Shoulder Fractures

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Clavicle Fractures

Introduction

Clavicle fractures are common injuries that are most frequently seen in both active males under the age of 30 and in the elderly population [1]. These fractures account for approximately 2.6–4% of all adult fractures and 44% of all shoulder fractures [1, 2]. Clavicle fractures also account for 10% of all sport-related fractures [3].

Mechanisms of injury include direct trauma to the clavicle or a fall onto the shoulder, such as from collisions in sports or motor vehicle accidents. Less commonly, clavicle fractures can result from a fall onto an outstretched hand. Young and active individuals typically sustain clavicle fractures by participation in contact sports, such as football and hockey, or sports with a risk of high-speed falls, such as skiing or bicycling. In comparison, the elderly population typically sustain clavicle fractures from simple falls directly onto their shoulder [3–6].

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The majority of clavicle fractures (about 80–85%) occur at the midshaft and are more likely to be displaced as compared with medial and distal third fractures [2, 4, 7]. The narrow cross section of the middle third of the clavicle makes it the most vulnerable to trauma [4]. It also lacks the strong ligaments and muscles which secure the medial and distal third of the clavicle [1]. Distal third fractures are the next most common type, seen in approximately 10–30% of clavicle fractures, and they tend to occur more in the elderly or osteoporotic individuals from falls [2, 4, 7, 8]. Medial third clavicle fractures are the least common.

There are several classification systems to assist in describing clavicle fractures, including Allman, Neer, Robinson, and Craig. These systems divide the clavicle into three segments and further divide into subgroups based upon various fracture factors including if the segment is displaced or comminuted.

The modified Neer classification system is widely used for distal clavicle fractures. It characterizes the fractures based upon the integrity of the coracoclavicular ligaments, consisting of the conoid and trapezoid ligaments:

Type I: Minimally displaced fracture lateral to the intact coracoclavicular ligaments, sparing the acromioclavicular joint.

Type IIA: Fracture is medial to the intact coracoclavicular ligaments with significant displacement of medial part of the clavicle.

Type IIB: Fracture is in between the torn conoid ligament and the intact trapezoid ligament with displacement of the medial clavicle.

Type III: Lateral to the intact coracoclavicular ligaments extending intra-articularly into the acromioclavicular joint.

Type IV: Physeal fracture in which the medial part of the clavicle is displaced superiorly as the periosteal sleeve alvuses from the inferior cortex and the coracoclavicular ligaments remain intact.

Type V: Comminuted fracture with medial clavicle displacement and a small inferior fragment attached to the intact coracoclavicular ligaments.

Clinical Presentation and Physical Exam

An individual may present with anterior shoulder pain after a known trauma. There may be an abrasion, swelling or ecchymosis, and both crepitus and tenderness upon palpation. Clavicle fractures present as an apparent deformity upon visualization, including skin tenting, which can indicate an impending open fracture. In midshaft clavicle fractures, the muscle attachments often cause the deformity seen after a fracture with subsequent clavicle shortening. The sternocleidomastoid muscle pulls the medial fragment posterosuperiorly, while the pectoralis major muscle and weight of the arm pull the lateral fragment inferomedially. Associated conditions, although rare, can include ipsilateral scapular fracture, rib fracture, and pneumothorax. A careful neurovascular exam is imperative to rule out any injury to the subclavian vessels or brachial plexus.

Diagnostic Studies

Diagnostic evaluation should consist of an anteroposterior (AP) radiograph ideally in the upright position and an AP radiograph with 15–20 degrees of cephalic tilt to help visualize the displacement of the clavicle. Occasionally, a stress view may be obtained, in which a 5–10 lb. weight is suspended on the ipsilateral wrist to determine the integrity of the coracoclavicular ligaments [4]. A CT scan can help further evaluate displacement, fracture type, articular extension, and clavicular shortening. CT scanning may be useful in identifying fractures of the medial clavicle.

Treatment

Treatment of clavicle fractures depends on both the location and the type of the fracture. Nonoperative care has traditionally been the treatment of choice for nondisplaced midshaft fractures. Sling immobilization for 2–4 weeks is recommended until there is evidence of clinical healing with an improvement in pain and radiographic evidence of bony healing [3, 9, 10]. A figure-of-eight brace has fallen out of favor due to patient dissatisfaction, brachial plexopathies, and upper limb thrombosis [4, 10]. Fracture reduction is not recommended as no current evidence supports that fracture reduction is maintained or clinical outcomes are improved. After the period of immobilization, a rehabilitation program beginning with range of motion and progressing to shoulder strengthening at 6 weeks should be implemented.

Surgical intervention, either with plate fixation or intramedullary nailing, is indicated for skin tenting, open fractures, the presence of neurovascular compromise, Z-type fracture pattern, and a floating shoulder [7, 11]. Surgical treatment is now commonly preferred for displaced midshaft fractures and fractures with greater than 1.5–2 cm of shortening due to the high nonunion rate and functional deficits reported with nonsurgical treatment [7, 11]. Surgical treatment has been found to decrease the nonunion rate, shorten the time to union, lead to better short- and long-term functional outcomes, and improve return-to-play rates [9, 12]. Operative treatment in children and adolescents remains controversial, with recent evidence in favor of surgical care for active individuals who would benefit from quick restoration of normal anatomy and fixation [4].

Nondisplaced lateral fractures are generally managed with conservative care including sling immobilization for 2–4 weeks. Type IIA, IIB, and V distal clavicle fractures are considered unstable fractures requiring operative treatment. Operative intervention is routinely performed for displaced lateral fractures, especially in the athletic population, as high rates of nonunion and subsequent shoulder function impairment have been reported [13]. Medial fractures are mostly treated nonoperatively with a sling for immobilization followed by a rehabilitation program.

Return to Play

Most individuals with a clavicle fracture will return to sports activity at their pre-injury level of sport. The decision to return to sport includes clinical and radiographic evidence of fracture healing and full pain-free range of motion with full strength. However, return-to-play timelines vary. With nonoperative treatment, it is generally recommended to wait 6–12 weeks from the time of injury to return to activity [3]. Others recommend avoiding contact sports for a minimum of 4–5 months to allow clavicle healing [7]. Postoperatively, patients should remain in a sling for immobilization for 2–4 weeks with immediate gentle range of motion exercises followed by a rehabilitation program between 4 and 6 weeks [9]. Return to sport has been recommended anywhere from 6 to 12 weeks to 4 to 6 months [11, 14].

Scapula Fractures

Introduction

Scapula fractures are uncommon injuries to the shoulder girdle. These fractures account for less than 1% of all fractures and about 3–5% of all fractures of the shoulder girdle [15]. Scapula fracture locations include the coracoid, acromion, glenoid, scapular neck, and scapular body, with about 50% involving the body and spine of the scapula [16]. They typically occur with high-energy traumas, such as motor vehicle collisions, and are often associated with rib fractures, ipsilateral clavicle fracture, spine fracture, brachial plexus injury, lung injuries, and head injury [15, 17].

Clinical Presentation and Physical Exam

The most common symptoms of fractures of the scapula are severe pain, abrasions near the affected area, ecchymosis, swelling, and limited range of motion, particularly with abduction. Individuals with suspected scapula fractures should be examined standing or sitting. Inspect for obvious deformity or marked asymmetry. As shoulder girdle injuries are often associated with neurovascular injuries, a full and thorough assessment of the brachial plexus and distal perfusion must be performed. Particularly, the suprascapular and axillary nerves are at increased risk for injury. If the time of presentation is more than 2 weeks after injury, an EMG can be performed to assess severity of injury and localize pathology to these nerves and the brachial plexus. Further, examination should include assessing for other associated injuries previously mentioned, especially those which are emergencies.

Diagnostic Studies

A true AP (Grashey view), scapular Y, and axillary lateral view radiographs are recommended. The axillary view is used to assess acromion and coracoid fractures. The Stryker notch view may be helpful to evaluate for coracoid fractures, too. A West Point lateral view can evaluate for glenoid rim fractures such as a bony Bankart lesion (fracture of the anterior-inferior glenoid cavity) or a reverse bony Bankart lesion (fracture of the posterior capsular periosteum).

A CT scan can assess for an intra-articular fracture or significant displacement. It allows for the evaluation of the size, location, degree of displacement, and humeral head position in relation to the glenoid fossa [16]. It can also be used for 3D reconstruction to better visualize displacement and assist in planning for surgical intervention.

Treatment

Treatment is dependent upon the location of the fracture within the scapula. The majority of scapular fractures are nondisplaced or minimally displaced and can be managed effectively with conservative treatment. Fractures of the scapular spine and body generally can be managed nonoperatively with excellent or good functional results [18]. This is largely due to the extensive muscular envelope which limits displacement of the scapular and facilitates healing. Conservative treatment typically consists of pain control, immobilization with a sling for 2 weeks, and an early rehabilitation program. However, indications for surgical intervention vary.

Fractures of the glenoid fossa that result in articular displacement greater than 5 mm can increase the risk for developing posttraumatic degenerative joint disease [19]. As such, surgical treatment with open reduction and internal fixation is favored by some surgeons. Further, operative intervention is indicated if the glenoid fracture is associated with persistent or recurrent glenohumeral instability. Glenoid fossa fractures managed operatively have been found to have excellent or good results in the majority of the cases [18].

Surgical intervention should also be considered for significantly displaced scapular fractures. Displaced scapular neck fractures treated nonoperatively were found to have poorer functional outcomes, increased pain, decreased range of motion, and weakness [20, 21]. Operative treatment is recommended for all glenoid neck fractures with at least 1 cm of translation or 40 degrees of angulation in the AP plane of the scapula [16, 20, 21]. Isolated glenoid neck fractures with no involvement of the glenoid fossa can be managed nonsurgically with excellent results [18].

Another indication for surgical treatment is disruption of the superior shoulder suspensory complex in two different locations. This is made up of the glenoid, coracoid, acromion, distal clavicle, coracoclavicular ligaments, and acromioclavicular ligaments, which secure the upper extremity to the axial skeleton [19]. Without an open reduction and internal fixation, there may be malunion or nonunion and long-term functional impairments [19].

Return to Play

Conservative management should consist of immobilization with a sling for 2 weeks followed by early rehabilitation and range of motion with union expected at 6 weeks. Postoperatively, strength and endurance training can begin after 8 weeks, and return-to-normal activities can happen after 12 weeks [15].

Proximal Humerus Fractures

Introduction

Proximal humerus fractures are common osteoporotic fractures seen in the elderly after a low-energy fall. These fractures account for about 6% of all fracture types with a female-to-male ratio of 70:30 [22]. About 87% of proximal humerus fractures occur from falls from a standing height [6]. Less commonly, these fractures can happen in the younger population after a high-energy impact.

The most widely used classification system is the Neer classification. It is based upon four segments consisting of the greater tuberosity, the lesser tuberosity, the humeral head, and the humeral shaft. It characterizes proximal humerus fractures by the number of displaced segments with further categorization for articular fractures and dislocation. A fragment is considered displaced if it is separated more than 1 cm or angulated more than 45 degrees [23].

One-Part Fractures

These are fractures with no displaced segments regardless of the number of fracture lines or their location.

Two-Part Fractures

There is displacement of one segment which may be the greater or lesser tuberosity or the humeral head at the level of the anatomic or surgical neck.

Three-Part Fractures

The greater or lesser tuberosity is displaced as well as the surgical neck fracture.

Four-Part Fractures

In these severe fractures, all four segments meet the criteria for displacement. Of note, the articular segment is typically laterally displaced and no longer in contact with the glenoid. This carries a high risk of avascular necrosis.

Another separate category was added for valgus-impacted four-part fractures. The humeral head is rotated into a valgus position and forced downward between the greater and lesser tuberosities, which will splay outward. The articular surface maintains contact with the glenoid.

Additionally, the AO/OTA classification system is commonly used, which focuses on the progressive severity of the fracture pattern. There are three main fracture types which are then categorized based upon the degree of displacement, impaction, and dislocation.

An additional fracture type of the proximal humerus includes a Hill-Sachs lesion, defined as a cortical depression in the posterolateral head of the humerus, resulting from the forceful impact of the humeral head against the anteroinferior glenoid rim. This lesion is typically associated with an anterior shoulder dislocation.

Clinical Presentation and Physical Exam

On examination, there may be ecchymosis, abrasions, or edema near the affected area. Gross deformity or the presence of a subacromial sulcus sign may suggest dislocation of the humeral head. Evidence of an open fracture or skin tenting should be quickly identified. A thorough neurovascular exam should be conducted with particular attention to the axillary nerve. Examination should also assess the function of the elbow, wrist, and fingers.

Diagnostic Studies

A true AP view of the glenohumeral joint, scapular Y view, and axillary view radiographs of the glenohumeral joint should be obtained ideally with the patient in an upright position. A CT scan is recommended for complex fractures or when fracture lines are not well visualized. MRI can be helpful in assessing rotator cuff integrity and other soft tissue injuries that may accompany a fracture. Rotator cuff pathology is frequently associated with proximal humerus fractures, both at the time of injury and 1 year later [24]. Additionally, a Stryker Notch view can assess for a Hill-Sachs lesion.

Treatment

Recommendations for the treatment of proximal humerus fractures vary and are still evolving. In general, minimally displaced fractures are treated conservatively. Displaced, comminuted, or angulated fractures are treated operatively; however, the type of intervention can be challenging. Operative interventions include percutaneous fixation, nailing, plating, and arthroplasty. Physiologic age, determined by bone quality and social independence, is more important than chronological age when determining treatment options and outcomes [25, 26].

About 50% to 66% of all proximal humerus fractures are minimally displaced, with the majority of all proximal humerus fractures involving the greater tuberosity or surgical neck [6, 27]. These fractures typically respond well to conservative treatment consisting of a sling for 4–6 weeks followed by early rehabilitation and physical therapy. Isometric, pendulum, and passive range of motion exercises should be initiated within a few days of injury [25]. Active strengthening exercises can begin once healing is evident, usually by 4–6 weeks. Minimally displaced injuries are at low risk for further displacement, nonunion, or avascular necrosis; however, patients are at risk for loss of range of motion and posttraumatic arthritis [28]. Isolated, minimally displaced greater tuberosity fractures can take up to a year for full recovery [25]. If the greater tuberosity is displaced more than 5 mm, surgery is indicated as it can result in impingement with loss of abduction and external rotation.

Surgery can be considered for two-part surgical neck fractures with significant displacement in patients with adequate bone quality. Surgical techniques include percutaneous wiring, nailing, and plating. Of the three, percutaneous wiring has been associated with superior outcomes [29]. Displaced two-part tuberosity fractures may benefit from surgical fixation. Fractures of the lesser tuberosity more commonly occur in conjunction with a posterior dislocation. If fragments are large and displaced or involve the articular surface, fixation is warranted.

Three- and four-part proximal humerus fractures can be treated nonoperatively with closed reduction. In general, this leads to poor functional results, although patients have reported limited pain and overall satisfaction [26]. Despite current evidence suggesting satisfactory outcomes with conservative management, operative care has been increasingly performed with locking plate reduction or arthroplasty in patients with severe fractures [30]. However, outcomes between operative and nonoperative treatments in displaced two-, three-, or four-part fractures have not been found to be significantly different after 5 years [31]. Ultimately, treatment for displaced fractures should consider a patient's bone quality, surgical candidacy, level of independence, lifestyle, and expectations.

Return to Play

Treatment options and modalities should place emphasis on the patient's characteristics and goals. For those who are active or participate in athletics, sports activities after surgical treatment are close to pre-injury level, with some avoiding overhead sports [32].

References

1. Kihlström C, Möller M, Lönn K, Wolf O. Clavicle fractures: epidemiology, classification and treatment of 2 422 fractures in the Swedish fracture register; an observational study. BMC Musculoskelet Disord. 2017;18(1):82. Published 2017 Feb 15. https://doi.org/10.1186/s12891-017-1444-1.
2. Postacchini F, Gumina S, De Santis P, Albo F. Epidemiology of clavicle fractures. J Shoulder Elb Surg. 2002;11(5):452–6. https://doi.org/10.1067/mse.2002.126613.

3. DeLee J, Drez D, Miller MD, Thompson SR. DeLee, Drez, & Miller's orthopaedic sports medicine: principles and practice. 5th ed. Philadelphia, PA: Elsevier; 2020.
4. Rockwood CA, Green DP, Bucholz RW, editors. Rockwood and Green's fractures in adults. 7th ed. Wolters Kluwer Health/Lippincott Williams & Wilkins; 2010.
5. Court-Brown CM, Wood AM, Aitken S. The epidemiology of acute sports-related fractures in adults. Injury. 2008;39:1365–72.
6. Court-Brown CM, Garg A, McQueen MM. The epidemiology of proximal humeral fractures. Acta Orthop Scand. 2001;72(4):365–71. https://doi.org/10.1080/000164701753542023.
7. van der Meijden OA, Gaskill TR, Millett PJ. Treatment of clavicle fractures: current concepts review. J Shoulder Elb Surg. 2012;21(3):423–9. https://doi.org/10.1016/j.jse.2011.08.053. Epub 2011 Nov 6
8. Kim DW, Kim DH, Kim BS, Cho CH. Current concepts for classification and treatment of distal clavicle fractures. Clin Orthop Surg. 2020;12(2):135–44. https://doi.org/10.4055/cios20010.
9. Robertson GA, Wood AM. Return to sport following clavicle fractures: a systematic review. Br Med Bull. 2016;119(1):111–28.
10. Miranda-Comas G, Cooper G, Herrera J, Curtis S, editors. Essential sports medicine: a clinical guide for students and residents. 2nd ed. Springer; 2021.
11. Wiesel B, et al. Management of Midshaft clavicle fractures in adults. J Am Acad Orthop Surg. 2018;26:e468–76. https://doi.org/10.5435/JAAOS-D-17-00442.
12. Guerra E, Previtali D, Tamorini S, Filardo G, Zaffagnini S, Candrian C. Midshaft clavicle fractures: surgery provides better results as compared with nonoperative treatment: a meta-analysis. Am J Sports Med. 2019;47(14):3541–51.
13. Bishop JY, Jones GL, Lewis B, et al. Intra- and interob- server agreement in the classification and treatment of distal third clavicle fractures. Am J Sports Med. 2015;43:979–84.
14. Ranalletta M, Rossi LA, Piuzzi NS, Bertona A, Bongiovanni SL, Maignon G. Return to sports after plate fixation of displaced midshaft clavicular fractures in athletes. Am J Sports Med. 2015;43(3):565–9. https://doi.org/10.1177/0363546514559913. Epub 2014 Dec 9
15. Cole PA, Freeman G, Dubin JR. Scapula fractures. Curr Rev Musculoskelet Med. 2013;6(1):79–87. https://doi.org/10.1007/s12178-012-9151-x.
16. Voleti PB, Namdari S, Mehta S. Fractures of the scapula. Adv Orthop. 2012;2012:903850. https://doi.org/10.1155/2012/903850.
17. Baldwin KD, Ohman-Strickland P, Mehta S, Hume E. Scapula fractures: a marker for concomitant injury? A retrospective review of data in the National Trauma Database. J Trauma. 2008;65(2):430–5.

18. Zlowodzki M, Bhandari M, Zelle BA, Kregor PJ, Cole PA. Treatment of scapula fractures: systematic review of 520 fractures in 22 case series. J Orthop Trauma. 2006;20(3):230–3.
19. Goss TP. Scapular fractures and dislocations: diagnosis and treatment. J Am Acad Orthop Surg. 1995;3(1):22–33.
20. Nordqvist A, Petersson C. Fracture of the body, neck, or spine of the scapula. A long-term follow-up study. Clin Orthop Relat Res. 1992;283:139–44.
21. Ada JR, Miller ME. Scapular fractures. Analysis of 113 cases. Clin Orthop Relat Res. 1991;269:174–80.
22. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. Injury. 2006;37(8):691–7. https://doi.org/10.1016/j.injury.2006.04.130. Epub 2006 Jun 30
23. Carofino BC, Leopold SS. Classifications in brief: the Neer classification for proximal humerus fractures. Clin Orthop Relat Res. 2013;471(1):39–43. https://doi.org/10.1007/s11999-012-2454-9.
24. Fjalestad T, Hole MØ, Blücher J, Hovden IA, Stiris MG, Strømsøe K. Rotator cuff tears in proximal humeral fractures: an MRI cohort study in 76 patients. Arch Orthop Trauma Surg. 2010;130(5):575–81. https://doi.org/10.1007/s00402-009-0953-2. Epub 2009 Aug 14
25. Schumaier A, Grawe B. Proximal humerus fractures: evaluation and management in the elderly patient. Geriatr Orthop Surg Rehabil. 2018;9:2151458517750516. Published 2018 Jan 25. https://doi.org/10.1177/2151458517750516.
26. Clement ND, Duckworth AD, McQueen MM, Court-Brown CM. The outcome of proximal humeral fractures in the elderly: predictors of mortality and function. Bone Joint J. 2014;96-B(7):970–7. https://doi.org/10.1302/0301-620X.96B7.32894.
27. Bergdahl C, Ekholm C, Wennergren D, Nilsson F, Möller M. Epidemiology and patho-anatomical pattern of 2,011 humeral fractures: data from the Swedish fracture register. BMC Musculoskelet Disord. 2016;17:159. Published 2016 Apr 12. https://doi.org/10.1186/s12891-016-1009-8.
28. Jo MJ, Gardner MJ. Proximal humerus fractures. Curr Rev Musculoskelet Med. 2012;5(3):192–8. https://doi.org/10.1007/s12178-012-9130-2.
29. Tamimi I, Montesa G, Collado F, González D, Carnero P, Rojas F, Nagib M, Pérez V, Álvarez M, Tamimi F. Displaced proximal humeral fractures: when is surgery necessary? Injury. 2015;46(10):1921–9. https://doi.org/10.1016/j.injury.2015.05.049. Epub 2015 Jun 14
30. Bell JE, Leung BC, Spratt KF, Koval KJ, Weinstein JD, Goodman DC, Tosteson AN. Trends and variation in incidence, surgical treatment, and repeat surgery of proximal humeral fractures in the elderly. J Bone Joint Surg Am. 2011;93(2):121–31. https://doi.org/10.2106/JBJS.I.01505. PMID: 21248210; PMCID: PMC3016042.

31. Handoll HH, Keding A, Corbacho B, Brealey SD, Hewitt C, Rangan A. Five-year follow-up results of the PROFHER trial comparing operative and non-operative treatment of adults with a displaced fracture of the proximal humerus. Bone Joint J. 2017;99-B(3):383–92. https://doi.org/10.1302/0301-620X.99B3.BJJ-2016-1028. PMID: 28249980; PMCID: PMC5404240.
32. Ahrens P, Martetschläger F, Siebenlist S, et al. Return to sports after plate fixation of humeral head fractures 65 cases with minimum 24-month follow-up. BMC Musculoskelet Disord. 2017;18(1):173. Published 2017 Apr 26. https://doi.org/10.1186/s12891-017-1532-2.