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THE ESSENTIAL FEATURES IN FRACTURES OF THE SHOULDER

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THE time is not long past when the treatment of almost any type of fracture was considered to be within the province of the medical practitioner, but with the advent of this highly industrialized era, fractures have taken on a new interest. Indeed, so important have they become that in most modern hospitals these cases are segregated and taken care of by a small surgical group who are particularly interested in this type of surgery. It is my purpose this evening to direct your attention to some of the more important features of fractures about the shoulder.

Before any fracture can be adequately treated, it is most essential to have a very clear idea of the displacement. If we are dealing with a fracture of the shaft of a long bone, little difficulty need be encountered in correctly interpreting the roentgenogragraphic appearances. This is likewise true of many joints, including that of the hip, in which the various prominences stand out clearly in the roentgenograms. But the shoulder joint presents many difficulties, as a perusal of the literature indicates. Most writers appear to be unanimous in thinking that the common displacement in a fracture of the shoulder is abduction and external rotation of the upper fragment, while the shaft is displaced to the inner side with a varying degree of upward displacement, with or without impaction. One searches in vain for any reference to flexion or internal rotation of the upper fragment, and only a few mention the anterior displacement of the upper end of the shaft. For some time I have felt that there is a great deal of misconception regarding this fracture. I have recently carried out some investigations which seem to substantiate this contention.

In the normal humerus, an anterior view will show just external to the rounded head a slightly constricted area, the anatomical neck, to which is attached the capsule of the joint. Immediately below the center of the head and blending with the neck is a cone shaped projection, the lesser tuberosity, which serves for the attachment of the powerful subscapularis tendon. It is slightly lower than the top of the great tuberosity which in turn is about an eighth of an inch lower than the highest point of the head. Immediately lateral to the lesser tuberosity is the bicipital groove which extends downward and slightly inward for some 2 to 3 inches on the shaft and lodges the long tendon of the biceps. Lower down the groove serves for the attachment of the latissimus dorsi tendon while the inner and outer lips provide insertion for the tendons of the teres major and pectoralis major muscles, respectively. Between the upper border of this muscle group and the anatomical neck lies the region known as the surgical neck of the humerus. To the outer side of the upper part of the neck is a flattened area representing the top of the great tuberosity and corresponding to the attachment of the tendon of the supraspinatus muscle. A very imperfect idea, however, is obtained of the shape of this tuberosity when viewed from the front.

Examined from the side it is seen to be an irregular quadrilateral about an inch and a quarter to the side. Its anterior border is straight and forms the outer lip of the bicipital groove which again is readily distinguishable. Anterior to this the conical projection formed by the lesser tuberosity is quite prominent. The upper border of the great tuberosity consists of two flattened surfaces. The more anterior of these is horizontal and, as mentioned, serves for the attachment of the supraspinatus tendon while the second, considerably longer, passes obliquely backward and downward at an angle of about 45 degrees and gives attachment to the infraspinatus tendon. The posterior border presents a

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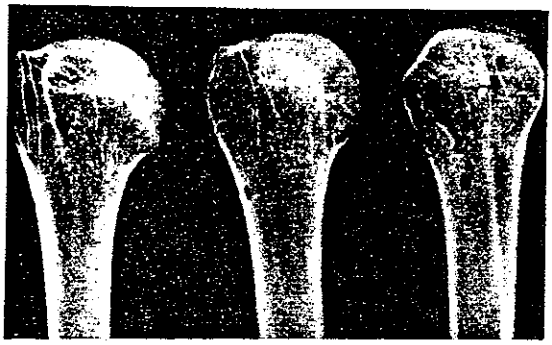

Fig. 1. Fig. 2. Fig. 3.

rounded contour and, together with a variable portion of the shaft with which it insensibly blends, serves for the insertion of the teres minor muscle. The lower border likewise fades into the shaft.

But while these various points are readily made out in a photograph, they are not so apparent in a roentgenogram, particularly when the upper fragment is rotated in one or more directions. In order to elucidate this problem the upper extremity was removed from a skeleton and the outlines of the lesser and greater tuberosities were marked by wires. Roentgenograms were then made with the arm in various positions. Figure 1 shows the appearance in the anteroposterior position, that is, with the arm supposedly by the side and the forearm pointing directly upward; or the same thing can be accomplished by having the forearm extended, but in that case the elbow must be close to the side and the palmar surface of the hand must be directed upward. In this slide the slightly constricted area corresponding roughly to the anatomical neck is distinctly visible and the great tuberosity stands out prominently on the outer side. Inasmuch as we are viewing it from the front, the wire which is fastened to its anterior, superior, and posterior borders looks very much like a fine hairpin. On the other hand, the wire which is fastened around the base of the lesser tuberosity appears as a wide, short loop. Between these loops an area of lesser density can usually be seen and this represents the bicipital groove.

Figure 2 shows the appearance when the bone has been rotated inward about 30 degrees. In this the constricted area of the neck is less evident and the fine hairpin appearance of the great tuberosity is giving place to one of much wider character; the outline of the lesser tuberosity widens slightly because now we are looking at this prominence, as it were, full face. Of more importance than the latter observation is the fact that a definite change can be made out in the position of the head which now points in a more vertical direction.

Figure 3 was taken with the forearm lying across the chest. In this the neck has for the most part disappeared and the head is directed almost vertically upward. The lines representing the greater tuberosity are now widely separated, and whereas the line depicting the posterior border in the previous slides was nearly straight, it is now bent markedly outward. The superior border of the tuberosity now stands out prominently due to the fact that the increased cortical thickening incident to the insertion of the supra- and infra-spinati tendons presents its maximum density when viewed from this angle. The lesser tuberosity again takes on an appearance which is very similar to that of the anterior view except that it is placed more internally.

But what is of the greatest significance is the appearance of a crescentic dense line with its convexity directed inward. This almost coincides with the inner margin of the head and when traced upward is seen gradually to disappear. It goes in the general direction of the upper border of the great tuberosity but is separated from that margin by the gap for the bicipital groove. This crescent is produced by the increased density about the base of the lesser tuberosity.

Figure 4 shows the appearance with the arm in full internal rotation, that is, with the forearm placed horizontally behind the back. Here the neck again becomes apparent but it is placed at an angle of about 90 degrees from that in the anterior anatomical position and the head is now directed upward and outward. The outlines of the tuberosities take on somewhat the appearance shown in the slide of the anteroposterior view, except that their positions are now reversed; but the feature of greatest significance is the conical projection of the lesser tuberosity on the

inside. The superior border of the great tuberosity does not stand out prominently as a distinct ridge because it is viewed rather obliquely, the direct result of extending somewhat the arm proper to permit the forearm to lie against the small of the back. This also accounts for the fact that the top of the tuberosity is so much below the top of the head. When the arm is externally rotated about 60 degrees, the appearance is that shown in Figure 5. In this the neck is quite apparent and the head is directed upward and inward. The wire around the base of the lesser tuberosity is represented as a fine hairpin with the ends almost in contact, and the apex of the lesser tuberosity points directly outward. The great tuberosity is outlined on the outer side by the straight line which corresponds to the outer lip of the bicipital groove. The anterior portion of the superior border of the tuberosity is also well marked but the rest of the border is less distinct and passes inward and downward. Indeed, the whole appearance is not unlike that in full internal rotation except that the various markings are reversed. This may be very confusing unless one takes into consideration whether the right or left shoulder is being examined.

In order to bring out the characteristic features when flexion is superadded, a picture was taken with the humerus rotated inward some 60 degrees and flexed about 30 degrees. Figure 6 is typical of such a position. The outline of the greater tuberosity is clearly defined as we are looking at it from its outer side, but instead of its upper border being slightly below the head, it is now above that portion of the bone. But a very interesting feature is now added in the cyst-like appearance which seems to fill the whole upper extremity of the humerus. It is caused by the slight density at the anatomical neck which in this view shows as a circle, inasmuch as we are looking at the head in a line directly opposite to the normal projection of that portion of the bone; or, in other words, if the tuberosities were removed up to the plane of the anatomical neck, the cut surface would be looking directly toward us. The projection on the inner side is due to the lesser tuberosity.

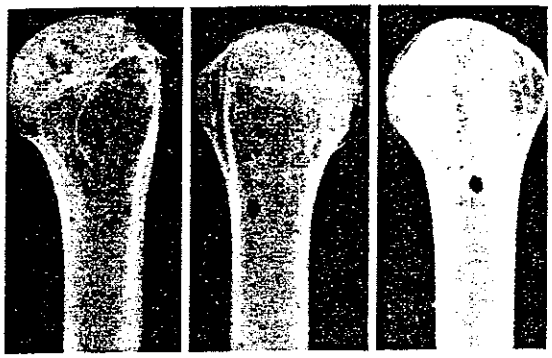

Fig. 4. Fig. 5. Fig. 6.

This aspect of the subject was further investigated on the cadaver. The upper end of the humerus was exposed by a long incision through the deltoid, the surgical neck sawed through in a transverse direction, and the movements of the two fragments investigated. Whereas it was an easy matter to move with the fingers the upper end of the shaft inward, outward, or in a forward direction, it was rather difficult to displace it behind the upper fragment. This was due to the resistance offered by the pectoralis major muscle, and when this attachment was severed, the shaft could be displaced backward with ease. The most interesting feature in regard to the upper fragment was the ease with which internal rotation could be accomplished, whereas external rotation, even to a very limited extent, required a very considerable twist. The tension on the subscapularis tendon naturally appeared to be the cause, but even after its division just proximal to where it blends with the joint capsule, there was little or no change, and it was only after dividing the supraspinatus tendon, just proximal to where it merges with the capsule, that the head could be rolled outward. Abduction, flexion, and adduction could each be brought about readily enough, whereas extension of the upper fragment was more difficult because of the close manner in which the posterior aspect of this portion of the bone is enveloped by the infraspinatus and teres minor muscles.

Figure 7 shows the appearance when the fragment is abducted and flexed 30 degrees and rotated internally about 60 degrees. In this the top of the great tuberosity can be

Fig. 7. Fig. 8. Fig. 9.

seen projecting over one-fourth of an inch above the outline of the head, while the contour of the lesser tuberosity almost reaches the margin of the head along its inner aspect. In addition, the cyst-like appearance is clearly visible. When the upper fragment is markedly internally rotated, flexed, and adducted about 20 degrees, the conical projection of the lesser tuberosity is visible on the inner side and the anterior margin of the great tuberosity can be seen extending vertically upward until it almost reaches the outline of the head which stands out just beyond the superior border of the great tuberosity. Here also, as in Figure 7 in which internal rotation was marked, the head is directed upward and outward. When the upper fragment is abducted and extended about 30 degrees without any rotation, the anatomical neck is readily discernible and the head is pointed well in an inward direction, but the most notable feature is the conical projection on the outer side. This is caused by the outer margin of the great tuberosity, and its resemblance to the lesser tuberosity is due to the fact that it is being viewed obliquely from above downward.

Having familiarized ourselves with the various appearances which the upper fragment may present, we are in a position to interpret correctly the displacement in any type of fracture. With this as a background, I have reviewed the x-ray films of one hundred cases of fracture of the upper end of the humerus in the x-ray department of St. Michael's Hospital. Naturally, a great variety of fractures is met with, but there are certain well defined types. The vast majority involve the upper aspect of the surgical neck not far below the old epiphyseal line and are more or less transverse. Apparently the older the patient, the higher is the fracture likely to be. The great tuberosity may be broken off alone or in association with a dislocation of the head, but it is commonly detached in a fracture in the upper limits of the surgical neck. Four common types of displacement were noted in the upper fragment—abduction, adduction, flexion and internal rotation, and it was found that a very constant relationship exists between abduction, flexion, and adduction and the position of the shaft. If the upper fragment is abducted, then the shaft is to the outer side, while if it is adducted, then the shaft is to the inner side. In this series there

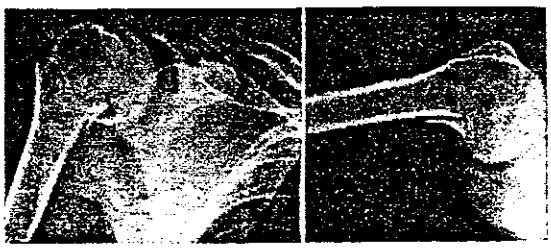

Fig. 10. Fig. 11.

Fig. 12. Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

was no exception to the latter association, but there were two in which the upper end was abducted while the shaft was to the inner side. This, I feel, was due to the position having become altered between the time of the accident and the taking of the film. A similar relationship appears to exist between flexion and an anterior displacement of the shaft, but this is not so surely determined, owing to the difficulty of interpreting depth with accuracy in stereoscopic anteroposterior plates; in only a few were lateral plates taken owing to the pain necessarily produced by abducting the arm sufficiently. But the similarity in the number of cases with flexion of the upper end to the number in which the shaft is displaced forward is very significant. Internal rotation of the upper fragment is of frequent occurrence. In some instances a moderate degree is doubtless due to faulty technique, as when the film is made with the forearm lying across the chest. Although it was twice as commonly associated with an adducted position of the shaft as with one in which the shaft was to the outer side, the relationship was not sufficiently constant to formulate a rule. There was not a single instance in which the upper fragment was rotated outward, and with the exception of the separated epiphysis in which a posterior position of the shaft is the usual condition, there was only one in which the shaft was found to lie posterior to the upper fragment, and in that instance the proximal fragment was extended. In only one other case in the series was the upper fragment extended.

These displacements are very interesting from the probable light which they shed upon the cause. Great care must be exercised in drawing conclusions as to the way in which an accident occurred from the description given by the injured, as very few people can give a reliable account. I have felt, however, that in the vast majority of instances the force is delivered to the region of the shoulder and the resultant displacement depends for the most part upon the position of the elbow at the time of the impact. A man cannot very well fall on the front of the shoulder unless he is carrying some object like a football and refuses to let it go. Instinctively the arm goes out to receive the impact and the common fracture is one that involves the wrist. But when he falls in a lateral or posterolateral direction, so rapidly may the feet go from under him that the arm cannot get back quickly enough to break the fall. Undoubtedly some force is commonly directed upward through the shaft of the humerus, and the position which the upper end finally assumes depends upon the

Fig. 17.

Fig. 18.

Fig. 19.

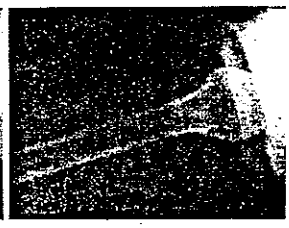

Fig. 20.

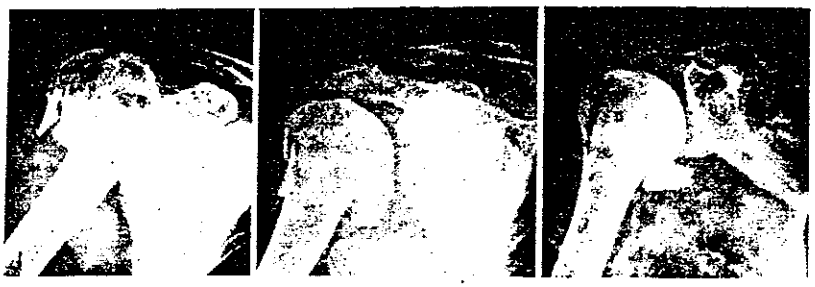

Fig. 21. Fig. 22. Fig. 23.

position of the elbow at the time of the fall. If it is close to the side and in the midaxillary plane, little change will be observed in the alinement, but there will likely be impaction; if it is away from the side a bit and still in the midplane, then the shaft will be displaced to the inner side with some adduction of the upper fragment; if it is posterior to this plane, then the shaft will be displaced anteriorly with flexion of the upper fragment. But in this instance, in addition to the flexion, the shaft may be displaced to either the inner or outer side, depending upon whether the elbow was to the outer or inner side of the sagittal plane of the arm when the break occurred. In my opinion it is the direct blow upon the shoulder which breaks the bone, a view that is supported by the fact that over 85 per cent of the cases in this series were of the transverse variety. Once a solution of continuity has been established, the displacement is largely due to the force transmitted along the shaft. This is derived from two sources, the pull of the muscles going from the shoulder girdle to the arm and that arising from the contact which the elbow makes with the ground. This does not, however, explain the prevalence of internal rotation which I believe to be due to the overpowering pull of the subscapularis muscle.

Fig. 24.

From the series under review, certain types of cases have been selected for illustrative purposes. While it is quite a simple matter to determine the displacement, provided one is thoroughly conversant with the details of the markings in the film, it is often impossible to reproduce these in a lantern slide. Consequently, many of the films have been retouched and this has been carried out by Eugene Shannon, head of the radiological department of St. Michael's Hospital.

Figure 8 is an example of fracture of the shaft directed to the inner side with adduction of the upper end, but in addition there is a very considerable degree of internal rotation of the upper fragment. This is very obvious from the outline of the top of the great tuberosity which is clearly delineated, and from the crescentshaped line with its convexity directed inward, produced by the base of the lesser tuberosity.

Figure 9 is a good example of the cyst-like appearance which is occasionally seen. The shaft is to the inner side and the upper fragment is adducted. The outline of the top of the great tuberosity is distinctly seen, its margin almost coinciding with that of the head, showing that in addition to a very considerable degree of internal rotation, the upper fragment is likewise flexed. This cyst-like appearance is not peculiar to a fracture of the upper end but is occasionally seen where the middle third of the shaft is broken. In such an instance it is necessary to place the lower fragment in marked internal rotation in order to get proper alinement.

In the series under review the shaft was to

the inner side in 42 cases, and of these, the upper fragment was adducted in 34; there were 6 instances of cyst-like appearance.

Figure 10 is an example of fracture of the shaft directed to the outer side with a moderate amount of abduction, internal rotation, and flexion of the upper fragment. The outline of the top of the great tuberosity is distinctly seen, and the density corresponding to the infraspinatus insertion overlaps this portion of the head. Figure 11 is a lateral view of the same fracture. In this the cone-shaped projection on the anterior aspect represents the lesser tuberosity, while the curved line which intersects the former and continues on to the outline of the head is the outer lip of the bicipital groove or, in other words, the anterior border of the great tuberosity. The flexion of the upper fragment is very obvious, but there is another very important feature, i.e., the marked prominence of the lesser tuberosity which proves that this fragment is very considerably rotated inward.

In this series there were 26 cases in which the proximal fragment was abducted, and of these, 24 had the shaft to the outer side. An impacted fracture with little or no other displacement is by no means a common type, and it is the variety which is most frequently mistaken for a sprain of the shoulder. Some of these are so firmly wedged together that it is impossible without using an unjustifiable amount of force to disengage the fragments even under an anesthetic. But the decision as to whether impaction has occurred from reading a roentgenogram is often open to doubt; we were reasonably certain, however, that it was present in 10 of our cases.

In a case of fracture dislocation of the shoulder, the roentgenogram showed the head broken off at the anatomical neck and lying in the axilla with its fractured surface directed upward and outward. The main line of fracture had gone through the anatomical neck and both tuberosities had been badly comminuted. This was the only case of this kind in the series, but in 2 other instances, besides the fracture of the humerus, there was a broken clavicle in one and a fracture through the surgical neck of the scapula in the other. In our series there were 2 examples of a separated epiphysis. In one the head was markedly abducted but without any rotational change, and the shaft was displaced upward to the outer side and backward. In a third case the epiphysis was displaced about one-fourth of an inch to the outer side, and carried with it a thin wedge from the outer side of the shaft. Most authorities claim that the typical displacement in this type of fracture is for the shaft to be shifted to the front, yet in the discussion they invariably depict just such a deformity as I have shown. In the dozen odd cases of complete separation of which I have records, the shaft has been to the outer side and posterior in all. This lends credence to the view that many of these injuries are due to a fall upon the outstretched hand.

This series of roentgenograms, while not including every variety, provides a very fair picture of what one is apt to meet in a fracture of the upper end of the humerus. I have not shown a fracture of the anatomical neck because in my experience a break through this region unassociated with a fracture involving the great tuberosity is extremely rare. In only one of this series was the head knocked off and that was complicated not only by much comminution of both tuberosities but by a dislocation as well. In very severe injuries the head may share in the general comminution of the upper end or it may be split into two more or less equal segments between which the great tuberosity may be so tightly wedged that it cannot be withdrawn without an open operation. In this series there were 4 instances in which the head was split. The great majority of fractures of the upper end of the humerus occur in people past middle life, and in these, comminution usually affecting some portion of the great tuberosity is common. It was present in 55 per cent of the cases of fracture of the surgical neck in this series, and from a study of these plates one gets the impression that the upward thrust of the shaft plays an important part in its production. Marked displacement of the shaft to either the inner or outer side was uncommon; in the vast majority it was less than half an inch. In only 12 instances was the separation about equal to the width of

the bone. It is in this type that shortening is likely to be marked. Table I gives in detail the important roentgenological findings.

Thus far we have dealt entirely with the roentgenological findings in arriving at a diagnosis because it is upon these alone that an accurate diagnosis can possibly be made. But the clinical evidence of a fracture must never be neglected and, in fact, this investigation shoud be carried out before resorting to the roentgenogram. When first seen the patient will be found steadying the arm against the chest and supporting it by the other arm. If seen early, there will be no evidence of ecchymosis, but the shoulder region will be swollen and invariably there will be found a spot corresponding to the surgical neck which is very tender to deep pressure. Measurement of the arm for shortening may give some useful information, but if there is much swelling, the landmarks may be difficult to detect. But shortening beyond a quarter of an inch or so was present in only 8 of our cases so that this method is not of much value in arriving at a diagnosis. If the shaft has been impacted into the upper end, the patient may be able to move the arm about through a considerable range without much discomfort, while if no impaction has occurred, active movements will be painful. In the latter event, gentle passive movements may be carried out through a narrow range without much pain. Although damage to important nerves and blood vessels is relatively rare in fractures of the shoulder, one should never fail to make sure that such complications are absent. To discover a nerve lesion for the first time after a fracture has been set may be very embarrassing to the surgeon if he has not previously examined the limb for such a complication. But injuries elsewhere should also be ruled out. If the patient be conscious, this is readily enough done, but if he is unconscious, it is comparatively easy to overlook quite an important injury. Indeed, such an associated injury may be much more important than the fractured shoulder.

Surgeons usually see these patients for the first time in a hospital so that the problem of how best to transport the individual to the place where the setting is to be done does not arise. It is nevertheless very important during this period, not only to lessen the pain as much as possible, but also to insure that no further damage to soft parts occurs. For this purpose the Murray-Jones splint is ideal; it not only provides adequate fixation but it restores the arm to something approaching the normal length which is an important factor in reducing the swelling. It has the further advantage that anyone at all familiar with first aid work need have no difficulty in applying it.

As soon as the roentgenograms have been studied and the exact deformity determined, the setting of the fracture should be proceeded with. There must be no waiting for the swelling to go down because the most effective way of decreasing it is the restoration of the fragments to their normal relationship. Furthermore, the earlier the fracture is reduced, the easier is the reduction, since delay simply allows time for the muscles to shorten.

A review of the literature discloses the fact that different authorities treat a fracture of the surgical neck of the humerus in a variety of ways. There is quite a consensus on the necessity of having the arm abducted. This position has the advantage that when active movements are begun, following union, the arm is in the optimum position because the difficulty is always in getting the arm up, not down. Then if ankylosis, a very rare occurrence, should supervene, the abducted position, provided it is not greater than 60 degrees, gives a much more useful arm in that it allows the maximum movement of the scapula. Some confine the patient to bed with the arm supported in a Thomas splint in an abducted position while others prefer to have him up and about with the arm abducted and supported on an aeroplane splint. As a result of our investigations we think that neither method is the correct one because neither takes into consideration either flexion or internal rotation of the proximal fragment, both of which are very common. The former was present in about half the cases in this series, while the latter displacement occurred in slightly over one-third. Indeed, the combination of flexion with internal rotation is a very common one.

It is a well recognized principle of treatment that where we have little or no control over a fragment, we must direct our effort to that fragment over which we have control; in other words, if we cannot bring the horse to the cart, we must bring the cart to the horse. Admittedly, a fracture of the surgical neck of the humerus is an example of this kind. The problem, then, is to ascertain the position of the proximal fragment, place the distal fragment in a corresponding position, and fix the fragments until union is sufficiently solid that gentle active movement will not disturb them. We believe that the establishment of proper alinement cannot be obtained by a routine placing of the arm in an aeroplane splint or by confining the patient to bed with the arm abducted and supported in a Thomas arm splint. For certain types of fracture, as, for example, those with an abduction deformity only of the proximal fragment, such treatment may suffice, although I can see no reason why a patient with an uncomplicated fracture of the shoulder should be confined to bed. But one must be careful lest too much abduction result in a downward angulation at the site of fracture. Many instances of this have come under our observation as illustrated in Figures 12 and 13 while in Figure 14 the position has been corrected by lessening the abduction. But where there is a variable amount of flexion, internal rotation, or adduction, such a procedure is bad and cannot possibly re-establish correct alinement. When the upper fragment of the humerus is internally rotated, the spinati muscles become flexors instead of abductors, and when the arm is put in the abducted position, these muscles keep up the flexion, thus rendering correct alinement in the lateral direction impossible. This is well illustrated in the anteroposterior view, Figure 15, and in the lateral view, Figure 16, and can be duplicated by illustration in most textbooks. Indeed, some authors, mistakenly, we think, regard this finding as an indication for doing an open operation. In our opinion there is no standard position in which the arm should be placed. Every fracture is an individual problem and the arm should be fixed in that position which most accurately establishes the alinement.

Having in mind the exact displacement, we proceed to set the fracture. If the greater tuberosity only is detached, no anesthetic may be necessary and the patient is seated on a stool. If the displaced fragment is mainly made up of the posterior portion of the tuberosity, the arm is best placed in 90 degrees' abduction and externally rotated, but if a considerable part of the anterior portion is also pulled off, abduction alone will probably suffice. In either event the extremity should be fixed in the desired position and this is best accomplished by encasing the chest and arm in plaster for 4 weeks. If the fracture is of the impacted variety and the position satisfactory, there is no necessity for fixation at all. The arm may be bandaged to the chest during the night and during the day carried in a sling from which it may be removed from time to time for gentle active movement, massage, or other form of physical therapy. But care must be exercised to make sure that impaction is really present. Roentgenographic appearances are deceptive, but if a considerable slab of the greater tuberosity is split off, the probability is that impaction is not very firm. However, cases of this kind are infrequently met with and present little difficulty.

The ones with a considerable degree of displacement of the proximal fragment are those most frequently encountered and the ones which present the greatest difficulty in setting. We accomplish this by reducing the fracture on a fluoroscopic table which is provided with a second tube whereby a lateral view can be obtained. The patient is given a general anesthetic and a mattress some 4 inches thick is placed beneath the pelvis and lower extremity, while the shoulder rest is adjusted under the upper part of the back and head. The shoulder rest is of very simple design. If a snugly fitting stockinette has not been previously applied to the trunk and upper arm, it should be adjusted now. The lights are then turned off and sufficient time allowed to get the eyes ready for screening. The forearm flexed to a right angle is then held in a vertical position and the fracture examined by means of the screen. The fragments are then manipulated and the distal fragment or

TABLE I.—IMPORTANT FEATURES OF 100 CASES OF FRACTURE OF THE UPPER END OF THE HUMERUS

	Cases
1. Fractures of the surgical neck	
1. Transverse	78
2. Oblique	13
3. With dislocation of head	1
2. Separated epiphysis	
1. Alone	2
2. Associated with fracture	1
3. Fracture of great tuberosity	
1. Associated with fracture of the surgical neck	50
2. Alone	4
3. Associated with head dislocation	4
4. Rotation of the upper fragment	
1. Internal	38
2. External	0
5. Adduction of the upper fragment	34
Shaft to the inner side	42
6. Abduction of the upper fragment	26
Shaft to the outer side	24
7. Flexion of the upper fragment	47
Shaft anterior	39
8. Extension of the upper fragment	2
Shaft posterior	2

shaft is made to conform to the direction of the proximal end. If the arm can be abducted 60 degrees at least, so much the better, but it must not be moved outward farther than conformation of the upper fragment will allow. If in this position the neck can be visualized, one may be sure that there is very little, if any, internal rotation, but if, on the other hand, the upper fragment appears as a uniform expansion of the shaft, resembling somewhat a tetanus bacillus, we know that we are looking at the external or lateral aspect of the upper fragment and, therefore, that it is very considerably internally rotated. In the latter event the forearm is rotated inward about 60 degrees.

Whether the forearm is now pointing in a vertical or nearly horizontal direction, the next thing to find out is whether the alinement in the opposite direction is satisfactory. This position of the arm being maintained, the patient is rolled over about 45 degrees, the injured shoulder being kept uppermost and the lateral screening carried out. The tube is adjusted to allow the rays just to miss the anterior chest wall and to pass through the shoulder in an oblique direction while the screen is held against the back of the shoulder. Although this is not a true lateral view, there is no difficulty in determining the position of the fragments and in obtaining a satisfactory alinement by changing the position of the lower fragment to correspond to that of the upper. This corrected position is maintained while the patient is again turned on his back and the fracture once more examined from the front to see if the alinement in this direction is still satisfactory, and any necessary correction is made. The lights are then turned on and plaster is applied to the trunk and to the forearm and to the lower two-thirds of the arm with the elbow at a right angle. This leaves the region of the shoulder free so as not to interfere with the subsequent screening.

A plaster brace about 2 feet long is then prepared and the central portion is twisted into a rope long enough to reach from the trunk plaster to the elbow which is held in the previously determined position. While an assistant exerts moderate traction upon the forearm, the split ends of the brace are bound to the trunk and elbow, respectively. The lights are now turned out again and the arm is held steady until the brace begins to show signs of hardening, at which time the anterior screening should be carried out and any necessary change made. Then as soon as the brace is firm enough to support the arm when very carefully handled, the patient is rolled over and screened in the lateral oblique direction and any necessary alteration made. When satisfactory, a plaster spica is applied to the shoulder, thus effectively binding the trunk and arm plasters. When the plaster has set, the brace may be either cut away or left.

Check-up plates are made the following day in the anteroposterior position and either the lateral or oblique lateral direction. If the arm has sufficient abduction, one plate should be taken in a lateral direction, that is, with the rays coming down over the top of the shoulder, but if the abduction is not great enough to permit this, then a plate should be made from an oblique lateral position instead. If the setting is considered satisfactory, the patient is allowed out of bed and may go home the following day. Figures 17 to 20 illustrate the result in a case in which a

lateral plate could be obtained. The anteroposterior view, Figure 18, shows an apparently good reduction, yet the lateral picture, Figure 19, shows marked flexion of the proximal fragment. Figure 20 shows the corrected position which was obtained by changing the arm from abduction to flexion. Figures 21 to 23 illustrate a case in which a lateral oblique exposure was used. Obviously these would be classed as satisfactory settings, but in arriving at a conclusion as to what constitutes a sufficiently good alinement, the type of injury must be taken into consideration. If the whole upper end of the humerus is badly comminuted, anatomical replacement must not be expected from any type of manipulation, in which event, if the upper end of the shaft can be made to conform to the general outline of the upper end in two directions, the setting should be considered satisfactory provided the elbow is abducted about 60 degrees and in such a position that the hand can touch the mouth. The alternative, of course, is an open reduction, in which event one must very seriously consider whether the end-result, having in mind the age of the patient, is likely to be improved by the operation.

The cast should not be disturbed for a period of 4 weeks, at which time the roof should be removed from the arm portion to allow the limb to be lifted out from time to time. At first this should be done by the surgeon, but in a day or so the patient should be encouraged to carry out the various movements, gradually increasing the range. At the end of a fortnight the remainder of the cast may be cut away. During this period advantage may be taken of the benefits to be derived from massage and other physical therapeutic measures to hasten the progress. These are of undoubted benefit and should always be recommended where feasible, but it cannot be too strongly emphasized that active purposive movements are the essential factors in the restoration of function. To a certain extent the end-result depends upon the age of the patient, the severity of the fracture, and the tendency of a person of advancing years to develop osteo-arthritis, but in the vast majority of instances a poor result is caused by inaccurate setting. This viewpoint is based on an examination of anteroposterior and lateral roentgenograms of individuals with various degrees of frozen shoulder following a fracture of the upper end of the humerus. In these the anteroposterior films may usually be classed as satisfactory, but invariably the lateral ones show gross displacement with the shaft displaced anteriorly and the upper fragment flexed, either with or without internal rotation. I have never seen one in which the shaft was posterior. Figure 24 is typical of these cases.

As for the fracture dislocations, an attempt should always be made to reduce the head by manipulation under a general anesthetic. Then, if successful, we proceed to set the fracture as previously outlined. During the manipulation we grasp the elbow in one hand and exert some control over the upper end of the shaft with a foot in the axilla; we feel that the latter procedure is a real help. In any event, we have been successful in reducing the head in the last 5 instances which we have encountered. Should manipulation fail, an open operation must be done, in which event one should be very guarded in the prognosis, as few individuals past middle life can have any sort of major operation on the shoulder without some residual loss of movement.