# Rehabilitation After Proximal Humeral Fractures

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**Abstract:** Proximal humeral fractures are the third most common type of fractures in those over 65 years of age. Indications for treating these fractures conservatively, with surgical fixation or arthroplasty are continually evolving and are based on the severity of the fracture and the age of the patient. Physical therapy is a part of any treatment approach to proximal humeral fractures with few guidelines available as to staging of interventions to maximize range of motion, strength, and optimize activities of daily living. As pain is often the best indicator of healing, physical therapy strategies that optimize active pain-free functioning with adequate humeral head control are best suited to this population. Rehabilitation guidelines are proposed to enhance patient satisfaction and provide a framework for physical therapists.

**Key Words:** proximal humeral fracture, physical therapy, humeral head, rehabilitation, early motion

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Proximal humerus fractures (PHFs) are the third most common fracture type in individuals older than 65 years, after distal radius and proximal femur fractures.[1] They account for approximately 5% of all fractures and have a substantial impact on personal function and the overall function of an individual.[2,3]

Indications to treat a PHF nonoperatively, with surgical fixation, or with arthroplasty, are still evolving. For the most part, patients with a PHF can be treated successfully without operative intervention. Approximately 80% of PHFs are minimally displaced low-energy injuries and are at low risk for future displacement, nonunion, or avascular necrosis.[4,5] For fractures with severe displacement, the decision for the type of treatment becomes more difficult. Indications for treatment are typically based on the patient's age and activity level, as well as radiographs and fracture patterns to assess the risk of vascular injury and potential avascular necrosis as well as assessing the severity of osteoporosis, which can affect the success of the operation.[5]

Physical therapy plays a significant role in the outcome of an individual's function after a PHF. Whether the choice is made to have surgical intervention or nonoperative care, a patient will be seen in physical therapy for a variety of strategies and progressions to return them to their optimal level of function. To date, no current literature exist specifying rehabilitation guidelines for conservative and surgical interventions. We will introduce conservative management guidelines and outline current rehabilitation phases for postoperative management.

## BACKGROUND

Fractures of the proximal humerus are increasing, with the expectation that the incidence will triple by 2030 related to our aging population.[6,7] Despite the incidence of falls in men being more frequent than in women among community-dwelling older adults, women experience more humeral fractures overall.[3] Although there are a number of independent risk factors for PHFs including a recent decline in health status, insulin-dependent diabetes mellitus, infrequent walking, neuromuscular weakness, osteoporosis, weight loss, previous falls, impaired balance, and maternal history of hip fractures, the primary risk factors are associated with low bone mineral density.[4,6] The mechanism of injury in young patients is often related to high-energy trauma; however, the most common mechanism in elderly patients is reported to be a fall from standing height. This low-energy fall in the elderly was reported in about 80% to 87% of individuals, making most people in this age group at risk for sustaining a fracture.[4,5]

The phases of rehabilitation depend on the severity of the fracture, bony healing, vascularization, and quality of the surrounding tissues. Fracture healing occurs in 3 distinct but overlapping stages: (1) inflammatory stage, (2) repair stage, and (3) late remodeling stage.[8] Fracture healing is completed during the remodeling stage in which the healing bone is restored to its original shape, structure, and mechanical strength. Remodeling of the bone occurs slowly over months to years and is facilitated by mechanical stress placed on the bone. As the fracture site is exposed to an axial loading force, bone is generally laid down where needed and resorbed from where it is not needed. Adequate strength is typically achieved in 3 to 6 months, although physical therapy will generally begin within the first 1 to 2 weeks of injury for nonsurgical candidates and within the first week postoperatively.

## CLASSIFICATIONS: NEER—THE GOLD STANDARD

The Neer classification system for PHFs is the most commonly used classification.[9] The Neer classification system was based on an observation made earlier by Codman, that all PHFs were composed of 4 major segments: the lesser tuberosity, greater tuberosity, articular surface, and humeral shaft.[1,9] This 4-segment classification system is based on the number of displaced segments or parts, with additional categories for articular fractures and dislocations. A segment is defined as displaced if there is >1 cm separation or 45-degree angulation.[1] According to Neer, fractures that do not have displacement, regardless of the actual number of fracture lines or their location are considered 1-part fractures.[1,6,9] Two-part fractures are defined as 1 segment being displaced, which may be the greater tuberosity, lesser tuberosity, or articular segment at the level of the anatomic neck or surgical neck. With a 3-part fracture, 1 tuberosity is displaced and the surgical neck fracture is displaced. The remaining tuberosity is attached, which produces a rotational deformity. Four-part fractures account for 3% of all humeral fractures and are regarded as the most difficult to treat in the elderly.[10] Four-part fractures involve all 4 segments meeting the criteria for displacement and can be valgus impacted or laterally displaced.[1] When the articular segment is not in congruity with the glenoid, it is considered a fracture dislocation and may be present in any subcategory but is always present in true 4-part fractures.[6] Although interobserver reliability with the Neer classification is variable and

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tends to hover in the moderate range, no other system has been used more consistently than the Neer classification.[1]

## TREATMENT OPTIONS

Decision making for the management of fractures of the proximal humerus can be challenging. A recent study by Roux et al[11] found surgical management in their practice was 21% of all cases. When displaced fractures occur in young active patients, surgical intervention is commonly selected as the treatment of choice. Although the majority of fractures are treated nonoperatively, the most appropriate form of management is less clear when it comes to elderly patients.[2,12] Surgical interventions may include closed reduction and percutaneous stabilization using pins or wires, open reduction plating, open reduction and fixation using a tension-band principle, intramedually nailing, or reverse total shoulder replacement.[9] However, to date, no surgical treatment option has proven superior.[13]

## SURGICAL INTERVENTIONS

Closed reduction and percutaneous pinning is a minimally invasive technique that has been primarily indicated for 2-part fractures with minimal comminution and 3- and 4-part valgus impacted fractures with minimal comminution of the tuberosities.[6] Theoretically, this technique is soft-tissue sparing and may reduce vascular/healing complications.[5,6,14] Good outcomes can be achieved 70% of the time in 2-part fracture patterns.[14] Comparison of percutaneous techniques in all fracture patterns revealed that 4-part fractures had the poorest results. Reported complications of this technique include pin-track infections, avascular necrosis of the humeral head, and pin migration with resultant loss of reduction.[14]

In a study by Boons et al,[10] hemiarthroplasty was compared with nonoperative treatment in a group of 50 elderly patients with 4-part humeral fractures. There were no differences in the Constant-Murley scores between the 2 groups at the 3- and 12-month follow-up. The nonoperatively treated and hemiarthroplasty groups had an improved Constant-Murley scores at 12 months compared with 3 months postoperatively. Forward flexion and abduction were better at 3 months after nonoperative treatment but no longer at 12 months. Also with no difference at 12 months, the mean values for pain as measured on a Visual Analog Scale at 3 months were better in the hemiarthroplasty group than in the nonoperative group.

Reverse shoulder arthroplasty (RSA) has recently been advocated for the treatment of 4-part fractures. The thought is that the RSA does not depend on the rotator cuff for elevation, and therefore is not dependant on tuberosity union.[15] RSA holds a number of theoretic advantages over hemiarthroplasty in the management of these fractures.[16] Functional outcomes seem to depend less on tuberosity healing and rotator cuff integrity and patients have been observed to recover more quickly, with less requirement of careful protection and rehabilitation than hemiarthroplasty.[16] The overall complication rate of RSA for fracture is 13% to 28%, which is similar to the rate of RSA for rotator cuff tear arthropathy.[15]

Garrigues et al[17] performed a retrospective review of 23 patients comparing reverse total shoulder arthroplasties and hemiarthroplasty treatment. This study showed a statistically significant superiority of reverse total should arthroplasty versus hemiarthroplasty for fracture. The mean American Shoulder and Elbow Society (ASES), University of Pennsylvania Shoulder Score (Penn), and Single Assessment Numeric Evaluation (SANE) Scores showed a significant difference given the small number of patients included in the study and mean active forward elevation after reverse total shoulder arthroplasty was 122 degrees compared with a hemiarthroplasty mean of 90 degrees. Another study comparing RSA with hemiarthroplasty by Boyle et al[16] found no statistical difference in Oxford Shoulder Score at 6 months between groups. However, the RSA group displayed a superior Oxford Shoulder Score at 5 years compared with the hemiarthroplasty group.

## CONSERVATIVE TREATMENT

With no definitive rehab management strategy for PHFs, rehabilitation is performed on an individual basis with communication to the referring physician with the utmost importance. This is imperative to ensure a safe and effective response to the rehabilitation program whether conservative or surgical.[18] Hodgson et al[19–21] demonstrated that early mobilization after fracture correlated with improved outcomes scores over those immobilized for longer periods of time and the improvements were noted to continue upward of 2 years postinjury.

Conservative treatment shows good to excellent outcomes for minimally displaced fractures in the elderly population and may be classified by the Neer classification as 1 part fractures.[6,10,14] Most patients are treated with a simple sling for 10 to 14 days with supervised passive range and active range of motion (PROM and AROM) with physical therapy.[6,14] Radiographs should also be taken at 2 to 3 weeks intervals to check for fracture displacement.[6,14,22]

## REHABILITATION GUIDELINES

Rehabilitation guidelines for various PHF patterns are lacking in the literature. Following the rules of bone healing and early range of motion, the guidelines proposed here are aimed at maximizing early PROM followed by AROM and subsequent progressive resistive exercises, and a return to as near-normal function as is possible given the patients physiological age and activity level.

Table 1 illustrates rehabilitation guidelines that are to be followed after greater tuberosity fracture. After 2 weeks immobilization in a sling, scapular AROM is initiated while improving or maintaining passive glenohumeral range of motion. At the 6-week interval, it is important to regain active humeral head depression to prevent superior migration of the humeral head during elevation as well as to strengthen and maximize active scapulohumeral rhythm with elevation in all planes (Fig. 1). If forward elevation is limited, passive grades 1 to 2 inferior glides may be initiated to improve the extensibility of the inferior glenohumeral joint capsule (Fig. 2). Passive-assisted and active-assisted shoulder abduction in the plane of the scapula are also initiated (Fig. 3). The patient can depress the humeral head in their available range of motion and continue to reach sideways to improve humeral elevation. Cueing the latissimus dorsi and the teres major/minor muscles assists in maximizing humeral head depression. Again, passive grades 1 to 2 inferior glides may be initiated to improve mobility in this plane (Fig. 4).

Table 2 illustrates rehabilitation principles for nonoperative surgical neck fractures. Importance is placed on pain management and improving range of motion in all planes. As typical sling usage is longer in this type of injury, proper attention must be paid to stretching the cervical spine, as it is often overused to elevate the stiff shoulder. In this type of injury, more aggressive range of motion exercises to the glenohumeral joint are used when the fractures are stable, as in Figures 2 and 4.

**TABLE 1.** Isolated Greater Tuberosity Fracture: Nonoperative

- Sling for 2 wk
- X-ray at 2 wk: no displacement begin passive motion only, otherwise continue sling
  - No limits in motion, but should not be aggressive
    - Emphasize FF, ABD, and gentle ER/IR
    - Scapular AROM in all planes as tolerated
    - Cervical AROM in all planes as tolerated
    - Modalities for pain control as needed
- X-ray at 6 wk: no displacement and signs of consolidation in conjunction with decreasing pain
  - Begin active motion as allowed by pain
    - Humeral head depression in FF and ABD
    - Goal of full PROM by 3 mo
      - Inferior glides G/H joint
      - A/C joint anterior/posterior glides
      - Scapulothoracic mobilization
- 3-6 mo: progress strengthening as tolerated with full AROM
  - All exercises must demonstrate active humeral head depression with elevation in the plane of the scapula to prevent impingement

ABD indicates abduction; A/C, acromioclavicular; AROM, active range of motion; ER, external rotation; FF, forward flexion; G/H, glenohumeral; IR, internal rotation.

In surgical cases where ORIF with a locking plate is utilized, the patient is referred to physical therapy at 2 weeks postoperatively, where gentle ROM exercises are begun as per Table 3. Now that there has been a surgical procedure, it is important to begin myofascial release and gentle scar tissue mobilization once the incision is completely healed. Typically in this group of patients, the muscles of the upper quarter become very tight with painful guarding spasms as a result of the surgical intervention and immobilization period. Along with the humeral head reeducation as described above, it is important to spend time on manual interventions to the soft tissues, including the subscapularis, subclavius, and the pectoral muscles. Proper passive motion of the acromioclavicular joint is necessary for maximal shoulder elevation in all planes.

Rehabilitation after total shoulder arthroplasty (TSA) is slow due to bone desiccation during the surgery and pain management in the early postoperative phase. Early

**FIGURE 2.** For the stiff shoulder, inferior glides of the humeral head may be performed while the patient is at the end of their available passive range of motion.

mobilization prevents contractures and adhesions from forming. Range of motion expectations are $\geq$160 degrees of forward elevation, 60 degrees of external rotation, and internal rotation to approximately T12. Normal scapulohumeral rhythm with elevation >100 degrees is expected.[18] Reverse TSA ROM expectations are lower than those for a traditional TSA, with maximum forward elevation ranging between 100 and 120 degrees and external rotation of 20 degrees.[23,24] Internal and external rotations are significantly limited secondary to severe

**FIGURE 1.** Humeral head depression is performed in a seated position with the arm over a foam roller. Patient will passively flex the shoulder by leaning forward. Humeral head stabilization and active depression may occur at any point in the range and especially at end range where impingement typically occurs.

**FIGURE 3.** Humeral head depression in abduction in the plane of the scapula. The patient will lean sideways, performing passive abduction. Active humeral head depression may be performed at any point in the range and especially at end range.


**FIGURE 4.** Passive inferior glides of the humeral head may be performed at end range abduction in the case of a stiff glenohumeral joint. Ensure that the humerus is aligned to the plane of the glenoid.

rotator cuff pathology.[24] With an early referral to physical therapy, pendulum exercises, scapular, and cervical AROM are initiated immediately (Table 4). It is important to limit internal rotation for at least 12 weeks postoperatively to prevent a possible dislocation, while maximizing range of motion in the other planes. Because of the lack of an adequate rotator cuff, active rotations will remain limited.

**TABLE 2.** Surgical Neck, 3- and 4-Part Fractures: Nonoperative

Sling for 2 wk
2 wk: begin gentle PROM, continue sling
  Emphasize FF, ABD, and gentle ER/IR
  Scapular AROM in all planes as tolerated
  Cervical AROM in all planes as tolerated
  Modalities for pain control as needed
6 wk: d/c sling and become more aggressive with ROM
  Begin active motion as allowed by pain
    Humeral head depression in FF and ABD
    Goal of full PROM by 3 mo
      Inferior glides G/H joint
      A/C joint anterior/posterior glides
      Scapulothoracic mobilization
    Monitor for excessive crepitus and pain
      Indicative of symptomatic nonunion, AVN, or OA degeneration
3-6 mo: progress strengthening as tolerated with maximum achievable AROM
  All exercises must demonstrate active humeral head depression with elevation in the plane of the scapula to prevent impingement

ABD indicates abduction; A/C, acromioclavicular; AROM, active range of motion; AVN, avascular necrosis; ER, external rotation; FF, forward flexion; G/H, glenohumeral; IR, internal rotation; OA, osteoarthritis; PROM, passive range of motion.

**TABLE 3.** ORIF With Locking Plate

2 wk: begin gentle PROM, continue sling
  Emphasize forward flexion, abduction, and gentle external/internal rotation
  Scapular AROM in all planes as tolerated
  Cervical ROM in all planes as tolerated
  Scar mobilization
  Modalities for pain control as needed
6 wk: d/c sling and become more aggressive with ROM
  Push ER/IR PROM to avoid adhesive capsulitis
  Mobilize clavicle
  Soft tissue release pectorals and upper quarter, subscapularis
  Begin active motion as allowed by pain
    Humeral head depression in FF and ABD
    Goal of full PROM by 3 mo
      Inferior glides G/H joint
      A/C joint anterior/posterior glides
      Scapulothoracic mobilization
3-6 mo: progress strengthening as tolerated with maximum achievable AROM
  All exercises must demonstrate active humeral head depression with elevation in the plane of the scapula to prevent impingement

ABD indicates abduction; A/C, acromioclavicular; AROM, active range of motion; ER, external rotation; FF, forward flexion; G/H, glenohumeral; IR, internal rotation; PROM, passive range of motion.

## CONCLUSIONS

Although PHFs are increasing in incidence and have a substantial impact on an individual's well-being, when a displaced fracture occurs in a young active patient, surgical intervention is commonly selected as the treatment of choice. However, the most appropriate form of management is less clear when it comes to the elderly population. Although there are a variety of surgical options available, complications have been attributed to each. Taking into account a patient's age (both chronological and physiological), overall health, lifestyle, and goals are imperative to optimizing outcomes.

Whether treating a patient conservatively or with surgical intervention, physical therapy is typically part of a patient's rehabilitation process that assists in returning them to their optimal level of function. Each case is unique and working closely with the physician is critical. Pain is the best indicator of fracture healing as x-ray evidence lags behind clinical healing. If a patient does not have much pain with active motion, their

**TABLE 4.** Total and Reverse Total Shoulder Arthroplasty

0-2 wk:
  Pendulums immediately
    Scapular AROM in all planes as tolerated
    Cervical ROM in all planes as tolerated
    Modalities for pain control as needed
2 wk: begin PROM—no limits except:
  Do not push IR due to possible dislocation
4 wk: d/c sling
6 wk: begin strengthening
  Begin submaximal isometrics in all planes
  Scapular stabilization
12 wk: finalize strengthening and ROM
  May achieve 120 degrees FF/ABD on average rTSA
    rTSA for fractures remain stiffer vs. those done for cuff tear arthropathy

ABD indicates abduction; AROM, active range of motion; FF, forward flexion; PROM, passive range of motion; rTSA, reverse total shoulder arthroplasty.

fracture is likely stable. Early motion is the key. Most elderly patients will tolerate a nonunion if they can get their hand to their head with minimal to no pain, which may take an average of 6 to 12 months. Nonoperative treatments generally will have good results if the shaft is touching the humeral head and the articular surface of the humeral head faces the glenoid, regardless of the severity of the fracture pattern. Good humeral head control in lower ranges of motion may have a more significant impact on function versus greater elevation.

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