14 Non-operative Management of Proximal Humerus Fractures

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Introduction

The management of proximal humeral fractures has been discussed in surgical textbooks for greater than 3000 years. Detailed descriptions of reduction and splinting are found in surgical texts from both Ancient Egypt and Greece [1]. Today, proximal humeral fractures account for up to 5 % of all fractures treated [2]. Between 50 and 80 % of these can be treated non-operatively and are non-displaced or minimally displaced 2-part fractures [3–8]. Three- and four-part fractures represent 15 % of all proximal humeral fractures. Seventy percent of three- and four-part fractures are seen in patients over 60 years old and 50 % of such fractures are seen in those over 70 years old [2]. The elderly are more susceptible to this type of fracture due to co-morbid conditions that predispose these patients to low energy falls. Such co-morbid conditions include poor vision, balance problems, loss of protective reflexes, and polypharmacy. Furthermore, poor bone quality in the elderly population accounts for a greater severity of injury with more complex fracture patterns in spite of little mechanical insult. With a growing elderly population, the rate of proximal humeral fractures has increased by an average of 13 % per year between 1970 and 2002 [2, 9–12]. The number of these fractures in the elderly population is expected to triple by 2030 [6].

Treating orthopaedic surgeons seldom need be reminded of the tremendous effect of these fractures on patients. Many patients are left with the inability to care for themselves at the most fundamental level. Dressing, bathing, toileting, feeding, and even the ability to leave the house may all be affected. Previously independent patients can become quite dependent and the period of dependence may last for several months. Indeed, approximately 6 months to 1 year is needed for good or very good recovery, with better results being obtained from the recovery of non-displaced versus displaced fractures [3, 5, 13–19].

It is imperative that treating orthopaedic surgeons have a thorough understanding of this common problem. However, there is a great deal of variability and heterogeneity among studies and treatment algorithms that investigate proximal humeral fractures. Differences in treatment manifest at all levels of the therapeutic chain. The relative influence and consideration of patient-related factors such as age, functional demand, and co-morbid conditions varies amongst surgeons in treating proximal humerus fractures. Similarly, there is considerable variance in standard imaging for diagnosis, splinting options for initial immobilization, and rehabilitation protocols between surgeons, institutions, and regions [20–22]. Finally, there is controversy regarding surgical versus conservative

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management of three- and four- part proximal humerus fractures [23]. Consequently, there is a need for a clear evidence-based consensus on how to manage these challenging and complex fractures. A thorough understanding of the natural history of conservative treatment is especially important to establish a baseline for which to compare the usefulness of emerging operative technologies.

Diagnosis

Our treatment algorithm starts with good quality radiographs. See Fig. 14.1. We use a trauma series which includes a true anteroposterior (AP) and a scapular Y views perpendicular and parallel to the plane of the scapula respectively. An axillary lateral view is also taken to asses the reduction of the humeral head within the glenoid. If radiographs are insufficient to understand the fracture morphology and identify all the components of the fracture then a CT scan is indicated. A CT scan can further aid in the diagnosis by giving information regarding fracture morphology, bone stock of the humeral head and tuberosities, degree of comminution, size of the fragments amenable to fixation, and the length of the posteromedial metaphyseal extension.

Proper imaging allows the determination of both fracture displacement and angulation. Both are helpful in deciding if non-operative treatment is appropriate. Neer has previously described acceptable displacement to be 1 cm and acceptable angulation of 45° [24]. Clinical and/or fluoroscopic image intensification can be used to determine the stability of the head and shaft. If the head and shaft move as a single unit then the fracture is deemed impacted and thus stable. If there is significant motion between the head and shaft then the fracture is deemed unstable.

Stable fractures respond well to short term immobilization to allow time for swelling and pain to resolve. While unstable fractures are often treated operatively the decision to operate must take into account other patient factors. Displaced fractures in patients in whom surgery may not be warranted include: elderly; low demand; uncooperative due to mental illness or substance abuse; significant co-morbid conditions; and those patients with active infections elsewhere. This group of patients with unstable fractures can be still be treated non-operatively. However, they often require a prolonged period of immobilization ranging from 2 to 4 weeks.

Initial Immobilization

The goal of initial immobilization is to provide mechanical support. Supporting the fracture acutely prevents fracture displacement and promotes fracture consolidation while pain and swelling resolve. Short term immobilization can take on a variety of forms. Splinting options include but are not limited to the broad arm sling, collar and cuff, sling and swath, shoulder immobilizer, Gilchrist bandage, and the shoulder abduction cushion. There is limited evidence for the superiority of one type of immobilization device over another. In 1993 Rommens et al. compared the Desault bandage against the Gilchrist bandage in 28 patients with a proximal humerus fracture. There was no effect on fracture healing or functional outcome. However, the Gilchrist-bandage appeared to cause less pain and skin irritation. In our opinion, there is not enough evidence to advocate for one sling over another as long as the goal of providing mechanical support is adhered to. Our preferred splinting methods include a simple collar and cuff or a Velpeau sling both of which are shown in Fig. 14.2.

Rehabilitation

Recommendations for the adequate time required for the initial period of immobilization varies from a few days to more than 3 weeks. Recommendations prior to the 90s were based on clinical experience and uncontrolled case studies [16, 18, 25–29]. Controlled clinical trials that examine when to begin mobilization of the injured arm started to appear in the 1990s and continue to be a topic of current interest.

The principal goal of rehabilitation is to restore functional range of motion to levels that

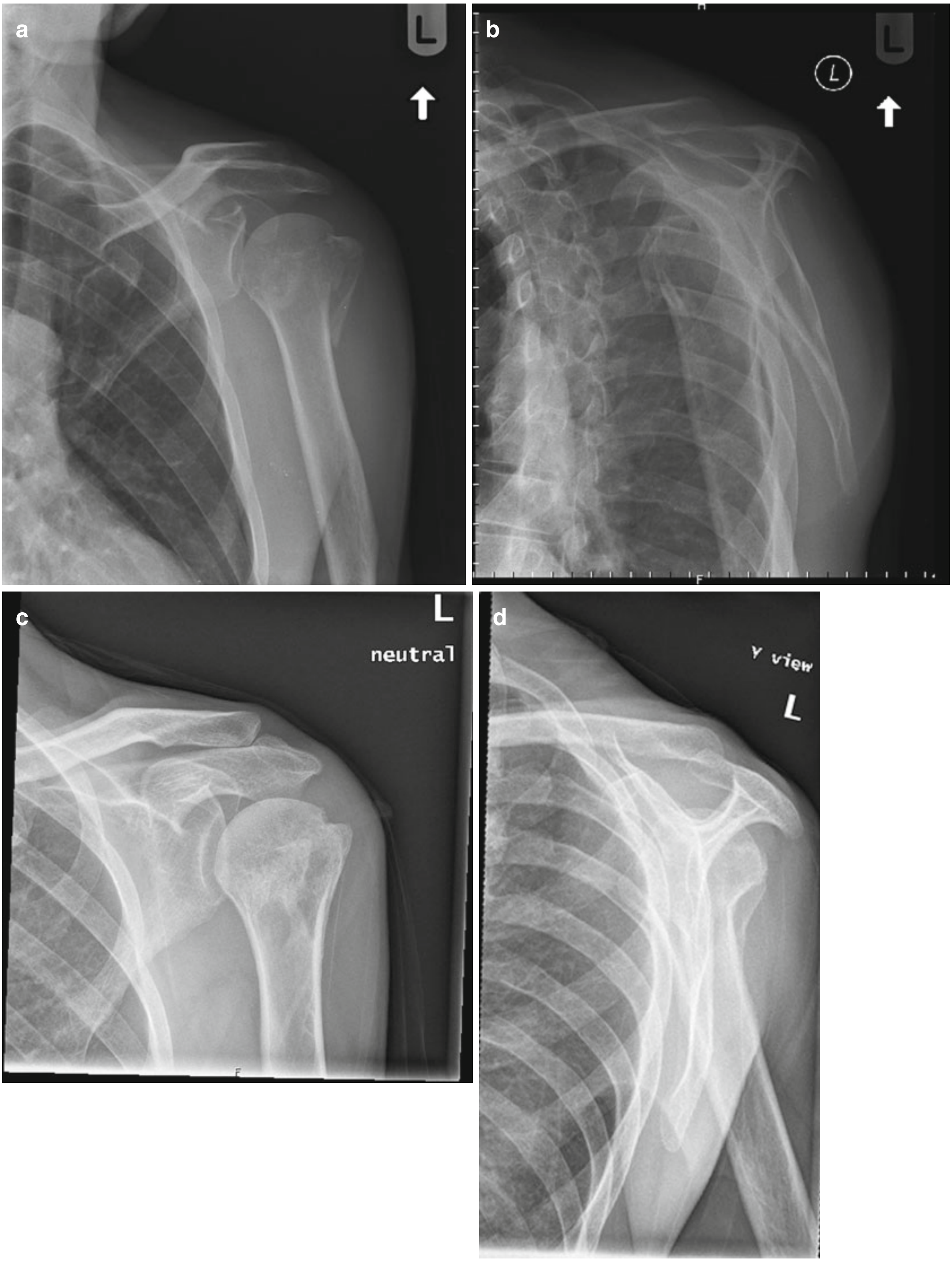

Fig. 14.1 Radiographs of a 3-part proximal humerus fracture. (**a**, **b**) AP, and scapular Y views on presentation to the emergency room. (**c**, **d**) AP and scapular Y views of healed 3-part proximal humerus fracture after non-operative management

closely approximate a patient's pre-injury status. However, rehabilitation regimens vary a great deal between surgeons, institutions, regions, and patient's personal resources. The recommended duration of immobilization, timing of first physiotherapy session, intensity and frequency of sessions, and setting for therapy be it home or hospital/private centre all play into this variability [30]. Furthermore, the experience level of the therapist and accessory modalities of treatment offered by therapists create further heterogeneity.

It is generally accepted that prolonged immobilization is complicated by shoulder stiffness and thus patients tend to have poorer outcomes. At our institution we emphasize self-performed early movement exercises after a short course of immobilization to ameliorate loss of function as shown

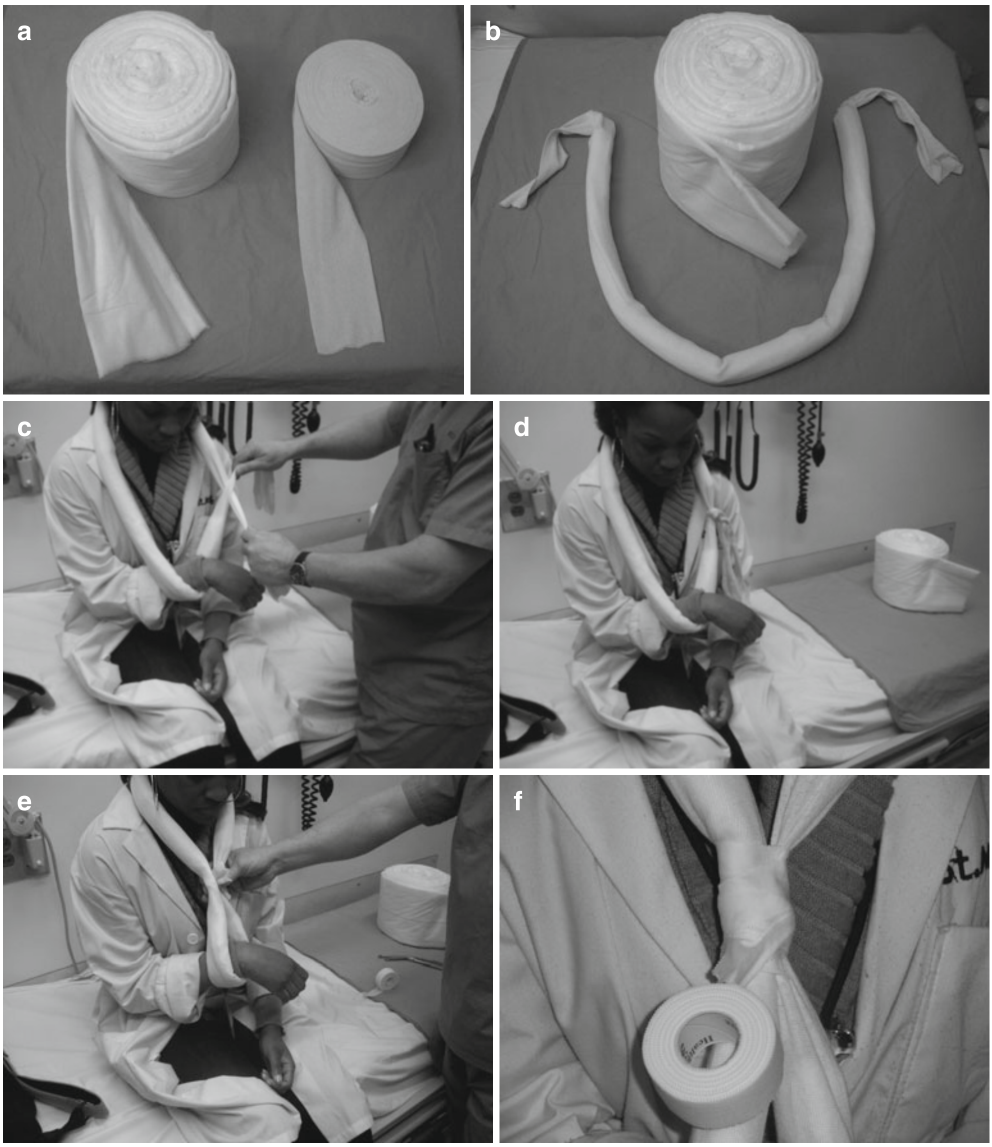

Fig. 14.2 Splint application. (**a**) Materials required are an 8″ ABD roll pictured on the left and a 3″ stockinette pictured right. (**b**) A length of ABD is cut and used to pad a cut length of stockinette. (**c**, **d**) The padded stockinette is used to support the wrist of the injured extremity, wrapped around the neck, and then tied off in a simple double knot as shown. (**e**, **f**) The knotted side and unknotted side are pinched together to form a cuff and tape is applied to secure it. (**g**) Completed collar-and-cuff style splint. (**h**) Velpeau sling pictured from the front and (**i**) back

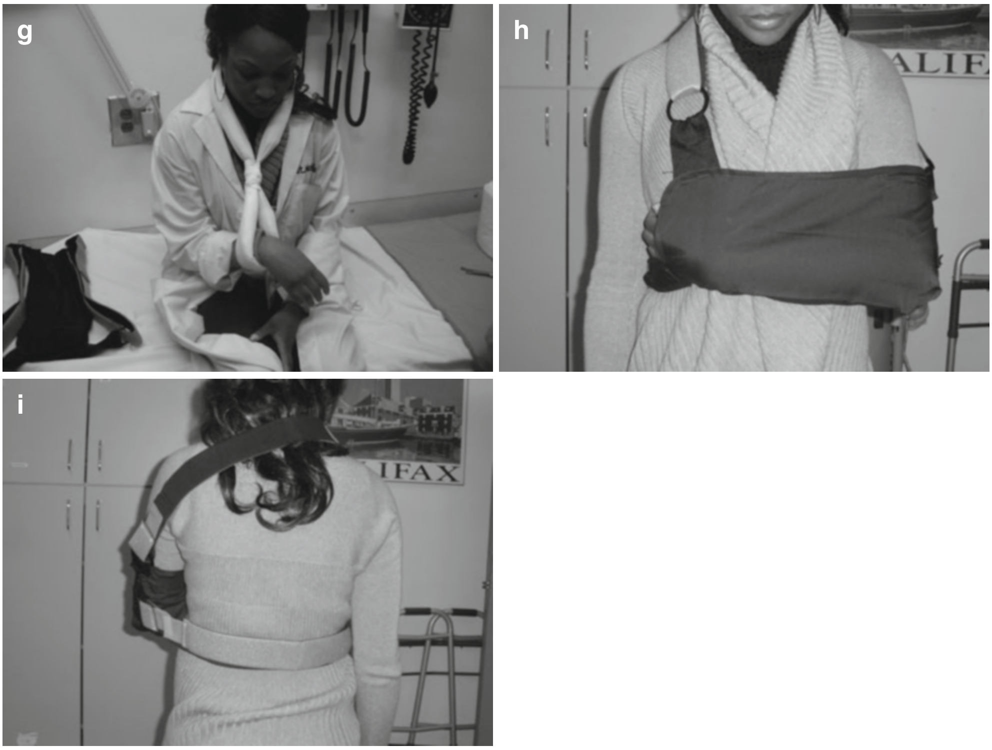

Fig. 14.2 (continued)

in Fig. 14.3. Rehabilitation generally follows two stages. Passive/assisted range of motion exercises followed by progressive resistance exercises.

Brostrom is credited as being the first to hypothesize that immediate mobilization following proximal humeral fracture would lead to faster recovery of functional mobility [18]. His brief report of 97 proximal humeral fractures found good or excellent results in 59 fractures treated with immediate passive mobilization on the fourth day following injury and active range of motion initiated 9–11 days following injury. Brostrom graded range of motion on a 100 point scale with good outcomes having a score of 75 or greater.

More recent studies have supported Brostrom's historical findings [13, 31]. Hodgson performed a prospective randomized controlled trial examining 86 minimally displaced two-part proximal humeral fractures comparing two rehabilitation regimens. Immediate physiotherapy within 1 week of injury was undertaken in one group and compared to a conventional 3 week period of immobilization in the other group. This study found better shoulder function in the group of patients mobilized immediately at the 8 and 16 week follow-up visits as measured by the Constant score. However, a statistical difference between the groups disappeared by 52 weeks. Importantly, patients mobilized immediately also reported less pain over the course of their treatment.

Hodgson's results were supported by an earlier study performed by Kristiansen in 1989 [14]. This study was a prospective randomized controlled trial which randomly allocated 85 patients with proximal humeral fractures to start mobilization exercises at 1 week or 3 weeks. Using a modified Neer's score [24, 32], they found that patients mobilized early had statistically significant better scores of overall shoulder function largely as a result of a reduction in their sensation of pain over the first 3 months. The effect disappeared at 6 months and both groups continued with similar outcomes over follow-ups for the 2 year duration of the study.

Fig. 14.3 Examples of selected self-rehabilitation exercises. (**a**, **b**) Pendulum swings. (**c**) Patient 'walks' fingers up wall as high as possible to increase shoulder flexion range of motion

Most recently, Lefevre-Colau performed a single institution RCT in 2007 [15]. In this trial, 74 patients with impacted proximal humeral fractures were randomized to either early mobilization regimens, beginning within 72 h of injury, or conventional mobilization regimens which immobilized fractures for 3 weeks. The primary outcome measure recorded was the patient's Constant score at 3 months. Secondary outcomes measured were: reduction in pain intensity; differences in active and passive range of motion as compared to the un-injured shoulder. Their results echo previous studies in that patients in the early mobilization group had significantly better Constant scores, reduction in pain intensity, and superior mobilization early during the course of treatment . However, statistical significance between the two groups was not seen after the 6 months.

Of great interest, the authors also pooled their data with other studies including those previously described above to examine the safety of early mobilization. Both fracture non-union and fracture displacement were considered. Studies that evaluated a conventional regimen of 3 weeks of fracture immobilization reported 4 patients out of a total of 373 with either a non-union or fracture displacement requiring surgical intervention [5, 7, 15, 29]. Studies that evaluated early mobilization within 1 week of injury failed to find a single case of non-union or fracture displacement out of a total of 165 patients [13, 15, 31]. The authors conclude these proportions are not statistically different when assessed with the Fisher exact test ($P = 0.32$).

Overall, it appears that early mobilization reduces the subjective experience of pain early in the course of treatment. However, the outcomes between early and late mobilizers seem to equalize after a period of 6 months to a year. This data might suggest that longer periods of immobilization for more complicated fractures may not worsen the final outcome and thus may be an appropriate treatment option for those patients who are not suitable surgical candidates due to medical co-morbid conditions.

However, currently there is insufficient evidence to definitively state when to begin rehabilitation. In a Cochrane database systematic review, Handoll and Olliviere explain the difficulties and dangers of trying to establish a general consensus for treatment with small, single institution trials [33]. Furthermore, trial heterogeneity prohibits the pooling of results in a meaningful manner. The need for large-scale and high-quality clinical trials with robust methodology is apparent.

Non-operative Treatment Outcomes

There has been recent interest in identifying those subgroups of proximal humeral fractures that can be successfully managed non-operatively. It is generally agreed that non-displaced and minimally displaced two-part fractures do well with conservative treatment [5, 7, 19, 34, 35] (Also 2,3,4 of Zyto paper). However, management of displaced three- and four-part fractures remains controversial and is an area of current scientific debate [17, 28, 36]. With the growing prevalence of operative care for three- and four- part fractures, there is a need for an understanding of the natural history of these fractures when treated non-operatively.

Valgus impacted fractures account for the most common type of proximal humerus fracture presenting to orthopaedic surgeons [37]. The identifying deformity of these fractures is the impaction of the humeral head on the proximal region of the metaphysis [38]. Often studies group together valgus three-part fractures with conventional Neer three-part fractures [5, 24, 39, 40]. The neglected distinction is that Neer's three-part fractures are displaced and include rotation of the humeral head as part of the patho-anatomy [41].

Court-Brown et al. studied the outcomes of non-operative management of different variants of B1.1 valgus impacted fractures of the proximal humerus [5]. Hundred and twenty-five consecutive valgus impacted fractures were analyzed over the course of a year. Most of these were in elderly patients. They found 80 % had a good to excellent result according to Neer's outcome criteria. The same study compared valgus impacted three-part fractures to the conventional Neer three-part fracture with rotation of the humeral head. Their findings suggest a better prognosis at 1 year for the valgus impacted group based on the mean Neer and Constant scores.

A systematic review of the literature was conducted in 2009 to consolidate the outcomes and summarize the complication rates of non-operative management of proximal humeral fractures [42]. Data was captured pertaining to fracture pattern, radiographic healing, clinical outcomes, and treatment complications. Predictably, one- and two-part fractures responded well to non-operative treatment with the best prognosis. The radiographic union rate was 100 % and patients achieved an average functional flexion range of motion of 151°.

With respect to three- and four-part fractures, it is important to first understand that the prevalence of operative care is growing. Patient demand is partly responsible for driving this trend. There are increasing numbers of more mobile elderly patients with greater demands of better functional outcome [43]. Advances in operative care are also driving this trend. The advent of fixed-angle plate fixation promised surgeons greater control over comminuted osteoporotic fractures. Consequently, there has been a renewed interest in the surgical management of patients with low-quality bone stock [44–46]. Prosthetic replacement is also being performed with greater interest in the light of addressing concerns regarding avascular necrosis, poor bone healing, and limited range of motion that is often thought to accompany conservative treatment [47].

Iyengar's systematic review also investigated three- and four-part fractures and found these demonstrated a 98 % rate of radiographic union but were also associated with a complication rate of 48 % [42]. Complications reported were: varus malunion (23 %, 15 cases); and avascular necrosis (14 %, 9 cases). The authors caution that conservative treatment carries a significant complication rate but also warn that the current literature is unclear as to whether or not operative treatment produces better outcomes or diminishes the aforementioned complication rate in these patients. Furthermore, operative treatment carries it's own inherent set of risks and complications [47–49]. Overall, the results support a high rate of healing and satisfactory outcomes with non-operative management of three- and four-part proximal humeral fractures.

Conclusion

Well designed prospective studies are clearly needed to assess the treatment effect, complications, outcomes, and cost effectiveness of operative management compared to non-operative management for displaced proximal humeral fractures. Future prospective studies should ideally include complete demographic information, long-term follow up, a validated shoulder outcome measurement tool, compiled range of motion data, and a thorough summary of complications [42]. Currently there are three such trials with published protocols [50–52]. Such studies will be the next step in guiding effective treatment for this challenging group of fractures.

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