Surgical Management of Displaced Fractures of the Proximal Humerus

a report by

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Displaced proximal humerus fractures are on the rise and, in many cases, are still the source of painful loss of function if not adequately treated. Many treatment options exist depending on the fracture pattern, the bone stock and the vascular status of the fractured fragments. Recently, many fixation techniques using various implants have been introduced; some implants have been successful, others less so. The indications for the newer plates with locking screws or locked nails have yet to be evaluated. Arthroplasty remains a useful option when the fracture is not reconstructible due to extensive comminution or inadequate osteoporotic bone. Whether the fracture is reconstructed or a prosthesis inserted, the rehabilitation protocol is a very important part of the treatment plan and must be strictly adhered to if good results are to be expected.

Introduction

Displaced fractures of the proximal humerus are frequent articular injuries that are a source of pain, functional loss and disability. These articular fractures are complex injuries involving the glenohumeral space, the subacromial space, the rotator cuff and the capsule. Furthermore, adjacent neurological and vascular structures are also at risk when these fractures occur.

Definition of ‘Displaced’

A fracture is said to be displaced when the morphologic disruption of the fragments hampers normally smooth and painless articular function. This concerns about 20% of all proximal humerus fractures. In the past, authors have used measurements (1cm translation and/or 45° angular displacement) to define the fragment displacement necessary for surgical intervention.1 Today, any displacement presumably leading to poor displacement (to define the fragment displacement necessary for surgical intervention) to define the fragment displacement necessary for surgical intervention.1 Today, any displacement presumably leading to poor function may qualify for surgical fixation. However, surgical indication is obviously not related solely to fracture displacement and must be associated with patient expectations and activity.

Pathophysiology

These fractures are essentially related to osteoporosis, which accounts for many of the difficulties encountered when performing internal fixation.2,3 This signifies that the bone fragments will be of a low mineral content and that the holding power of the implants will be compromised. This implies using techniques or implants designed for fragility fractures. The vascularisation of the proximal humerus is of a terminal type, similar to other epiphyses such as the femoral head or talus. The main sources of blood supply are the anterior circumflex and posterior circumflex arteries, the vessels of the rotator cuff and the intraosseous metaphyseal artery. If the main nutrient arteries to the humeral head are interrupted, avascular necrosis with subsequent collapse of the articular surface will occur.4 Neer has contributed to establishing an estimation of prognosis with the fragment classification of proximal humeral fractures, which other authors have refined.5 Other factors affecting outcome are the complexity of the surgical approach, the obligatory use of indirect reduction techniques because the articular surfaces cannot be visualised intra-operatively and the lack of perfect fixation techniques. Once the purely surgical hurdles have been passed, there remains the rehabilitative process, which is also a cause for controversy. All these problems have led some authors to refer to this fracture as being still ‘unsolved’.6

Imaging

Accurate imaging is mandatory for precise classification, a strategically essential step for establishing the operative tactics. Strict anteroposterior (AP) and axillary views with a clear view of the glenohumeral space will show fragment displacement, allowing pre-operative planning. Spiral 3-D computed tomography (CT) scanning is an ideal imaging modality showing from all perspectives the exact relationships and positions between all involved fragments. Surgical planning is enhanced by these techniques and hopefully a better outcome will be achieved in these difficult injuries.

Patient Positioning for the Intervention

In most cases the patient is operated on in a beach chair position under a general anaesthetic and the question arises as to whether an interscalene bloc is indicated. This is only possible after a careful neurological examination has ruled out any pre-existing neurological
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injury; in cases of doubt one should abstain and use other antalgic modalities, including patient-controlled antalgia pumps and the generous use of ice applications (see Figure 1).

Surgical Approaches
As a rule, when reduction manoeuvres must be undertaken it is safest to use an extensile delto-pectoral approach and the axillary may be palpated as it lies anteriorly to the subscapularis muscle. The individual tendons and fragments are then carefully identified using the biceps tendon as a marker. The tuberosity fragments can then be reduced around the head. In case of an isolated greater tuberosity fracture or an impacted three fragment necessitating little reduction a deltid split rotator cuff approach can be performed. For intramedullary nailing a small incision made superiorly over the greater tuberosity may be sufficient. Very rarely, in cases of an associated posterior dislocation, a posterior incision might be necessary. In any case the use of an image intensifier is useful for evaluating fracture reduction.3

Fixation Modalities

Osteosynthesis
See Figure 2. In certain situations, such as two-part fractures at the surgical neck in strong bone, a standard plate and screw fixation may be sufficient. With weaker bone, the newer locking plates afford excellent stability.7 Displaced fractures of the greater tuberosity are adequately fixed with heavy non-resorbable sutures; displaced lesser tuberosity fractures are better fixed with isolated compression screws. Strong fixation will allow stable fixation and immediate mobilisation of the shoulder.

Osteosuture
See Figure 3. In case of a three-fragment fracture or a four-fragment valgus-impacted fracture in a patient with porotic or soft bone, it may be useful to proceed with a supple fixation involving steel wire or heavy non-resorbable suture.8 The sutures are passed through the bony fragments at the tendon–bone interface of each main tendon. These are tied around a screw and washer inserted distally to the fracture into the metaphysis after the main cephalic fragment has been reduced with a K-wire manoeuvred as a joystick. In this situation, locking plates can be used to buttress the fragments. However, care must be taken not to use screws that are too long in the cephalic fragment with the danger of over-penetration and breaching into the articular space. The advantage of this technique is the solid fixation obtained allowing immediate post-operative mobilisation.

Intramedullary Nailing
See Figure 4. Some authors have advocated the use of closed techniques such as locked intramedullary nailing to obtain an acceptable reduction and an adequate fixation of the fracture fragments.9 Further evaluation of these techniques, applied to articular fractures, is still needed.

Fascicular Pinning
See Figure 5. In an effort to minimise the surgical approach, some authors advocate the use of multiple percutaneous K-wires. This necessitates accurate reduction, which can be obtained with percutaneous joystick manoeuvring. This is a demanding technique and it is not really possible to mobilise the shoulder before sufficient bony healing has taken place.

Arthroplasty
See Figure 6. In cases of comminuted, displaced four-fragment fractures in weak bone or if a dislocation has completely detached the cephalic fragment, arthroplasty is indicated. The surgical difficulties include obtaining adequate prosthetic head height, suitable torsion or strong tuberosity fixation. For the head height, a pre-operative plan using the contra-lateral shoulder as a model can be useful. Concerning prosthetic retro-torsion, it is imperative that in a resting position the humeral head
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Conclusion
Displaced proximal humerus fractures are on the rise and, in many cases,
are still a source of painful loss of function if not adequately treated.
These fractures always involve the articular space, whether
glenohumeral or subacromial. Once the indication for operative
treatment has been ascertained it remains to choose between the many
surgical options available. This will depend on the patient’s expectations
and their overall medical condition. Locally, the fracture pattern, the
bone stock and the vascular status of the fractured fragments all play a
role in the choice of the treatment method. Some authors have
advocated arthroscopic techniques to aid in visualisation. Recently,
many fixation techniques using various implants have been introduced;
some implants have been successful, others less so.1,6-13 The results of
the newer plates with locking screws or of the locked nails have yet to be
evaluated.7,8 Arthroplasty remains a useful last-ditch option when the
fracture is not reconstructable due to extensive comminution or
inadequate osteoporotic bone. Whether the fracture is reconstructed or
a prosthesis inserted, the rehabilitation protocol is an extremely
important part of the treatment plan and must be strictly adhered to if
good results are to be obtained.14