

Dual fixation for coracoid fracture with acute acromioclavicular joint disruption: a case series

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Introduction

The management of acute disruption of the acromioclavicular joint (ACJ) in conjunction with a concomitant coracoid fracture has been discussed. This combined orthopedic injury is uncommon because radiographs alone may not always be enough to identify the coracoid component clearly. There are different options for management, ranging from nonsurgical, single, or double fixation strategy. The purpose of this study was to evaluate the results of a clavicular hook plate combined with a coracoid screw fixation in patients who engage in high-demand activities and athletes over a minimum of a year of follow-up.

Patients and methods

Following the dual fixation strategy, seven patients were followed clinically and radiologically with a mean follow-up 16 weeks, through which a rehabilitation program was adhered to. The range of motion around the shoulder, American Shoulder & Elbow Surgeons, and constant scores were utilized to evaluate patients clinically during their last follow-up visit. Furthermore, radiological assessment of the reduction of the ACJ according to coracoclavicular distance (CCD) and CCD ratio.

Results

The findings in this study showed a statistically significant improvement between the 3, 6, and 12-month American Shoulder & Elbow Surgeons scores, which were 39.1 ± 14 , 67.4 ± 1 , and 86.7 ± 5 , respectively ($P < 0.001$). The mean range of motions for active shoulder abduction and forward elevation was $171.4 \pm 6.3^\circ$ and $156.4 \pm 12.8^\circ$, respectively. 9 ± 0.9 mm was the mean CCD, and 1.07% was the mean CCD ratio.

Conclusion

A stable fixation construct with significant functionality can be successfully achieved through the dual fixation strategy using a coracoid screw and hook plate with no coracoclavicular ligament reconstruction in the treatment of concomitant coracoid fracture and acute ACJ injuries in athletes and high-demand patients.

Keywords:

acromioclavicular joint, coracoclavicular distance ratio, coracoclavicular distance, coracoid, hook plate

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Introduction

Acute traumatic acromioclavicular joint (ACJ) disruption associated with coracoid fractures is rare [1]. Management options reported in literature varied from conservative to surgical management with more superiority to surgical ones regarding the functional outcome [2]. In view of the absence of solid evidence regards the ideal fixation modality through surgical management of such injuries, and with only case reports without a considerable follow-up period, we undertook this research to consider the efficacy of clavicular hook plate and coracoid screw fixation without ligamentous reconstruction for management of this combined injury in athletes and patients with high-demand activities.

for acute traumatic ACJ disruption combined with coracoid fracture via open reduction and stabilization by clavicular hook plate and coracoid screw. This research has been approved by the institutional research board of the authors' affiliated institution in line with the principles of the Declaration of Helsinki. Informed consent was obtained from all enrolled patients in the study.

This study included skeletally mature patients more than or equal to 18 years, acute coracoid fracture combined with ACJ disruption Rockwood [3] type III or more, managed by a clavicular hook plate and coracoid screw, within 3 weeks of trauma, with

Patients and methods

Type of study: retrospective case series

Between March 2018 to October 2022, seven patients were enrolled in this study who underwent management

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a minimum follow-up period of 12 months. The exclusion criteria were chronic injuries, ACJ disruption Rockwood types I, II, open injuries, concomitant shoulder injury including associated scapular or humeral fractures, concomitant neurovascular injuries, previous shoulder injury, and follow-up less than 12 months.

Preoperatively, a careful radiological evaluation (Fig. 1), taking advantage of an anteroposterior (AP) view radiograph of both shoulders to grade the ACJ disruption as per the traditional Rockwood classification and delineate the site of coracoid fracture. Additionally, a computed tomography scan was obtained in all cases to detect the coracoid injury site.

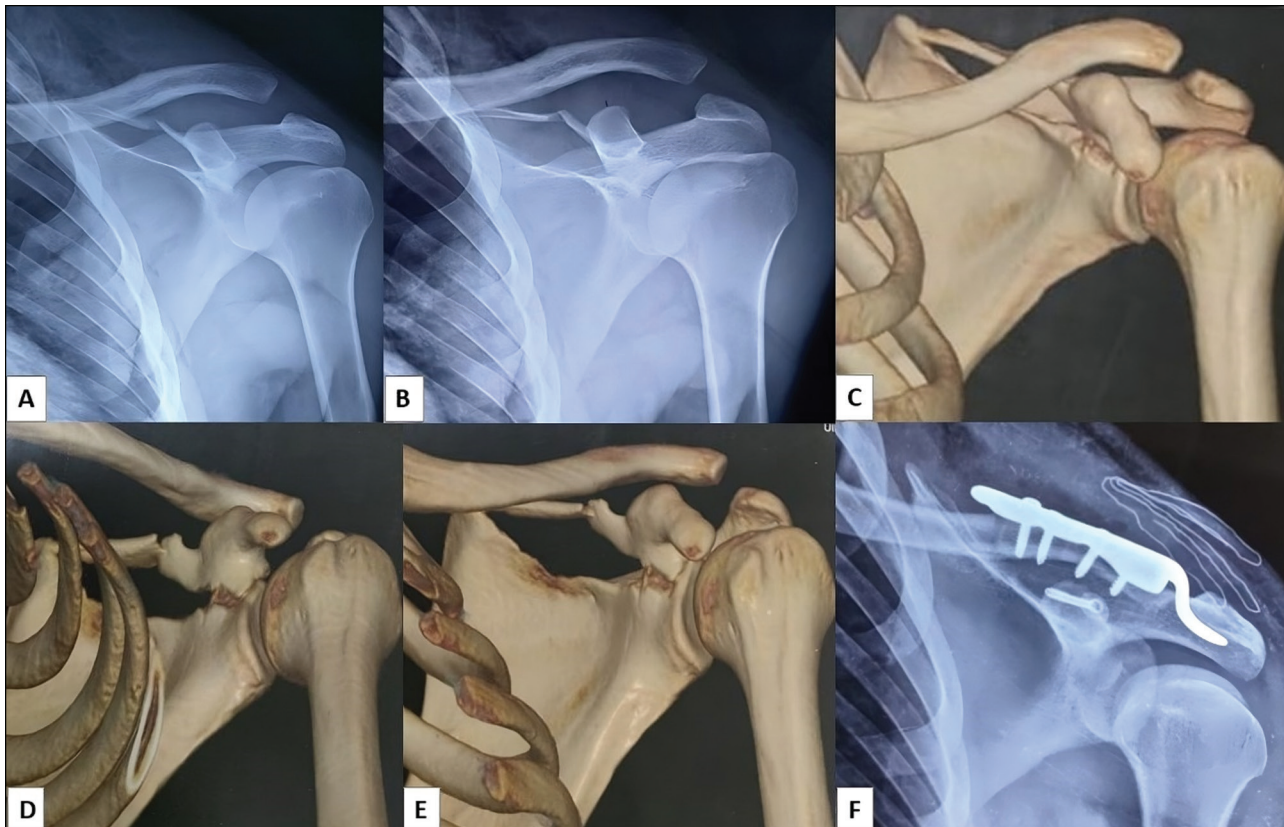
Under general anesthesia combined with preoperative ultrasound-guided interscalene block, patients were in a beach-chair position with a sandbag under the scapula. All bony prominences were secured and well-padded. The patient's arm was draped free, allowing intraoperative manipulation of the limb and easy fluoroscopic access. Satisfactory fluoroscopic views were obtained before starting surgery.

Surgical technique

After palpation of the coracoid process, a longitudinal shaped skin incision was made along the anterior border of the lateral third of the clavicle, starting medial and posterior to ACJ, and curved medially outward the ACJ (Fig. 2). The incision was extended distally 2–3 cm inferior to the coracoid tip. The anterior deltoid insertion with the periosteum was incised along the skin incision, exposing the ACJ. Stay sutures were placed through anterior deltoid fibers for later reattachment. The ACJ, coracoclavicular ligament (CCL), coracoacromial ligament, coracoid process, and conjoint tendon were identified.

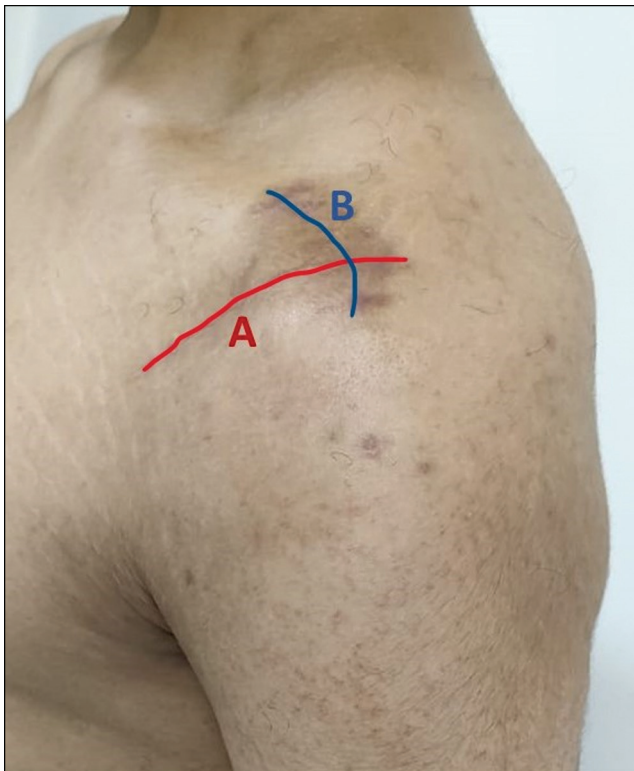
Reducing the ACJ separation was performed using a titanium clavicular hook plate (DePuy Synthes) (four or five hole) with a 15-mm-hook offset. The hook was passed into a 5 mm snip in the trapezium muscle passing beneath the posterior aspect of the acromion. The plate was then secured by three to four screws inserted from medial to lateral, aiming at indirect reduction of the clavicle into its position. The reduction was checked under fluoroscopy. Afterward, the coracoid bed on top of the glenoid was prepared, and the coracoid was temporarily reduced with a Kirschner

Figure 1



Preoperative radiological assessment of a 24-year-old male patient with grade III acute ACJ disruption and coracoid base fracture through: (A,B): AP shoulder radiographs, and (C-E): 3D CT images delineate coracoid base fracture. Postoperative radiograph (F) shows ACJ reduction via hook plate and coracoid fracture fixation via a coracoid screw.

Figure 2



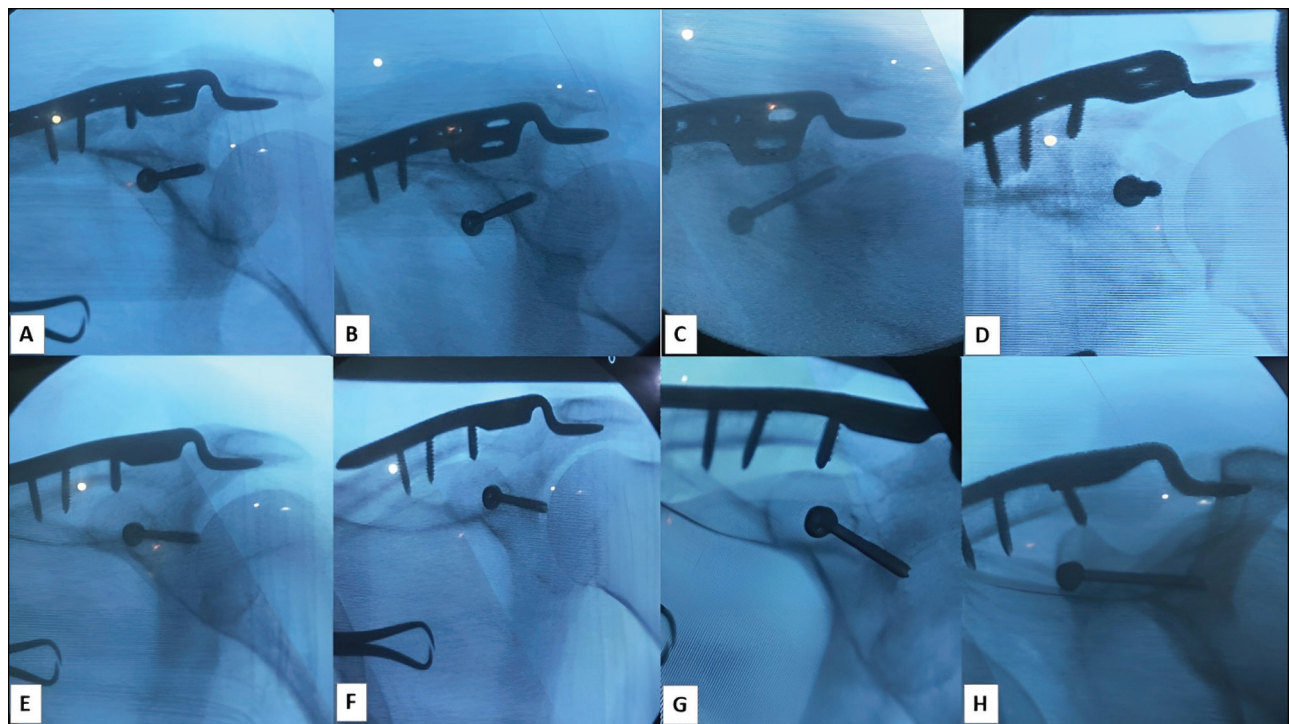
Clinical photo shows (A): A longitudinal scar (red line) of the primary surgery for hook plate & coracoid screw, and (B): transverse scar (blue line) for subsequent surgery of hook plate removal.

(K) wire, subsequently, stabilized by a 4-mm-partial cancellous screw with a washer after being drilled under fluoroscopic guidance. Proper coracoid screw positioning was confirmed with the advantage of AP shoulder images at 40°–60° cephalad tilt and at 40°–60° caudal tilt (Fig. 3). Care was taken not to attack the glenoid articular surface. The CCL and coracoacromial ligament were neither repaired nor reconstructed in any cases. At the end of the procedure, the anterior deltoid and the delto-trapezoidal fascia were repaired. The wound was closed in layers.

Postoperatively, the arm sling was used for 2 weeks till stitches removal. Under the guidance of a physiotherapist, progressive passive and active-assisted shoulder exercises were initiated from 3 weeks postoperatively, with a strengthening exercise program starting 6 weeks postoperatively. Patients were advised to restrict abduction of the affected shoulder to 90°, external rotation to 30°, and forward flexion only and to avoid sports and heavy physical activity until the plate was removed [4].

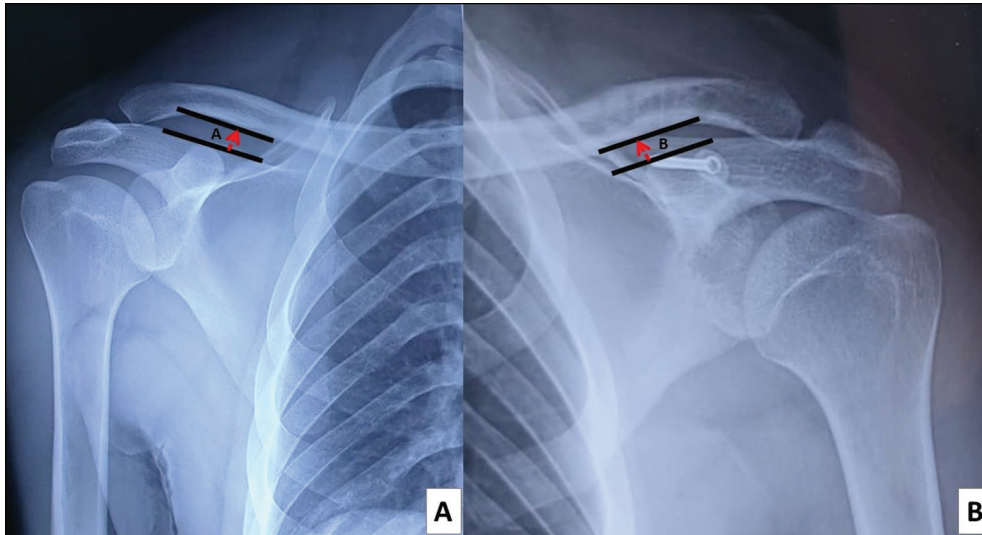
All patients underwent plate removal after an average period of 16.1 weeks (15–18 weeks) without the need for coracoid screw removal in any of the patients. A targeted shoulder rehabilitation program was subsequently commenced [4], including cuff-strengthening exercises to regain range of motion

Figure 3



Intraoperative fluroscopic images to evaluate coracoid fracture reduction with proper positioning of coracoid screw and confirm its trajectory through AP caudal views from 40 to 60 degrees (a-d), and AP cephalad views from 40 to 60 degrees (e-h).

Figure 4



(A) CCD of the sound shoulder =A-distance. (B) CCD of the surgery (injury) side=B-distance, and CCD ratio = surgery side CCD/sound side CCD (B/A).

(ROM). Patients could return to work after 12 weeks and contact sports were allowed after 12 months.

Follow-up

The patients were followed up for a minimum of 12 months after plate removal. The patients were subjected to clinical assessment at 3, 6, and 12 months postremoval, and at the last visit. The functional outcome was assessed using the Constant–Murley score [5], and the American Shoulder and Elbow Surgeons assessment scoring system [6]. Active shoulder ROMs and pain grade as per the visual analog scale [7] were documented at the last visit. Radiological assessment at follow-up intervals included ACJ congruency, coracoid fracture union, and coracoclavicular distance (CCD) observation. Coracoid fracture union was judged radiographically through AP shoulder radiographs at cephalic and caudal tilt only without postoperative computed tomography scan. Bilateral shoulder AP radiographs at the final follow-up visit were utilized to evaluate ACJ reduction. The CCD was measured [8], which was defined as the perpendicular distance between the highest upper border of the coracoid process and the opposing lowest inferior cortex of the clavicle (Fig. 4). The CCD ratio [4] was also calculated by dividing the CCD of the injured shoulder by that of the sound shoulder (surgery side CCD/opposite side CCD).

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 22.0 (Armonk, NY: IBM Corp.). Data were reported as (minimum–maximum) or means±SD. All data were evaluated for

normal distribution using the Kolmogorov–Smirnov test. Subsequently, the data were compared using the nonparametric Mann–Whitney *U* test for independent samples and Student's *t* test for dependent samples. The level of significance was defined as *P* value less than 0.05.

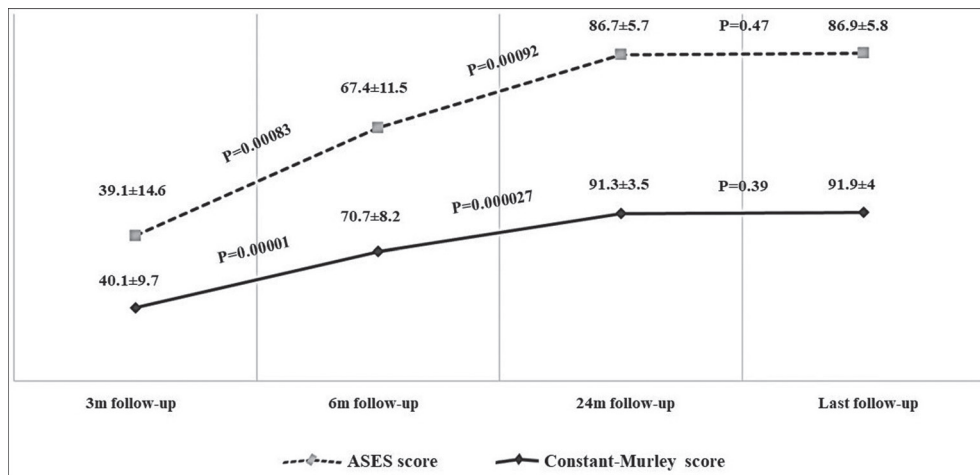
Results

All included patients were males, accounting for one dentist, three athletes, and three manual workers with heavy duties. The mean age of enrolled patients was 32.7 ± 6.4 years (24–43 years). The mechanism of injury was sports injuries in three (42.9%) cases and road traffic accidents in four (57.1%) cases. Three (42.9%) of the patients had injuries in their dominant arm. All the patients had acute injuries (within 3 weeks), with the average duration of surgical intervention of 10.9 ± 6.5 days (4–21 days) from the injury. The coracoid was fractured at its base in all cases. Five patients had Rockwood's type III AC dislocation (71.4%) and two patients with type V (28.6%). All patients were operated on by a senior trauma orthopedic surgeon with more than 10 years' of experience.

All patients were taken up for removal of the hook plate after an average period of 16.1 ± 1 weeks (15–18 weeks). All but one patient were compliant for the postoperative rehabilitation program. The mean follow-up period was 17.6 ± 1.3 months (16–20 months) after fixation and an average of 13.6 ± 1.3 months (12–16 months) after plate removal.

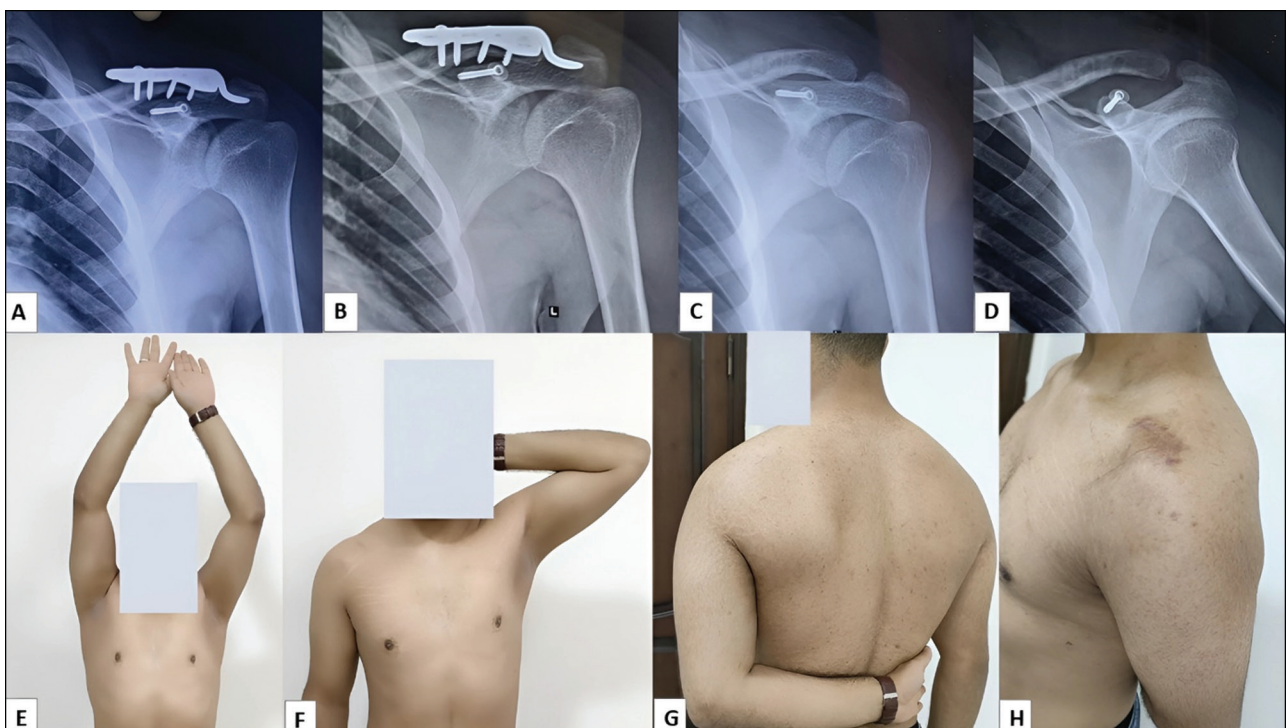
The functional outcome was assessed after plate removal. The average Constant score at 3 months

Figure 5



Curve chart showing postoperative ASES and Constant-Murley scores at subsequent postoperative follow-up visits.

Figure 6



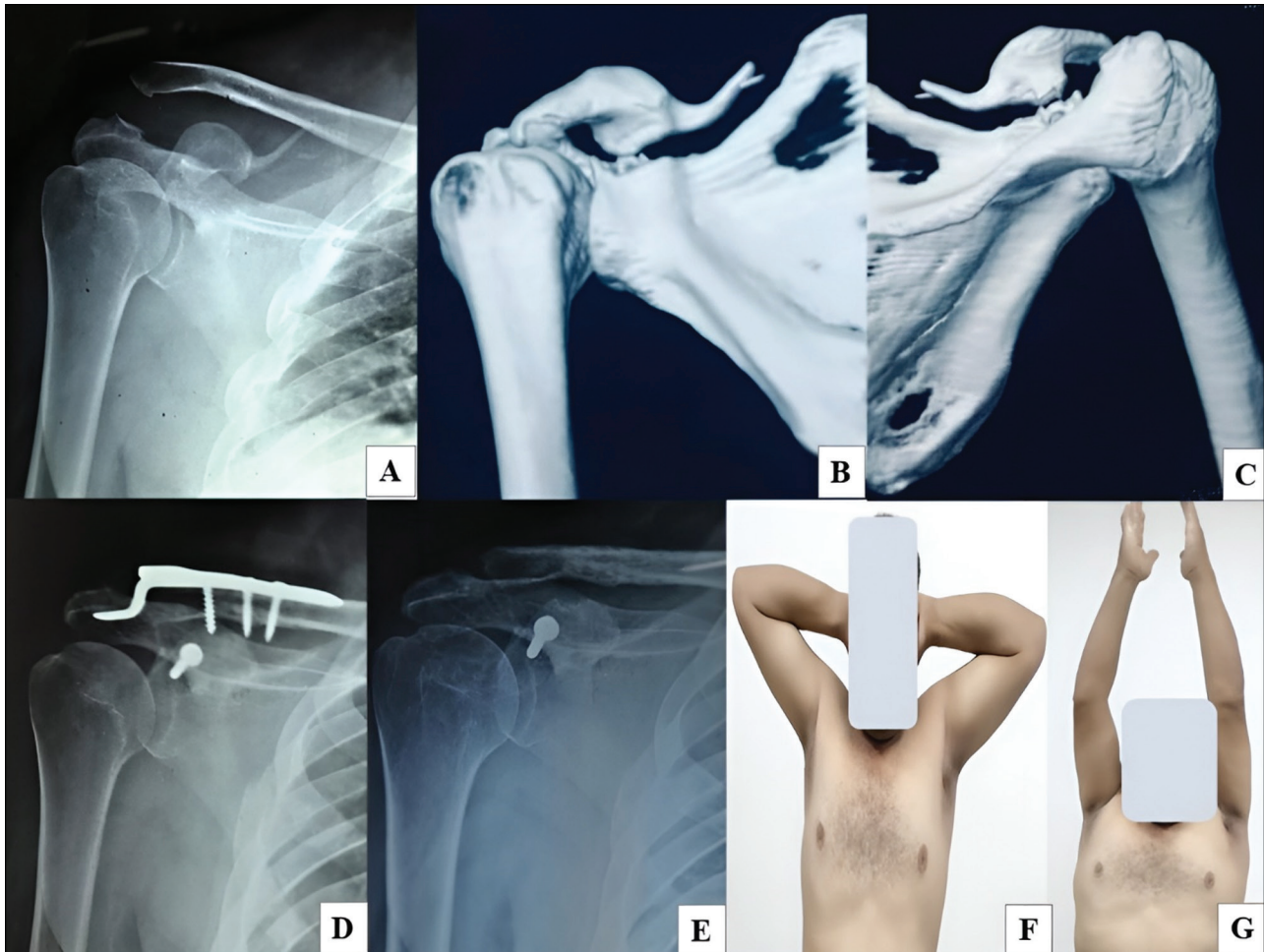
Followup postoperative radiographs of a 24-year-old male patient with grade III acute ACJ disruption and coracoid base fracture reveal appropriate ACJ congruency with consolidated coracoid fracture before hook plate removal (1,2), and after removal (3,4). (5-8): indicate shoulder ROMs at final followup visit.

postremoval was 40.1 ± 9.7 as compared to 70.7 ± 8.2 , 91.3 ± 3.5 , and 91.9 ± 4 at 6, 12 months, and last visit, respectively. A statistically significant improvement was reported between follow-up ($P < 0.0001$), as shown in Fig. 5. The mean American Shoulder & Elbow Surgeons scores were 39.1 ± 14.6 , 67.4 ± 11.5 , 86.7 ± 5.7 , and 86.9 ± 5.8 at 3, 6, 12 months, and last follow-up, respectively, after plate removal, which showed a statistically significant improvement as well ($P < 0.001$) as shown in Fig. 2. The functional evaluation at the last follow-up revealed an average pain grade

of 1.4 ± 0.8 as per the visual analog scale. Patients had achieved a mean active overhead abduction and forward elevation ROMs of $156.4 \pm 12.8^\circ$ and $171.4 \pm 6.3^\circ$, respectively.

The final radiographs (Figs 6, 7) revealed neither ACJ subluxation nor dislocation and no osteolysis at the distal clavicle. The CCD of the injured shoulder was comparable to other shoulder. The average CCD was 9.04 ± 0.9 mm (7.6–10.2 mm), and the mean CCD ratio was $1.07 \pm 0.03\%$ (1.01–1.11%). Coracoid

Figure 7



(A): Preoperative radiograph of a 43-year-old male patient shows ACJ disruption with a coracoid fracture. (B, C): Preoperative 3D CT images revealing coracoid fracture site. (D, E): Followup postoperative shoulder radiographs before and after plate removal. (F, G): indicate shoulder ROMs at final followup visit.

fracture consolidation was confirmed in all cases with AP shoulder radiographs at cephalad and caudal tilt. Amid the follow-up period, none of the patients experienced complications related to coracoid screws, including skin irritation, screw head prominence, or screw packing out.

Discussion

Acute traumatic ACJ disruption associated with the coracoid fracture is considered uncommon. This rare injury was documented as case reports in the literature. It was managed either conservatively [9-18] or surgically. Surgical management included fixation of ACJ alone [2,19-22], coracoid alone [23,24], or both simultaneously [1,25-32]. A consensus never exists regarding the best management method, especially with the reported comparable clinical results of conservative and surgical strategies [2]. The surgical decision often depends upon the patient's activities and associated injuries.

Good to excellent results were reported with conservatively managed injuries, however, patients with light duties and lower grades ACJ disruption were included [11,12,22,24]. Notwithstanding, reported results were slightly inferior to surgical management [2]. Additionally, ACJ pain, cosmetic problems, and weak shoulder musculature might persist after conservative management [2].

This combined injury represents a double break in the superior shoulder suspensory complex (SSSC), with a compromise to the integrity between the clavicle and scapula [23,28,33] that might necessitate rebuilding the suspensory complex circle at one or both points. Hence, we preferred to fix both breaks to regain SSSC integrity.

Our case series followed a uniform way for fixation, taking the advantage of a clavicular hook plate with a coracoid screw to reach a rigid fixation. This management allows for early ROM and return to normal routine

activities. Additionally, it guards against coracoid nonunion by reducing muscular displacing forces on the coracoid process. This can provide a chance for CCL or its remnants to heal without the need for ligamentous reconstruction. Coracoid pseudoarthrosis was reported in the literature with ACJ fixation and conservative management of the coracoid process, however, the patient experienced excellent short-term outcomes [2].

To the best of our knowledge, the reported cases with such injury aged between 9 and 60 years, with a median of 23.5 years [1,23-32]. The mean age of patients in this study was 32.7 ± 6.4 years (24–43 years). The mode of combined ACJ and coracoid injuries often mimics that of isolated ACJ disruption, except for, the coracoid fracture allows for more clavicular superior displacement with no or inconsiderable CCL injury [22]. Rockwood type III disruption represented the main type in our patients (71.4%). The resultant traction forces by CCL yield this combined fracture pattern [20,34]. As per the Ogawa *et al.* [35] classification, coracoid fractures can be differentiated into two types depending on their attachment to CCL. Types I and II represent fractures behind and in front of CCL attachment, respectively. Almost all cases with combination injuries had coracoid base fractures [2]. Similarly, all patients in this study showed coracoid base fractures (type I Ogawa).

In this series, the coracoid fracture was stabilized after ACJ, leaving no stresses on CCL or its remnants to guard against any superadded ligamentous damage risk. The status of preoperative CCL integrity among patients might be questioned and often depends upon the grade of ACJ disruption. We preferred not to reconstruct ligamentous structures in an acute setting. The joint was stabilized within 10.9 ± 6.5 (4–21) days of injury. Internal splinting of the ACJ via hook plate maintains the joint reduced during the time necessary for biological healing of CCL or its remnants and adds more stability [36].

Considering the preinjury activity performance of injured patients, the debate of surgical versus conservative management might be overlooked in this injury pattern (double disruption of SSSC), particularly in athletes and patients with heavy duties [37,38]. The goal of management was to regain their pre-injury level of activities, this was achieved in all patients in our study, like antecedent reports where a hook plate was used [36,38].

Vertical stability and integrity of ACJ were achieved in all cases. Radiographs revealed an average CCD

of 9.04 ± 0.9 mm (7.6–10.2 mm), and the mean CCD ratio was $1.07 \pm 0.03\%$ (1.01–1.11%). In this study, we had no surgical site infection and no incidence of ACJ subluxation or dislocation after plate removal. There was no need for further surgeries except for the removal of a hook plate.

Study limitations were represented in its retrospective design, noncomparative nature to other management ways, and the limited number of involved cases. Additionally, ACJ horizontal stability was not checked among cases. Further comparative studies involving a larger number of patients are recommended. The strength of our research is represented in advocating the same way of management for a considerable follow-up period, along with clinical and radiological assessments via validated clinical and radiological parameters.

Conclusion

A stable fixation construct with significant functionality can be successfully achieved through the dual fixation strategy using a coracoid screw and hook plate with no CCL reconstruction in the treatment of concomitant coracoid fracture and acute ACJ injuries in athletes and high-demand patients.

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Authors' Contribution: M.S.A. reviewed and collected patients' records. A.E. performed statistics and wrote the manuscript. Both authors revised the manuscript.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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