



Anatomical Precontoured Locking Plate versus Reconstruction Plate in Unstable Clavicular Fractures

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Abstract

Introduction: For the fixation of unstable clavicular fractures, unique plates are available with merits and demerits. Reconstruction plates are reasonably-priced but their strength and rigidity had been doubtful. The anatomical pre contoured locking plates offer better stability in comparison with the reconstruction plate.

Materials and Methods: We have analyzed prospectively 40 unstable clavicular fractures treated surgically with pre contoured anatomical locking plate (20cases) or reconstruction plate (20 cases) for patients admitted in our institute between June 2018 and Oct 2019. The clinical and radiological results among the reconstruction plate and pre contoured anatomical locking plate have been compared by Quick Disability of the Arm, Shoulder and Hand (DASH) score and plain radiographs, respectively.

Results: The mean time of union was 16.3 weeks with the reconstruction plate as compared with 13.4 weeks with the pre contoured locking plate. The Quick DASH score was 32.65 in the reconstruction plate patients and 25.44 in the pre contoured locking plate group. Screw cut out and plate failures were found within the reconstruction plate group which needed removal of implant. The mean follow-up month was 16.44 months (14–31 months). Implant removal was carried out in three patients in the reconstruction group and one patient in pre contoured plate group. 3 nonunion occurred with recon plate and one with pre contoured plate.

Conclusion: Surgical management of unstable clavicle fractures with anatomical pre contoured locking plate results instable fixation, early union, and better results in comparison with the reconstruction plating.

Keywords: anatomical pre contoured plate fixation, quick DASH score, reconstruction plate fixation.

Introduction

Comminuted displaced midshaft Fractures of clavicle are common injuries across the shoulder girdle. Fractures of the clavicle account for about 2.6% of all fractures Historically, the clavicle

fractures had been managed conservatively^{1,14}. The middle-third fractures are common and account for approximately 85% of all clavicular fractures⁸. The narrow segment of the bone in the middle of shaft combined with usual muscle

forces acting over it predispose to fracture the bone on this locality. Most clavicle fractures generally unite with any approach of immobilization.¹ Hence, non-operative treatment initially was the accepted modality of those fractures. But research have shown a high rate of non union^{7,9,10} and symptomatic malunion¹³ and shortening¹⁵ when the displaced fractures are treated conservatively.² Other shortcomings of non-operative treatment had been functional impairment of the shoulder and a non-cosmetic bump at the bottom of the neck possibly due to shortening and displacement of the clavicle and exuberant callus formation. Functional results of unstable clavicle fractures isn't simply related to its union, but additionally to its length. To maintain the length plate is the ideal implant than a nail⁴. Clavicle acts as a "strut" that keeps the upper limb away from the torso for efficient shoulder and upper limb function, while also transmitting forces from limb to the trunk. Thus, displaced or comminuted fractures carry a chance of symptomatic malunion and poor functional outcome with cosmetic deformity. Plate fixation provides immediate rigid stabilization and pain relief and facilitates early mobilization.³ Regarding plate osteosynthesis the implant used mainly are reconstruction plate and pre contoured locking plates. Restoration of length and alignment achieved only by way of surgical strategies¹² which are not achieved by conservative treatment. Good outcome with high union rates and minimal complications has been mentioned with surgical fixation of the unstable clavicle fractures with anatomical locking plate compared to reconstruction plate.⁴ However, operative management got its disadvantages like infection at surgical site, hypertrophic scar, hardware prominence and another surgical treatment for implant removal. Hence, in this study we compare the outcome of unstable clavicle fractures fixed with reconstruction plate and anatomical locking plate.^{5,6} The implant used in all our patients was a pre-contoured 3.5 mm superior clavicle anatomical locking compression

plate and 3.5 mm reconstruction plate. Another set of 2.7 mm lag screws was always kept ready, in order to lag any unstable butterfly fragment(s), if the need arose.

Materials and Techniques

Our study from June 2018 to Oct 2019 prospectively analysed 40 cases of unstable clavicle fractures treated with anatomical locking plate 20 patients and reconstruction plate 20 cases. Inclusion criteria were age among 20 to 50, closed displacement > 2cm unstable clavicle fracture with shortening > 2cm with or without comminution falling under Robinson category as kind 2B1 and 2B2, Segmental fractures, Open fracture, Impending compound fracture with soft tissue compromise, bilateral clavicular fractures

Operative technique

The surgery was performed under regional block or general anaesthesia when needed. The patient was positioned supine, with the head and neck tilted away from the surgical site with a bump placed behind the scapula to aid in reduction. The arm was prepared in the field to allow for traction and manipulation to assist in the reduction. Pre-operative intra-venous antibiotic (Cefotaxime 1 gram) was given to the patient, at least 30 minutes before making the skin incision. The skin inferior to the fracture site was incised after pulling it up to the fracture site. As the skin was released, it fell 1 to 2 cm below the clavicle and prevented the wound from being in contact with the plate on the clavicle. The subcutaneous tissue and platysma muscle were kept together as one layer and extensively mobilized, especially proximally and distally. Sharp dissection was taken down to the bone, with care to identify, and if possible, preserve the cutaneous supraclavicular nerves. When deemed necessary, they were sacrificed. The myofascial layer over the clavicle was incised and elevated in one continuous layer comminuted fragments, especially the often seen anterosuperior fragment was teased back into position, as much as possible, maintaining its soft tissue attachments. The fractured bone was reduced and

the reduction held with the aid of reduction clamps. The reconstruction plate was contoured to the shape of clavicle. The pre-contoured plate matching the clavicle was placed on superior position. Biomechanical studies have shown this position to provide best stability. The clavicle was drilled cautiously keeping in mind the relation of the subclavian vessels to the inferior surface to clavicle. Ideally 3 (at least 2) bicortical screws on either side of the fracture were needed; lag screws were used wherever needed to reduce the comminuted fragments. Once plating was completed, the fascia was repaired over the plate. Skin incision was closed. Antiseptic dressing was applied, and the arm was rested in an arm sling. Postoperative the patient was kept in the post-operative recovery ward, under observation. Vitals were monitored.

Assessment of Treatment Results

The patients followed at 6 weeks and at 3, 6, 12 months. At each visit, and for any complications, anteroposterior radiographs were taken. Radiographic union was defined as cortical bridging throughout the fracture so that fracture line is not visible. Functional evaluation done using the DASH score. Statistical evaluation was done. $p < 0.05$ was considered significant.

Results and Observation

It has been noted that fractures were found in the working age-group mostly with male predominance and dominant side. Road traffic

accidents contributed to most of the injuries. The patients age, gender, cause of injury, and fracture pattern were not statistically significant between the two groups ($p > 0.05$). The mean operative time was 85.1 min (SD 19.4 min) within the reconstruction group, and 59.3 min (SD 12.6 min) in the anatomical locking plate patients revealing intergroup differences. The need for lag screw is more for reconstruction plate than anatomical plate. The shorter time is particularly due to no need for plate contouring as compared with the reconstruction plate group in which maximum of the time spent in contouring the plate to the bone curvature. Bony union occurred at 16.3 weeks (range: 8–31 weeks) and 13.2 weeks (variety: 8–18 weeks) in the reconstruction and anatomical locking plate, respectively, indicating intergroup difference ($p < 0.05$). In the clinical assessment, the reconstruction group and anatomical locking group showed a mean Quick DASH score of 32.65 (SD $\frac{1}{4}$ 9.4 points) and 25.44 points (SD $\frac{1}{4}$ 12.7 points), respectively ($p > 0.05$). Postoperative complications were noted in both the groups. In the reconstruction group, there was hypertrophic scarring without pain in 3 cases, shoulder movement restriction in 2 cases, painful shoulder in a single case, screw pull out in 2 cases, and plate failure in one case. In the anatomical locking plate group one screw pull out was there and infection and non union in 1 person due to diabetes.

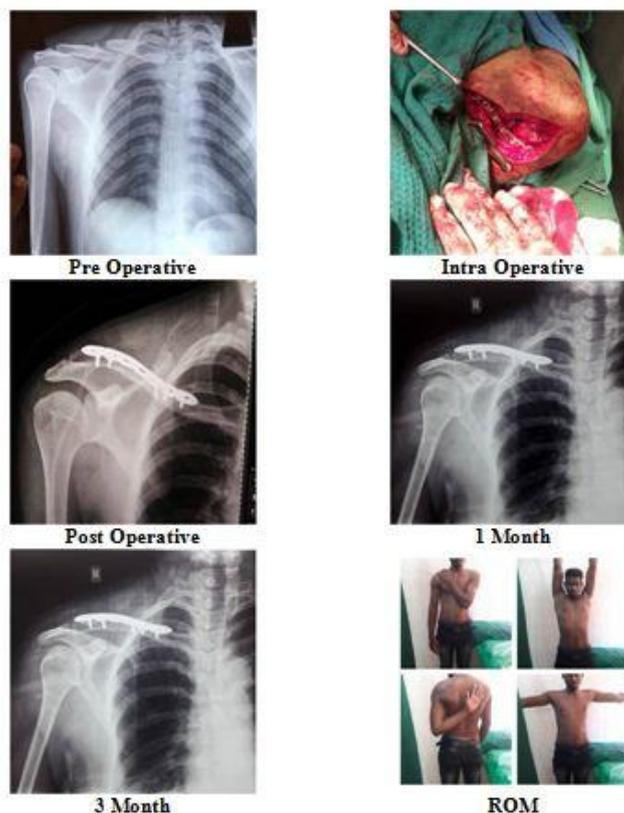
Table-1: Demographic profile

	Reconstruction group	Pre contoured plate group	p value
Age	29.5	27.5	>0.05
Sex	12:8	13:7	>0.05
Dominant side	84%	92%	>0.05
RTA	14	15	
Fall	6	4	>0.05
Sports injuries	0	1	
Type of fractures			
Type b1	7	5	>0.05
Type b2	13	15	

Table-2: Outcome Analysis

	Reconstruction plate	Anatomical plate	P value
Operative time (min)	85.1	59.3	<0.5
Bone union period (weeks)	16.3	13.2	<0.5
Quick DASH score	32.65	25.44	>0.5
Plate prominence	3	1	
Hypertrophicscar	2	-	
Implant removal	2	1	
Non union	2	1	
Screw pull out	3	1	

Fig-1: Case Illustration



Discussion

Clavicle fractures are normally treated conservatively. In a study conducted to analyze the results of conservative treatment of displaced midshaft fractures of clavicle by Michael et al they detected residual deficits in shoulder strength, especially endurance strength, in this patient population.^{7,8} They also found clavicular shortening was associated with a decreased abduction strength¹¹, and shortening of >2cm was associated with a patient dissatisfaction. A.H Qvist et al compared plate fixation with non operative treatment of displaced midshaft clavicular fractures and concluded pre contoured and locking plates results in faster functional

recovery and a higher rate of union when compared with non operative management.

Fig-2: 3D Reconstruction of plate



Reconstruction plates have fallen into disfavor, since they are susceptible to deformation at the fracture site, leading to malunion. In study by J-W Shen and others concluded a three dimensional reconstruction plate is better than 2D plate which is placed superiorly. To overcome this Site specific pre contoured locking plates^{16,17} are now available. Hardware prominence was less when pre contoured plate was used. Tania Reisch et al in their research in 100 patients found the new pre contoured locking plate fit to the anatomical shape of the clavicle. The implant seems to be reliable regarding handling and complications.^{9,10} Hardware removal rates are comparable to other studies with a pre-contoured plate and lower compared to non pre-contoured. In a study by Alexander et al they found the pre contoured plates significantly diminish hardware prominence. Corine van beck et al compared superior plating of non contoured and pre contoured plating and found superior pre contoured plates have low incidence of plate prominence and hardware removal. McKee (2010) reported that primary plating of displaced middle third clavicle fractures has better outcome, quick functional recovery, and decreased rate of non union and symptomatic malunion when compared to non operative treatment. Two of the most commonly used techniques for operative treatment are open reduction and internal fixation with plate and intramedullary nail fixation.¹¹⁻¹⁴ Nidhinarsaria in his study found elastic intramedullary nailing is a safe, minimally invasive technique with a lower complication rate but Arno frigg and others studied about the complications like nail breakage, medial migration, hardware irritation. The sigmoid shape of the clavicle poses specific problem in the design and insertion of intramedullary devices and static locking is not possible with the implants currently available. There is biomechanical evidence to suggest that plate fixation provides a stronger construct than intramedullary fixation. Functional results of unstable clavicle fractures isn't simply related to its union, but additionally to its length. To

maintain the length plate is the ideal implant than a nail. Clavicle acts as a "strut" that keeps the upper limb away from the torso for efficient shoulder and upper limb function, while also transmitting forces from limb to the trunk. Thus, displaced or comminuted fractures carry a chance of symptomatic malunion and poor functional outcome with cosmetic deformity. Plate fixation provides immediate rigid stabilization and pain relief and facilitates early mobilization.¹⁵⁻¹⁷ Most commonly the plate is implanted on the superior aspect of clavicle. Currently the implants most commonly used are locking plates.

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significantly lower for anatomical locking plate than reconstruction plate. Patients return early to routine works in anatomical plate group when compared to reconstruction plate group.

Conclusion

So we conclude from our study anatomical locking plate used for fixing unstable clavicle fractures results in early and good fracture union and early return to routine activities when compared to reconstruction plate.

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