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2 **FUNCTIONAL RESULTS OF UNSTABLE(TYPE 2)DISTAL CLAVICLE**
3 **FRACTURES TREATED WITH SUPERIOR ANTERIOR LOCKING PLATE**

4

5 **ABSTRACT**

6 **BACKGROUND** :The treatment of distal clavicle fracture is always a challenge,as it is
7 mostly unstable and has higher rate of delayed union, malunion,non-union and associated
8 acromioclavicular arthritis.So the management of these fractures remains controversial. The
9 purpose of this study is to evaluate the functional results of Type 2 distal end clavicle
10 fractures treated with superior anterior locking plate.

11

12 **MATERIALS AND METHODS:**From June 2011 to August 2015 a retrospective study
13 of 12 male patients(mean age of 41.3 years)11 with unilateral and 1 with bilateral distal
14 clavicle fractures treated with superior anterior locking plate was done.They were evaluated
15 at regular intervals with mean follow up of 14 months(12-18months).Those with minimum
16 one year follow up were included in our study. All were evaluated for the functioning of the
17 shoulder joint by both Oxford shoulder score and QuickDASH scores, rate of bone union,
18 complications and earliest time for return to work.

19 **RESULTS:**All fractures union seen within 6-8 weeks (mean time :7.1 weeks).All had good
20 shoulder range of motion. The average oxford shoulder and QuickDASH score were 46.2 and
21 6.5.There were no major complications in our study viz. non-union ,plate failure, secondary
22 fracture.But one patient had superficial wound infection.All patients returned to work within
23 3 months of postoperative period.

24 **CONCLUSION:** Displaced distal clavicle fractures treated with superior anterior locking
25 plates achieved excellent results in terms of bony union with rarely any complications and
26 demonstrate promising results with this novel technique.

27 **LEVEL OF EVIDENCE:** Level III ,Retrospective Cohort Study.

28 **KEY WORDS:** Clavicle,Non-union,Arthritis,Mal-union,Fracture

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30 INTRODUCTION

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32 Clavicle fractures are common due to its subcutaneous position.It accounts for 2-5% of all
33 fractures in adults and 10-15% of all fractures in children (Roughly a quarter – Lateral end)
34 ^{1,2}.Neer classified these lateral end fractures into three types³ according to their relation to the
35 coracoclavicular ligaments followed by Rockwood's subclassification in 1982.

36

37 Neer recognised that the type II fractures carry a higher risk of non union (22-50%) for non
38 operatively managed fractures.^{3,4} The high incidence of non union is due to displacement of
39 two fragments by opposing forces acting on them, mainly, trapezius that displaces the
40 proximal fragment superiorly and the weight of the arm draws the distal fragment inferiorly
41 resulting in major displacement.⁵

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43 A prolonged conservative management results in bone resorption, prominent scar and an
44 altered surgical field that further complicates any subsequent surgical intervention⁶. Surgical
45 management ranges from joint spanning to joint sparing implants such as K wires, tension
46 band fixation, coracoclavicular screw fixation, distal clavicle excision, osteosynthesis by

47 hook plate or a locking plate fixation¹¹ each having its own sets of merits and
48 demerits.^{7,8,9,10,11}

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50 Our study evaluates these fractures treated by superior anterior locking plate meant
51 specifically for the distal clavicle. We analysed the following: a)union rates b)complications
52 c)functional outcome by oxford shoulder score and QuickDASH scoring d)earliest time for
53 return to work.

54

55 **MATERIALS AND METHODS**

56

57 In our retrospective study of 12 male patients, there were 11 unilateral unstable fractures
58 (seven right ,four left) and one bilateral fracture (Case 1 {Figure 1 a – e}) treated between
59 June 2011 to August 2015 at our centres. The mean age was 41.3 years (22-54 years).Mode
60 of injury- 1.Nine due to road traffic accidents 2.three due to fall and none had significant
61 associated injuries. At the time of presentation we obtained two radiographic views (AP &
62 Zanca) of the distal clavicle.All patients were taken up for surgery within 10 days of injury.
63 Appropriate consent and approvals were obtained.We had an inclusion & exclusion criteria,

64 **INCLUSION CRITERIA-** 1. Skeletally mature individuals with Type II fractures within 10
65 days of injury. 2.Absence of pre-existing subacromial pathology.

66 **EXCLUSION CRITERIA-** 1. Type I & Type III fractures 2. Open fractures 3.Type II
67 fractures with comorbidities that would elevate the risk of anaesthesia &surgery 4.nonunion
68 5.fractures presenting after 10 days of injury 6.skeletal immaturity. 7.Surgical technique
69 other than locking plate.

70 We did not distinguish Type II fractures into IIA & IIB, as they are clinically equivalent
71 injuries and it is difficult to distinguish them radiologically¹².

72 **SURGICAL TECHNIQUE**

73 All procedures were carried out under general anaesthesia after prophylactic antibiotics, with
74 patient in “beach chair” position on operating table. We used the standard anterosuperior
75 approach to the clavicle. The fracture site, acromion were exposed completely. The initial
76 reduction was maintained with K-wires followed by plate fixation. In few cases we used
77 2mm mini fragment screws to lag the fracture fragments together. We countersunk the lag
78 screws to avoid prominence and conflicts with plate positioning. In one case wiring was done
79 in the form of cerclage for additional stability. The plate design allowed multiple 2.7mm
80 locking screws polyaxially in the distal fragment. We used both locking and non locking
81 screws with lag and lock principle in the proximal fragment. The torn coracoclavicular
82 ligament was identified and if found necessary suturing done. We did not use any suture
83 anchors for coracoclavicular augmentation in our fixation techniques. The patient with
84 bilateral clavicular fracture underwent surgery in same sitting. Final screw position was
85 confirmed by C-arm before wound closure. The average surgical time was 40-60 minutes,
86 with an average blood loss of 75-100ml.

87 **POST OP PROTOCOL** -Postoperatively, patients were on IV antibiotics for three days. The
88 sutures were removed on the tenth day, and the arms were placed in arm sling for 6weeks.
89 Pendular exercises commenced within the first 24 hours after surgery .Passive flexion and
90 extension was started after suture removal. All patients were referred for physiotherapy and
91 clinicoradiological follow up was done at third week, sixth week, third month, sixth month
92 and one year following surgery.

93 The functional outcome was evaluated using Oxford shoulder score¹³ and QuickDASH
94 scores¹³. There are no clavicle trauma scores and hence shoulder outcome scores were used.
95 The Oxford sholder score which is a questionnaire based subjective assessment of patients'
96 pain and impairment of activities of daily living. The QuickDASH is shortened version of the
97 DASH outcome score, uses 11 items in the full questionnaire to measure physical function
98 and symptoms in patients with any disorders of the upper limb. Tests were done to identify
99 any associated acromioclavicular joint and rotator cuff pathology .Serial Radiographs were
100 looked for union, implant migration and acromioclavicular pathology. Patients were usually
101 allowed to get back to their normal activity 10-12 weeks following surgery.

102

103 **RESULTS**

104 All twelve patients returned for clinical and radiological follow up (Table 1). Average clinical
105 follow up was for 14 months (range, 12-18months). Radiological assessment was done for
106 bony union and clinical outcome was evaluated by using both shoulder scores at each follow
107 up, which showed gradual improvement in score in each follow up . All fractures united well
108 without any additional procedures like bone grafting, or revised fixations. The mean time for
109 fracture union was 7.1 weeks (range, 6-8 weeks) in all cases.

110 The patients were followed up at regular intervals and there was no statistical difference
111 between the functional scores and the range of movements when the scores were compared at
112 three, six, twelve months and the final follow up using Wilcoxon signed rank test(p=0.45).

113 All patients with minimum one year follow up were included in our study showing an
114 average Oxford shoulder score of 46.2(range 39-48) and QuickDASH score of 6.5(range 0-
115 13.5) at the end of final follow up.

116 All twelve showed good satisfactory outcome (Case 2 {Figure 2 a – d}) results based on
117 Oxford and QuickDASH¹³ scoring system. One patient had a superficial wound infection that
118 resolved after oral antibiotics. All patients returned to work within 3 months of post op period
119 (range, 8 – 12 weeks). No implant related complications occurred in our patients during
120 follow up. Four patients underwent metal exit due to prominent hardware after 1 year of
121 surgery.

122 **CASE ILLUSTRATION**

123 CASE-1(Figures 1 a – e):

124 Figure 1a. 49 yr male with bilateral clavicle fractures (type 2)



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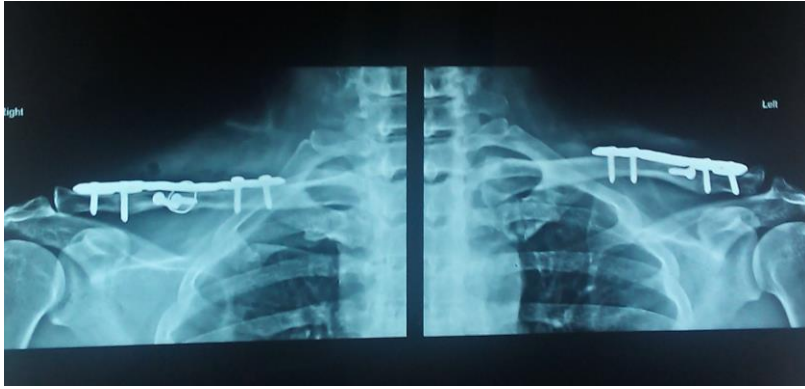
126 Figure 1b. Immediate post op X-rays

Figure 1c. Patient after suture removal



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128 Figure 1d. post operative x-ray after 8 months with good union



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130 Figure 1e. Patient had satisfactory functional outcome



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133 **CASE -2(Figures 2 a – d)**

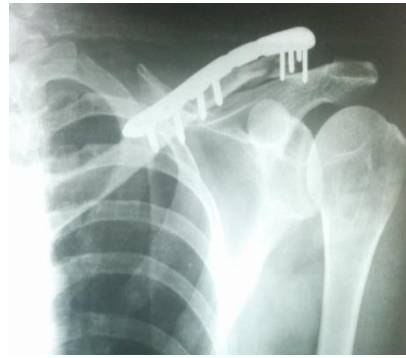
134 Figure 2a. 35 yrs male patient with left side distal clavicle fracture



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136 Figure 2b. Immediate post op X-ray. Figure 2c.post op X-ray after 7 months with

137 good union



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139 Figure 2d. Patient had satisfactory functional outcome



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142 **DISCUSSION**

143 Surgical intervention is an indication for displaced Type II distal clavicle fractures^{14,15}. The
144 rarity of the fracture, the lack of documentation of the results, poor fixation of the lateral
145 fragment with several surgical techniques, poor acceptance of any single method and the
146 proposed techniques having its proven advantages and disadvantages are the problems
147 encountered.

148 Transacromial K-wires have high risk of infection, nonunion and a potential risk of wire
149 migration¹⁶. Tension band techniques provide no protection against wire migration and give
150 rise to skin problems which necessitates its removal¹⁷. Bosworth's Coracoclavicular screw
151 fixation has screw backout and peri-implant fracture as possible complications⁸.

152 Coracoclavicular slings though satisfactory, needs extensive dissection to pass the slings

153 below the coracoid process, it has high risk of fatigue fracture of sling, coracoid process &
154 fixation failure^{18,19}.

155 To improve the osteosynthesis of the distal fragment two newer implant designs were used
156 ,joint spanning hook plate¹⁰ and joint sparing precontoured locking plates¹¹. Hook plate
157 achieved excellent union rates but it is not without its complications which include peri-
158 implant fracture, plate's hook fracture, enlargement of the hook's hole in the acromion, hook
159 migration with rotator cuff tear, acromial wear , need of plate removal before mobilisation
160 and persistant nonunion¹⁰.

161

162 Fixation of fractures of the lateral clavicle with locking plates is relatively a new technique
163 and had proven beneficial in treating fractures with poor bone quality,fractures with short
164 distal segment and distal fractures involving the diaphysis(segmental fractures)(fig:3). Its a
165 low profile plate with multiple divergent, fixed angle screws which increases pull out
166 strength in the distal segment which is small and osteopenic.It avoids the need to bridge
167 across the clavicle to the acromion, motion at the acromioclavicular joint is preserved.In our
168 study group of 12 ,all achieved excellent bony union(100%).We had only one complication
169 of superficial infection (bilateral fracture)and it settled by oral antibiotics.



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171 Figure:3 - 30 yrs male with segmental fracture clavicle with type 1 distal clavicle fracture
172 showing extended indication of locking plate (but this case is not included in our study)

173 Our study had number of limitations. The study included only a small group. It was due to
174 low overall incidence of this particular fracture pattern, we didn't have non operative control
175 group and our results were not compared with other methods of fixation.

176 Superior anterior locking plate is a low profile implant providing stable fixation of the
177 fracture and there is no need for implant removal prior to mobilisation^{20,21,22}.

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179

180 **CONCLUSION:**

181 Displaced distal clavicle fractures (type 2) treated with superior anterior locking plates
182 achieved excellent results in terms of bony union and satisfactory functional outcome with
183 rarely any early complications and demonstrate promising results with this new technique.
184 The number of patients treated by this technique is low but concordant with the incidence of
185 the fracture, inspite the results of our 12 patients are encouraging , we need a longer term
186 follow up with more number of patients as well as further comparative studies are warranted.

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