



Outcomes following non operative management for proximal humerus fractures



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1. Introduction

Proximal Humerus fractures are increasingly common, comprising 4–5% of all fractures.¹ They are the third most common type of fracture in the elderly, affecting 250 in every 100000 patients in the United States.² These are often debilitating injuries, resulting in significant loss of function, irrespective of their mode of management. Ultimately, the objective for the treatment of proximal humeral fractures is the restoration of pain free movement and strength in the shoulder. These fractures present a real challenge for the treating surgeon in terms of accurate diagnosis, classification and treatment.

Despite the high incidence of these injuries within the population, there remains a comparative lack of high-level evidence available regarding their treatment, in particular with regards to the more complex comminuted fractures of the proximal Humerus. Options for operative fixation have increased in the last two

decades, though recent evidence emerging from the PROFHER³ trial would suggest that non-operative fixation is preferable in these injuries.

In light of this evidence, as well as longer term follow up studies supporting the PROFHER trial,⁴ the authors would like to distil and clarify existing evidence with the hope of informing the orthopaedic practitioner of the modalities of non-operative treatment and the outcomes that can be expected as a result.

2. Epidemiology and aetiology

Fractures of the proximal Humerus occur most commonly in the elderly. Approximately 75% of proximal Humerus fractures occur after a low energy fall.⁵ These fractures occur most commonly in females (ratio 2:1). In the younger population, these injuries occur more commonly as the result of high energy trauma, seizures or electric shock.

The biomechanics of the fracture and general bone quality of the patient may determine the fracture pattern.⁶

Medical comorbidities have a bearing on both the risk of fracture and type of fracture sustained.⁶ Early menopause, osteoporosis, malignancy and neuromuscular disorders all play a role in addition to alcohol, tobacco, and drug abuse.⁶

3. Applied anatomy of the proximal humerus

In 1970, Neer first published his classification of proximal humeral fractures⁷ and subdivided the proximal Humerus into 4 parts for ease of interpretation: the humeral head, shaft and both the greater and lesser tuberosities.

Each of these fragments may be displaced by the action of tendons. The understanding of the actions of these tendons is key to predicting the deforming forces which lead to the various fracture patterns observed. In the case of the humeral shaft, the pectoralis major attaches to and distracts it inferiorly and medially. The greater tuberosity is distracted by the supraspinatus and teres minor, which produces a posteriosuperior displacing force. The lesser tuberosity is displaced medially by the subscapularis tendon.

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The blood supply to the proximal Humerus arises from both the anterior and posterior humeral circumflex branches of the axillary artery. Direct injury to this artery is exceptionally rare in proximal humeral fracture. Fractures with short calcar fragments (<8 mm), surgical neck fragments or a disrupted medial hinge can lead to arcuate artery injury and subsequent ischaemia of the proximal Humerus and eventually avascular necrosis (AVN).⁸ Although higher energy fractures and significant soft tissue stripping from the Humeral head may lead to disruption of the arcuate artery, this can occasionally be compensated for by collateral blood supply and AVN is not inevitable.^{9,10}

Nerve injuries are relatively common in Proximal Humerus fractures. Despite this, few studies documenting the incidence of neurological injury in proximal Humerus fractures have been published. Neurological injury is more common in open fractures and in the elderly. Visser et al. conducted a study of 143 consecutive proximal Humerus fractures in the setting of low velocity trauma.¹¹ Denervation on the electromyogram was found in 96 of these patients (67%). They observed that the nerves most frequently involved in descending order were the axillary, suprascapular, radial, musculocutaneous, median, and ulnar nerves. Nerve lesions were more frequently found in displaced fractures (82%) than undisplaced fractures (59%). Nerve injury and the corresponding loss of muscle strength was found to recover well in all patients;¹¹ therefore surgical exploration of these nerve injuries is rarely recommended.

4. Assessment and imaging

A thorough history should be taken, in particular with regards to mechanism of injury, hand dominance, level of function, occupation and past medical history. Meticulous and systematic examination is essential. One in ten patients will present with an additional fracture.¹² Inspection and a documented neurovascular exam are essential. It is prudent to examine for more proximal injuries to both the c-spine and the chest wall. Management with ATLS protocols is essential for all high energy injuries. Muscular perforation by fragments, rotator cuff defunctioning or injury and Labral tears are all commonly associated injuries.

Initial investigations should include a true AP Film [Fig. 1] which is taken with the uninjured shoulder at 40° to the X-ray plate. This

is necessary because of the anatomic relationship between the Humeral Head and the glenoid (angulated). A standard AP of the shoulder is therefore inadequate as there will be significant overlap between these structures.

A scapular Y [Fig. 2] view or an Axillary view may also be useful [Fig. 3]. The Axillary view may be used to assess the position of the humeral head in relation to the glenoid.⁶ In order to achieve this the X-ray beam may have to be directed up at the cassette from underneath the arm and this may be poorly tolerated by the patient as abduction is often very painful.⁶ This can be overcome with the use of a Velpau view. This is obtained by leaning the patient over the plate in a more comfortable manner. Rotation views may also be useful in identifying displaced fractures of the tuberosities, though these may also be poorly tolerated.⁶

Bone density may be assessed on the AP view using the Tingart and DTI methods. These methods have been shown to correlate well with the findings of DEXA scans. They provide a clinically relevant, rapid, sensitive, and inexpensive method for assessing bone density.¹³ This may guide the decision to manage fractures of the proximal Humerus non-operatively as poor bone density is a predictor of surgical reduction quality and screw cutout.¹⁴

5. Classification

Charles Neer first described his classification of proximal humeral fractures in 1970.⁷ A detailed analysis of the subtypes of this classification system can be found in a recent paper by Carofino et al.¹⁵ Essentially, the classification system breaks these fractures down according to the number of displaced segments present. The 4 fragments described included: the greater tuberosity, the lesser tuberosity, the humeral head, and the humeral shaft. A segment is considered displaced if it is separated from the rest of the proximal Humerus by greater than 1 cm or is at an angulation of greater than 45°. Modern treatment guidelines are not based on Neer's classification as it is only shows moderate inter-rater reliability¹⁶ and there is no evidence behind this definition of displacement. The classification currently remains useful, primarily in terms of description.

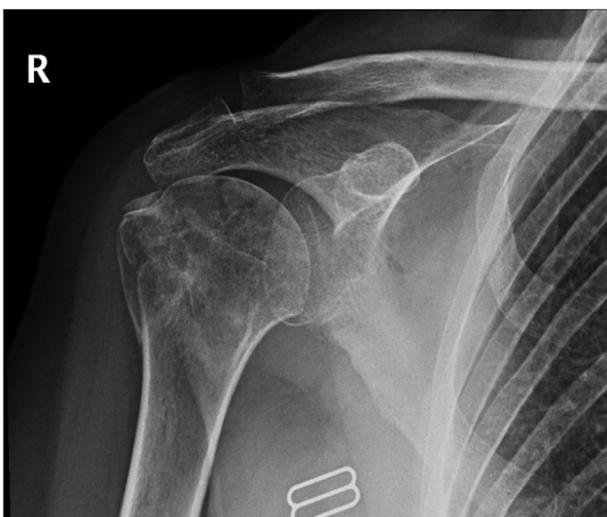


Fig. 1. (Grashey view).



Fig. 2. (Y-view).

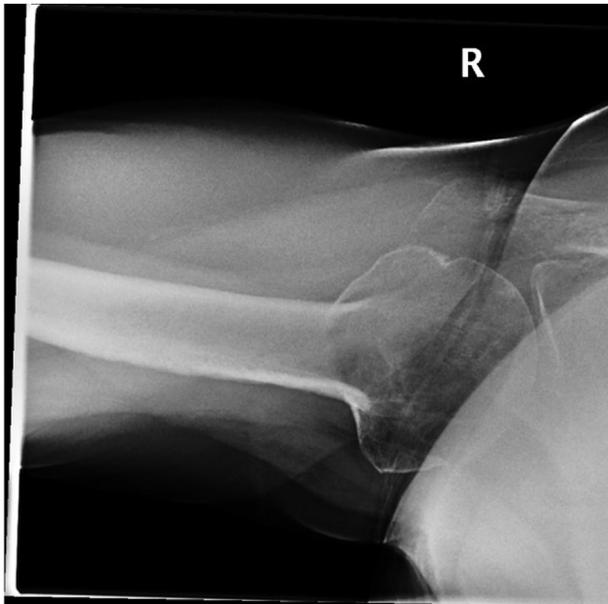


Fig. 3. (Axillary view).
Computed Tomography may be useful in delineating the fracture configuration in a more accurate manner than plain films [Figs. 4–7].

6. Management

Before embarking on the management of these fractures, the treating surgeon should have a clear aim as to what they are trying to achieve, both in terms of expected outcomes and the risks involved in treatment. There is no clear consensus backed by strong evidence for the treatment of each fracture type. For the purposes of this article, we will examine the fracture patterns by type and look at existing trends as well as the evidence supporting the management of each of them.

In particular, the authors have considered the evidence presented in the most relevant recent papers and compared it with the findings of previous systematic reviews,¹⁷ Cochrane reviews¹⁸ and of course the PROFHER trial.¹⁹

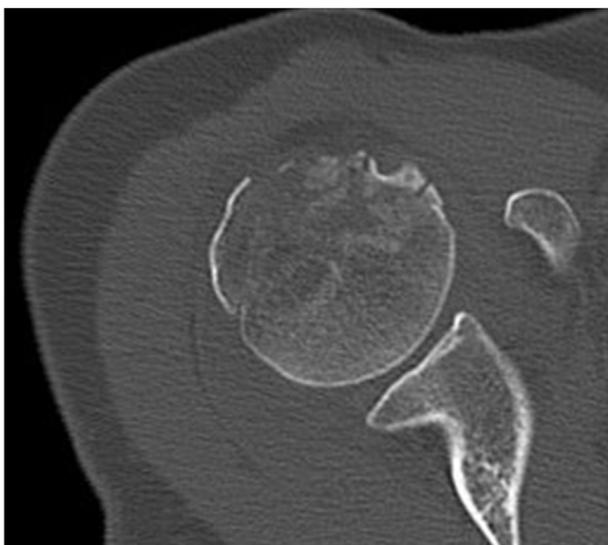


Fig. 4. (Axial CT cuts).



Fig. 5. (Axial CT cuts).

Patient related factors including age, functional expectations, medical comorbidities, potential rehabilitation, mental status, alcohol/substance abuse must all be considered when planning management. As a rule of thumb, those patients who are lower demand and who are of ill health are more suited to non-operative management, if the aim is to regain early and pain free function.²⁰ A study by Court-Brown et al., in 2002 indicated that patients who were managed non-operatively performed worse depending on two factors: age and the degree of fracture displacement.²¹ Although these poor outcomes can be attributed to frailty, medical co-morbidities, cognitive and neurological deficit and poor rehabilitation potential, none of these factors are offset by the risks of surgery (infection, further fracture, stripping of the soft tissue envelope, damage to the muscular and tendinous attachments and the need for removal of metalwork).

There remains considerable disagreement among surgeons with regards to the optimal management in individual age groups and



Fig. 6. (Coronal views on a CT).



Fig. 7. (Coronal views on a CT).

fracture pattern. The decision to perform surgery may be influenced by a fracture's configuration and to a certain extent, a surgeon's personality.²²

If a decision is made to operate then the consensus is generally that earlier surgery is preferable, with a delay in intervention of greater than 5 days being related to significant increase of post-operative complications.²³

7. Non-operative modalities

Unlike the humeral diaphysis, the proximal humerus has multiple complex deforming forces, which cannot be neutralized with a brace, and control of the bone proximal to the fracture fragments is unlikely.⁶ Historically, airplane splints and shoulder spica casting were used to neutralise the deforming forces of the proximal humeral shaft. These methods were poorly tolerated.²⁴ Tuberosity displacement is often difficult to reduce non-operatively but occasionally, an unstable two-part proximal humerus fracture can become stable with closed reduction.⁶ Shaft displacement can more easily be managed with reduction.

The reduction manoeuvre for a proximal humeral shaft fracture involves traction with adduction and a posteriorly directed force.⁶ This allows for neutralisation of the pectoral muscles. The shaft must then be impacted into the head for stability.

Bracing options include: a standard sling, shoulder spica cast, hanging arm cast, and airplane splint. A standard "collar and cuff" sling provides adequate immobilization for all proximal humerus fractures treated nonoperatively.²⁵ This allows for gravitational distraction of the fracture ends which in itself may carry some analgesic effect. Hanging arm casts do not provide an advantage over slings. In fact, excessive distraction of the bone ends may lead to non-union.

8. Minimally displaced fractures

Minimally displaced fractures of the proximal humerus comprise the majority of these fractures (50%–65%). These include fractures of the tuberosities and of the surgical neck. These types of fracture tend to respond well to non-operative management²⁶ assuming they remain undisplaced. Initial immobilization with a collar and cuff may be necessary for pain relief but early initiation of pendular exercises of the shoulder is advised, in particular to limit

the occurrence of elbow stiffness. This should be followed by passive exercises and at the 6-week mark, active exercises can begin.

There are few studies looking at functional outcomes in minimally displaced fractures alone. Koval et al. followed one hundred and four patients for a year, noting their functional outcome.²⁷ Pain, function, and the range of motion of the shoulder were all assessed. Eighty patients (77%) had a good or excellent result. Ninety-four patients (90%) had either no or mild pain in the shoulder. Functional recovery averaged 94%; forty-eight patients (46%) had 100% functional recovery. Patients who had started supervised physiotherapy less than fourteen days after their injury performed better.

9. Fractures of the greater tuberosity

Fractures of the greater tuberosity (GT) occur rarely in isolation. Isolated fractures comprise 14–20% of all fractures involving the GT.²⁸ Neer et al.⁷ suggested that, a displacement of the tuberosity fragment of >10 mm and an angulation of 45° (later modified to >5 mm and 30°) is an indication for the operative treatment of these fractures. There has been a paucity of studies looking specifically at these fractures since. Platzer et al.²⁹ retrospectively analysed functional and radiographic outcomes of 52 patients with operative treatment of displaced greater tuberosity fractures at an average time of 5.5 years (range, 2–11 years) after trauma. All patients had a displaced fracture (>5 mm). These were compared with the functional and radiographic outcome of 9 patients with equally displaced injuries, who had been treated nonoperatively. Patients with reduction and fixation of greater tuberosity fractures had significantly better results on shoulder function than did those with conservative treatment. Several other studies have followed outcomes in patients with minimally displaced fractures and concluded that these can be managed non-operatively.^{30–32} It should be noted however that displacement of as little as 3–5 mm can result in impingement and an increase in the force required for abduction. Schliemann et al.³³ carried out a retrospective study on 114 patients with undisplaced or minimally displaced fractures of the GT and concluded that these fractures can successfully be managed non-operatively. Surgery was most likely required for associated soft tissue lesions rather than for secondary displacements.

10. Two-part surgical neck fractures

These fractures represent approximately 20%–30% of proximal humeral fractures.³⁴ Patients may respond to nonoperative management³⁵ provided there is adequate reduction of the fracture fragments. Surgery may be attempted in suitable patients (those with good bone stock) with significantly displaced fractures.

Non-operative management remains the mainstay of treatment. As with minimally displaced fractures of the tuberosity gradual mobilization should be initiated early on. Prolonged immobilization can be counterproductive and results in increased levels of pain and a decrease in ultimate range of motion and function.²⁷

A systematic review by Iyengar et al.¹⁷ focused on the subgroup of one- and two-part fractures and demonstrated the best prognosis, including an excellent rate of radiographic union (100%) and good functional flexion range of motion (151°) after nonoperative treatment.

Two-part surgical neck fractures managed non-operatively may heal in varus or valgus angulation. Court-Brown and McQueen³⁶ prospectively studied 99 patients with this type of malunion and noted that decreased shoulder function was associated with increasing age but not with increasing varus angulation. They concluded that non-operative outcomes were good, regardless of

the degree of varus.

A prospective study on 125 patients²¹ by the same group on the management of Valgus impacted fractures of the proximal Humerus concluded that at one year the majority (80.6%) of patients had a good or excellent result following non-operative management. The quality of which was dependent on the age of the patient and the degree of displacement of the fracture. A comparison was made with other studies. The authors concluded that operative fixation was unnecessary

11. Three- and four-part fractures

These fractures account for 21%–23% of proximal humerus fractures.⁵ Both operative and non-operative management can be attempted, depending on patient factors and fracture configuration. Closed reduction with non-operative management tends to result in poor functional outcomes,¹² though these do not necessarily correlate with patient satisfaction. In 1998, Zyto conducted a retrospective study of patients with comminuted fractures of the proximal Humerus.³⁷ He noted that: “In spite of low functional scoring and poor fracture reduction in many shoulders, the patient’s contentment with their injured shoulder after 10 years was high”. There is a lack of high-quality studies within the literature comparing specific operative techniques with non-operative management. There are several studies of varying levels and quality comparing operative and non-operative management, but these are heterogenous and fail to address individual fracture types in specific age groups.

The lack of consistently successful surgical techniques has in many cases led to the preference of non-operative fixation over surgery. The PROFHER trial⁴ would support this position. It is a randomised controlled study, using patient-reported outcomes to compare surgical and non-surgical management in patients with displaced proximal humerus fractures. At 5 year follow up there was no significant difference found in outcomes between operative and non-operative treatment in 2, 3 or 4-part fractures. Though the majority of current evidence points to non-operative treatment as being acceptable, many surgeons continue to treat these fractures with either ORIF or arthroplasty. Few papers have been published comparing non-operative management with specific surgical techniques.

In 1997 Zyto et al.³⁸ conducted a prospective randomised controlled trial on 40 patients with 3 or 4-part proximal humeral fractures treated with either tension band or with conservative management. Although radiological outcomes were improved, they could find no differences in functional outcomes.

A systematic review of 24 studies in 2001 by Misra et al.²⁴ concluded that conservatively managed patients had more pain and a poorer range of motion than those managed by either fixation or arthroplasty. Superior restoration of anatomy was delivered in the fixation group. There was no significant difference in the functional range of motion between the arthroplasty and fixation groups. The authors concluded that despite these findings, “the data from the published literature are inadequate for evidence-based decision making with regards to the treatment of complex proximal humeral fractures”. The results of this systematic review should be considered in light of the fact that arthroplasty in the shoulder has advanced somewhat in the last 20 years or so since it was published.

The aforementioned review by In our review by Iyengar et al.¹⁷ observed that studies that focused exclusively on nonoperative treatment yielded a 98% rate of radiographic union. This was offset by the high overall complication rate (48%), including a 23% rate of varus malunion and 14% rate of avascular necrosis (nine cases). The authors suggested that the complication rate associated with

nonoperative management of three- and four-part fractures was significant and should be approached with caution.

Of note, in patients aged 65 and over with proximal Humerus fractures, the overall mortality of those treated surgically is significantly lower, when age gender race and medical comorbidities are all taken into account.³⁹

12. Discussion

Proximal humeral fractures, irrespective of type may be managed non-operatively. There remains some controversy with regards to the more complicated fracture patterns, as those with said injuries are known to have poorer functional outcomes.

The high complication rates associated with non-operative treatment of 3- and 4-part fractures are noted though whether or not operative treatment mitigates the complication rate is unclear.

The existing evidence does not indicate that operative management produces superior outcomes. The significant complication rate associated with operative treatment (as high as 70%) may explain the overall lack of superiority with regards to outcome measures.

Large studies have attempted to settle such controversy with little success. The most high profile of these studies is the PROFHER trial.¹⁹ In this pragmatic, multicenter, parallel-group, randomised clinical trial 250 patients (aged 24–92) were randomised between surgical and non-surgical intervention. The trial demonstrated that there were no significant differences in Oxford shoulder scores at 2 years between the groups. A follow up study was carried out on 149 of these patients at 5 years.⁴ It confirmed the original findings of the PROFHER trial. Other studies, such as the meta-analysis on 3 and 4-part fractures by Li et al. (2013),⁴⁰ also found that the fixation of these fractures was not superior to conservative management.

The question for orthopaedic surgeons is therefore whether or not surgical fixation has any role in the management of these fractures. Scrutiny is therefore required of the above studies. Although the PROFHER trial has various strengths it is also a fundamentally flawed trial with several weaknesses. The heterogeneity of the selected patients in terms of age and fracture pattern alone may have clouded the conclusions drawn by the authors. The fact that the trial was carried out across 30 different centres and by 66 different surgeons raises questions about the consistency of the treatment. Perhaps the most significant factor is the exclusion of patients “with a clear indication for surgery”. Finally, the inclusion of all surgically treated patients into one category would appear to be erroneous as it has been shown that patients with different forms of surgical treatment have different outcomes.^{41–44}

A Cochrane review by Handoll and Brorson¹⁸ suggested that “there is high or moderate quality evidence that, compared with non-surgical treatment, surgery does not result in a better outcomes at one and two years after injury for people with displaced proximal humeral fractures involving the humeral neck”. It is important to note however, that the evidence did not cover the treatment of two-part tuberosity fractures, fractures in young people, high energy trauma, or less common fractures such as fracture dislocations and head splitting fractures.

In conclusion, it is clear that the majority of minimally displaced and simple proximal humeral fractures can be safely managed non-operatively. What is also clear is that large, well designed trials are needed comparing non-operative management with specific operative techniques in specific patient groups with 3 or 4-part fractures, before significant conclusions can be drawn with regards to management of these fractures. One such trial is underway comparing 3 and 4-part fractures in the proximal Humerus, specifically in elderly patients.⁴⁵ The authors also keenly await the release of the findings of the PROFHER 2 trial.

Conflicts of interest

We, the authors have no conflict of interest to declare.

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