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Functional outcome of Clavicular Hook Plate Fixation in Acute Acromio-clavicular joint dislocation: A Prospective Study

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Abstract
Background*: Acromioclavicular (AC) joint dislocation is one of the most common shoulder problems. In most cases, AC joint dislocation is the result of a direct and high energy impact to shoulder. Different approaches have been described for management of these injuries ranging from conservative management with bandages and slings to multiple surgical options including fixation of the AC joint with pins, tension band wiring, the modified Weaver–Dunn procedure, fixation with washer and screw, suspensory fixation devices and clavicular hook plate. All of these options have their own specific advantages and disadvantages, but no clear superior option has been established as yet.*
Aim*: To evaluate the functional outcome of acute Acromioclavicular joint dislocation managed by hook plate fixation.*
Materials and Methods*: A total of 37 patients within the age group of 18-60 years with Acromioclavicular joint dislocation who attended the RIMS Orthopaedics emergency block/OPD within the study period of 2 years (2019-2020) fulfilling the inclusion criteria were included in the study. Patients diagnosed with Acromioclavicular joint dislocation underwent fixation by Clavicular Hook Plate. The outcome of the treatment modality was assessed by using Constant Score.*
Results*: The mean Constant score at 24 weeks after plate fixation is 74.6±7.7 and after 48 weeks of fixation is 85.5±5.1. All the patients were considered for plate removal after 48 weeks, majority of the plate removal was done between 50 weeks to 56 weeks after plate fixation. At 8 weeks after plate removal majority of the patient 21(56.8%) have excellent functional outcome and only 1(2.7%) patient is having satisfactory outcome, there is no patient with poor outcome. AC joint dislocation treated with clavicular hook plate fixation have favorable functional outcome considering the pain, daily activity, range of motion and strength of the shoulder involved.*
Conclusion*: The present study demonstrates that Clavicular Hook Plate fixation can be considered as a very good option for treatment of AC joint dislocation of Rockwood type III and above. The functional outcome associated with this technique is excellent and complications are minimal.*
Key Word*: Constant score, Rockwood type*

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I. Introduction

The acromioclavicular (AC) joint is a diarthrodial joint between the lateral end of clavicle and medial border of the acromion process; it is statically supported by acromioclavicular, coraco-clavicular and coraco-acromial ligaments, and dynamically supplemented with deltoid and trapezius muscles. Acromioclavicular (AC) joint dislocation is one of the most common shoulder problems accounting for 9% of all the shoulder injuries.[1-3] Most of the AC joint dislocations are the result of a direct and high energy impact to shoulder particularly during sport activities which involve contact as well as in road traffic accidents. AC joint dislocations can result from both direct and indirect trauma. Direct trauma is caused when impact is on the lateral part of the shoulder by a vertically oriented superior force, forcing the AC joint in an inferior direction.[4] Indirect trauma generally

results due to fall on an adducted and outstretched arm causing the humeral head to be driven into the inferior aspect of the acromion and the joint itself.[5] Different approaches have been described for management of these injuries ranging from conservative management with bandages and slings to multiple surgical options including fixation of the AC joint with pins, tension band wiring, the modified Weaver–Dunn procedure, fixation with washer and screw, suspensory fixation devices and clavicular hook plate. All of these options have their own specific advantages and disadvantages, but no clear superior option has been established as yet.[6] The clavicular hook plates are pre-contoured plates with varying sizes and depths as well as side to fit different anatomy. After reduction in the AC joint, the hook is placed under the acromion process posteriorly and the screws are used to fix the plate to lateral clavicle maintaining the reduction. Clavicular hook plates have been demonstrated to be an effective implant option for surgical treatment of Rockwood type III AC joint dislocation.[7] The advantage of this technique is that it not only reduces the dislocation but also maintains the amphiarthrosis of the AC joint[8]. Successful results with this technique have been reported. However, the disadvantages of the plate are the compression of the sub-acromial space, rotator cuff lesions and the even the acromial stress fracture of the hook.[9,10] Thus it is important to study shoulder function after reduction and fixation of dislocated AC joint, which will help to provide the basis of selection of treatment of AC joint dislocations.

II. Materials and Methods

Total 37 patients with Acromioclavicular joint dislocations within the age group of 18-60 years were included in the study (10 females and 27 males) conducted at Regional Institute of Medical Sciences between September 2018 to August 2020. Patients diagnosed with Acromioclavicular dislocation and medically fit for surgery were advised to undergo open reduction and internal fixation by Clavicular Hook Plate. Ethical approval was taken from Institutional Research Ethics Board, RIMS Imphal before starting the study and informed consent was taken from all the participants.

Inclusion criteria:

1. Acute complete dislocation Rockwood type III to VI of the AC joint dislocation
2. Not more than 21 days of trauma.
3. No history of AC joint dislocation or other shoulder trauma.
4. No previous surgery on the shoulder.

Exclusion criteria:

1. Other types (Rockwood I-II) of AC joint dislocations.
2. Polytrauma patients.
3. History of previous disease or injury to shoulder.
4. Associated fracture on any bone of shoulder.

The patients, after admission were thoroughly examined to evaluate regarding their general physical examination, nature of injury any other associated injury. The dislocation was assessed by anterio-posterior x-ray of shoulder joint. The dislocations were classified according to Rockwood classification. All the patients were subjected to routine investigation likes routine blood examination, urine examination, serum urea, creatinine and electrolytes, blood sugar fasting and post-prandial, ECG and chest x-ray.

Operative procedure: Patients were placed in the beach chair position under general anaesthesia with or without interscalene block. An approximately 6 cm incision was made at the superior end of the injured AC joint. Soft tissues were dissected until visualization of the AC joint. The anterior and posterior edges of the acromion were located, and their midpoint was marked to guide the placement of the plate. AC dislocation was reduced, and the hook plate was placed over the AC joint. The hook was placed as posterior as feasible to ensure complete attachment to the acromion and to avoid subacromial impingement (on the supraspinatus bursa or rotator cuff) or overlapping of the hook over the AC joint. Conventional screws were used to fix the plate to the lateral part of clavicle. Abduction, flexion, and external rotation of the joint were checked for any sign of impingement or contact between the humeral head and the hook plate. Stability and positioning of the plate and the length of screws was checked using fluoroscopy. Postoperatively, the operated limb was immobilized in an arm pouch. IV antibiotics were continued for 48 hrs and switched over to oral antibiotics on the 3rd day and continued till the 5th day. Wound was inspected on 3rd postoperative day and Sutures were removed on 10th postoperative day. Patients were discharged on 5th postoperative day but some patients were discharged later due to associated injuries and co morbidity. The arm was kept in a sling for 15 days. Active exercises of the elbow, wrist, and hand, and passive exercises of the shoulder were allowed at postoperative day 3. Active-assisted exercises involving abduction and frontal elevation up to 45º were allowed at day 4, and elevation up to 90º at day 10. Pendulum exercises were allowed at day 15 as pain tolerated. Frontal elevation up to 150º and abduction over 90º were allowed at 3rd week.

The patients were followed up for post-operative care at an interval of 4 weeks till 12thweekand again at 24th week and 48th week at outpatient department of RIMS Orthopaedics Department. Clinical and

radiological assessments were done during the follow up studies. All patients were subsequently enrolled in an institutional shoulder rehabilitation programme to regain shoulder range of motion including cuff strengthening exercises. The patients were followed up for a minimum period of 48 weeks after hook plate fixation, after which patients were considered for removal of the plate. After hook plate removal patient was followed up at 8th week. The patients were subjected to radiographic assessment at 12thweek, 24th week and 48thweek after hook plate fixation, and 8th week after hook plate removal. The functional outcome was assessed using the Constant Score at 24thweek and 48thweek after hook plate fixation and 8th week after hook plate removal.

III. Results

In the present study, Majority of the patient were from the age group of 31-40 years of age (40.5%) with a mean age of 34.11±8.9 years. The majority of patients are male with 73% and 27% are female with male to female ratio of 2.7: 1. The injury is more prevalent in dominant side (64.9%) as compare the non-dominant side (35.1%). 51.4% of the patients were having Rockwood type III. There is no patient with Rockwood type VI dislocation. The most common mode was sports injuries followed by RTA. Associated injuries like rib fracture, patella fracture and both bone leg fracture were seen in 3 patients who were managed by appropriate treatment modalities. Majority of the type IV and type V injuries occurs due to RTA while type III injury results mostly due to sports injury and accidental fall. All patients were operated as soon as patient was fit for surgery and mean time interval between trauma and surgery was 6.2±1.4 days. The average duration of surgery was 48.78±4.47 minutes. The mean timing of removal of hook plate after fixation was 53±1.7 weeks. All the hook plates were removed in time period between 50 and 56 weeks after fixation. At 24th week and 48th week after hook plate fixation the mean Constant score were highest among the Rockwood type III injuries i.e 78.9±5.3 and 88.1±3.7 respectively. At 8th week after hook plate removal the mean Constant score were highest among the Rockwood type III injuries i.e., 93.2±2.0.

Table 1 : Relation between Rockwood type of injury and Constant score at 24th week, 48th week after hook plate fixation and 8th week after removal of hook plate.

Rockwood type	Constant score at 24th week after plating (Mean±SD)	Constant score at 48th week after plating (Mean±SD)	Constant score at 8th week after plate removal (Mean±SD)
III	78.9±5.3	88.1±3.7	93.2±2.0
IV	72.2±7.8	82.8±5.5	88.8±4.4
V	67.2±5.8	82.8±4.8	88.7±3.2
Total	74.6±7.7	85.5±5.1	91.05±3.7
One Way ANOVA test	F=11.249 p=0.00	F=6.29 p=0.05	F=9.62 p=0.00

Table 2 : Distribution of patient's Functional Outcome at various intervals.

Variable	24th week after plating	48th week after plating	8th week after plate removal	Repeated ANOVA (Wilks lamda) p value
Pain score (Mean±SD)	8.3±1.8	9.7±1.4	12.0±1.6	Value=0.099 p=0.00
Activity score (Mean±SD)	16.7±1.1	17.1±0.7	18.0±0.6	Value=0.028 p=0.00
ROM score (Mean±SD)	28±2.4	34.2±2.4	36.2±1.6	Value=0.034 p=0.00
Strength score (Mean±SD)	21.2±3.5	24.6±1.3	24.8±0.9	Value=0.466 p=0.00
Constant score (Mean±SD)	74.6±7.7 (Adequate)	85.5±5.4 (Good)	91.0±3.7 (Excellent)	Value=0.90 p=0.00

Based on assessment by Constant Score (0-100) with 90-100 as Excellent, 80-90 as Good, 70-80 as Satisfactory, 60-70 as Adequate and less than 60 as poor. Mean functional outcome at 24th week is Good (74.6±7.7), at 48th week is Adequate (85.5±5.4) and 8th week after the removal of plate is Excellent (91.0±3.7).

Table 3 : Distribution of patients based on Functional Outcome at 24th week, 48th week after Hook plate fixation and 8th week after hook plate removal (N=37)

Functional outcome	Frequency at 24th week after hook plate fixation	Frequency at 48th week after hook plate fixation	Frequency at 8th week after hook plate removal
Excellent	0 (0%)	6(16.2%)	21(56.8%)
Good	11(29.7%)	26(70.3%)	15(40.5%)
Satisfactory	17(45.9%)	4(10.8%)	1(2.7%)
Adequate	7(18.9%)	1(2.7%)	0(0%)
Poor	2(5.4%)	0(0%)	0(0%)
Total	37(100%)	37(100%)	37(100%)

There was no intra-operative and immediate post-operative complication. Late complications encountered are 2 case of superficial incision site infection which was treated with oral medication and have favorable outcome, and on assessment at 48 weeks 1 patient was found to have subacromial osteolysis which was improved after removal of the plate.

Pre-operative clinical and x-ray image of right sided AC joint dislocation

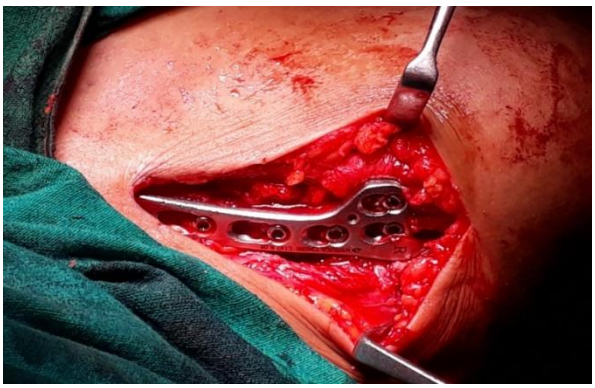

Image showing intraoperative picture of hook plate fixation

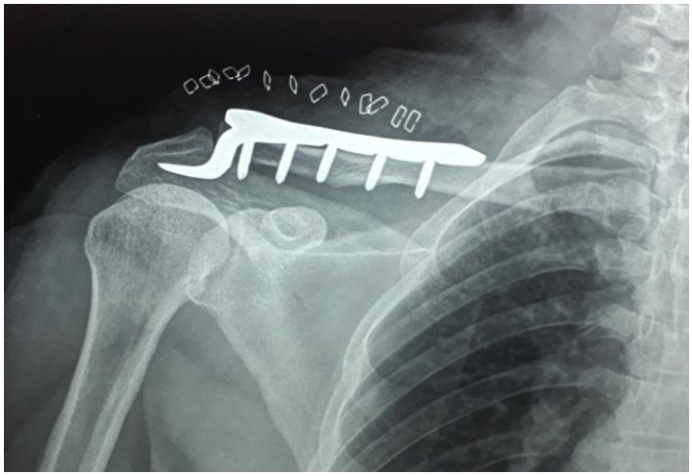

Image showing post-operative X-ray after hook plate fixation

Image showing post-operative X-ray after hook plate removal

Images showing examination of patient with right AC joint dislocation treated with hook plate fixation, after removal of hook plate.

IV. Discussion

Acromioclavicular (AC) joint dislocation is one of the most common shoulder injuries which cause impairment in daily activity and functions associated with the involved upper limb. The demographic pattern of the AC joint injuries has depicted a steep trend towards males sustaining a greater number of these injuries with majority being the young adults.[11] The mean age group in the study is 34.1±8.9 years with the age group 20-30years and 31-40years comprises of 28 patient which is 75.6% of the total case, this finding is comparable to the finding in a study by Kumar N and Sharma V [12] (24 years). The majority of the patients are male which constitutes about 73%. In 64.9% of the patients injury occurs in dominant side. The common mechanisms of injury are high energy impact during sports injuries and road traffic accidents. In the study it is found that maximum number of the injuries 17(46%) are associated with sports injuries followed by RTA 11(29.7%), which is comparable with the study by Claudio C[11] et al (sports injury 40% and RTA 33%). AC joint dislocation are classified on the basis of radiographic findings, different classification systems are available, but classification system of Rockwood et al[21] is widely used which classified AC joint dislocation into 6 types. In the study considering only type III-VI injury, majority of the patient 19(51.4%) were having type III injury, it is comparable with the study by Claudio C et al[11] (type III injury 40%). There has been general consensus about conservative management for Rockwood type I and II injuries, and surgical management for Rockwood type IV, V and VI injuries.[13] The debate for non-operative versus operative management for type III injuries remains undecided as studies found both advantage and disadvantage. The most significant disadvantages of conservative management are an impaired shoulder function, pain, cosmetic deformity and effect on performance of athletes involves in upper limb activity. Traditionally Kirschner wire or tension band wiring, fixation with washer and screws, and suspensory fixation devices were used to treat AC joint dislocation. However various complications such as metal breakage, loosening of implants, recurrence of instability, migration of implants and neuro-vascular damage have been reported. Recently, the hook plate has become widely used as it enables to secure fixation against rotational, horizontal and vertical forces. Furthermore, it avoids direct joint injury as it doesn't involved fixation by screw or pin into the joint. Since the clavicular hook plate works by forming a leverage through the proximal ends of the plate fixed to the distal clavicle and penetrates the undersurface of the acromion, so it not only reduces the dislocation of the AC joint by adding pressure joint, but also maintains the characteristics of amphiarthrosis of the AC joint. All the patients in this study were treated with clavicular hook plate fixation using appropriate sizes. The mean time interval between day of injury and surgery is 6.2±1.4 days with range of 4-10 days. The mean duration taken for the procedure was a 48.78±4.4 minute which is comparable with the study by Kumar N and Sharma V[12] (43 minutes). The ultimate goal of surgical intervention in these injuries is to facilitate early return of the activity of the patient in their pre-injury levels. In the study the variables of the Constant score i.e., pain, activity, range of motion and strength increased favorably in 24 weeks interval after the plate fixation and 8 weeks after the plate removal. The mean Constant score at 24 weeks after plate fixation is 74.6±7.7 and after 48 weeks of fixation is 85.5±5.1, this can be compared to the study by Shah SH and Parmar P[14] (mean Constant score at 24 weeks is 72.4 and at 48 weeks is 80.6). At 24 weeks 11(29.7%) patients show good functional outcome and 17(45.9%) patients show adequate functional outcome, while 2(5.4%) patients show poor outcome. On further assessment at 48 weeks 6(16.2%) patients are having excellent outcome and patients having good outcome have increase to 26(70.3%). All the patients were considered for plate removal after 48 weeks, majority of the plate removal was done between 50 weeks to 56 weeks after plate fixation, and this is comparable to study by Chen CH et al[15] (plate removal within 8-12 month). 8 weeks after the removal of the plate there is increase in mean constant score to 91.0±3.7 which is also comparable to study by Chen CH et al[29] (mean constant score 89±5 at 2 month after removal of plate). At 8 weeks after plate removal majority of the patient 21(56.8%) have excellent functional outcome and only 1(2.7%) patient is having satisfactory outcome, there is no patient with poor outcome. The major disadvantages of hook plate cited in the earlier series have been repeat surgery required for plate removal, persistent shoulder pain, incomplete shoulder function, acromial osteolysis and acromioclavicular subluxation.[51]In this study there are 2 patient with superficial incision site infection which was treated with oral antibiotics and have favorable outcome, 1 patient have sign of subacromial osteolysis during assessment at 48th week after plate fixation which after plate removal improved significantly. There is no incidence of acromioclavicular subluxation. There was no need of repeat surgery other than surgery for plate removal.

V. Conclusion

This study concluded that clavicular hook plate fixation is a very good option to be considered for treatment of AC joint dislocation of Rockwood type III and above. AC joint dislocation treated with clavicular hook plate fixation have favorable functional outcome considering the pain, daily activity, range of motion and strength of the shoulder involved. However there have been reports of complications like osteolysis and acromioclavicular osteoarthritis which may be related with the timing of removal of plate.

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