Notes on Military Orthopaedics.

I. REMARKS ON POSITIONS OF ELECTION FOR ANKYLOSIS FOLLOWING GUNSHOT INJURIES OF JOINTS.

BY

LIEUTENANT-COLONEL ROBERT JONES, CH.M.,
F.R.C.S.I. (HON.),

INSPECTOR OF MILITARY ORTHOPAEDICS, ARMY MEDICAL SERVICE.

THERE are certain injuries to joints occurring after gunshot wounds which must inevitably end in bony ankylosis. From their very nature some of these will not admit of excision.

When a joint has been shattered, and the muscles governing it have been in part or wholly destroyed, excision is not merely difficult from the point of view of surgical technique, but often results in a flail articulation which renders the limb quite useless. This is especially the case when such joints as the shoulder, elbow, and wrist are concerned. Excisions of the upper part of the humerus are frequently practised as a conservative procedure in the presence of acute or persistent sepsis, especially at the French front. This may be very necessary, but the resulting condition will at a later date require further surgical intervention. The question has often been put to me, "What should be done with these flail joints, and, if ankylosis is to be expected, in what position should the joint be placed in order to be of the greatest use to the patient?" The question as to flail joints will be considered at the end of this article, but in the first place it may be of service to indicate briefly the conclusions as to the positions for ankylosis to which experience has led me.

SHOULDER-JOINT.

Position.

The arm should be abducted to about 50 degrees (Figs. 1 and 2). The elbow should be slightly in front of the coronal plane of the body (Fig. 2), so that when it is at right angles and the forearm supinated, the palm of the hand is towards the face. The arm is placed in this position while the scapula retains its normal position of rest.

Reasons.

If the arm be correctly placed the hand (Fig. 3) can be brought easily to the mouth by bending the elbow. Further, the humerus, being fixed to the scapula at the angle indicated, the arm can be lifted to a considerable height by scapular action (Fig. 4); moreover, pockets can be reached, the hair brushed, and the patient can pick up a plate or cup without spilling the contents.

The arm should never be kept to the patient's side if

ankylosis is feared, for in such a case the functional result must be most unsatisfactory; not only will it be difficult to reach many parts of the body, but difficult also to reach across a table or to perform many simple movements constantly recurring in everyday life. Flail shoulder-joints also should be ankylosed in the position described; and joints which have been allowed to ankylose in an adducted position (Figs. 5A, 5B) may require osteotomy of the humerus high up to correct this faulty position. The shoulder-joint should never be allowed to become fixed at right angles to the side in adults, as in that case the patient will be unable to bring his arm down to his side.

It is to be clearly understood that I am dealing with injuries to soldiers and sailors, and not with children in whom other means can be adopted owing to anatomical considerations.

ELBOW-JOINT.

Position.

The proper course to adopt will depend upon the patient and his calling, but by far the greater number of men would prefer the fixation to be at just below a right angle—that is, about 100 degrees (Fig. 6). It is important to bear in mind that in cases in which both elbows will become ankylosed it is necessary to fix the one at an angle of 80 degrees and the other at 100 degrees as recommended for one-sided trouble (Fig. 7). The ankylosis commonly met with at 130 degrees is not useful.

Reasons.

This position enables the patient to move his hand to his mouth, button his clothes, brush his hair and to reach over a table. At an angle less than a right angle it is certainly more easy to get the hand to the mouth and to various parts of the head, but limitations in other directions more than counterbalance these advantages.

FOREARM.

Position.

If the movements of pronation and supination are lost, the radius should be fixed midway between pronation and supination.

Reasons.

The hand is more useful for dressing and eating and for manual labour in this position. A minor advantage is that of appearance.

WRIST-JOINT.

Position.

All injuries of the wrist-joint should be treated with the wrist dorsiflexed (Fig. 8).

This is a priceless surgical axiom, the neglect of which is grave.

It is an urgent necessity where ankylosis is expected, or where even limitation in movement is likely to occur.

The common deformity of palmar flexion occurs when no splint is applied, or from the use of a straight splint; in all cases in which the arm and fingers are kept on such

F.G. 1.

FIG. 2.

FIGS. 1 AND 2.—To illustrate the position for ankylosis of the shoulder in abduction.

FIG. 3.

FIG. 4.

FIGS. 3 AND 4.—Ankylosis of the shoulder in abduction to show, (Fig. 3) degree of abduction, (Fig. 4) the degree of power of lifting the arm.

a splint palmar flexion of the wrist occurs, and this condition is a lifelong handicap to the usefulness of the hand.

Reasons.

The grip of the fingers is diminished if the wrist is palmar-flexed. The strong flexors overpower the extensors

FIG. 5 A.

FIG. 5 B.

Fig. 5 A shows faulty adducted position of arm, and Fig. 5 B the consequent extremely limited power of abduction.

of the fingers, and in consequence proper co-ordination of the finger movements is impaired. The grasp of the hand

FIG. 8.—Dorsiflexion of the wrist.

is strongest when the wrist is in the dorsiflexed position, the balance between the flexors and extensors is better preserved, and the co-ordinated movement of the fingers is secured.

The splints required are simple.

In proof of the importance I attach to the dorsiflexed ankylosed wrist, I may state that I always restore hyper-extension of the ankylosed joint from the position of

FIG. 6.—Ankylosis of elbow-joint at 100 degrees.

FIG. 7.—Right elbow at 80 degrees, left elbow at 100 degrees.

flexion by manipulation or incision. This invariably improves the grip of the fingers.

Apart from the impairment of function, a flexed wrist is unsightly.

HIP-JOINT.

Position.

Ankylosis should be encouraged in a position of very slight abduction, with thigh extended and very slight outward rotation (Fig. 9).

Reasons.

The common deformity in ankylosis of the hip is flexion, adduction and internal rotation (Fig. 10), which is the characteristic position we find in an untreated or imperfectly treated tuberculous hip-joint; it leads to lumbar lordosis and an ugly limp. Adduction deformity brings the limb too near the middle line, interferes with the normal position of the sound limb in walking, and by involving abduction of the sound limb, interferes also with a free gait.

If the hip-joint is ankylosed in the fully extended position lordosis and the consequent trouble from back-ache is avoided, and there is freer pelvic movement in walking if the thigh is slightly abducted.

The limb should be very slightly rotated outwards, to avoid the unsightly lift of the pelvis as the patient rises on his toes when walking, due to the immobile condition of

FIG. 9.

FIG. 10.

Figs. 9 and 10.—Ankylosis of hip. (9) Correct position, in slight abduction with extended thigh and slight outward rotation. (10) Faulty position of ankylosis in flexion with adduction and internal rotation.

the hip-joint. This gives an easier walk than if the toes are pointed straight forward.

KNEE.

Position.

This joint should be fixed in an extended position.

Reasons.

Very good reasons may be given in favour of slight flexion from the point of view of elegance in repose and that of ease in mounting stairs. Due weight should be given to these arguments, but in the case of war injuries the straight position obviates many risks. Ankylosis, as we know, is not necessarily bony; when it is fibrous the tendency is for the flexion angle to increase by exercise. The incidence of the body weight on a slightly bent knee, unless the ankylosis is sound and bony, will increase the flexion. The position, therefore, is mechanically a weak one for carrying body weight. Even when new bone is forming its complete consolidation is sometimes a slow process, and if the surgeon places such a knee in a slightly flexed position the degree of ultimate flexion is often much greater than he would wish. The advantage of increased strength and stability ensured by an extended joint will generally outweigh all other considerations.

ANKLE.

Position.

The foot should be kept at a right angle with the leg, so that the sole impinges on the ground in a slightly varus rather than a valgus position (Fig. 11).

Reasons.

If the reader will recall the ankylosed ankles he has seen, he will remember that most of them were in a valgoid position. A varoid position conduces to a strong type of foot; a valgoid (flat-foot) to a weak foot, and all the disability associated with erroneous deflection of body weight.

JOINTS OF THE TARSUS AND METATARSUS.

In gunshot wounds and other injuries of the tarsus and metatarsus, the deformities to be feared correspond to the

FIG. 11.—Ankylosis of ankle with foot at right angle and sole in slightly varus position.

common static deformity of flat or pronated foot—a subject with which I propose to deal more at length in a subsequent article—that is to say, to pronation at the mid-tarsal joint, flattening of the longitudinal arch, and sometimes flattening of the transverse arch associated with pain in the metatarso-phalangeal joints. Callus exudation added to plantar malposition results in a very crippled foot. In all gunshot injuries of tarsus and metatarsus the surgeon should take care during the later stages of healing not to bandage the sole rigidly against a flat foot-piece, for if that be done every irregularity of bone will conduce to

FIG. 12.—Boot with bar behind head to relieve injured metatarsal joints and phalanges from pressure.

FIG. 13.—Heel elongated and raised $\frac{1}{4}$ in. on inner border, with small piece on inner side of sole.

callosity when walking is resumed. It is necessary, therefore, at this stage to adjust a splint having an inside arch padded to conform to the natural shape of the foot. Eversion of the foot should be guarded against, and the hollow of the arch should, when possible, be emphasized. Later, the heel of the boot should be raised on the inner side to obviate eversion, and, if the metatarsals are involved, in order to allow of early walking, a bar should be placed across the sole of the boot behind the tread (Figs. 12, 13). Light duty can then be undertaken at a much earlier date.

FLAIL JOINTS.

In answer to the question "What should be done with flail joints?" I would say, "Secure by operation an ankylosis in the most useful position." The only exception is in the case of the hip-joint where by means of simple mechanism a very useful limb may be obtained in spite of the joint being flail.

Preliminary Note

ON

A METHOD FOR THE PREPARATION OF A NON-TOXIC DYSENTERY VACCINE.

BY

H. R. DEAN, M.D., F.R.C.P.,

AND

R. S. ADAMSON, M.A., B.Sc.

(From the Pathological Laboratory of the University of Manchester.)

(Report to the Medical Research Committee.)

THE susceptibility of the rabbit to *B. dysenteriae* (Shiga) is well known, and constitutes a practical difficulty in the preparation of agglutinating serums for use in the recognition of this micro-organism. During attempts to produce antiserum we ascertained that the intravenous injection of one-twentieth of a loop* of the culture of the particular strain which we were using, killed by heating for one hour at 58° C., invariably produced the death of a rabbit in five to seven days. Smaller quantities frequently produced a

fatal result. One strain of Shiga's bacillus was used in all our experiments.

The very marked success obtained by Lorrain Smith, Ritchie, and others by the employment of eusol¹ in the treatment of toxæmia and septicaemia suggested the possibility of its employment *in vitro* for the destruction of the toxins of the bacillary emulsion. The object of our experiments has been to modify the toxic properties of a bacillary emulsion of the Shiga bacillus without interfering with its capacity for producing immunity.

That bacillary antigens are not destroyed by hypochlorous acid had been shown by the successful use of antiformin extracts in the complement fixation reaction by Altmann and Schultz.² In 1912 Dean³ prepared a soluble typhoid antigen by precipitating an antiformin extract of typhoid bacilli with alcohol. By this method a fine white powder was prepared, which was freely soluble in water. The solution so obtained was injected into a rabbit, and induced the formation of agglutinins against *B. typhosus*.

The results of our experiments on forty-seven rabbits have convinced us that it is possible by the use of dilute solutions of hypochlorous acid to prepare a Shiga vaccine, the injection of which is practically harmless to the rabbit, but is nevertheless followed by the production of a satisfactory degree of immunity.

The first few experiments showed that eusol very effectually destroys the Shiga toxin *in vitro*. The entire growth from three agar plates, which had been profusely inoculated with the Shiga bacillus on the day before, was emulsified in 15 c.cm. of saline solution. To the emulsion was added an equal quantity of eusol, and the mixture was allowed to stand at room temperature for twenty-four hours. Of this mixture quantities containing $\frac{1}{10}$, $\frac{1}{100}$, and $\frac{1}{1000}$ of the entire growth on an agar plate were injected into the ear veins of three rabbits. No symptoms of any kind were observed, and all these rabbits remained in excellent health during the next seven days, when they received further inoculations. On the seventh day a sample of blood was taken, and agglutination tests were carried out. No formation of agglutinins could be demonstrated.

What is the smallest quantity of eusol which, when allowed to act on an emulsion of Shiga bacilli, will render the mixture non-toxic for rabbits?

In the endeavour to supply the answer to this question we have carried out experiments on twenty-four rabbits. The method employed throughout the series was the same. An emulsion was prepared by rubbing up one or more loops of a twenty-four hours' agar culture in a measured volume of saline. In the later experiments of the series the bacilli were killed by heating the emulsion for one hour at 58° C. In the earlier experiments we relied on the bactericidal action of the eusol. The emulsion was mixed with an equal volume of diluted eusol and left for twenty-four hours at room temperature. The amount of the mixture that was injected was usually 1 c.cm. If, for example, it was decided to inject one-fifth of a loop of culture in a 1 in 1,000 solution of eusol, an emulsion of bacilli was prepared which contained two-fifths of a loop in 1 c.cm., and added to an equal volume of 1 in 500 eusol. The following examples are fairly typical of the results obtained:

Rabbit 27.

This animal was one of the three mentioned above. It had been inoculated on February 26th with one-hundredth part of the entire growth of an agar plate previously digested with an equal volume of eusol. On March 6th it was given an intravenous injection of Shiga emulsion, half a loop, in eusol, 1 in 1,000. (The mixture was shown to be sterile.) The animal remained perfectly well, and on March 10th Shiga emulsion, half a loop, in eusol, 1 in 1,000, was injected. This mixture was found to contain living bacilli, for a few colonies of *B. dysenteriae* developed on an agar slope which had been inoculated with several loops of the mixture. We had been using throughout the experiment the same solution of eusol which had been prepared on February 25th. It will be seen that a 1 in 1,000 dilution of this solution sterilized the emulsion on March 6th, but was unable to do so completely four days later. This result was probably due to the deterioration of the eusol solution. If we had titrated our eusol solution before use and determined the hypochlorous acid content, we should probably have obtained more constant results. The result was, however, of interest, for the rabbit survived the inoculation with the living organism, and had evidently developed a high degree of immunity as a result of its previous inoculations with eusol-treated Shiga emulsion. The rabbit, in fact, showed no

* Throughout this series of experiments we have expressed the quantities injected in loops and fractions of a loop. In all experiments we have used the same platinum loop, and cultures of the same strain, previously grown for twenty-four hours at 37° C. If one loopful of the culture is emulsified in 1 c.cm. of saline solution and of this emulsion 1 c.cm. is injected, the amount injected is reckoned as one-fifth of a loop. The method is old-fashioned but provides comparable measurements, provided that the above precautions are adhered to. We have ascertained that one-fifth of a loop in our series of experiments contains from 160 to 180 million bacilli.