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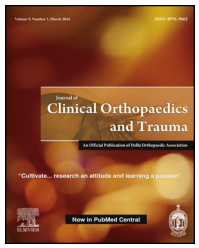

Original Article

Comparison of treatment of fracture midshaft clavicle in adults by external fixator with conservative treatment

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ABSTRACT

Purpose: High rate of malunion and non union in displaced fracture clavicle treated conservatively lead to use of different types of internal fixation methods which also were found to be associated with various complications. Moreover their superiority over conservative treatment has not been established. This study was designed to compare clinical outcome of conservative treatment with external fixator in cases with displaced midshaft clavicle fractures.

Methods: Fifty adult consenting cases of acute midshaft fracture clavicle, displaced >15 mm were included. Twenty five cases were allotted to conservative (group A) and external fixator (group B) each. In group A treatment was given in form of clavicle brace. In group B schanz pins were inserted obliquely between supero-inferior and anterior-posterior direction and connected with rod. The outcome was measured by Constant score, union time and complications.

Results: Mean radiographic union time in group A was 23.45 ± 1.40 weeks (with 8% non union and 80% malunion) and in group B it was 9.36 ± 1.49 weeks. Mean Constant score at 6 months in group A was 78.28 ± 6.45 and in group B 92.72 ± 1.48. Mean shortening at 6 months in group A was 19.36 mm. In group B shortening at 6 months was noticed in three cases (6, 5, 6 mm).

Conclusion: Close reduction of acute fracture mid clavicle and application of external fixator is a simple procedure providing the benefits of rigid fixation and undisturbed fracture environment. Pain relief is faster, union time is shorter and there are no hardware related problems.

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1. Introduction

Clavicle fracture is one of the most common fractures in adults. Majority of clavicle fractures are situated in the middle (81%).[1]

All methods used for treatment of displaced fractures of midshaft clavicle have shortcomings. Conservative treatment of displaced fracture clavicle leads to shortening of clavicle, pain, loss of strength, rapid fatigue, hyperaesthesia of the hand and arm, difficulty sleeping on the affected side and aesthetic complications.[2–6] More than 9.7% shortening of

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clavicle of its original length is associated with poor outcome.[7] There is evident association between shortening and non union.[3] Pseudarthrosis (upto 5%),[8] high rate of malunion (upto two thirds)[9] and non union (upto 15%)[3] have been reported with displaced fracture treated conservatively. Many patients remain symptomatic for long time with increased risk of prolonged sequels at 9–10-year follow up.[10]

In cases of displaced or comminuted fractures operative treatment is reported to be better than conservative treatment[2] but every fixation method has associated complications.

Intra-medullary devices are difficult to insert in clavicle due to inherent gentle s shape of the bone and small medullary canal. They can be associated with complications such as hardware failure, nerve injury, skin breakdown[11–13] hardware migration and neurovascular injury.[14,15] Without static locking mechanism there can be shortening of the clavicle in comminuted fractures.[12,13]

Plate fixation is associated with infection (5–22%), hardware irritation (9–64%), subcutaneous prominence, poor cosmesis due to postoperative scar, resurgery to remove plate, refracture after removal of plate and even non union after plating.[2,3,16,17]

Recently reported studies and cochrane review have not been able to establish clear superiority of operative over conservative management in fracture clavicle.[18–20] This study was conducted to evaluate the clinical outcome and complications of fracture clavicle treated by external fixator in comparison to conservative method.

1.1. *Research question*

Does acute displaced fracture midshaft clavicle treated by external fixator result in better outcome than conservative method.

2. Methods

This study was conducted between October 2010 and April 2012. Fifty adult patients with midshaft clavicle fractures were enrolled in this study which was designed as a case control study. Institutional approval was obtained from the local Ethics Committee before initiation of the study. Informed consent was obtained from cases.

All consenting adult patients with less than one week old closed midshaft fracture of clavicle (Fig. 1) were included in the study. The fractures that were completely displaced, comminuted or with shortening of more than 15 mm (in comparison to normal side) were included.

Open fracture clavicle, associated neurovascular injury, undisplaced fracture, fracture of medial or lateral ends, non union, malunion, medically unfit and non-consenting cases were excluded.

The conservative treatment was given in form of clavicle brace application. The affected upper limb was supported in an arm pouch. The clavicle brace was discontinued at 6 weeks but arm pouch sling was continued till union was ascertained. Pendulum shoulder exercise was initiated when pain resolved. Range of motion exercises were initiated after union was ascertained.

2.1. *Technique of clavicle external fixation*

Patient was put in supine position with a sandbag between the scapulae. Closed reduction was done under image intensifier guidance (antero-posterior and 45° cephalic tilt in antero-posterior) and was provisionally fixed with Kirschner wires. Two schanz pins (3.5 mm) were inserted on medial fragment from anterior to posterior in horizontal plane in slightly cephalad direction to avoid the injury to the pleural dome. On the lateral fragment two schanz pins were inserted obliquely between supero-inferior and anterior-posterior direction to avoid neurovascular structures. The pins were connected with the appropriate length of 'gentle S' shaped rod to complete the construct (Fig. 2). The limb was supported in an arm pouch sling. At each follow up pin sites and fixator stability was checked clinically and radiologically, till union. The fixator was removed when radiological union was evident (Fig. 3). The fracture was considered to be united when there was no tenderness and the fracture line was not visible or callous formation was seen on X-ray. Gentle pendulum exercise of the shoulder in the arm pouch was initiated at second day of surgery. At 4 weeks active range of motion of the shoulder was allowed but abduction was restricted to 80°. At 8 weeks active range of motion in all planes was allowed.

Follow up was done at 2, 4, 8, 12, 16, 20 weeks and finally at 6 months for both the groups. The outcome was measured in terms of Constant and Murley score, union time and complications. The functional outcome by Constant and Murley score was performed at 6 months. The length of fractured

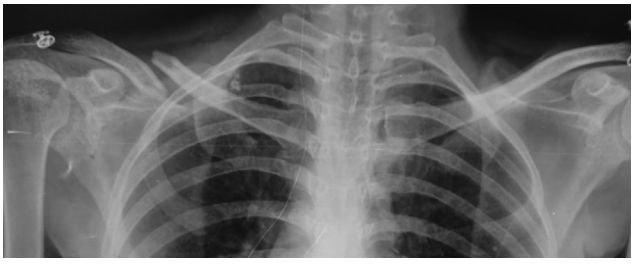


Fig. 1 – Shows displaced fracture midshaft clavicle.

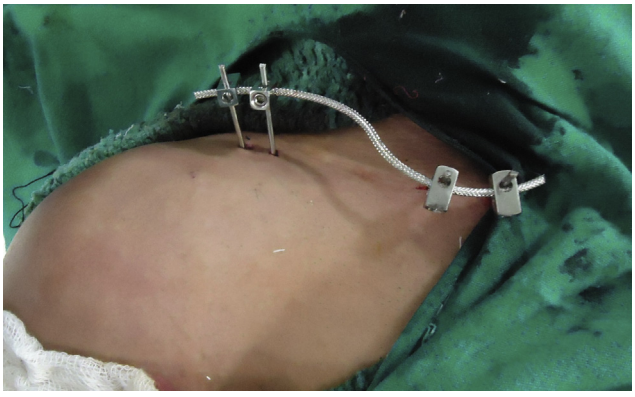


Fig. 2 – Shows external fixator on right clavicle after close reduction.

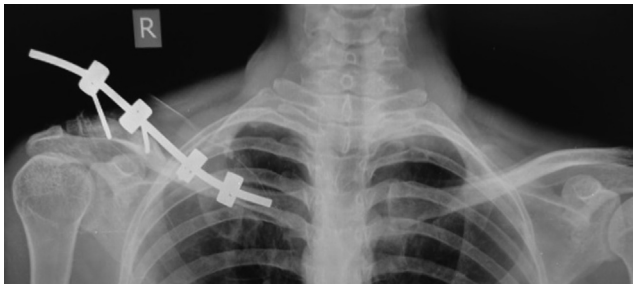


Fig. 3 – Shows union without shortening of fracture clavicle with external fixator.

clavicle was also measured at final follow up to calculate shortening.

3. Results

Out of 25 cases in each group, there were 96% male, 4% female in group A and 84% male, 16% female in group B. The mean age was (32.6 ± 6.43) in group A and (30.56 ± 7.10) in group B. Seventy six percent cases in group A and eighty percent cases in group B were younger than 39 years of age (Table 1). There were 8 cases (32%) of right side and 17 cases (68%) of left side fracture in both groups.

The most common cause of fracture in both the groups was road traffic accident (72% cases in group A and 76% cases in group B). Fall on the affected shoulder was the cause of fracture in 12% cases in group A and 16% cases in group B. In group A in 16% cases and in group B in 8% cases cause of fracture was indirect injury due to fall on outstretched hand. Five cases had associated injuries due to road traffic accident, one had humerus fracture and one had head injury and 3 cases had ribs fracture.

Mean time of radiographic union in group A was 23.45 ± 1.40 weeks and in group B was 9.36 ± 1.49 weeks. In group A fracture union was documented in 16% cases by 16 weeks, 76% cases by 20 weeks and 8% resulted in non union. In group B union was documented in 72% cases by 8 weeks and in rest of 28% cases also fracture united by 12 weeks (Table 2).

In group A, 80% cases resulted in malunion (Fig. 4) and 8% cases had non union whereas Group B patients did not have any complication (Table 3). The cases in group A required analgesics till first follow up at two weeks but in group B analgesic support was not required beyond third post-operative day.

Mean pre-operative Constant and Murley score in group A was 30.56 ± 1.29 and group B was 32.24 ± 2.45. At 6 month follow up Constant and Murley score in group A was 78.28 ± 6.45 and in group B was 92.72 ± 1.48 (Table 4). After six month follow up, the difference in functional outcome in both groups was statistically significant ($p = 0.00$).

In group A the mean pre treatment shortening was 23.28 mm and mean shortening at 6 months was 19.36 mm. In group B the mean pre treatment shortening was 25.76 mm and shortening at 6 months was noticed in three cases (6, 5, 6 mm).

Table 1 – Shows demographic distribution.

Age in years	Group A	%	Group B	%
20–29	9	36%	10	40%
30–39	10	40%	10	40%
40–49	6	20%	5	24%
Total	25	100%	25	100%

Table 2 – Shows time of union.

Time of union (in weeks)	Group A	%	Group B	%
8	0	0	18	72%
12	0	0	7	28%
16	4	16%	0	
20	19	76%	0	

4. Discussion

Most of the fractures of clavicle unite conservatively but surgery is indicated at the first place in open fractures, floating shoulders, and fractures associated with neurovascular injuries.[21] Surgery should also be considered for fractures which are grossly displaced and severely comminuted as they have propensity to land up in non union [Table 5].[22,23]

Recent studies which have compared conservative with operative treatment of displaced midshaft fracture clavicle, have documented better union rates and early functional return with fixation and association of malunion and non union with conservative treatment [Table 6].[19,24–29]

4.1. *Union*

To achieve union in anatomic position, fracture has to be reduced anatomically and fixed in this position till union occurs. We found that closed reduction of acute midshaft clavicle fracture is not difficult. As clavicle can be palpated through out its length and can be visualised per-operative by image intensifier (antero-posterior and 45° cephalic tilt in antero-posterior), acceptable reduction can be achieved. Application of external fixator is a simple procedure and it is capable in maintaining fracture in reduced position till union. We documented significantly shorter union time in fixator group than conservative group in this study. All the cases in external fixator group went on to have solid union by 12 weeks and in 72% cases union was noticed by 8 weeks. Excellent outcome with 100% union rate has been reported by use of

Fig. 4 – Shows malunion with shortening of fracture clavicle.

Table 3 – Shows complications.

Complications	Group A	Percent (group A)	Group B	Percent (group B)
Malunion	20	80%	0	0%
Non union	2	8%	0	0

external fixator in cases of established non union of fracture clavicle by Lodhi et al.[30] But in conservative group in this study union was noticed in only 82% cases that too by 20 weeks and 8% cases in this group resulted in non union.

The inherent advantage of any closed reduction is undisturbed fracture haematoma and intact soft tissue envelop that provides a perfect biological milieu for fracture union. The combination of advantages of closed reduction and sound fixation leads shorter union time in external fixator group as noticed in this study.

Clavicle by virtue of its compact structure offers good hold of schanz screws. We inserted schanz screws in slightly different planes across fracture site to improve the construct biomechanically. There was no instance of failure of fixator in this study.

4.2. *Pain relief*

Because of minimal surgical invasion and immobilisation of fracture, all cases in the fixator group had substantial pain relief on first postoperative day and no need of analgesics after 3 days. But the group treated conservatively had pain for long time. Pain relief is an important factor for initiation of rehabilitation program hence preventing stiffness of shoulder and regaining strength around shoulder girdle. Because of pain relief in external fixator group pendular shoulder exercises could be initiated in immediate postoperative period.

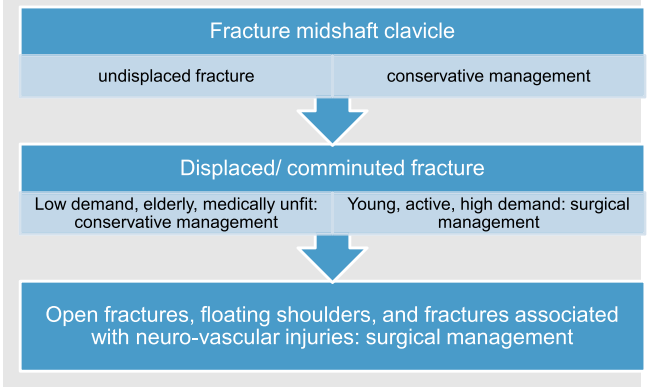
4.3. *Functional outcome and disabilities*

We noticed that cases in external fixator group regained near normal shoulder function and all the cases had excellent Constant score whereas none of the cases in conservative group reached excellent constant score. Better functional outcome in external fixator group is depicted by statistically significant difference in mean Constant score of 92.72 ± 1.48 in external fixator group as compared to 78.28 ± 6.45 in conservative group at the end of six months.

Table 4 – Shows the functional outcome as assessed by Constant and Murley score.

Functional outcome at 6 months	Group A	%	Group B	%
Excellent	0	0%	25	100%
Good	17	68%	0	0%
Fair	5	20%	0	0%
Poor	3	12%	0	0%
Total	25	100%	25	100%

Table 5 – Treatment recommendation for fracture midshaft clavicle.



4.4. *Implant removal*

Patients on external fixator had to undergo fixator removal but it is an out patient procedure with minimal pain. In many studies reported with plating, the rate of implant removal is high either due to hardware problems (breakage, failure, irritation) or routinely.[17] Removal of plate requires surgical invasion, anaesthesia and admission hence increasing the cost of treatment. Cosmesis is also not a problem in external fixator as there is no surgical scar or palpable or visible bony bump which is present in displaced fracture managed conservatively.

4.5. *Complications*

Out of all potential complications, malunion associated with shortening is of utmost importance as it is associated with impaired biomechanics of the shoulder girdle by scapular winging, change in orientation of glenoid and sternoclavicular joints.[9,31] All the cases in group A had significant shortening at 6 months with a mean of 19.36 mm. Where as minimal shortening was also noticed in three cases of comminuted fracture of fixator group (6, 5 and 6 mm) but this did not cause any hindrance to functional return. Hill[3] reported more than 20 mm shortening and Di Giorgi more than 9.7% shortening of length of clavicle as cut of leading to unsatisfactory outcome. The universal problem with external fixator group was difficulty with normal clothing. Displaced midshaft clavicle fractures managed conservatively have been reported to be associated with high rate of malunion and non union[2–7] as also in this study. There were two cases of non union and shortening with malunion was a universal phenomena in the conservative group.

Any midshaft fracture clavicle which is comminuted and/or grossly displaced with shortening more than 15 mm as compared to the opposite side in young active adult is a suitable case for surgical fixation. Use of external fixator in such situation is valid alternative to open reduction and internal fixation. Because of paucity of literature for this technique as well as small sample size of this study it is difficult to establish superiority of this method over other methods of fixation. But because of inherent advantages like simplicity of

procedure, faster pain relief, shorter union time and lesser chances of hardware related complications, use of external fixator in displaced midshaft clavicle fracture can become mainstay treatment. The small sample size is a drawback of the study.

5. Conclusion

Close reduction of acute fracture midshaft clavicle and fixation with external fixator is a simple procedure. It provides the benefits of conservative treatment as the fracture environment is undisturbed and also provides the benefits of implant fixation in terms of maintenance of reduction. Pain relief is faster, union time is shorter and there are no hardware related complications. It has potential to become a main line treatment option for displaced midshaft fracture of clavicle.

Conflicts of interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

Table 6 – Shows recent studies comparing conservative with surgical treatment.

Robinson CM. J Bone Joint Surg Am. 2013 Sep 4; 95(17):1576–84	Prospective randomised multi centric study comparing plating with conservative treatment	Plating reduces chances of non union and results in better functional outcome but can not be recommended for every case
Virtanen KJ et al J Bone Joint Surg Am. 2012 Sep 5; 94(17):1546–53	Prospective randomised study comparing conservative with plate fixation	Higher non union rates at one year in conservatively treated group
McKee RC. J Bone Joint Surg Am. 2012 Apr 18; 94(8):675–84.	Meta analysis of conservative verses operative treatment	Operative treatment has significantly lower rate of non union and symptomatic malunion with early return of function
Kaisa J Virtanen et al Acta Orthopaedica 2012; 83(1): 65–73	A systematic review of 1190 patients from the literature	Patients treated surgically had better functional outcome in short term. Surgery to be reserved for young active patients who want to return to previous activity level early.
Fardin Mirzatolooei. Acta Orthop Traumatol Turc. 2011; 45(1):34–40	Prospective randomised trial comparing plating with conservative treatment	Open reduction and plating of comminuted fracture of clavicle has better outcome than conservative treatment
Vander Have KL. J Pediatr Orthop. 2010 Jun; 30(4):307–12	Comparison of conservative treatment with plating in adolescents (case control study)	Plating group was found to have shorter union time, better pain relief and less complications.
Altamimi SA, McKee MD; Canadian Orthopaedic Trauma Society. J Bone Joint Surg Am. 2008 Mar; 90 suppl 2 Pt 1:1–8	Prospective randomised multi centric study comparing plating with conservative treatment	At one year surgically treated had better functional outcome and lower rates of malunion and non union

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