A Comparison of Outcome after Fixation of Unstable Lateral Third Clavicle Fractures, with Clavicular Hook Plate versus Precontoured Anatomical Locking Plate

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ABSTRACT

BACKGROUND

Lateral end clavicle fractures are of three types (Neer type- I, II, & III). In Neer Type-II, the fractures are very unstable due to damage to the coracoclavicular (CC) ligament. So, it is always treated surgically. This comparative cross-sectional prospective study compares the outcome after internal fixation of these fractures with clavicular hook plate and precontoured anatomical locking plate.

METHODS

Thirty-two (32) patients attending the OPD and ER of R.G. Kar Medical College, Kolkata, having Neer Type-II fractures, were treated surgically within three weeks of injury using either clavicular hook plate (17 patients) or precontoured anatomical locking plate (15 patients) and then systematically reviewed. The relevant literature of the two fixation methods were studied to note union, infection, hardware prominence, implant failure, metaphyseal fracture and other complications. Constant-Murley score was also used for evaluation.

RESULTS

In our study, with both the fixation modalities, union was achieved in all cases by three months. No impingement was noted. Patients having fixation with precontoured anatomical locking plate had better scores and returned earlier to better function than the other group (p value <0.0001).

CONCLUSIONS

Precontoured anatomical locking plate might be a better option which provides better functional outcome.

KEY WORDS

Unstable Distal Third Clavicle Fracture, Clavicular Hook Plate, Precontoured Anatomical Locking Plate

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BACKGROUND

Fractures of clavicle are not uncommon in young individuals, particularly those who take part in contact sports like football or sustain high velocity trauma during racing sports. They constitute about 2.6% of all fractures. The yearly incidence of this fracture is 29 per one lac population.¹

Maximal clavicle fractures (80% to 85%) are found in the midshaft of the bone, where the compressive forces acting on the shoulder and the narrow cross section of the bone combine to break the bone.^{2,3} Second most common clavicular fracture site is in the distal third region (20%). Mechanism of injury may be the same as with midshaft fractures, but it may also happen in more elderly individuals as a result of simple falls.^{4,5,6,7}

The classification and management of distal clavicle fractures is dependent on the position of the fracture in relation with the conoid and the trapezoid part of the coracoclavicular (CC) ligament. According to Neer, distal clavicle fractures are of three types. Type-I: Fractures in between acromioclavicular (AC) joint and CC ligament, with CC ligament remaining intact. Type-II: Fractures associated with torn CC ligament where sometimes the trapezoid part remains intact on the distal part. Type-III: Fracture line involving the AC joint. As type-I and type-III are stable, they can be sometimes managed conservatively. On the other hand, due to unstable nature in a case of Type-II fracture, non-operative treatment frequently results in non-union.⁸ So, for Type-II fractures, surgery has been regarded as the treatment of choice.

Regarding implants many options have been tried as found in literature like K-wires,⁹ Screw fixation,¹⁰ Hook plates^{11,12,13,14} and Locking plates.^{15,16,17} Orthopaedic surgeons are often in a dilemma while planning treatment of distal third clavicle fractures. The unstable nature of these fractures makes them prone to non-union and may hamper normal shoulder function. Although many treatment options are available in the literature, there is no gold standard protocol for treating this injury till date.

METHODS

After designing this institution based prospective comparative study, we got approval from the Institutional Ethics Committee. Then we made an "Informed Consent" format for the purpose of information, consent and counselling of the patient and his or her relatives. 32 patients of either sex, aged between 18 years to 65 years who were clinically and radiologically diagnosed to have traumatic unstable distal clavicle fractures, within three weeks from date of trauma, had been recruited for this study in R.G. Kar Medical College, Kolkata, over a period of 13 months (May, 2016 to June, 2017). We included patients with Neer Type-II¹⁷ fractures only excluding pathological fractures and persons with pre-existing shoulder pathology or medical comorbidities. Fixation method was decided according to the nature and location of the fracture. Fractures nearer to the AC joint or with comminution were treated by hook plate whereas the more medially located, non-comminuted

fractures were treated with precontoured anatomical locking plate.

Hook Plate Group

After proper anaesthesia with the patient in supine position and a bolster in the interscapular region, the fracture site was opened through the anterior approach. Then open reduction was done, and the plate portion was applied over the clavicle and hook portion was introduced into the subacromial space through a tunnel made behind the AC joint. Plate bender was used when necessary.

Precontoured Anatomical Locking Plate Group

After proper anaesthesia patient position and surgical approach was the same as the hook plate group. Open reduction and provisional fixation were done with k-wires and finally the precontoured anatomical locking plate was applied placing maximum possible number of locking screws in the lateral fragment. Appropriate attention was given to avoid encroaching the AC joint.

Postoperative Protocol

For both the groups, the operated limb was kept in collar and cuff sling and early mobilisation exercises were started from third postoperative day. Nearly normal range of shoulder movement was noted within three to four weeks after operation. Vigorous activities were not allowed until radiological union was achieved.

Statistics

Microsoft Excel spreadsheet was used for data entry and the analysis was done by SPSS 20.4 as well as GraphPad Prism version 5. Data had been summarised as mean and standard deviation for numerical variables and counting and percentages for categorical variables. Student's t test, chi square test and one-way analysis of variance (one-way Anova) were used. $p\text{-value} \leq 0.05$ was considered as statistically significant.

RESULTS

After satisfying the inclusion and exclusion criteria 32 patients were selected for this study. In the precontoured anatomical locking plate group there were 15 patients and in the hook plate group there were 17 patients. The mean age of locking plate group was 38.93 years and for hook plate it was 44.35 years. There were 10 female patients (hook plate 8, precontoured anatomical locking plate 2) and 22 male patients (hook plate 9 and locking plate 13). Left sided fractures were 19 (hook plate 8 and precontoured anatomical locking plate 11) and right sided were 13 (hook plate 6; precontoured anatomical locking plate 7). The mean of the time of surgery since injury, in days was 9.0 for hook plate (minimum 4, maximum 17) and in case of precontoured anatomical locking plate was 9.8 (minimum 4, maximum 17) (table 1). In both the fixation modalities 100% union was

achieved at 3 months (table 2). One patient had superficial infection in the precontoured anatomical locking plate group (table 3) who was treated with antibiotics, and the infection resolved uneventfully. Mean Constant Murley score in the hook plate group was 82.0 with standard deviation of 3.446 and in the precontoured anatomical locking plate group was 87.6 with standard deviation of 2.6132. (Table 4).

Mode of Fixation (Mof)	No.	Mean	SD	Minimum	Maximum	Median	P-Value
Hook plate	17	9.0000	3.6401	4.0000	17.0000	8.0000	0.5509
Locking plate	15	9.8000	3.8582	4.0000	17.0000	12.0000	

Table 1. Distribution of Mean Time (in Days) of Surgery Since Injury

Difference of mean time of surgery since injury in days versus mode of fixation in two groups was not statistically significant (p-value = 0.5509).

Mode of Fixation	Number	Union at 03 Months	Non Union	Percentage
Hook plate	17	17	0	100%
Locking plate	15	15	0	100%
Total	32	32	0	100%

Table 2. Association between Union at Three Months and Mode of Fixation

Infection	Hook Plate	Locking Plate	Total
No	17	14	31
Row %	54.8	45.2	100.0
Col %	100	93.3	96.9
Yes	0	1.0	1.0
Row %	0.0	100.0	100.0
Col %	0.0	6.7	3.1
Total	17	15	32
Row %	53.1	46.9	100.0
Col %	100	100	100

Table 3. Association between Infection and Mode of Fixation (MoF)

Chi-square value: 1.1699; p-value: 0.2794

Difference of mean for infection versus mode of fixation in two groups was not statistically significant (p-value: 0.2794)

Mode of Fixation	No.	Mean	SD	Minimum	Maximum	Median	P-Value
Hook plate	17	82.0000	3.4460	76.0000	88.0000	82.0000	p-value< 0.0001
Locking plate	15	87.6000	2.6132	82.0000	91.0000	88.0000	

Table 4. Distribution of Mean Constant Murley Score (CMS) versus Mode of Fixation (MOF) Difference of Mean CMS versus MOF in the Two Groups was Statistically Significant (p<0.0001)

DISCUSSION

In cases of Neer Type-II fractures, sternocleidomastoid muscle acting from above on the medial fragment and gravity pulling the distal fragment downwards along with the pull of the pectoralis major (particularly if CC ligament is deficient) results in significant displacement of the fragments. So, chances of non-union is higher if these fractures are treated non-operatively.^{9,18}

The hook plate and precontoured anatomical locking plate are relatively new generation of implants and were used in a few recent studies. Part of the hook plate fixed to the medial fragment neutralises upward distracting forces, whereas the hook which is placed under the acromion neutralises downward forces on the distal part. So, a very high percentage of union rates were noted in most of the recent studies. Few complications were also reported like

implant failure, acromial fracture, metaphyseal fracture, hook migration, subacromial impingement and rotator cuff damage.^{18,19} So while using this implant we must be aware and remain very careful to avoid these complications.

74% of hook plate group had complained of mild to moderate shoulder pain in a recent study by Tan et al.²⁰ In another study, Kashii et al reported that one patient developed acromion fracture and there was hook cut-out in 19 patients. Subacromial morphometric assessment of clavicle hook plate in cadaveric model was done by Elmaraghy et al.²¹

They noted that although the orientation of the hook is posterior, it remains in the middle of the supraspinatus fossa. Sometimes there may be inflammation of the subacromial bursa which further compromises the subacromial space leading to impingement of the rotator cuff. In addition to all these, majority of the authors recommended removal of the hook plate after achieving radiological union to negate the risk of osteolysis of acromion and subacromial rotator cuff impingement.

In another study, Klein et al²² noted a complication rate of 22.7% in patients treated with hook plate. Hook plates were removed after clinical and radiological confirmation of union, on an average after seven months from surgery. Interestingly, Largo et al²³ reported that 53% of implant removal was the result of cultural belief and not because of cosmesis or complications.

In our study, we observed 100% union rate without rotator cuff impingement. However, we found partial loss of reduction in three patients and one patient had symptomatic hardware prominence producing a complication rate of 23.5%.

With the introduction of locking plate concept, precontoured anatomical clavicular locking plates are now available for providing better fixation with lesser complications like symptomatic hardware which requires removal.¹⁶ According to Tan et al²¹ use of locking plate often gives excellent results in cases of Neer Type-II fractures.

In our study, precontoured anatomical locking plate group showed very good functional outcome with high union rate and with only one infected case (only 3.1% of cases; p=0.2974) which resolved uneventfully during the follow up period. With our treatment strategy we achieved very high union rate (100%) and very low complication rate. Our results were at par with those found in the recent literature without any non-union.

However, we observed statistically significant difference in Constant Murley Score between the two groups, with the locking plate group returning earlier to their pre-injury level of activity.

We thoroughly scrutinised and meticulously compared the difference in postoperative clinical and radiological findings for both the groups from the relevant literature. Observation revealed no significant difference in non-union rate. However, we found lower complication rate in locking plate group in our study.

As there were no uniform criteria to assess functional outcome in the literature, it was very difficult to analyse and compare the results in this regard. Subsequently, we used Constant Murley scoring system to compare the functional

results and we observed statistically significant difference between the two groups.

CONCLUSIONS

Although the number of patients recruited for our study was small, we can conclude that pre-contoured anatomical locking plate and hook plate can yield very good results if used within 3 weeks from injury for Neer Type-II clavicle fractures. Locking plate can lead to earlier return to full functional outcome within 3 months after surgery with lesser complication rate when compared to the hook plate group.

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