis is just beyond a right-angle; for the shoulder, there should be slight flexion and external rotation with 60 degrees abduction; the wrist should be slightly dorsiflexed, the hip slightly abducted, the ankle at a right-angle with the leg, and the knee extended straight.

In this account of the treatment of wounds of joints I have made little reference to several methods which were in common use during the last war: continuous irrigation by the Carrel-Dakin method, the insertion of bipp into wounds, the use of strong salt solution, and other techniques were proved of value in these cases, but none of them has definite advantages over the plaster-immobilization method as outlined by Trueta. In cases in which for one reason or another plaster is not available these other methods may be tried, and will often be successful. The internal administration of sulphanilamide has certainly to a large extent ousted the treatment by autogenous or stock vaccines, though in difficult cases one should always have recourse to treatment by autogenous vaccine.

MEDICAL AID POSTS IN LONDON SHELTERS

Temporary Closure

As few people are now using public shelters in London and the most dangerous season for epidemics has passed, nearly all the shelter medical aid posts in the London Civil Defence Region are to be temporarily closed and put on a care and maintenance basis. Only the posts in the shelters or groups of shelters which are still regularly used by 500 persons or more will be kept open. This decision has been taken by the London Civil Defence Commissioners with the approval of the Ministry of Health.

Medical aid posts and regular medical and nursing attendance have been provided in every public shelter or group of public shelters regularly used for sleeping by 500 people or more since the beginning of the winter of 1940-1. The main object was to prevent the spread of infectious disease among the larger aggregations of shelterers. Now that the number of regular users has in most shelters fallen well below 500 it is considered that there is little or no need for these regular health services. The majority of the 203 medical aid posts recently in operation were regularly attended by doctors and were staffed by 390 nurses. The number of shelterers, however, has shrunk to 8,600, an average of only 43 persons per post. Only 4 cases are, on the average, being treated each week at each post. Doctors will continue to be available on call to deal with emergency cases of illness or accident in the shelters.

The Commissioners have asked the local authorities to arrange to maintain the medical aid posts in proper condition, and the local medical officers of health will continue to supervise health conditions in the shelters generally. All practicable steps will be taken to ensure that the full shelter medical organization can be brought into operation again at short notice if the need arises. For example, arrangements are being made for suitable nurses released from shelter work to be employed in hospitals or on other work under their own local authority on condition that they are released at short notice if required again for shelter duties.

E. L. Taylor (*Vet. Rec.*, 1942, 54, 95) gives a short account of phenothiazine poisoning in horses, to which the drug is often given as an anthelmintic. Symptoms may appear within 6 hours of administration, and consist of restlessness or dullness, a quick, weak pulse, colicky pains, diarrhoea or constipation, jaundice, and profound muscular weakness. One of the most prominent effects, he states, is the destruction of red blood corpuscles. Mr. Taylor believes it to be not improbable that occasional susceptibility to this drug may be related to the diet of the animal. In treatment, calcium gluconate and methylene blue have been given intravenously, and blood transfusion has also been resorted to. As the incidence of phenothiazine sensitivity is low the author does not recommend that its use should be discontinued; thousands of horses have been treated without ill effect.

Correspondence

Child Health

SIR,—There is a risk that the article by Prof. Charles McNeil (April 4, p. 429) may give public health workers an exaggerated idea of their own importance. When our local infant death rates fall to 31 per 1,000 live births (as was the case in several extra-metropolitan boroughs in 1939) are we justified in claiming it as a triumph for the child welfare service? I have never considered it to be so, but Prof. McNeil's article suggests that certain reforms he advocates in our present system of infant health control in Great Britain will result in reduction in our infant mortality to the low rate present in Holland in 1938. This would appear to be an over-simplification of the problem. One notes from Prof. McNeil's chart that the Dutch infant mortality had overtaken the English and Scottish rates by 1910 (before the maternity and child welfare services were in being). The Dutch figures established increasing superiority over the English rates from 1920, and Prof. McNeil considers it is significant that the States of the Continent spared by the 1914-18 war have all much lower infant death rates to-day than those that were engaged in it. The position after this war may be much less fortunate for Holland.

In the years when the English infant mortality was higher than the Scottish rate—i.e., until 1910—epidemic diarrhoea took a heavy toll of child life in England. In 1906 Newman stated that it was the most destructive of all diseases attacking children under 5 years of age. It was never such a scourge in Scotland, so that the dramatic improvement in the English rates when summer diarrhoea disappeared did not occur in Scotland.

In looking for an explanation of Holland's present superiority over England and Scotland in infant mortality Prof. McNeil says, "Climate can hardly have much to do with it," but he allows a "harsher climate" in Scotland as one of the factors which may explain the higher infant mortality there compared with England. The Registrar-General's Statistical Review for 1937 gives the rate for England and Wales as 57.6, the rates for the East, South-East, and South-West as 46.1 to 49.7, for the Midland areas as 57.3, and for the North as 67.7. This steady rise in infant mortality from the South of England to the North, whose figure of 67.7 in 1937 approaches very near the Scottish figure of 70 in 1938, suggests that climate may have something to do with infant mortality, and that the Continental climate which Holland enjoys may be kinder to infant life than even the South of England. The Registrar-General's Review shows also that infant death rates from measles, whooping-cough, bronchitis, and pneumonia rise from the South of England to the North.

Scientific work has been done which suggests that deficiency of calcium and deficiency of iron both result in lessened resistance to infection. If, as Prof. McNeil states, "the prevention of infection lies in a general strict technique of sanitation in the city, the street, and inside the home," we ought to have been overwhelmed with infection in the early days of air raids and communal shelters. Prof. McNeil suggests that for the improvement of child health to the level reached by Holland we should concentrate our attention on two main objectives: (1) the prevention of infection in infancy by improved domestic hygiene; (2) the improvement of infant feeding, especially in the first month of life. I should expect even more striking results from a rise in the standard of living and a reduction in overcrowding and other defects of urbanization. The degree of overcrowding in the larger Scottish towns is considerably greater than in the English towns, and this undoubtedly has an adverse effect on child health.

There is likely to be disagreement among different sections of the medical profession as to how far Prof. McNeil's criticisms of the child welfare services are justified, and which of his suggested reforms would result in improvement in the service. He is surely in error when he states that the essence of the service is a chain of clinics. The essence of the service is regular home visits by the health visitor. The proportion of her time spent in clinic work varies from place to place: 2/11ths to 3/11ths, which is the proportion in the borough in