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Original Article

Retrospective study of superior anterior plate as a treatment for unstable (Neer type 2) distal clavicle fractures☆

Syed Ibrahim*, **Jimmy Joseph Meleppuram**

Vinayaka Missions Medical College and Hospital, Department of Orthopaedics, Pondy, India

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ABSTRACT

Objective: To analyze the sequelae of Neer type 2 distal end clavicle fractures treated with superior anterior locking plate.
Methods: From June 2012 to February 2015 a study was conducted with 14 male patients; 12 with unilateral and two with bilateral distal clavicle fractures treated with superior anterior plate. They were evaluated at intervals, with mean follow up of 16 months (14–18 months). All patients were evaluated clinically by both the Oxford Shoulder Score and the QuickDASH score.
Results: Union was seen in all fractures within 7–9 weeks (mean time: 8.2 weeks). All patients had good shoulder range-of-motion. The average Oxford Shoulder Score and QuickDASH score were 45.6 and 7.1, respectively. All patients returned to work within 3–4 months of the postoperative period.
Conclusion: Displaced distal clavicle fractures treated with superior anterior plates accomplished superlative results in terms of bony union, with rarely any complications.

Estudo retrospectivo da placa anterior superior como tratamento para fraturas instáveis da clavícula distal (tipo 2 de Neer)

Palavras-chave:
Clavícula
Placas ósseas
Artrite
Fraturas ósseas

RESUMO

Objetivo: Analisar as sequelas de fraturas distais da clavícula do tipo 2 de Neer tratadas com placa bloqueada anterossuperior.
Métodos: Realizou-se um estudo com 14 pacientes do sexo masculino entre junho de 2012 e fevereiro de 2015; 12 pacientes apresentaram fraturas unilaterais e dois, fraturas distal bilaterais da clavícula, tratadas com placa anterossuperior. Os pacientes foram avaliados em intervalos, com seguimento médio de 16 meses (14-18 meses). Todos os pacientes foram avaliados clinicamente tanto pelo Oxford Shoulder Score quanto pelo QuickDASH.

☆ Work performed in the Vinayaka Missions Medical College and Hospital, Department of Orthopaedics, Pondy, India.
* *Corresponding author.*
E-mails: dr.ibrahim_21@rediffmail.com, drsyedibrahima@gmail.com (S. Ibrahim).
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Resultados: Após sete a nove semanas (tempo médio: 8,2 semanas), todas as fraturas apresentaram consolidação. Todos os pacientes tinham boa amplitude de movimento no ombro. A média dos escores Oxford Shoulder Score e QuickDASH foram 45,6 e 7,1, respectivamente. Todos os pacientes retornaram ao trabalho dentro de três a quatro meses após a cirurgia.
Conclusão: As fraturas distais de clavícula com desvio tratadas com placas anterossuperiores apresentaram resultados superlativos em termos de consolidação óssea, com raras complicações.

Introduction

Due to its superficial location and alignment, clavicle is one of the bone that is most frequently fractured in the upper body due to direct or indirect trauma. As of the presence of numerous muscular and ligamentous attachment along with weight of upper limb, the clavicle is able to carry significant force.

Fracture of clavicle is most common due to its subcutaneous location. It accounts for 3–5% of all fractures in adults and 10–15% of all fractures in paediatric age group.[1,2] Roughly a Quarter of every clavicle fractures seems to be at the distal end.[2] Neer has classified these lateral end fractures into three types (Fig. 1) according to their relation to the coracoclavicular ligaments[3] and Rockwood in 1982, subclassified Type II fractures as Type IIA and Type IIB fractures.[4]

Neer observed that the type II fractures carries a higher risk of non union (as high as 25–50%) for conservatively managed fractures.[3,4] As trapezius displaces the proximal fragment superiorly and the weight of the arm draws the distal fragment inferiorly results in major displacement which leads to higher incidence of non union.[5]

Among this, 15% non union is symptomatic and painful, which have made many to suggest early surgical management of this fractures.[6] The delayed conservative management results in bone resorption, prominent deformity and an altered surgical field that further complicates any subsequent surgical intervention.[6] Delay in surgical intervention results in elevated complication rate. Surgical management ranges from joint spanning to articulation sparing implants, distal clavicle excision, osteosynthesis by hook plate or a locking compression plate fixation, poor fixation still remains a challenge and no definitive solution has been identified, so none is widely accepted as a Gold standard, each has its own sets of advantages and disadvantages.[7–11] In our study, we evaluated the fractures which were treated by superior anterior locking plate (Fig. 2). We measured the following: a) union rates, b)

Figure 2 – Superior anterior clavicle plate with polyaxial screw alignment.

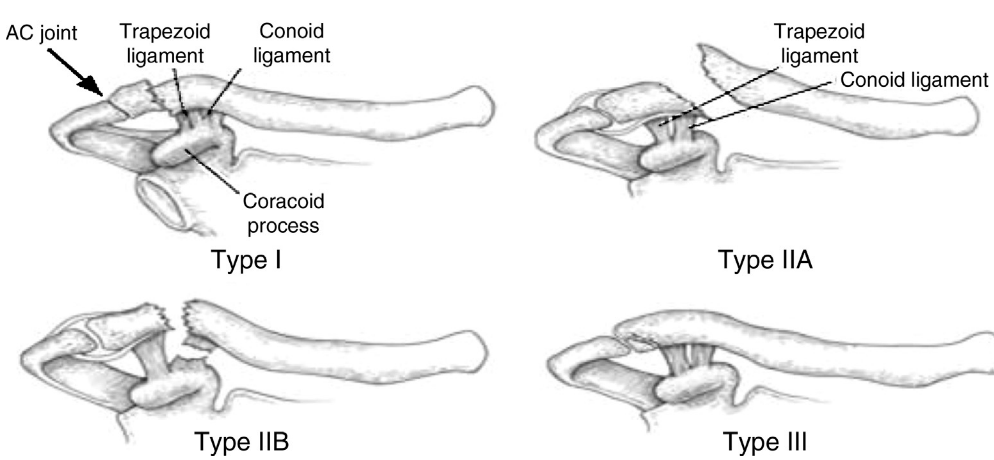

Figure 1 – Neer's classification of distal end fracture (Courtesy: Kennet's & Koval's Handbook of Fracture, 4th ed, 2010).

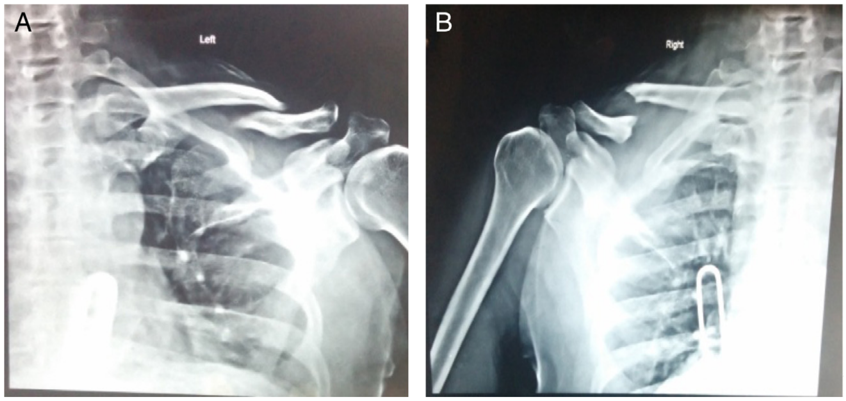

Figure 3 – (A) 45 yrs male with bilateral clavicle fracture, left side; (B) 45 yrs male with bilateral clavicle fracture, right side.

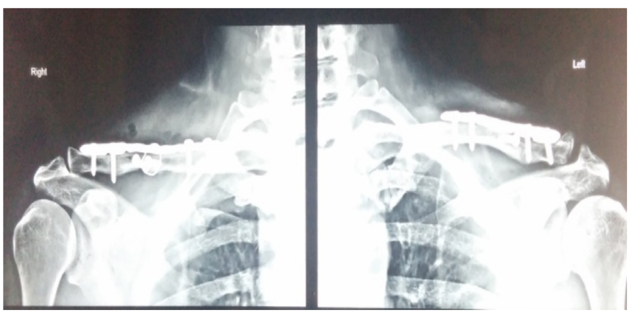

Figure 4 – Immediate post-op X-ray.

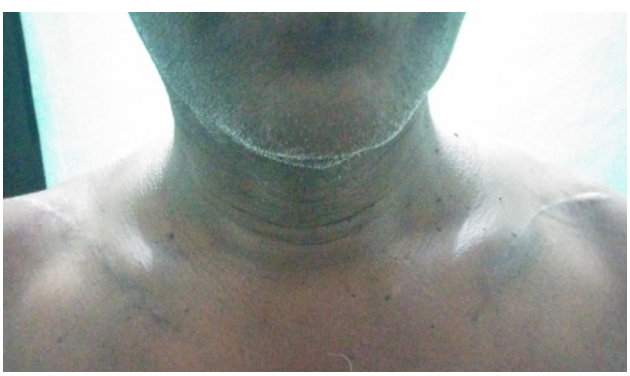

Figure 5 – Patient after suture removal.

complications, c) functional outcome by Oxford shoulder score and QuickDASH scoring, d) earliest time for return to work to find out its advantages and applicability as compared to previous mentioned modalities of fixation.

Materials and methods

In this retrospective analysis of distal clavicular fractures treated at our setting, we found among 14 male patients, there were 12 unilateral unstable fractures (eight right, four left) and two bilateral fractures (case 1 – Figs. 3–7) treated between time period of June 2012 to February 2015. The mean age of patients was 43.5 years (24–55 years). The mode of injury – ten due to road traffic accidents and four due to direct fall on

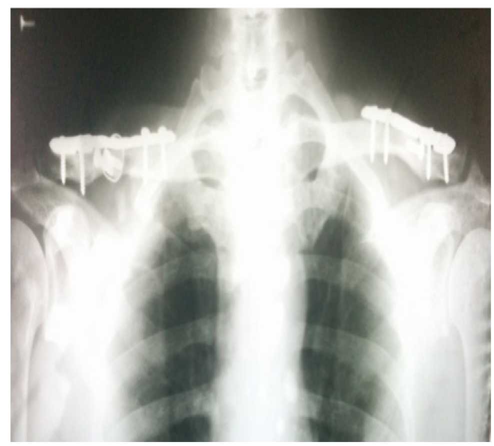

Figure 6 – Post operative X-ray after 8 months with good union.

shoulder. None of them had significant associated injuries. On initial visit of the patient, we obtained two roentgenic views (AP & Zanca) of the distal clavicle. All patients were taken up for surgery within nine days of injury. Necessary consent and approvals for surgery were obtained. We had an inclusion & exclusion criteria for our study.

Inclusion criteria

All skeletally mature individuals with Type II fractures within 10 days of injury, Absence of pre-existing subacromial pathology.

Exclusion criteria

Type I & Type III fractures, Open fractures, Type II fractures with comorbidities that would elevate the risk of anaesthesia and surgery, skeletal immature individuals, non-union, Surgical procedure other than locking plate.

Type II fractures into IIA & IIB were not sub-classified, as they are clinically equivalent injuries and is cumbersome to distinguish them radiologically.[12]

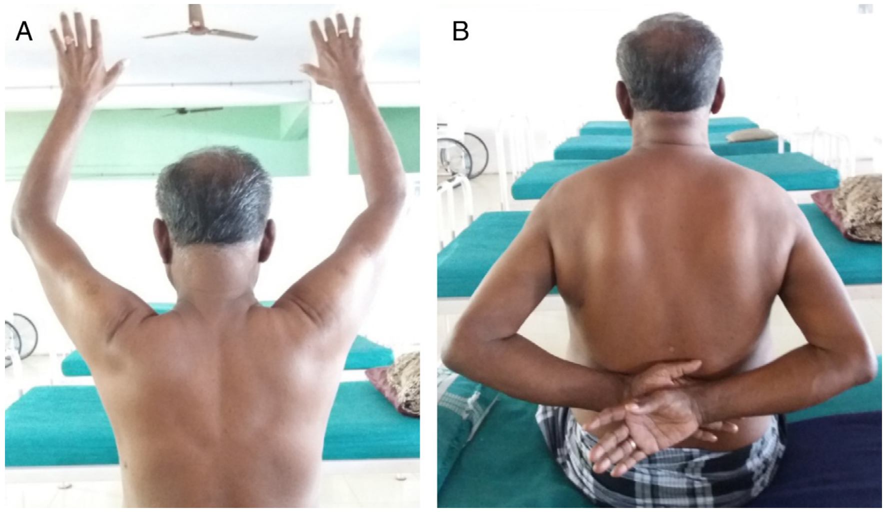

Figure 7 – (A) Patient had satisfactory functional outcome (hyperabduction); (B) patient had satisfactory functional outcome (internal rotation).

Surgical technique

Surgical procedures were taken under general anaesthesia after prophylactic antibiotics, with patient in supine position on the operating table. The operated surgical field was elevated using a sand bag under the shoulder for better exploration. Under strict aseptic precaution, patient parts were painted and drapped. We used the standard anterosuperior approach to the clavicle. Both the fracture site and the acromion were exposed completely. The initial reduction of fragments was maintained with K-wires. The appropriate plate size was assessed and fixation performed. In few cases, we encountered inappropriate anatomical reduction where we had to use 2 mm mini fragment screws to lag the fracture fragments together. The lag screws were countersunk in order to avoid hardware prominence and conflicts with positioning of plate.

Due to instability of fracture fragment, in one case, SS (Stainless steel) wiring was done in the form of cerclage for additional stability. The locking compression plate design allowed multiple 2.7 mm locking screws polyaxially in the distal fracture fragment. Both the locking and non locking screws with lag and lock principle was used in the proximal fracture fragment. The torn coracoclavicular ligament was identified and if so, necessary suturing was done. No suture anchors were employed for coracoclavicular augmentation in our fixation procedure. The patient with bilateral clavicular fracture underwent surgical fixtation in the same sitting. Final plate as well as screw position was confirmed with the help of C-arm intensification. After achieving satisfactory intra-operative fixation the wound was closed in layers. The average surgical time was 40–60 min, with an average blood loss of 70–100 mL. Intra-operative period was noted to be uneventful.

Post op protocol

Postoperatively, all patients were on appropriate IV antibiotics and IM analgesics for three days. Alternate day dressing was done for every case. The sutures were removed on the tenth post operative day, and the arms were placed in arm sling for a period of six to eight weeks. To prevent early stiffness pendular exercises were initiated within the first 24–48 h post surgery. Passive flexion and extension was started after suture removal. All patients were referred for physiotherapy, clinical and radiological follow up at third week, one and a half month, three month, six month and one year following surgery.

The Oxford shoulder score and QuickDASH scores were implemented to assess the functional outcome.[13] As there are no specific clavicle trauma scores we had to implement the shoulder outcome scores for the following study. The Oxford Shoulder Score (OSS) is a 12-item patient-reported uni-dimensional score specifically designed and developed for assessing outcomes of shoulder surgery. The Oxford shoulder score is a questionnaire based subjective assessment of patients' pain and impairment of activities of daily living. The QuickDASH is shortened version of the DASH outcome score, uses 11 items in the full questionnaire to measure physical function and symptoms in patients with any disorders of the upper limb. Series of tests were done in order to identify any associated acromioclavicular joint and rotator cuff pathology. Serial Radiographs were looked for fracture union, implant migration and any associated acromioclavicular pathology. Patients were usually allowed to get back to their normal activity in 11–14 weeks following surgery.

Results

Every 14 patients returned to our setting for clinical and X-ray follow up and none of the patients were missed. Average clinical follow up was for 16 months (range, 14–18months). Assessment was done for bony union radiologically and clinical results was evaluated by using both Oxford shoulder score as well as QuickDASH scores at each consecutive follow up, which showed gradual improvement in score at each follow up. All fractures united well without any additional procedures like bone grafting or revised internal fixations. The mean time for fracture union was 8.2 weeks (range, 7–9 weeks) in all cases.

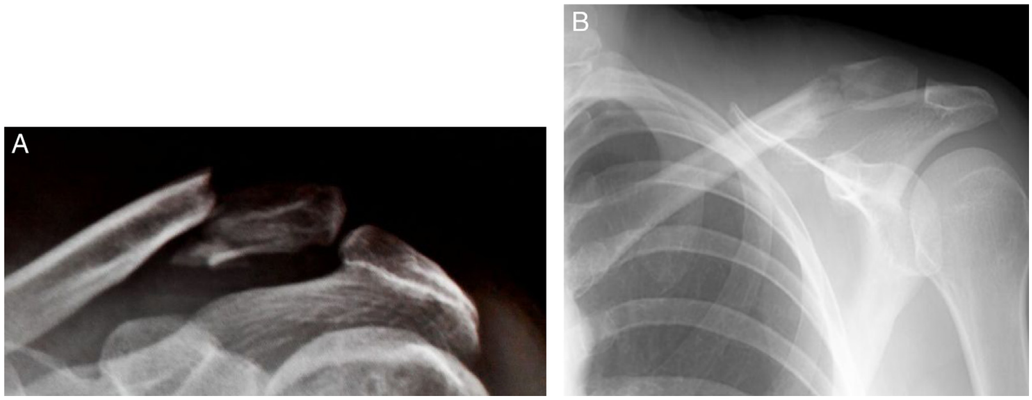

Figure 8 – (A) 38 yrs male patient with left side distal clavicle fracture (magnified image); (B) 38 yrs male patient with left side distal clavicle fracture.

Figure 9 – Immediate post op X-ray.

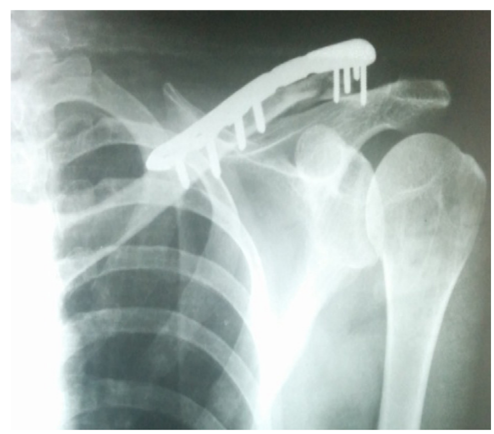

Figure 10 – Post operative X-ray after 7 month with good union.

Regular interval follow up was performed and there was no statistical difference between the functional scores and the range of motion as it was compared at three, six, twelve months and the final follow up using Wilcoxon signed rank test ($p = 0.45$). All patients with minimum one year follow up were included in our study showing an average Oxford shoulder score of 45.6 (range 38–47) and QuickDASH score of 7.1 (range 0–13.5) at the end of final follow up.

Every patient showed satisfactory to excellent outcome (case 2 – Figs. 8–11) based on Oxford and QuickDASH scoring system (Table 1). Two patients had superficial wound infection that resolved after oral antibiotics and regular dressing. All patients returned to their normal day to day activities and work within three–four months of post operative period (range, 9–16 weeks). No implant related complications occurred in our patients during follow up. Unfortunately, three patients underwent surgical removal of implant due to prominent hardware after 1–2 years of surgery.

Discussion

The displaced lateral clavicle fracture is an uncommon fracture. Although 15% of all clavicle fractures consist of lateral clavicle fractures, only a third of these fractures are displaced (Neer type 2).[2]

Due to the rarity of this fracture, literature consists mainly of retrospective case series with small number of patients, some with inclusion of heterogeneous patient population, usually with a short and sometimes incomplete follow up.

Neer described this type of clavicle fracture as an unstable clavicle fracture requiring operative treatment due to the high rate of observed non union and the even higher rate of delayed union. He explained this by the deforming forces around the fracture, causing displacement and interpositioning between the fracture fragments, with continuous motion at the fracture ends.[14–16] Operative intervention is an indication for displaced Type II distal clavicle fractures.[17,18]

The unique presentation of these fractures, the inadequate documentation of the results, incorrect fixation of the lateral fragment with several operative techniques, poor

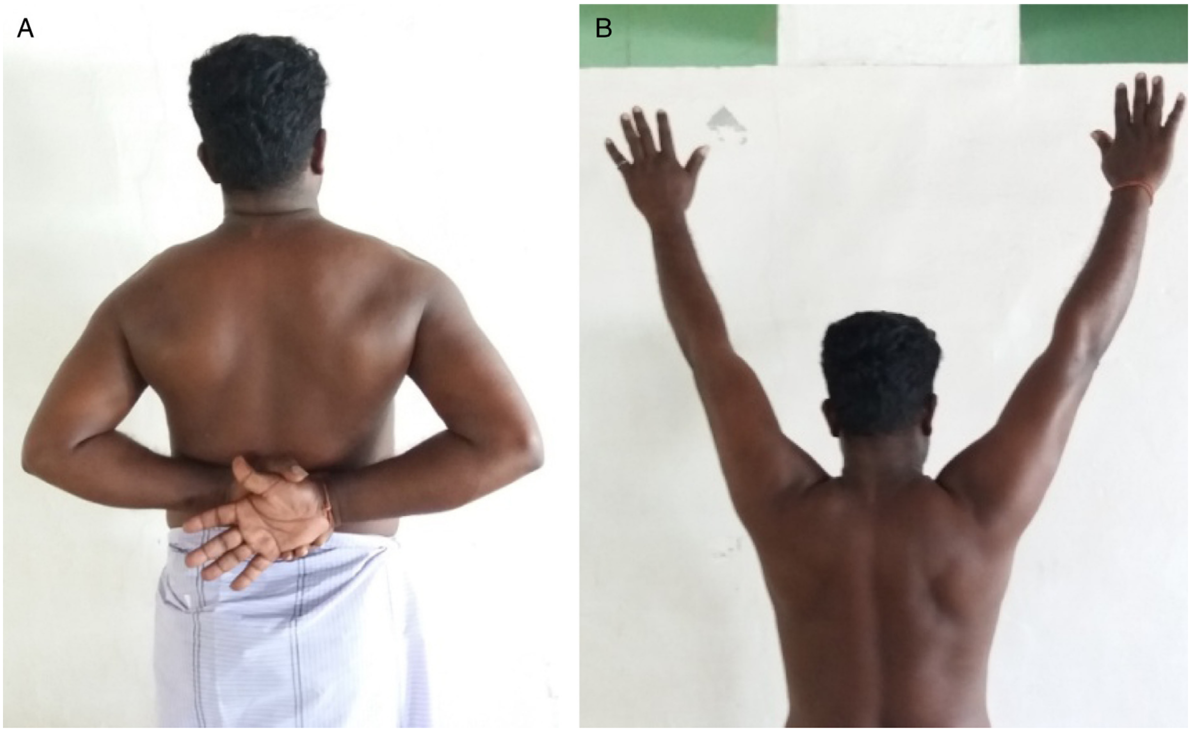

Figure 11 – (A) Patient had satisfactory functional outcome (internal rotation); (B) patient had satisfactory functional outcome (hyperabbduction).

Table 1 – Demographic and follow-up results.

Case no.	Age (in years)	Side involved (L/R/BIL)	Mode of injury (RTA/FOOH)	Mean time for fracture union (in weeks)	Time period for returns to work (in weeks)	Average duration of follow-up (in months)	Evaluative scores at end of follow-up	
							Oxford shoulder score	QuickDASH score
1	22	R	RTA	6	8	12	46.2	7.1
2	39	L	RTA	6	10	14	46.5	8.9
3	49	BIL	FOOH	8	12	16	45.6	6.6
4	50	L	RTA	7	8	14	44.4	6.9
5	46	R	RTA	7	8	18	47.9	7.3
6	35	L	RTA	6	10	12	43.6	8.1
7	54	R	RTA	8	8	14	44.3	5.7
8	40	R	FOOH	7	8	12	45.8	6.7
9	37	L	RTA	6	10	12	46.8	7.5
10	28	R	RTA	8	12	14	47.8	6.2
11	51	R	FOOH	8	8	16	47.9	7.6
12	45	R	RTA	8	8	14	47.6	6.3
13	41	BIL	FOOH	7	10	16	46.4	6.4
14	32	L	RTA	6	12	14	42.5	7.2

R, right; L, left; BIL, bilateral; RTA, road traffic accident; FOOH, fall on outstretched hand.

acceptance of a single method and the proposed techniques having its proven merits and demerits are the problems faced.

K-wires fixed transacromially have increased risk of infection, nonunion and a high risk of wire migration.[19] Kona et al.[20] reported 52.6% success rate with Krischner wires and reported complications like loosening of K-wires, migration, undue stress during active mobilization, back out, and breakage. Skin problems and wire migration are faced in tension band techniques which leads to removal of hardware.[21] Coracoclavicular screw fixation by Bosworth's technique has screw backout and peri-implant related fracture as possible complications.[8] Coracoclavicular slings though satisfactory, needs extensive dissection to pass the slings below the coracoid process, it has high risk of fatigue fracture of sling, coracoid process and fixation failure.[22,23]

To gain the osteosynthesis of the distal fragment two newer implant designs were introduced; joint spanning hook plate[10] and joint sparing precontoured locking compression plates.[11] Excellent union rates were achieved by hook plate but it is not without its complications which include peri-implant fracture, enlargement of the hook's hole in the acromion, hook migration with rotator cuff tear, acromial wear, plate's hook fracture, need of plate removal before mobilization and persistant nonunion.[10] Overall it seems that in spite of giving good functional outcome hook plate tend to produce major complications and there is a definite need for implant removal which again puts the patient under risk of one more general anaesthesia.[11,24]

Locking compression plates used in fixation of lateral clavicle fracture, relatively a new technique and had proven beneficial in treating fractures with poor bone quality, fractures with short distal segment and distal fractures involving the diaphysis (segmental fractures). It is a low profile plate with multiple divergent, fixed angle screws which maximize pull out strength in the distal segment that is small in size and osteopenic in nature. It eliminates the need to bridge across the clavicle to the acromion, action at the acromioclavicular joint is secured. In our setting of 14 patients, all accomplished excellent bony union. We had only one complication of superficial infection in two cases that settled by oral antibiotics with regular dressing.

Our study illustrated superior results in terms of union rates and decreased complication rates when compared to Andersen et al.[25] series and other Indian subcontinent study series. As due to the rarity of such unstable fracture pattern is noted, our study stands out to be similar comparable to the western population group. The better values of oxford shoulder score and quick DASH scores in our series makes it a better result study as compared to other series of dignified series of research.

Limitations of our study were noted as follows. The study included only a small sample size. It was due to low general incidence of this particular fracture kind, we lacked a non operative control group and our outcomes were not compared with other modalities of fixation. Superior anterior locking plate is a low profile implant providing rigid fixation and there is no need for implant removal prior to active mobilization.[25–28]

Conclusion

Superior anterior locking plates used for the treatment of displaced distal end clavicle fractures (Neer type 2) gained good to excellent results in terms of bony union and highly satisfactory functional results with uncommonly any early complications and illustrates promising outcomes with this new technique.

Conflict of interest

The authors declare no conflicts of interest.

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