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Prospective study of middle 1/3rd clavicle fracture managed with clavicle contoured plates

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Abstract
Aim
Clavicle being most common bone to get fractured, accounting for about 5-10% of all injuries, with middle 3rd being the commonly fractured site. As it is common in young active adults and the incidence being increased due to RTA's and sports injuries, clavicular plate fixation gained importance in recent trends. Earlier clavicle fracture is managed conservatively with figure of '8' bandage, arm sling or clavicular brace with a relatively good outcome. Though uncommon, nonunion rate of 0.8-1% is seen in conservatively managed patients according to Rowe [1]. In 2006 Michael Mckee *et al.* [2] concluded residual deficits in shoulder strength and endurance in conservatively managed patients.
Purpose of this paper is to study clavicle middle 1/3rd fractures treated with plating technique.
Materials and Methods
Prospective analysis of 30 patients who were operated at MIMS hospital, Nellimarla, Vizianagaram, between Nov 2015 to Jan 2017 for clavicle fractures treated with clavicle contoured plate fixation. Patient position is beach –chair semi sitting position on regular operating table. An oblique skin incision centered over fracture site. Sub cutaneous tissue & platysma muscle are kept together as one layer and extensively mobilized. Supra clavicular nerve is protected. Myofascial layer over clavicle is incised & elevated in one layer. The main fragments cleaned and debris removed. Do not violate the subclavicular space. Then precontoured plate positioned and fixed over superior surface of clavicle and neutral mode for comminuted and unstable fractures. The wound is closed in layers with interrupted, non-absorbable sutures.
Review done post- operatively at 2 weeks, 6 weeks, 12 weeks and 6 months.
Results
The average hospital stay is 7days. 27 out of 30 had functional & radiological union by 12 weeks (range of 6-18 weeks), 2 had deep infection and nonunion, 1 got superficial infection which was treated with antibiotics. No significant difference in functional & ROM scores at 3, 6 months. We followed standard score like Constant Murley score, oxford shoulder score, DASH scoring system for evaluating the functional outcome. We had Average oxford shoulder score of 42 (range 34-48). Lane Sandhu score showed no difference between control group and experiment group, Average Quick DASH score of 46 (range 38-54).
Conclusion
Open reduction and internal fixation with clavicle contoured plate is gold standard treatment for displaced middle 1/3rd clavicle fracture. It helps in getting back to daily activities and early mobilization with significantly less nonunion rates.

Keywords: Clavicle Contoured Plate, MID 1/3rdClavicle Fracture

Introduction
Clavicle is horizontal bone at the root of the neck. It is a sub-cutaneous bone. It is a crank shaped cartilever trust carries scapula. It transmits part of weight to the axial skeleton. Acromial end with medial side of acromian and medial end with clavicular notch of sternum and first coastal cartilage. The shaft is gently curved & resembles the Italic letter *f* in shape convex forwards in medial 2/3rd and concave forwards in lateral 3rd. Clavicle ossifies before any bone in the body that is 5th and 6th week of I.U.L which fuses about 4th and 5th day but growth completes by 23rd year in both sexes.
Clavicle fracture common in young those who participates in sports activities and where high speed falls or violent collisions are frequent, accounting for 2.6% of all fractures.

Epidemiologic study (Robbinson) [3] reported annual high incidence in males under 20 years decreasing with each subsequent age cohort. The incidence in female was constant with peaks in teenagers (sports, motor vehicle accidents) and elderly osteoporotic fractures from simple falls. Majority of clavicle fracture 80-85% occur in middle shaft where clavicle has narrow cross section of bone and typical compressive force applied to shoulder. Distal 3rd fracture is next common, medial 3rd is rare (0% -5%) associated with head and chest injuries. Neer [4] reported nonunion with sling or figure of 8 in 20-35 patients. Rowe showed nonunion rate of 0.8%.

The incidence of nonunion of midclavicular fractures is usually quoted as being from 0.1 to 0.8%, and the mainstay of treatment has long been nonoperative. These data, however, are based on studies in which clavicle fractures were not adequately classified regarding patient age and fracture displacement. More recent data, based on detailed classification of fractures, suggest that the incidence of nonunion in displaced comminuted midshaft clavicular fractures in adults is between 10 and 15%.

Several studies have examined the safety and efficacy of primary open reduction and internal fixation for completely displaced midshaft clavicular fractures and have noted high union rate with a low complication rate (3). In a large number of complex clavicle fractures a satisfactory outcome is possible with a low complication rate using a locked compression plate. Primary internal fixation of displaced comminuted mid-shaft clavicular fractures leads to predictable and early return to function.

Historically in a metaanalysis from 1975-2015 nonunion was 15%. We eliminated soft tissue damage, selection bias of patients, inadequate implants. Recent metaanalysis by Mckeeetal [5] of 6 randomized clinical trails on non-operative versus operative cases for displaced mid shaft clavicle fracture showed nonunion and mal union in 46/200 cases i.e 23% in non-operative group to 3/212 cases i.e 1.4% in operative group. Clinical and basic science research shows results depend on function and expectation of patients, location of the fracture and degree of displacement or communution

Materials and Methods

Study involved 30 patients were operated at MIMS hospital, Nellimarla, Vizianagaram, between Nov 2015 to Feb 2017 for clavicle fractures treated with clavicle contoured plate fixation.

We followed the most commonly used system of classification of clavicular fractures that of Allman [6]. It is divided into 3 groups.

- Group I: Middle-third fractures [7].
- Group II: Lateral-third fractures.
- Group III: Medial- third fractures.

Group1 is our study group, after admission, thorough physical examination and investigations are done. All patients were counseled about their condition. Informed consent was taken from all the patients.

Patient positioned in beach –chair semi sitting position on regular operating table. An oblique skin incision centered over fracture site. Sub cutaneous tissue & platysma muscle are kept together as one layer and extensively mobilized. Supra clavicular nerve is protected. Myofascial layer over clavicle is incised & elevated in one layer. The main fragments cleaned and debris removed. Do not violate the subclavicular space. Then precontoured plate positioned and fixed over superior surface of clavicle and neutral mode for comminuted and unstable fractures. The wound is closed in layers with interrupted, non-absorbable sutures.

Results

Post-Operative Care:

1. We gave a standard sling for comfort.
2. Gentle pendulum Exercises after 10-14 days. Unrestricted range of motion exercises allowed at 6th week, follow up X-ray taken and at 12 weeks active games were encouraged.

Routine plate removal is not typically needed.

Patients were evaluated clinically and radiologically for union. Clinical union described as no tenderness on clinical examination at old fracture site. Radiological union described as callus bridging or no fracture line after comparing the pre-operative x-ray with the latest follow up x-ray.

Clinical evaluation by using

1. Constant-Murley score [8]

The Constant-Murley score (CMS) is a 100-points scale composed of a number of individual parameters. These parameters define the level of pain and the ability to carry out the normal daily activities of the patient [1]. The Constant-Murley score was introduced to determine the functionality after the treatment of a shoulder injury. The test is divided into four subscales: pain (15 points), activities of daily living (20 points), strength (25 points) and range of motion (40 points)

Criteria	Maximum Score
Pain	15
Activities Of Daily Living	20
Range Of Motion	40
Strength	25
Total	100

2. Dash Score [9]

The Disability of the Arm, Shoulder and Hand (DASH) upper extremity outcome measure was developed by the American Academy of Orthopedic Surgeons and Institute. It was designed to assess the functional status and symptoms of clients with upper extremity conditions. The DASH contains 30 items, most of which describe the amount of difficulty the patient faces while performing various physical tasks due to arm, shoulder or hand problems (21 items). The DASH can also be used to monitor patient status over time and measure the therapeutic effectiveness of a particular method of intervention.

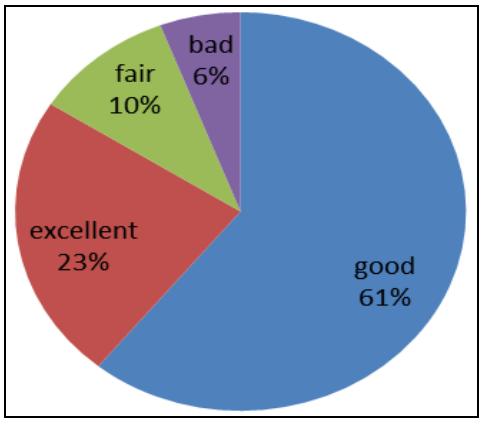
3. Oxford Shoulder Score [10]

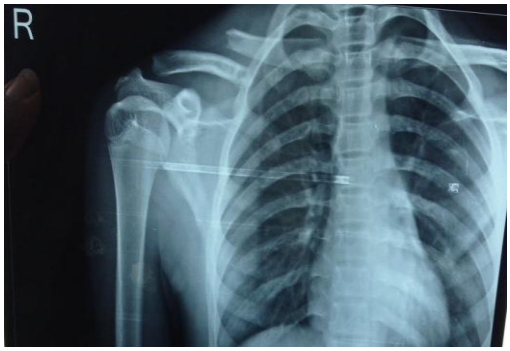
The Oxford Shoulder Score is a unidimensional score comprising 12 questions. A single score is derived from the PRO. Substantial evidence from clinical studies shows that the PRO has high internal consistency and is a valid and reliable measure of patient well-being.

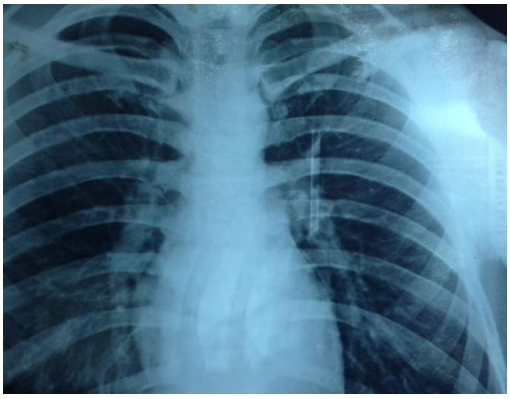
Total Cases –30

Age	Males - 24	Females-6
<20 years	8	2
20-40 years	12	3
>40 years	4	1

Oxford Shoulder score average ----42







Discussion

Open reduction and internal fixation with clavicle contoured plate is gold standard treatment for displaced middle 1/3rd clavicle fracture. It helps in getting back to daily activities and early mobilization with significantly less nonunion rates in fractures treated with plating. Gereon Schiffer [11] *et al* presented and evaluated the current treatment options on the basis of a selective review of the literature. They confirmed some long-held concepts and refuted others. The risk of non-union after conservative treatment was previously reported as 1% to 2% but has turned out to be much higher in selected subgroups such as in patients with severe displacement, female patients, and patients of advanced age. Furthermore, new implants and techniques have made surgery safer and more likely to result in bony union.

In 2006 Michael McKee *et al*. [2], concluded that although good results with minimal functional deficits have been reported following non-operative treatment of clavicular fractures, surgeon-based methods of evaluation may be insensitive to loss of muscle strength. They detected residual deficits in shoulder strength and endurance in this patient population, which may be related to the significant level of dysfunction detected by the patient-based outcome measures.

In 2007 Canadian Orthopaedic Trauma Society [12] conducted a multicenter, randomized clinical trial to compare patient oriented outcome and complication rates following non operative treatment and those after plate fixation of displaced mid shaft clavicular fracture. In the trial 132 patients with displace mid shaft clavicular fracture were randomized to either operative treatment with plate fixation or non-operative treatment with sling. Constant shoulder score, DASH (disability of arm, shoulder and hand), standard clinical follow-up and radiograph were used for outcome analysis. The trial showed operative fixation of displaced clavicular fracture results in improved functional outcome and decreased rate of malunion and non-union compared with non-operative treatment after 1 year follow up. 25 patients out of 30 operated had good functional outcome with near normal range of movements.

We followed superior approach to clavicle to fix the displaced mid clavicle fractures. In 2007 Huang *et al*. [13], concluded apex of the superior bow of the clavicle is typically located along the lateral aspect of the bone, whereas the medial aspect of the superior surface of the clavicle remains relatively flat, making it an ideal plating surface. They also opined that displaced midshaft clavicular fractures that are treated with plate fixation have better functional outcomes than those that are treated nonoperatively.

Locking plate gives optimum fixtaion and allowed immediate mobilisation. Excellent results achieved with union & without any deformity so cosmetic stigma. Patients are more comfortable and more secure socially and immediately attended their jobs/works. In 2008 Wg Cdr v kulshrastha *et al*. [14], concluded that internal fixation of displaced comminuted mid shaft clavicular fracture leads to predictable and early return to function thus preventing unacceptably high complication rates of non-operative procedures.

In 2008 Byron Chaldis *et al*. [15], concluded that conservatively treated fracture united in 96.9% of cases and the time of union was no different from sling or figure of eight bandage. One third of patients still complained of pain and discomfort during overhead activities and polytrauma patient had lower constant score.

In 2009 L.A. Kashif Khan *et al*. [16], concluded that undisplaced fractures of both the diaphysis and the lateral end

of the clavicle have a high rate of union, and the functional outcomes are good after non-operative treatment. Non-operative treatment of displaced shaft fractures may be associated with a higher rate of nonunion and functional deficits than previously reported. However, it remains difficult to predict which patients will have these complications. Since a satisfactory functional outcome may be obtained after operative treatment of a clavicular nonunion or malunion, there is currently considerable debate about the benefits of primary operative treatment of these injuries.

In 2011 Olivier A. van der Meijden *et al*. [17] concluded that outcomes of surgical treatment of midshaft clavicle fractures have become more favorable over the past 2 decades. A meta-analysis of current data on nondisplaced fractures suggested a relative risk reduction of 72% and 57% for nonunion as compared with non-operative treatment by use of intramedullary pin fixation and plate fixation respectively. For displaced fractures, the relative risk reduction increased to 87% and 86%, respectively.

Function of the shoulder is very essentuial for an individual for socio economic thinking. Fracture clavicle affect function and movemnet of the shoulder. The optimum surgical approach is superior approach. By compression, the fracture is united by primary bone healing if the fragments are fixed rigidly and the blood supply distuirbed as little as possible. Under compression, remodellinmg of the havershian canals takes palce. Havershian remodelling is necessary in all fractures healing to achieve restoration of origianl integrity there by absolute stability.

Conclusion

Increase incidence of clavicle fractures mostly in RTA (road traffic accidents) and falls, commonly involving young adolscent patients and also in osteoporotic elderly patients. Clavicle contoured Locking plate gives optimum fixtaion and allowed immediate mobilisation. Excellent results achieved with union, without any deformity so no cosmetic stigma. Patients are more comfortable and more secure socially and immediately attended their jobs/works. Under certain circumstances where patients are not fit for surgery we considered conservative management.

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