



CLAVICLE HOOK PLATE FOR MANAGEMENT OF FRACTURES OF LATERAL END OF CLAVICLE AND ACROMIOCLAVICULAR (AC) JOINT DISRUPTION – A CROSS-SECTIONAL STUDY

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Abstract

Background: Injuries to the acromioclavicular (AC) joint and fractures of the lateral end of the clavicle are prevalent in young individuals and athletes, posing significant challenges in orthopedic management. The use of a clavicle hook plate for the treatment of these injuries has been a subject of interest in recent orthopedic research.

Materials and methods: Conducted as a cross-sectional study at a private hospital from August 2021 to January 2022, it included 25 cases based on specific inclusion criteria: AC joint disruptions of Tossy type 3 and fractures of the lateral end of the clavicle of Neer type 2 and 3. Participants underwent open reduction and internal fixation with a clavicle hook plate. The study utilized the Quick DASH score and Constant-Murley score for outcome assessment, and the data were analyzed using SPSS version 25.

Results: The study demonstrated predominantly positive outcomes, with a majority of patients showing good to excellent recovery based on Constant-Murley and Quick DASH scores. The mean age of participants was 42.52 years, with a balanced distribution in terms of gender and injury side. Notable complications included hook cut-out, impingement, and osteolysis at the tip of the hook. However, these complications were reversible upon implant removal.

Conclusion: The study indicates that clavicle hook plate fixation is effective for treating lateral end clavicle fractures and AC joint disruptions, leading to improved shoulder function. However, limitations like a small sample size, absence of a control group, potential bias, and a short follow-up period underscore the need for larger, randomized trials to confirm and assess long-term safety and efficacy.

Keywords: Clavicle fractures, Acromioclavicular joint, Hook plate fixation, Orthopedic surgery, Shoulder injuries.

Introduction

Young individuals and athletes experience a disproportionately high number of injuries to the acromioclavicular (AC) joint in comparison to other age groups. The acromioclavicular joint is the

site of around forty percent of all injuries that occur to the shoulder. Mild injuries have a low risk of significant consequences, but severe injuries can result in chronic paralysis and decreased shoulder function. Mild injuries pose a low risk of serious problems. An injury to the acromioclavicular joint can result in a number of complications, including a broken clavicle, impingement syndromes, and even neurovascular insults.¹

The acromioclavicular joint, often known as the AC joint, is a diarthrodial joint that connects the acromion process of the scapula to the lateral process of the clavicle. The acromion process is an anterior projection of the scapula. The primary source of the joint's stability comes from the acromioclavicular ligament, which is a structure made up of four separate parts. The superior portion of the AC ligament is of particular significance in terms of the stability of the AC joint. The vertical support that is provided by the coracoacromial ligament, the two coracoclavicular ligaments known as the trapezoid and the conoid, and the coracoacromial ligament all contribute to the structural integrity of the shoulder. On the other hand, minor injuries are not related with any significant morbidity, whereas severe injuries can lead to a large loss of shoulder strength and function. Mild injuries are not linked with any significant morbidity. An acromioclavicular injury can potentially lead to a number of problems, including impingement syndromes, neurovascular injuries, and fractures of the clavicle.^{2,3}

Injuries to the anterior cruciate ligament (AC) are frequently sustained as a result of athletic activities, including sporting events, automobile accidents, falls from bicycles, and other sports incidents. Up to forty percent of all sports injuries affect the ac joint, while around ten percent of all sports injuries occur in contact sports such as football. The most common cause of shoulder dislocation is a direct blow to the acromion process or the lateral facet of the shoulder joint while the arm is in the adduction position. A dislocation of the AC joint can also be induced by landing on an extended hand or elbow after an accident.^{4,5}

On the basis of the distance that the clavicle is displaced from the acromion, it is feasible to classify AC dislocations into one of six different groups. When both the acromioclavicular (AC) ligament and the coracoclavicular (CC) ligament are fully ruptured, the clavicle becomes entirely dislocated from the acromion, and there is no longer any stability in either the vertical or horizontal plane. When the arm is extended, the weight is transmitted from the humeral head to the acromion in a circuitous manner. This causes the distal end of the clavicle to migrate superiorly. When the arm is retracted, the weight is transferred in the opposite direction.^{6,7}

Rockwood types I and II require extra care when being handled. Surgical surgery is indicated for Types IV–VI when the CC ligaments are involved and the clavicle is displaced in any way, even slightly. By restoring the normal architecture of the AC joint, it may be possible to correct the obvious deformity, as well as avoid the potentially unsatisfactory results of chronic discomfort and eventual AC joint degenerative modifications. These outcomes may be avoided by correcting the deformity. Despite the fact that the majority of authors support surgical treatment for manual labourers who have sustained a dislocation of a Rockwood Type III AC joint, the debate is far from over.⁸

The various treatment options for these injuries have been extensively discussed. These treatment options range from conservative care such as bandages and slings to a wide range of surgical options such as AC joint fixation with pins, tension band wiring, the modified Weaver-Dunn procedure, fixing the joint with a washer and screw, suspensory fixation devices, and a clavicular hook plate.⁹

A wide variety of patient body types can be accommodated by the hook plate because it is a preshaped device that comes in a variety of sizes and hook depths. This implant can only be utilised on the side of the body that is afflicted by the condition being treated because the hook is situated in the back. One of the manufacturers of the implant is known as the AO synthesis system, however there are several other manufacturers. The hook plate device allows for the beginning of rotational mobility in the shoulder to begin at an earlier stage. Open reduction and internal fixation with a hook plate for AC joint dislocation is an effective treatment for the condition, with very little impact on the shoulder's ability to function normally after the procedure.¹⁰

According to the findings of a study that was carried out by Sivanandan S and colleagues, the surgical and functional outcomes following AC joint stabilisation with hook plate fixation are positive, regardless of whether the patient suffered from lateral end clavicle fractures or not. In addition to this, the hook plate provides exceptional stability in all three axes of rotation as well as in the vertical plane. In addition, the preservation of reduction that was accomplished by the hook plate was much superior to that which was accomplished by other treatment approaches. In addition, the hook plate facilitates early mobilisation and reduces shoulder joint stiffness in the patient.¹¹

This study was designed to analyse the outcome of clavicle hook plate fixation for the management of fractures of lateral end of clavicle and acromioclavicular joint disruption especially in the given study area.

Material and methods

It's a cross sectional study done at a private hospital based in Thiruvallur district from August 2021 to January 2022. Around 25 cases were estimated using the formula $N = Z^2 pq/d^2$. All AC joint disruptions of Tossy type 3 (Rockwood and Young type 3-6); either acute/chronic symptomatic cases; all fractures of lateral end of clavicle of Neer type 2 and 3 (Craig type 2 and 6); either acute or with painful non-union were included. Those patients not willing to undergo surgery and unfit for surgery were excluded. Quick DASH score and Constant-Murley score were used. Lateral end of clavicle fracture were classified according to Neer as type 2A (medial to CC ligaments, intact, unstable), type 2B (either between/lateral to CC ligaments, one or both torn, unstable), type 3 (intraarticular lateral to CC ligaments and extending into AC joint).

AC joint disruption: Classified according to Rockwood as type 3 (clavicle displaced superiorly; AC, CC ligaments ruptured), type 4 (clavicle displaced posterior into trapezius; AC, CC ligaments ruptured), type 5 (clavicle markedly elevated, CC distance more than double of normal value), and type 6 (clavicle displaced inferiorly behind coracobrachialis and biceps tendons). Only patients defined by the above mentioned parameters were recruited for the study.

Data were collected and entered in Microsoft excel 2007. Software to be used for statistical analysis: SPSS version 25. Continuous variables were summarized using mean (SD), Categorical variables like sex were summarized using proportion. The association between categorical variables were analysed using Chi square test and P value <0.05 were considered as statistical significant.

The study was started only after obtaining due permission from the Ethical Committee. All those willing to participate in the study, subject to inclusion and exclusion criteria, will be explained about the procedure. Written informed consent were obtained from study participants.

Results

Mean age of the study participants was 42.52 ± 6.46 years. Around 16% were in the age group of 31-35 years, 8% 36-40 years, 32% 41-45 years and 44% 46-50 years. There were about 48% males and 52% females. Around 36% had right side and 64% left side.

Table 1: Distribution of demographic parameters among the study participants (N=25)

Slno	Variable	Frequency	Percentage
1	Age		
	31-35	4	16
	36-40	2	8
	41-45	8	32
	46-50	11	44
2	Gender		
	Male	12	48
	Female	13	52

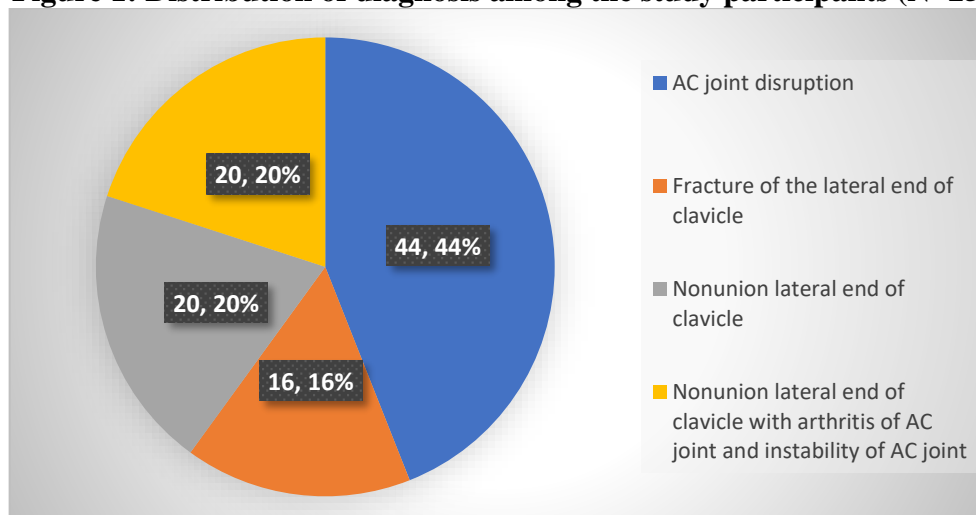
3	Side of injury		
	Right	9	36
	Left	16	64
4	Injury to treatment duration in days		
	1-3 weeks	9	36
	3-6 weeks	9	36
	6-12 weeks	7	28

Table 2: Distribution of study parameters among the study participants (N=25)

Sno	Variable	Frequency	Percentage
1	Type of implant		
	DCP	9	36
	RECON	16	64
2	Calcification		
	AC joint disruption	3	12
	Fracture lateral end	2	8
	Non union	3	12
3	Complications		
	Cut out of hook	4	16
	Impingement	6	24
	Osteolysis at tip of hook	10	40
4	Time in weeks to the appearance of complications		
	<20 weeks	16	64
	>20 weeks	4	16

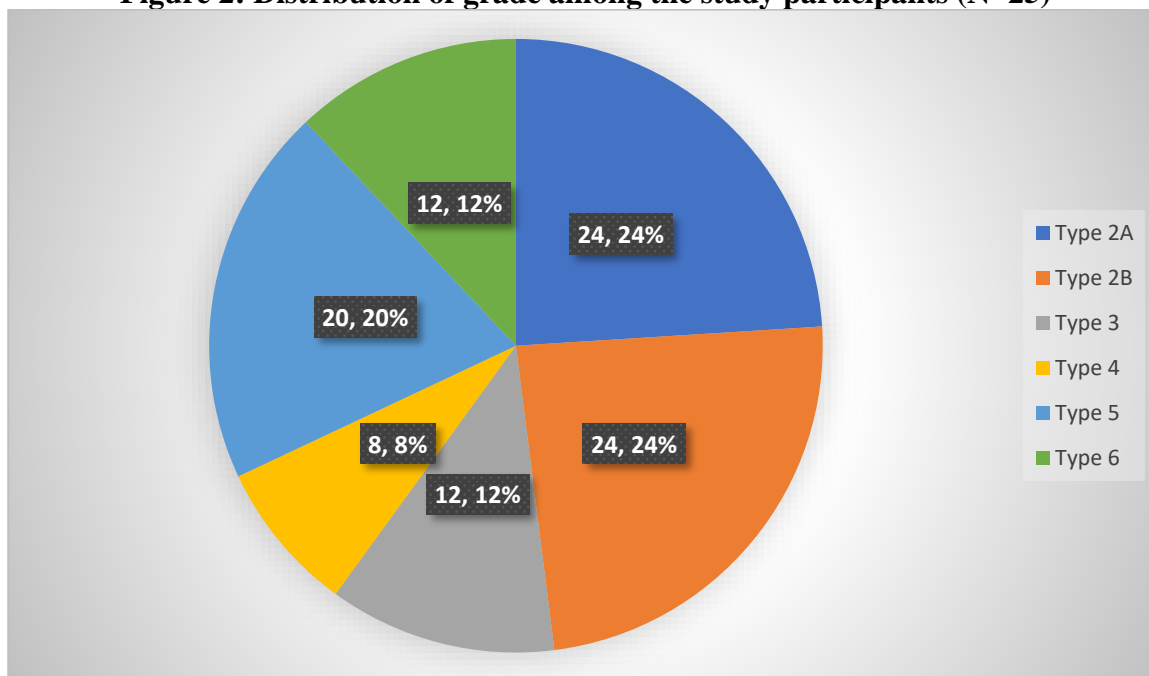
Around 36% DCP and 64% RECON. Around 12% AC joint disruption, 8% fracture lateral end and 12% non-union. Around 16% had cut out of hook, 24% impingement and 40% osteolysis at tip of hook. Around 64% had <20 weeks to appearance of complication and 16% had >20 weeks in appearance of complications.

Figure 1: Distribution of diagnosis among the study participants (N=25)



Around 44% had AC joint disruption, 16% fracture of the lateral end of clavicle, 20% non-union lateral end of clavicle and 20% nonunion lateral end of clavicle with arthritis of AC joint and instability of AC joint (Figure 1).

Figure 2: Distribution of grade among the study participants (N=25)



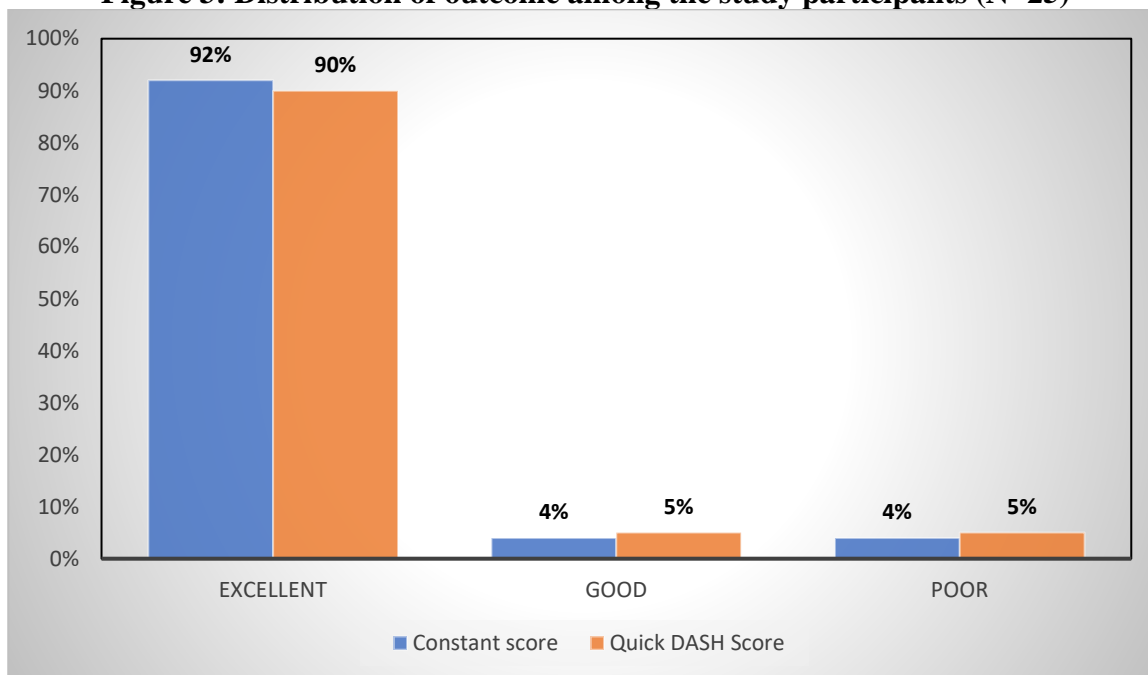
In this study around 24% had type 2A, 24% Type 2B, 12% Type 3, 8% type 4, 20% type 5 and 12% type 6 (Type 2). Around 38% had excellent results, 51% good results and 11% satisfying according to Constant-Murley score. As per DASH score 40% had excellent results, 55% good results and 5% satisfying results.

Table 3: Distribution of descriptive variables among the study participants (N=25)

	Minimum	Maximum	Mean	Std. Deviation
Constant score	65.00	97.00	76.32	7.94
DASH score	3.00	25.00	12.52	7.01
Quick Dash score	2.00	25.00	12.60	7.78
CC DISTANCE (in mm) OF THE NORMAL SHOULDER	10.00	13.00	11.52	1.23
CC DISTANCE (in mm) OF THE AFFECTED SHOULDER	15.00	24.00	20.12	3.26
CC DISTANCE (in MM) AT IMMEDIATE POST-OP interval	13.00	18.00	14.72	1.14
LENGTH OF HOOK	10.00	11.00	10.56	0.51
DEPTH OF HOOK	10.00	12.00	11.24	0.78

Mean constant score 76.32 ± 7.94 , mean DASH score 12.52 ± 7.01 , mean quick dash score 12.60 ± 7.78 , mean CC distance in mm of normal shoulder 11.52 ± 1.23 , mean CC distance in mm of the affected shoulder 20.12 ± 3.26 , mean CC distance in mm at immediate post-op interval 14.72 ± 1.14 , mean length of hook 10.56 ± 0.51 and mean depth of hook 11.24 ± 0.78 .

Figure 3: Distribution of outcome among the study participants (N=25)



Applying Constant-Murley score out of 25 subjects 92% had excellent outcome followed by 4% good outcome and 4% poor outcome. Applying quick DASH score 90% had excellent outcome, 5% had good outcome and 5% poor outcome.

Discussion

Treatment for unstable fractures of the lateral end of clavicle and AC joint disruptions have been shown historically to be an area of much debate in respect to the indications, choice of treatment procedure and choice of implant. Historically a variety of implants have been used such as Kirschner wires¹², tension band wires around coracoid-clavicle, transfixation of clavicle to coracoid with screw¹³, repair of CC ligament with augmentations^{14,15}, endobuttons¹⁶ and the hook plate^{17,18}. Others advocate the excision of the lateral end of clavicle in chronic painful dislocations^{19,29}. Debate as to the use of synthetic²¹ or autologous fascia slings and tendons for repair of CC ligament and its fixation techniques are yet to be resolved. Surgical approaches may be luggage strap, along the clavicle, mini stab incisions or arthroscopic reconstruction of CC ligament^{22,23}. The Weaver Dunn procedure has a weak strength and can result in incomplete reduction or recurrence with a high failure rate of approximately 29%. Kirschner wire fixation has a high rate of migration²⁴ while the Bosworth screw needed a wide surgical exposure but provided a rigid fixation leading to loss of rotation and screw cut out. In young patients, there is a need to restore anatomical reduction because of high rates of non-unions and shoulder pain and that the ligaments will not heal without surgery.²⁵

The use of hook plate in the treatment of AC joint disruptions and fractures of the lateral end of clavicle is shown to be a good and acceptable treatment option. AC joint dislocations result in an inferior sag of the scapula²⁶ and stability at this joint must be achieved either by repair of the ligaments and/or stabilizing with a plate or other fixation devices. Implants like endobuttonsTM (Smith & Nephew) need not be removed and this avoids an additional surgery to the patient²⁷. In regards to the use of a hook plate, there are debatable statements regarding retaining the implant for a more longer duration as against removal when the patient is symptomatic. Most of the patients in this study had an excellent or good outcome which is similar to the findings of various other studies.^{19,28} There is literature questioning the need for either simultaneous reconstruction or repair of the ligaments along with hook plate method of fixation, further suggesting implant removal after radiological or clinical indication and /or reconstruction after plate removal depending on the instability.²⁹

In this study, 23 patients had an excellent outcome as assessed by Constant score and quick DASH score, one patient had good outcome and one had poor outcome (he has developed a frozen shoulder and uncontrolled diabetes). These results are comparable to other studies using a hook plate.^{19,28} Of the one patient who had good outcome had a resection of the lateral end of clavicle (with arthritis of AC joint) followed by hook plate stabilization of AC joint and will be arriving for follow-up and implant removal at a later date. We have noted the following complications in our study around 16% had cut out of hook, 24% impingement and 40% osteolysis at tip of hook. Three results are comparable with other studies^{19,25,28} though the exact reason of shoulder stiffness is unknown, it appears to be a post-traumatic frozen shoulder. The presence of osteolysis between the plate and the acromion has been attributed to the rotational movement (micro motion) which occurs with abduction resulting in rotation of clavicle and the hook plate in respect to the acromion. In our study, 10 patients (40%) developed osteolysis which was temporary and resolved after implant removal, the incidence of which is similar to one¹ but higher than some other studies.²⁸

Limitations

The modest sample size of 25 cases may constrain our ability to detect smaller effect sizes and restrict the generalizability of our results to a broader population. Additionally, the exclusive conduct of this study within a single center may not fully encompass the diverse clinical practices and patient demographics observed in other healthcare settings, potentially impacting the external validity of our findings. The absence of a control group prevents us from definitively attributing observed improvements solely to clavicle hook plate fixation, as we cannot make direct comparisons with other treatment modalities or no treatment. The maximum 18-month follow-up period limits our capacity to assess long-term complications and the sustained effectiveness of the procedure adequately. The inclusion criteria, which required patients to be willing and fit for surgery, may introduce selection bias by excluding individuals with more complex health profiles or those opting for non-surgical alternatives. Furthermore, the reliance on subjective outcome measures such as Constant-Murley and DASH scores, susceptible to patient self-reporting variability, could impact the precision of our data. The absence of randomization and the potential for observer bias in data collection and interpretation may introduce confounding factors that influence our study's findings. Failure to compare the hook plate method with alternative treatment modalities restricts our understanding of its relative efficacy and safety. Lastly, the exclusion of specific patient groups, particularly those not amenable to surgery, may skew our perception of the treatment's applicability and outcomes.

Conclusion

The use of hook plate in the treatment of fractures of the lateral end of clavicle and AC joint disruptions has been established as a good and acceptable treatment option. Hence, it can be expected that a majority (>90%) will have a good, uneventful recovery. Known complications include osteolysis, impingement, and cut out of hook, but these are uncommon and can be reversed by removal of the implant at 3 months.

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Case 1



35-year-old male with an alleged history of road traffic accident with pain and deformity at the left shoulder



Immediate post operative period



At 6 months follow up

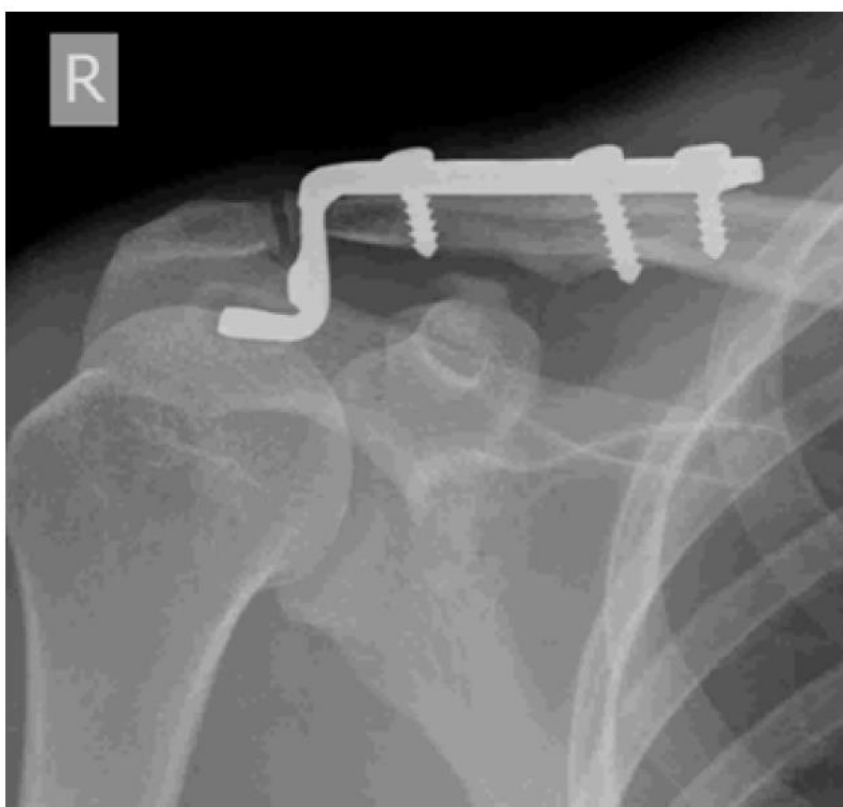
Case 2



24-year-old male with an alleged history of road traffic accident with pain and deformity at the right shoulder



Immediate post operative period



At 18 months follow up