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Original Research Article

Functional outcome of surgical fixation in significantly displaced floating shoulder injury

Animesh Kumar Singh[1], Suresh Kumar Kaushik[1,*], Apser Khan[1], Sanjay Gupta[1], Vivek Prakash[1]

[1] *Dept. of Orthopedics, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India*

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ABSTRACT

Introduction: The floating shoulder is a rare complex injury involving fracture of the clavicle and the fracture of the neck of scapula with concomitant disruption of the ligaments stabilizing the ipsilateral shoulder joint. Most of the isolated clavicle or scapular fractures, as well as minimally displaced floating shoulder can be managed conservatively, with reasonably good results. But significantly displaced floating shoulder should be fixed surgically to obtain best functional outcome.

Materials and Methods: In this retrospective study the surgical fixation of 12 significantly displaced floating shoulder was analysed. All were done as a single stage procedure from December 2014 till June 2019. The final assessment was done upon only those patients who have been followed for at least 9 months post-operatively, using Oxford shoulder score (OSS).

Results: Most of the patient had no major complications postoperatively. The mean time for radiological union of clavicle and scapula was found out to be 13.5 weeks and 9.1 weeks respectively. The mean Oxford shoulder score was 45.9 in7 patients, 36.3 in 2 patients and 27.1 in 1 at the end of at least 9 months follow up.

Conclusion: The surgical fixation of all the floating shoulders, especially significantly displaced, allows for early rehabilitation and better functional outcome.

1. Introduction

Floating shoulder is a rare complex high velocity injury constituting < 0.10% of all fractures.[1] Most of the fractures of the scapula are extra-articular.[2] More than 50% have concomitant injuries, making it prone for under diagnosis.[2]

Ganz and Noesberger in 1975 first described the floating shoulder as an ipsilateral fracture of the clavicle and glenoid neck.[3] Later Goss described it as a 'double disruption' of superior shoulder suspensory complex.[4] Superior shoulder suspensory complex is essential for functional integrity of upper limb with respect to the trunk. It forms a stable ring of bone and soft tissue, consisting of glenoid, coracoid process, lateral end of clavicle and acromian process interconnected by coracoclavicular ligament, acromioclavicular ligament and coracoacromian ligament. Disruption of this superior shoulder suspensory complex ring at more than one place makes the functional integrity of the shoulder joint unstable. Herscovici et al. in 1992 described it as comprising of fracture of clavicle and the surgical neck of the scapula.[1] Williams et al. found in a cadaveric study that glenoid becomes unstable when both the coracoacromian and acromioclavicular ligaments were divided.[5]

Goss further described significant translational displacement of the scapular neck as ≥1cm and angulatory displacement as ≥ 40° in either plane.[6] Pailhes et al. described the Glenoid Offset as distance between medial end of the clavicle and lateral end of the greater tuberosity of the humerus.[7] DeFranco et al.[8] and Wright et al.[9] explained that decrease in the offset or medialization of glenoid by 10-25 mm leads to the abduction weakness. Bestard et al. described Glenopolar angle (GPA) as a

* *Corresponding author.*
E-mail address: drskkaushik08@gmail.com (S. K. Kaushik).

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measure of significant displacement of scapular neck fracture.[10] It is an angle formed by the line joining the superior and inferior pole of a glenoid and the line joining the superior pole of the glenoid the inferior most point of scapula. Normal value ranges between 30°-45°.[11] Results have shown that GPA < 20° has shown to have poor functional outcome.[12]

Hardegger et al. suggested that floating shoulder destabilizes the shoulder joint. There is altered glenohumeral joint relationship.[13] The weight of the upper limb acting on the shoulder joint displaces the scapular neck infero medially[14] and the neuro-vascular structures crossing the shoulder joint stay in traction. The inferomedial displacement scapular neck leads to alteration of the normal lever arm of the rotator cuff. Subsequently this resultant functional imbalance affects all the movements of the shoulder but abduction is affected the most.[13] Ada and Miller have also shown that conservatively treated displaced scapular neck fractures have poor functional outcome because of rotator cuff dysfunction.[15]

The conservative approach in significantly displaced fracture is slow to heal with poor functional outcome, whereas early surgical fixation (preferably within 10 days, otherwise manipulation and reduction of fractures becomes difficult)[16] provides early rehabilitation of the shoulder joint and results in better functional outcome.[17]

2. Materials and Methods

This retrospective study was conducted upon the patients with significantly displaced floating shoulder, treated by surgical fixation from December 2014 till June 2019 at our institute. Twelve significantly displaced floating shoulders (scapular neck medialization >10mm and GPA <30°) were selected. The minimally displaced floating shoulder, intrarticular fractures of shoulder joint and the patients having any associated life threatening injury were excluded.

Standard X-ray shoulder AP and Lateral views both pre and post operative were obtained. Pre operative CT scan with 3D reconstruction was obtained in most of the cases. It helped in better understanding of fracture pattern, displacement of the scapular neck and for the preoperative planning. Clavicular fracture and scapular fracture were classified according to Allman and Goss classification respectively.

Clavicle was fixed with anatomical 3.5mm clavicle plate through standard direct approach in supine position. Scapular fixation was done with 2.7mm anatomical plate for scapula viz. lateral plate for lateral column and/or boomerang plate for body fixation (wherever required) through Judet approach in lateral position. The whole fixation was done as a single stage procedure.

In Judet closure, trapezius released at the medial angular margin of the incision has to be securely restored. Postoperatively the arm was kept in shoulder immobilizer for two weeks till suture removal. This was followed by gentle pendulam exercise in shoulder arm pouch for next fortnight. Full ROM exercises were started after 4 weeks. The clinicoradiological assesment was done at every subsequent 4 weeks of interval with X-ray shoulder AP/Lateral view and Oxford Shoulder Score till 9 months.

3. Results

Twelve patients were operated, two lost to follow up because of non compliance. Eight had sustained injury due to motor vehicle accident while four had history of fall from height. There were nine males and three females. Mean age was 36.9 years. The mean delay in surgery from the day of accident was 5.4 days. Mean stay in the hospital postoperatively was 7.2 days.

Seven had type I Allman clavicle fracture, three had type IIA and two had type IIB. Only type II Goss scapular neck fracture with medial displacement >10mm and GPA <30° were included. Most of the patient had no major complications postoperatively. The mean time for radiological union of clavicle and scapula was found out to be 13.5 weeks and 9.1 weeks respectively. The mean Oxford shoulder score was 45.9 in 7 patients, 36.5in 2 patients and 27in 1 at the end of at least 9 months follow up.

One had concomitant acromion fracture which was managed with plate and screw simultaneously while fixing clavicle. Suprascapular nerve was injured in one patient preoperatively. Three patients had open clavicle fracture one (Gustillo-Andersons Type II), and two (Gustillo-Andersons Type I). One developed infection postoperatively at the clavicle fracture operated site. It was managed with debridement and antibiotics initially and eventually implant removal at 3 months postoperatively. This clavicle fracture went for delayed union at the end of 1 year with no further treatment.

4. Discussion

Scapula fracture constitutes 1% of all the fractures.[18] Scapula neck fracture constitutes 18-33% of scapula fractures.[18] The floating shoulder is a rare complex high velocity injury constituting < 0.10% of all fractures,[1] and only 50% have double disruption of superior shoulder suspensory complex.[18] Half of them have concomitant injuries[2] such as hemothorax, pneumothorax, multiple ribs fracture, brachial plexus injury, cervicle spine and extremities fracture which may lead to under-diagnosis of the condition.[2] Thus high index of suspicion is necessary while assessing injury of shoulder girdle.

There has been a variation in description of floating shoulder in past. It was first described by Ganz and Noesberger in 1975 as an ipsilateral fracture of clavicle and glenoid neck.[3] Herscovici et al. in 1992 described it as ipsilateral mid shaft fracture of clavicle and scapular

Table 1:

S.No	Age/Sex	Fracture Classification		Radiological Union		Functional Outcome (OSS)
		Clavicle (Allman)	Scapula (Goss)	Clavicle (Weeks)	Scapula (Weeks)	
1	27/M	Type I	Type II	14	9	49
2	35/F	Type I	Type II	13	8	43
3	45/M	Type I	Type II	15	11	45
4	37/F	Type IIB	Type II	12	9	47
5	29/M	Type I	Type II	13	8	36
6	26/M	Type IIA	Type II	12	7	43
7	36/M	Type I	Type II	13	9	48
8	54/F	Type IIA	Type II	17	13	27
9	44/M	Type I	Type II	14	9	37
10	36/M	Type IIA	Type II	12	8	46
Mean	**36.9**			**13.5**	**9.1**	

neck fracture.[1] Hardegger in 1984 classified scapular neck fractures as anatomical and surgical neck fractures.[19] Goss introduced 'double destruction' of superior shoulder suspensory complex.[4] Williams et al. found in a cadaveric study that Glenoid becomes unstable when both the coracoacromian and acromioclavicular ligaments were divided.[5] Hence in floating shoulder, stability of the shoulder joint is at stake when either the bony integrity and/or the ligamentous continuity are lost.

Bestard et al. described Glenopolar Angle,[10] normal value ranges from 30-45°.[11] Kim et al. found that functional outcome score in patient with GPA >30° is better than those with GPA <30°.[12] Our results too have shown that >30° Glenopolar angle have shown better functional outcome. Goss also described that >10mm medial displacement and >40° angular displacement of glenoid as a measure of significant displacement.[6] Glenoid Offset described by DeFranco et al. showed poor outcome with the loss of >30mm glenoid offset.[8] Thus displacement plays a major role in functional outcome. So, we decided to study only significantly displaced floating shoulder injury.

Hardegger have shown that the injury in the floating shoulder destabilizes the shoulder joint. There is altered gleno-humeral joint relationship and loss of the normal lever arm of the rotator cuff muscles.[13] Ada and Miller have also described that resultant functional imbalance leads to weakness of all the movements especially abduction.[15] Hence biomechanical alterations affect functional outcome. The surgical fixation restores the normal anatomy.

Most of the studies in past on conservative treatment in minimally displaced fractures, have shown good to excellent results viz Edward et al.,[20] Ramos et al.,[21] Van Noort et al.,[22] Labler et al.[23] Ramos et al. used Herscovici's score for the functional assessment of conservative management after intense physical therapy to conclude that mal-unions are well tolerated in minimally displaced fractures, in our study we have excluded these minimally displaced fractures. But in significantly displaced fractures, treated conservatively, had abduction weakness and acromian impingement.[13] They also concluded that conservative treatment resulted in drooping of glenoid. Caudal dislocation of glenoid is indication of operative intervention.[22] Thus these studies indicatethe need for surgical fixation in significantly displaced floating shoulder.

Fig. 1: Case 1: Pre-op X-ray (Clavicle Type I, Scapula Goss Type II GPA <30°)

The study on fixation of only clavicle viz. Rickli et al.,[24] Hashiguchi et al.,[25] Low et al.[26] and Constant et al.[14] have advocated that fixation of clavicle indirectly reduces the scapular neck and restores almost normal anatomy. Low et al. in their study have shown excellent result using Rowe's score, after fixation of clavicle only, they believed that clavicle fixation reduces the scapular fracture indirectly with the help of intact ligaments, moreover they did not fixed scapula considering prolonged operative time as well as musculature trauma may lead to delay the rehabilitative

Fig. 2: Case 1: Pre-op 3-D CT Scan(Clavicle Type I, Scapula Goss Type II GPA <30°)

Fig. 3: Case 1: Post-op X-ray AP view (2 plates in Scapula, GPA restored > 30°)

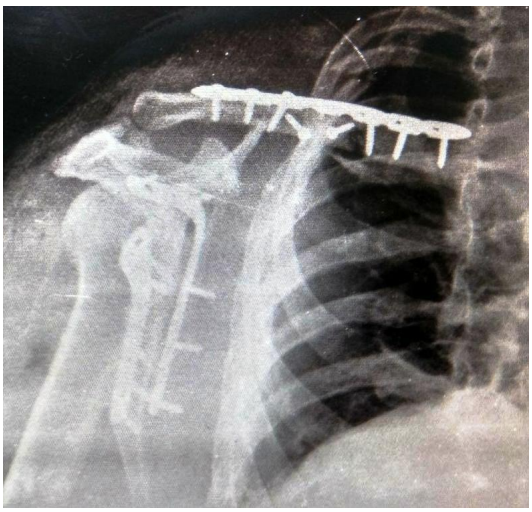

Fig. 4: Case 1: Post-op X-ray Lat view (2 plates in Scapula, clavicle fixed with plate)

Fig. 5: Case 1: Functional Outcome(Painless Abduction > 160°, No Winking of face present)

process. In our study we assumed that significantly displaced scapular neck may not have intact ligament for indirect scapular reduction, so we preferred scapular fixation in same stage, we did not find that prolonged operative time or trauma to the scapular musculature had any bearing on the rehabilitative programme. Thus in cases where ligaments are intact, only clavicle fixation may reduce the scapular fracture, but where ligament intactness is questionable, as in significantly displaced scapular fracture, fixation gives better functional outcome. As the role of MRI to diagnose ligament injury in the acute phase is doubtful, we can indirectly relate the intactness of the ligaments on the measure of the displacements.

Fig. 6: Case 2: Pre-op X-ray (Clavicle Type I, Scapula Goss Type II GPA <30°)

The proponents of both clavicle and scapula fixation viz. Goss et al.,[4] Herscovici et al.,[1] Leung et al.,[27] Van Noort

Fig. 7: Case 2: Pre-op 3-D CT Scan (Clavicle Type I, Scapula Goss Type II GPA <30°)

Fig. 8: Case 2: Post-op X-ray AP view (1 plates in Scapula, GPA restored > 30°)

et al.[18] and Labler et al. showed good to excellent result in significantly displaced fractures when both the fractures were fixed surgically. Herdegger et al. recommended fixation in all anatomic neck scapular fracture.[13] Leung et al. expressed that post operative rehabilitation was started early in this group.[27] Results of our study are in unison with this group of researcher.

Though there is debate over timing of fixation from the time of injury and sequence of fixation. We at our institute fix both the fractures in the same sitting within 10 days of injury as suggested by William et al.[16] We fix clavicle first as suggested by William et al. as it makes scapula fracture less mobile and hence reduction once achieved becomes stable.[16] They suggested the key step in scapular lateral border reduction is that it is achieved much easily by

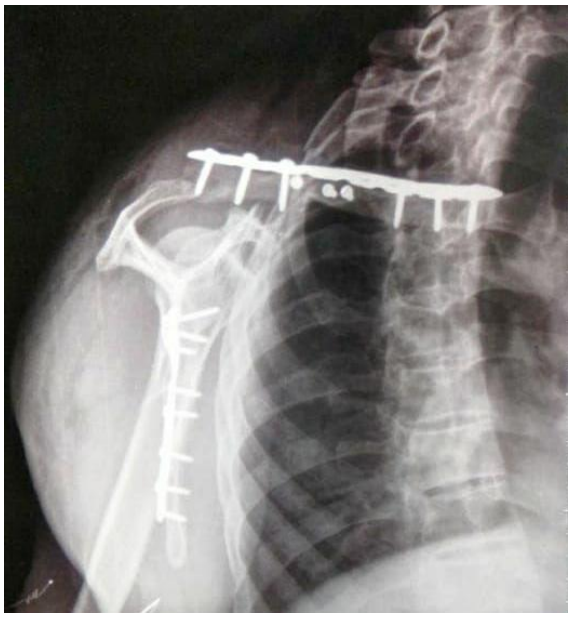

Fig. 9: Case 2: Post-op X-ray Lat view (1 plates in Scapula, clavicle fixed with plate)

Fig. 10: Case 2: Functional Outcome (Painless Abduction > 150°)

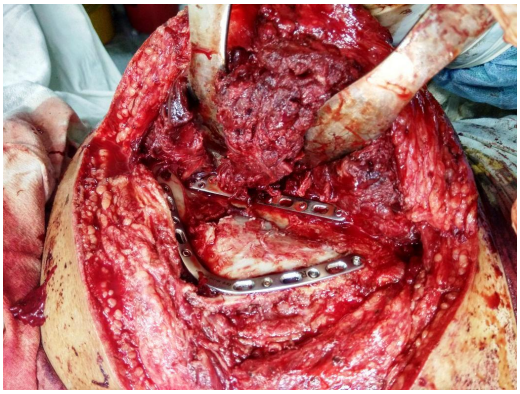

Fig. 11: Intra-operative: Intra-op Plate In-situ (Both lateral and medial border of scapula fixed

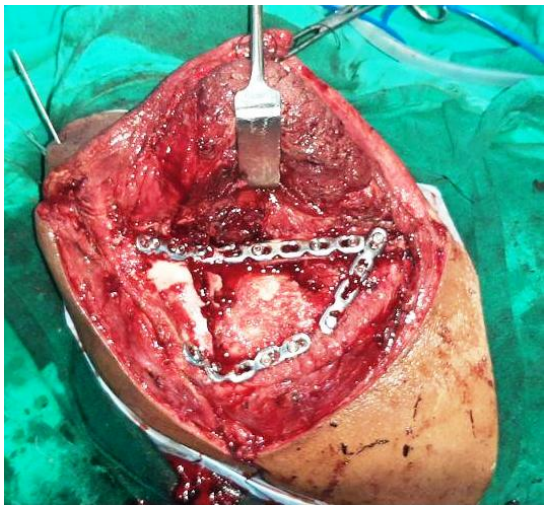

Fig. 12: Intra-operative: Intra-op Plate In-situ (Both lateral and medial border of scapula fixed)

retracting body of the scapular body infero-medially instead of giving traction on the glenoid neck laterally.[16]

From the above studies we interpreted that the important prognostic factors for the management of floating shoulder depends on injury to ligaments stabilizing the shoulder joint (viz coracoclavicular, acromioclavicular and coracoacromian), degree of medial and caudal displacement of scapular neck fracture and glenopolar angle. Hence we have included only significantly displaced floating shoulder.

5. Conclusion

One should have high suspicion for floating shoulder in poly trauma patients resulting from high velocity injury. Unarguably minimally displaced floating shoulder should be managed conservatively, but those with significant displacement should be fixed, as soon as possible, preferably within 10 days. The fixation of clavicle first makes the scapula fixation easier. The surgical fixation allows early rehabilitation as well as better functional outcome in significantly displaced floating shoulder. Though the sample size is very small in our study, the study on the large group is required to reach to a definite conclusion.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Author biography

Animesh Kumar Singh Assistant Professor

Suresh Kumar Kaushik Associate Professor

Apser Khan Associate Professor

Sanjay Gupta Professor and Head

Vivek Prakash Junior Resident

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