Functional Outcome of Open Reduction and Internal Fixation of Displaced Extra-Articular Scapula Fractures

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Abstract

Background Scapular fractures are uncommon injuries of upper extremity resulting mostly from high-energy trauma. Extra-articular fractures form the majority of them. Un-displaced fractures can be managed conservatively with good results. But displaced fracture does not yield satisfactory results and needs surgical fixation. In this case series, we report our experience about such fractures.

Methods This was a retrospective study of 12 patients with displaced scapular body and neck fractures treated between 2015 and 2018. Scapular fractures were exposed by modified Judet approach and fixed with either 3.5 mm T buttress or recon locking plate and screws. One case had associated clavicle fracture which was fixed along with scapula. Patients were put on structured rehabilitation and followed up regularly. Functional outcome and range of motion were analyzed.

Results The patients included 10 males and two females. Mean age was 42 years. Average follow-up was 33 months. Average constant and Murley score was 80. Excellent results were seen in four patients, good results in seven patients and one patient has got fair result. The mean post-operative range of motion of the shoulder at the time of final follow-up was 140° of forward flexion, 136° of abduction, and 34° of external rotation.

Conclusion Displaced extra-articular scapular fractures managed by internal fixation using T buttress locking plates and reconstruction plates give good functional outcome.

Keywords Scapula fracture · Extra-articular fracture · Floating shoulder · Plating

Introduction

Scapula forms an important link between the upper limb and trunk. It has an important role to play in coordinating the complex shoulder movements. Scapular fractures usually result from high-energy trauma. Scapular fractures per se are relatively uncommon. They constitute 0.4–1% of all fractures and 3–5% of shoulder injuries [1, 2]. Extra-articular fractures of the body and neck account for 62–98% of all scapular fractures sub-types [3, 4]. Most of the scapular fractures are treated conservatively. But displaced fractures have to be fixed surgically. Conservative management in displaced fracture can lead to shoulder joint dysfunction,

chronic pain, and other complications [5, 6]. Internal fixation of scapular fracture is not an easy solution, because it posts unique challenges, with regard to approach and fixation technique. Obtaining proper reduction and a proper intra-operative radiographic image will be challenging, particularly with comminuted fracture. Moreover, there is a risk of injury to neurovascular structures around the scapula. Clinical observations have shown that most unstable fractures of the scapula are comminuted extra-articular fractures of the scapular body or glenoid neck. A variety of implants are available for fixation of these complex fractures. Some of the implants used for scapula fracture fixation reported in literature include locking compression plate, reconstruction plate, distal radius plate, distal humerus Y-type locking plate, T-plate, calcaneus deformed plate, and microplate [3, 4, 7–11]. Aim of our study was to evaluate the functional outcome of extra-articular scapula fractures treated by open reduction and internal fixation using recon plates and T buttress plates.

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Materials and Methods

This was a retrospective study done at our institution, after obtaining approval from the institutional review board. Inclusion criteria were (1) Extra-articular Scapula fractures which were surgically managed with plate osteosynthesis. (2) Completed a minimum follow-up of 18 months. Exclusion criteria were (1) Conservatively treated scapula fracture (2) Open fracture. (3) Type 3 fractures of Ada and Miller's classification (Intra-articular glenoid fracture) [5]. Twelve patients met with the criteria who were operated between 2015 and 2018 at our institute. All the patients who presented after the injury were examined according to ATLS protocol. Physical examination was done and other associated injuries were looked into. Plain radiograph was used to diagnose the fracture. These 12 patients were chosen for internal fixation based on the indication elucidated by Cole et al. [12].

1. Medial/lateral displacement > 20 mm,
2. Angular deformity > 45°,
3. Glenopolar angle (GPA) < 22° (defined as the angle between the line connecting the uppermost with the lowermost point of the glenoid cavity and the line connecting the uppermost point of the glenoid cavity with the lowermost point of the body of the scapula)
4. Medial/lateral displacement > 15 mm and angulation > 30°, and
5. Double disruption of the superior shoulder suspensory complex with displacement > 10 mm.

Surgical Technique

The procedure was performed under general anesthesia. The patients were placed in the lateral decubitus position with the affected side facing up. All the bony prominences were adequately padded. The affected shoulder and arm were disinfected and the entire upper limb was wrapped in an aseptic drape, since manipulation of the limb will be needed to facilitate reduction. The modified Judet approach was used to expose the scapular fracture. A boomerang shaped incision was made from the distal tip of the acromion, extending parallel to the scapular spine and then along the lateral border of the scapula till the inferior scapular angle. The skin, subcutaneous tissue, and fascia were incised to expose the posterior part of the deltoid muscle. Deltoid was dissected off its origin from scapular spine and base of acromion. An interval between infraspinatus and teres minor was made, by retracting teres minor inferiorly, to avoid injury to posterior branch of axillary nerve and infraspinatus superiorly, to avoid

injury to suprascapular nerve and artery. Scapular spine, glenoid neck and the lateral aspect of the body will be exposed. The fracture was reduced and held temporarily using Kirschner wires. Fixation was done based on the 'three point two line' principle of internal fixation [13]. Distal radius T buttress locking plate or 3.5 mm locking reconstruction plate was used to fix the fracture along the lateral column of the scapula. Additional fixation of the medial column and the spine was done in cases where it was needed. In those cases, infraspinatus was erased of its origin for additional exposure which was repaired at the end of the procedure. The shoulder joint was repeatedly moved and intraoperative image intensifier was used to see if the screws penetrated into the joint cavity. Deltoid repaired back to its origin from the scapular spine and base of acromion. Suction drain was placed and the incision was closed in a layered fashion. Apart from scapular fracture, one patient had associated clavicle fracture. This fracture was also fixed internally using anatomical pre-contoured clavicle locking plate. For fixation of clavicle, the patient was turned from lateral to supine position.

Post-operatively, the shoulder was immobilized for 2 weeks in an arm sling. Active mobilization of the elbow, wrist, and fingers was encouraged. Passive shoulder-lift and pendulum exercises were performed after 1 week. After 2 weeks, active-assisted forward flexion and abduction of the shoulder joint were started. Gradually active movements were encouraged. After 6 weeks, shoulder muscle strength training was gradually started. Further follow-up was done at 3, 6 and 12 months after

Fig. 1 Preoperative radiograph showing displaced scapular fracture involving the spine, medial and the lateral column

Fig. 2 Plain radiograph at 2-year follow-up showing good fracture healing

Fig. 4 Plain radiograph at 2-year follow-up showing good fracture healing

Fig. 3 Preoperative radiograph showing displaced scapular fracture involving the medial and lateral column

surgery. Fracture union was assessed using plain radiographs (Figs. 1, 2, 3, 4). Further, yearly follow-up was undertaken. Functional outcome was measured using the Constant Murley scores [14] and range of motion in the shoulder joint was recorded.

Results

Twelve patients were included as per the inclusion and exclusion criteria. There were 10 males and two females (Table 1). Mean age was 42 years ranging from 26 to 64 years. Eight patients had a left side scapula fracture and the rest had a right side involvement. The cause of injury was road traffic accident in eight patients and fall from height in the remaining four patients. There were five associated injuries in addition to scapula fracture. Four patients had associated rib fractures and one patient had ipsilateral clavicle fracture. One patient had hemothorax which compromised respiration. An intercostal drainage tube was inserted to drain the hemothorax for that patient which was removed later. The average duration from injury to surgery was 3 days with a range of 1–10 days. Average follow-up was 33 months ranging from 18 months to 5 years. Average constant and Murley score was 80 (range of 68–87). Excellent results were seen in four patients, good results in seven patients and one patient has got fair result due to delayed infection and restriction of shoulder movement in our series. The patient with a fair result was diabetic and developed a delayed infection after 8 weeks. He was treated with intravenous antibiotics and infection got settled with the same. The mean post-operative range of motion of the shoulder at the time of final follow-up was 140° (range of 130–160°) of forward flexion, 136° (range of 130–150°) of abduction, and 34° (range of 30–40°) of external rotation. All the patients went back to their original profession and were able to do their routine activities without any difficulty.

Table 1 Demography and results

S. No	Age	Gender	Side	Criteria for surgical fixation	Duration from injury to surgery (in days)	Follow up (in years)	Constant Murley score	Abduction	Flexion	External rotation	Associated injury
1	41	Male	Left	Displaced	5	4	78	130	130	30	Rib fracture
2	26	Male	Left	Double disruption of SSSC	1	5	78	130	140	30	Clavicle fracture
3	48	Male	Right	Displaced with angular deformity	3	2	87	150	150	40	
4	29	Male	Left	Displaced	2	2	85	150	150	40	
5	37	Female	Right	Angular deformity	1	4.5	78	130	140	30	Rib fracture and hemothorax
6	35	Male	Right	Displaced	3	2	87	150	160	40	
7	45	Male	Left	Displaced	2	4	78	130	130	30	
8	58	Male	Left	Displaced	7	3	78	130	140	30	Rib fracture
9	43	Female	Left	Displaced	10	1.5	78	130	140	30	Rib fracture
10	64	Male	Left	Angular deformity	2	2	68	130	130	30	
11	50	Male	Right	Displaced	1	2	81	140	140	40	
12	28	Male	Left	Displaced	1	1.5	85	140	140	40	

Discussion

Scapula forms an important part of shoulder girdle linking the upper extremity and the axial skeleton. It has three articulations: glenohumeral joint, acromioclavicular joint, and the scapulothoracic joint. Full range of motion at the shoulder needs movement at all three articulations. This complex movement is brought about by eighteen different muscles that originate from or insert on the scapula. These muscles coordinate six basic movements of the scapula: elevation, depression, upward rotation, downward rotation, protraction, and retraction. In earlier days, scapular fracture was managed by benign neglect. Poor functional outcome from conservative management led to internal fixation of the fracture. First internal fixation of scapula was performed by Albin Lambotte in 1910 [15]. He fixed an unspecified transpinous fracture of the body, or neck with two screws. William Arbuthnot Lane was the first one to do a plate fixation for a displaced vertical fracture at 1914 [16]. Posterior approach for shoulder joint, with retraction of the spinal portion of the deltoid and the infraspinatus was first described by Rowe in 1944 [17]. Gradually techniques and implant got refined coping with the increasing needs for fixing these complex fractures.

A number of classification systems exist for scapula fractures. We followed the one elucidated by Ada and Miller [5] because of its simplicity. It is an anatomical classification and divides scapula fractures into 4 types: type 1a: fracture of acromion; type 1b: fracture of spine; type 1c: fracture of coracoid; type 2: fracture of neck; type 3: glenoid fracture (intra-articular); type 4: body fracture. Undisplaced extra-articular scapula fractures can be managed conservatively with good functional outcome. On the other hand, angular deformity and displacement will result in malunion, which in turn leads to muscle imbalance, rotator cuff dysfunction, scapulothoracic dyskinesis and impingement. In a biomechanical study done by Chadwick et al. [18], shortening of rotator cuff muscles and reduced forces were observed in cases of scapular malunion, which will compromise shoulder function. In a case series of 113 patients, Ada and Miller [5] observed that patients with displaced scapular neck fractures had weakness with overhead activities, subacromial pain, and decreased shoulder motion. A systematic review done by Zlowodzki et al. had 22 case series with 520 cases [6]. They observed that 20% of the conservatively treated extra-articular scapula fracture had poor functional outcome, 25% had radiographic scapula deformity and 12% had persistent pain. Another systematic review done by Kannan et al. also established the fact that displaced and comminuted fractures warrant operative fixation [1]. They found that displaced scapular neck fractures (> 10 mm) had a better functional outcome following operative management.

Internal fixation of extra-articular scapula fractures has its own list of challenges. Surgical approach itself is a bit complicated. The modified Judet approach needs a meticulous dissection because of the proximity to suprascapular nerve and vessel superiorly and the axillary nerve inferiorly. Excessive dissection and traction can cause injury to these vital structures. The deltoid which was released off its origin from the scapular spine and acromion must be repaired back strongly, preferably by making osseous tunnels. Otherwise there will be loss of deltoid strength and chronic shoulder pain. All 12 patients in our study regained good deltoid strength postoperatively. Unlike the classical Judet approach where the infraspinatus muscle is erased off the infraspinous fossa, modified Judet approach spares the infraspinatus. In an observational study, [19] Porcellini et al. found that an infraspinatus-sparing surgical approach for scapular fracture avoids infraspinatus hypotrophy and external-rotation weakness and suggested to restrict the classic Judet approach only to difficult fractures, not reducible with a narrow exposure. In our series, infraspinatus was erased of its origin and repaired back later, in cases where a medial column plating was required. But we did not encounter any weakness or hypotrophy postoperatively. Numerous plates are available to suit the surgeons' need. But from our experience, a locking reconstruction plate or a distal radius T buttress locking plate is well and good. Placement of plate is extremely important to get adequate hold. A cadaveric study done by Burke et al. [20] to measure the scapula osseous thickness for optimum implant placement found that the lateral border, the lateral aspect of the base of the scapula spine, and the scapula spine provide adequate screw purchase and improved strength of fixation. In our study, plating was also done along the medial column in four patients and all had adequate bony purchase and none had implant failure.

Majority of the scapular fractures occur as a result of high-energy trauma and there can be other associated injuries. Most of these associated injuries can be more dangerous than the scapular fracture itself. Therefore, all cases should be carefully evaluated for other associated injuries. Rib fractures and pulmonary injuries are the commonly associated injuries [5]. Double disruption of the superior shoulder suspensory complex (SSSC) is one other commonly observed pattern with scapular fractures. The SSSC is a functional ring in the shoulder girdle consisting of the glenoid, coracoid, acromion, distal clavicle, coracoclavicular ligaments, and acromioclavicular ligaments. These structures secure the upper extremity to the axial skeleton. Single disruptions of the SSSC are generally stable, but a double disruption will be very unstable. Surgical fixation is indicated for double disruptions that are accompanied by significant displacement, as these may lead to malunion, or nonunion with poor long-term results. In our case series, we had one such case with associated clavicle fracture which

was surgically fixed along with the scapular fracture. Last but not the least, injury to neurovascular structures should be carefully ruled out. Injury to brachial plexus and subclavian artery can be associated with scapular fracture.

Limitations

Sample size was small. But considering the rarity of this injury and a very small percentage of them needing internal fixation, getting a large sample size will be difficult. Second, a comparison with non-operative management was not done. A comparative study would have been more informative.

Conclusion

Extra-articular scapular fracture with significant displacement can be very well managed by internal fixation. T buttress locking plates and reconstruction plates are very good implants for these complex fracture fixation. With this modality of treatment, one can expect good functional outcome and return to pre-injury level of physical activities.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standard statement This article does not contain any studies with human or animal subjects performed by the any of the authors.

Informed consent For this type of study informed consent is not required.

Patient consent The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understood that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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