Functional and radiological outcomes following arthroscopic-assisted tight-rope technique versus clavicular hook plate fixation in management of acute acromioclavicular joint dislocation

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Purpose
The purpose of this study is to assess the clinical and radiological results following using the clavicular hook plate (CHP) and the arthroscopic-assisted Tight rope (TR) technique for the treatment of acute acromioclavicular joint (ACJ) dislocation.
Patients and methods
This study included 58 patients, with acute ACJ dislocation who were equally distributed into two groups. Patients in group A were treated using the arthroscopic-assisted TR technique. Patients in group B underwent open reduction and internal fixation using the CHP. The shoulder functional results were assessed using the Constant and Murley score (CMS) at preoperative and 1-year follow-up. The radiological assessment involved the comparison of the coracoclavicular distance (CCD) at preoperative and 1-year following surgery.
Results
Patients in both groups showed a significant improvement in the CMS, visual analog scale (VAS), and CCD at 1-year follow-up compared with the preoperative values (P<0.001). The mean CMS, VAS, and CCD improved significantly in the TR group to 91.14, 2.17, and 10.52, respectively, at 1-year follow-up. In the CHP group, the mean CMS, VAS, and CCD improved significantly to 87.34, 3.14, and 10.55, respectively, 1-year after surgery. However, the TR group showed statistically significant better CMS and VAS at 1-year follow-up. No statistically significant differences were noted regarding the CCD between both groups at 1-year follow-up.
Conclusions
Successful and comparable functional and radiological outcomes are associated with using the CHP and the arthroscopic-assisted TR technique following treatment of acute ACJ dislocation. However, patients treated with the arthroscopic-assisted TR technique had significantly better CMS and VAS than those in the CHPP group at 1-year follow-up. No significant differences were observed between both groups regarding the overall rate of complications.
Level of evidence
Level II, prospective randomized comparative study.

Keywords:
acromioclavicular joint, clavicular hook plate, tight rope

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Introduction

Acromioclavicular joint (ACJ) dislocation is a frequent disorder accounting for 50% of all shoulder injuries related to sports [1,2]. The Rockwood system is the most frequently utilized method to categorize ACJ dislocations from type I to VI depending on the direction and magnitude of the lateral clavicle transposition [3].

The optimal treatment for unstable ACJ remains a highly debated topic in orthopedic practice [4]. Conservative management is often advocated for grade I and II ACJ dislocations while operative treatment is recommended for grade IV-VI dislocations. In addition, the management of grade III injuries is a matter of debate [5,6].

Several methods were used for surgical treatment of ACJ dislocation involving ACJ fixation using Kirschner wires or tension banding, the Weaver–Dunn method, coracoclavicular ligament reconstruction

using autograft, synthetic grafts, or ACJ stabilization by the clavicular hook plate (CHP) or Endobutton fixation [7]. There is no gold standard treatment for ACJ dislocation and debate still exists regarding the ideal treatment. Currently, the CHP and the Tight rope (TR) device are frequently used to surgically fix ACJ dislocations [8–11].

The present study aims to compare the functional and radiological results following the fixation of acute ACJ dislocations using either the (CHP) or the arthroscopic-assisted (TR) device technique. We hypothesize that better functional outcomes are associated with the arthroscopic-assisted (TR) technique compared with the CHP in the management of patients with ACJ dislocation.

Patients and methods

This is a prospective randomized study done at a tertiary trauma center Hospital between June 2021 and November 2023. Simple randomization was done using a computer to allocate patients in either group. This study was validated by the research ethical Committee [(Institutional Review Board (IRB) number: N-379-2023)]. All patients signed an informed consent before participating in the study. This study included 58 patients managed using either the arthroscopic-assisted TR fixation or the CHP for the treatment of acute ACJ dislocation. Patients were equally distributed in two groups. The arthroscopic-assisted TR technique was performed for patients in group A, while patients in group B were treated using the CHP for their ACJ dislocations.

The inclusion criteria were

(a) Acute (within 3 weeks from initial injury) ACJ dislocation (Rockwood III–V).
(b) Skeletally mature patients.

The exclusion criteria were

(a) Chronic ACJ dislocation (longer than 3 weeks from initial injury).
(b) Skeletally immature patients.
(c) Prior surgery to the ipsilateral shoulder joint.
(d) Pre-existing or concomitant injuries of the affected shoulder joint.

Functional and radiological assessment

The shoulder functional outcomes were assessed using the Constant and Murley score (CMS) and the visual analog scale (VAS) and compared both preoperative and at 1-year follow-up in both groups. The coracoclavicular distance (CCD) was measured both preoperative and at 1-year follow-up in both groups using plain radiographs. Measurement of the CCD was done from the superior aspect of the coracoid to the inferior aspect of the clavicle.

Statistical methods

Data were represented statistically in the form of mean±standard deviation (± SD), range, frequencies (patient number), and percentages when suitable. Numerical variables were compared between both groups using the Student *t*-test for independent samples. Comparison of categorical data was done using a χ^2 test. In cases where the expected frequency was less than 5, an exact test was performed. A Paired *t*-test was performed to compare numerical variables within the group. *P* value less than 0.05 was deemed statistically significant. All statistical analyses were performed using IBM SPSS (Statistical Package for the Social Science; IBM Corp, Armonk, New York, USA) release 22 for Microsoft Windows.

Operation procedures

General anesthesia was administered to all patients and all surgical steps were done in the beach chair position.

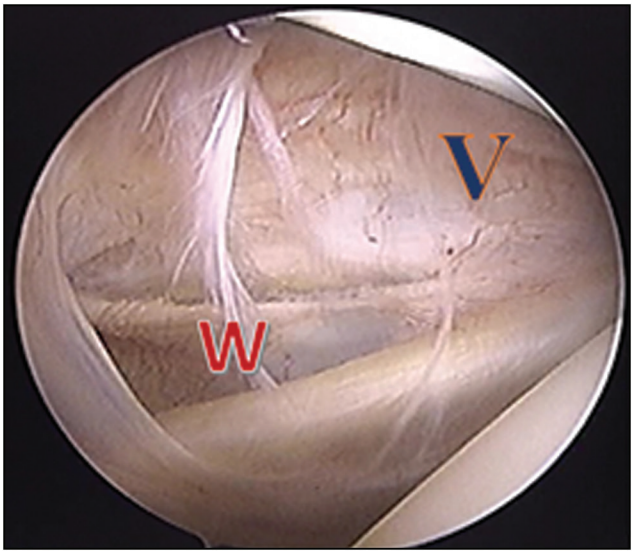
TR group (arthroscopic-assisted Tight rope)

Reduction of ACJ was done and temporarily fixed with one or two Kirschner wires through the acromion under fluoroscopic guidance. A vertical or horizontal 2 cm skin incision was performed 2 cm medial to ACJ directly over the superior aspect of the clavicle. A horizontal incision was favored in cases of difficult ACJ reduction as it can be extended to the ACJ. Diagnostic arthroscopy of the shoulder joint was first done using a standard posterior portal. An anterior working portal slightly medially and just above the subscapularis tendon was made in the rotator cuff interval, using an 18-gauge needle, in an outside-in technique. Concomitant intra-articular pathologies were addressed if present. A second accessory visualizing the anterolateral portal was done in the superolateral aspect of the rotator cuff interval (Fig. 1).

A radiofrequency device was used to open the rotator cuff interval till reaching the undersurface of the coracoid process. The arthroscope was then shifted to the high anterolateral portal to adequately visualize the lower aspect of the coracoid process. The C-guide tip, introduced from the anterior working portal, was centered over the inferior surface of the coracoid process (Fig. 2), while the C-guide bullet was centered over the upper aspect of the clavicle approximately 3 cm medial to the ACJ.

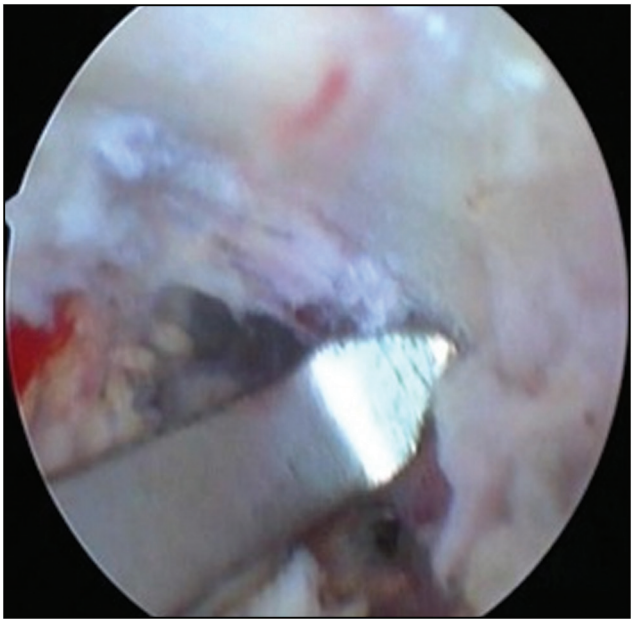
A guide wire was then introduced followed by drilling using a 4 mm drill bit creating a tunnel from the clavicle towards the center of the inferior surface of the coracoid process. The oblong button of the TR

Figure 1



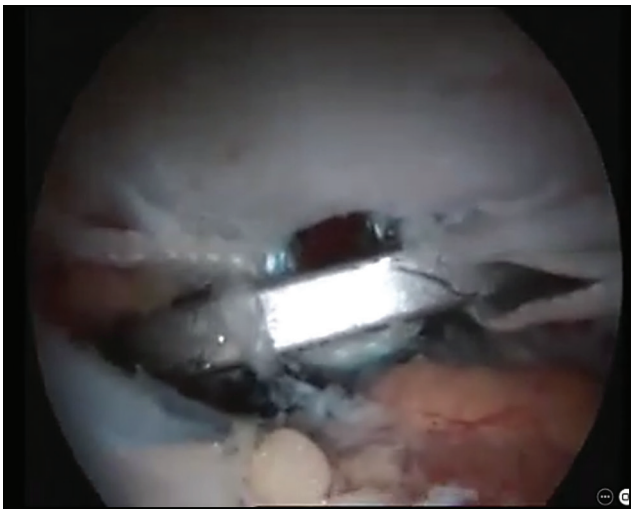
Arthroscopic view of the shoulder joint showing the location of the working anterior portal (W) and the accessory visualizing anterior portal (V).

Figure 2



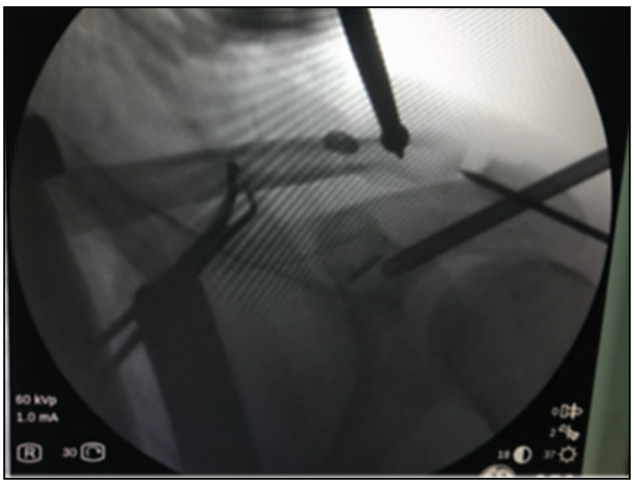
Arthroscopic view of the shoulder joint showing proper positioning of the C-guide tip below the coracoid process.

Figure 3



Arthroscopic view of the shoulder joint from the accessory visualizing portal showing proper positioning of the TR below the coracoid process.

Figure 4



Intraoperative fluoroscopic images showing proper ACJ reduction and TR position. ACJ: Acromioclavicular joint; TR: Tight rope.

was shuttled through the created tunnel under direct arthroscopic visualization (Fig. 3). The TR suture strands were then pulled to tighten the round button of the TR to the upper clavicular surface to maintain ACJ reduction. The temporary fixing Kirschner wire was removed. The TR position and ACJ reduction were confirmed using an image intensifier (Fig. 4).

CHP group (clavicular hook plate)

A 6–8 cm straight horizontal skin incision was performed over the distal clavicle across the ACJ laterally. The deltotrapezial fascia was cut. Reduction of ACJ was done and temporarily fixed with one or two Kirschner wires through the acromion under fluoroscopic guidance. The plate hook was introduced below the posterior side of the acromion. The appropriate plate length and hook depth were chosen and applied. The plate was contoured, if needed, to fit the clavicle ensuring proper joint reduction. Acceptable joint reduction and plate position were confirmed intraoperative under fluoroscopic guidance (Fig. 5). Closure of the wound was done in layers. Preoperative and postoperative plain radiographs are shown in (Fig. 6).

Rehabilitation

All patients followed identical rehabilitation protocols after surgery. Active range of motion (ROM) exercises to the hand, wrist, and elbow were

commenced from day 1 after surgery. All patients were instructed to use an arm sling for 4 weeks postoperative. Pendulum exercises were initiated 2 weeks following surgery. Active assisted ROM exercises started 6 weeks following surgery. Active resisted ROM exercises were initiated at 12 weeks postoperative.

Results

The present study involved 58 patients for whom CHP or arthroscopic-assisted TR was used to treat acute ACJ dislocation. Each group included 29 patients. The study included 51 male patients and 7 female patients. The right shoulder was affected in 40 patients, while the left shoulder was injured in 18 patients. The mean age of patients at the time of surgery in the TR group and the CHP group were 31.45±9.51 and 30.28±9.23 years, respectively. All patients in both groups completed an average follow-up of 1 year. The mean follow-up period for the TR group was 12.38±1.66 months, while the mean follow-up period for the CHP group was 11.93±1.31 months with no statistically significant differences between both groups (P=0.26). The patients' demographic data are shown in Table 1. No statistically significant differences were found between both groups regarding the patients' demographic characteristics (P>0.05).

Values are expressed in the form of mean±standard deviation (SD), range, number of patients, and their percentage within the group.

Functional and radiological outcomes in both groups

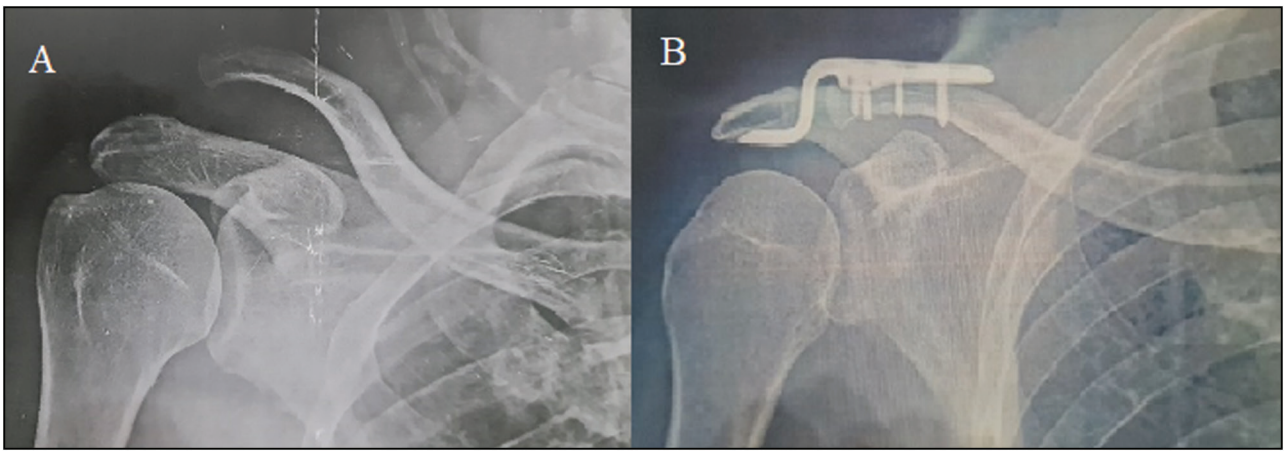
Functional and radiological outcomes in both groups are shown in Table 2. The mean CMS in the TR group improved significantly from 46.31±6.71 preoperative 91.14±7.41 at 1-year follow-up (P<0.001), while in the CHP group, the mean CMS ameliorated significantly from 44.83±7.15 to 87.34±6.13, respectively, (P<0.001). The mean VAS in the TR group improved significantly from 6.03±1.43 preoperative to 2.17±1.85 at 1-year postoperative (P<0.001), while in the CHP group, it ameliorated from 6.24±1.33 to 3.14±1.46 (P<0.001).

The mean CCD in the TR group improved significantly from 24.03±3.34 preoperative to 10.52±1.45 at 1-year follow-up (P<0.001), while in the CHP group, the mean CCD improved significantly from 23.52±4.01 to 10.55±1.59 (P<0.001). However, the TR group showed statistically significant CMS and VAS compared with the CHP group at the final follow-up (P<0.05). No statistically significant differences were observed in terms of the CCD between both groups (P>0.05) (Table 3).

Figure 5

Intraoperative fluoroscopic images showing precise ACJ reduction fixed with CHP. ACJ: Acromioclavicular joint; CHP: Clavicular hook plate.

Figure 6



Plain radiograph anteroposterior view of the right shoulder showing: a) Preoperative ACJ dislocation, b) Postoperative ACJ fixed with CHP. ACJ: Acromioclavicular joint; CHP: Clavicular hook plate.

Table 1 Patients' demographic data

	TR group (*n*=29)	CHP group (*n*=29)	*P* value
Age	31.45±9.51	30.28±9.23	0.64
	(18-49)	(18-49)	
Sex			1
Male	25 (86.2)	26 (89.7)	
Female	4 (13.8)	3 (10.3)	
Affected shoulder joint			0.57
Right	19 (65.5)	21 (72.4)	
Left	10 (34.5)	8 (27.6)	
Time interval between injury and surgery in days	7.72±4.8	9.03±5.07	0.32
	(2–20)	(2–21)	
Occupation			
Athlete	2 (6.9)	0	0.59
Student	4 (13.8)	8 (27.6)	
Manual worker	11 (37.9)	8 (27.6)	
Housewife	1 (3.4)	2 (6.9)	
Engineer	3 (10.3)	3 (10.3)	
Doctor	4 (13.8)	2 (6.9)	
Clerk	4 (13.8)	6 (20.7)	

CHP, Clavicular hook plate; n, number of patients; TR, Tight rope.

Table 2 Functional and radiological outcomes in both groups

	TR Group *n*=29	CHP Group *n*=29
Preoperative CMS	46.31±6.71	44.83±7.15
	(36–58)	(34–57)
CMS at 1-year follow-up	91.14±7.41	87.34±6.13
	(73–98)	(76–98)
Preoperative VAS	6.03±1.43	6.24±1.33
	(3–8)	(4–9)
VAS at 1-year follow-up	2.17±1.85	3.14±1.46
	(0–7)	(0–6)
Preoperative CCD	24.03±3.34	23.52±4.01
	(18–31)	(17–32)
CCD at 1-year follow-up	10.52±1.45	10.55±1.59
	(8–13)	(8–14)
Follow-up period in months	12.38±1.66	11.93±1.31
	(10–16)	(10–16)
Hospital stay in days	1.1±0.31	1.14±0.35
	(1–2)	(1–2)

CCD, coracoclavicular distance; CMS, Constant and Murley score; n, number of patients; VAS, visual analogue scale.
Values are expressed in the form of mean±standard deviation (SD), range.

The mean hospital stay for patients in the TR and the CHP groups were 1.1±0.31 and 1.14±0.35 days, respectively, which showed no statistically significant differences between both groups (P=0.69). Plate removal was done in all patients in the CHP group after a mean time interval of 5.34±1.23 months postoperative.

Values are expressed in the form of mean±standard deviation (SD).

Complications

Several complications have been encountered in this study which were different among both groups. Acromial osteolysis was observed in three (10.3%) patients in the CHP group. Subacromial impingement was reported in two (6.9%) patients in the CHP group confirmed clinically by a positive Neer's impingement sign. Patients with subacromial impingement were treated conservatively with the resolution of symptoms and signs after CHP removal. Fixation failure was encountered in three (10.3%) patients in the CHP group and five (17.2%) patients in the TR. Coracoid process fracture was encountered in two (6.9%) patients in the TR group. No statistically significant differences were detected regarding the overall rate of complications in both groups (P>0.05).

Table 3 Comparison of functional and radiological outcomes between both groups

	Preoperative	1-year follow-up	*P* value
CMS			
TR group (*n*=29)	46.31±6.71	91.14±7.41	(*P*<0.001)
CHP group (*n*=29)	44.83±7.15	87.34±6.13	(*P*<0.001)
P value	0.42	0.04	
VAS score			
TR group (*n*=29)	6.03±1.43	2.17±1.85	(*P*<0.001)
CHP group (*n*=29)	6.24±1.33	3.14±1.46	(*P*<0.001)
P value	0.57	0.03	
CCD in mm			
TR group (*n*=29)	24.03±3.34	10.52±1.45	(*P*<0.001)
CHP group (*n*=29)	23.52± 4.01	10.55±1.59	(*P*<0.001)
P value	0.6	0.93	

CCD, coracoclavicular distance; CMS, Constant and Murley score; n, number of patients; VAS, visual analog scale.

Discussion

The concept in the management of ACJ separation is to regain the congruency of the ACJ and mechanical stability till strong healing tissue is achieved [12]. CHPs are used to fix ACJ dislocations in a reduced position enhancing the natural healing of both the joint capsule and the coracoclavicular ligaments responsible for ACJ stability [13].

CHP has the merit of restoring ACJ stability in both the vertical and horizontal levels [14]. Nevertheless, CHP occasionally leads to a nonanatomic ACJ reduction resulting in complications including acromion fracture or osteolysis, ACJ degenerative changes, and rotator cuff injuries [15]. A second operative procedure for plate removal is another drawback concerning using the CHP.

On the other hand, the arthroscopic-assisted TR technique has the advantages of less soft tissue dissection and the absence of a second procedure to remove the hardware [16]. However, an anatomic ACJ reconstruction cannot be achieved by the arthroscopic-assisted TR technique which might

result in repetitive instability [17]. Furthermore, the tunnel created in the coracoid process increases the hazards of coracoid fracture, particularly in small-statured patients [18].

The chief finding of our study is that both the CHP and the TR provided successful and comparable clinical and radiological outcomes for the treatment of acute ACJ dislocation. However, the CMS and the VAS in the TR group were significantly better compared with that in the CHP group at 1-year follow-up. No statistically significant differences were observed between both fixation techniques regarding the CCD 1-year after surgery.

The results obtained in our study are in line with various studies in the literature [10,11]. A study, including 112 patients, compared the arthroscopic-assisted TR system and the CHP for the treatment of acute ACJ dislocation and showed that the constant score and VAS score were significantly higher in the TR system group compared with the CHP group after a minimum of 2 years follow-up. Furthermore, a significantly smaller skin incision, blood loss, and shorter hospital stay were observed in the TR system group compared with the CHP group [10].

A study involving 58 patients reported that the arthroscopic-assisted TR system showed a statistically significant less intraoperative bleeding, smaller skin incision, lower VAS score, and higher CMS at 6 and 12 months postoperative compared with the CHP for the management of acute ACJ dislocation [11].

However, several studies in the literature reported no significant differences between the results of the arthroscopic-assisted TR technique and the CHP plate for fixation of acute ACJ dislocation [8,9]. A comparative study including 61 patients with acute ACJ dislocation evaluated the clinical and radiological outcomes between the TR and the CHP fixation methods and observed no statistically significant differences between both methods in the context of the functional outcomes assessed by the VAS for pain, the American Shoulder and Elbow Surgery, the Korean Shoulder, and the University of California, Los Angeles shoulder scores after a mean follow-up of 7.0±1.0 years. In addition, a comparison of the final CCD and the rate of complications in both fixation techniques showed no statistically significant differences. However, shoulder joint forward flexion was better in patients managed using the arthroscopic-assisted TR technique [8].

A retrospective study compared the clinical and radiological results after the management of acute ACJ dislocation in 71 patients using CHP, CHP augmented with suture anchor, and the arthroscopic assisted TR fixation techniques. The previous study concluded that no statistically significant differences were observed between the three techniques regarding the CMS, American Shoulder and Elbow Surgery, and VAS at 2-years postoperative. In addition, the CCD ratio was significantly higher in the TR group than in the CHP and the CHP augmented groups. Furthermore, a poor correlation was observed between the functional outcomes and the CCD [9].

Various complications have been encountered in our study which were different among both groups. Complications observed in the CHP group involved acromial osteolysis, subacromial impingement, postoperative shoulder stiffness, and fixation failure. While in the TR group, complications included loss of ACJ fixation and coracoid fractures.

Studies in the literature mentioned that acromial osteolysis following using CHP was attributed to the compact proximity of the hook part with the undersurface of the acromion and that using a small hook depth was a contributing factor to the occurrence of acromial osteolysis [19,20].

Subacromial impingement may be related to positioning the plate hook in the subacromial space narrowing the subacromial area. In addition, the plate hook also hinders the sagittal rotation of the AC joint and prevents the acromial posterior tilt leading to diminished internal rotation of the lateral clavicle [21].

Complications noted in the TR group involved fixation failure in five (17.2%) patients. The incidence of fixation failure in our study coincides with a study by Olivos-Meza *et al.* who reported that the incidence of fixation failure was 19% in 52 patients who underwent arthroscopic-assisted TR technique for the treatment of ACJ dislocation [22].

In addition, the incidence of coracoid fracture observed in our study was (6.9%) which is slightly higher than that reported by Olivos-Meza *et al.* who reported a 2% incidence of coracoid fractures following using the arthroscopic-assisted TR technique for the treatment of ACJ dislocation [22]. Milewski *et al.* documented that the incidence of coracoid fracture was 20% following coracoclavicular ligament reconstruction using coracoid tunneling [23].

In our study, all patients in the CHP underwent plate removal after a mean time interval of 5.34±1.23 months postoperative. A study by Kashii M *et al.* recommended

removal of the CHP following surgery, typically at 3–6 months [24].

The main implication of this study is that although both the CHP and the arthroscopic-assisted TR techniques are successful treatment methods for ACJ dislocation, each treatment method has specific associated complications that should be carefully considered. In addition, the second operation for removal of the CHP may add to the socioeconomic burden.

Limitations

The main limitation of this study is the relatively short follow-up period. However, the large sample size and the prospective comparative methodology are strength points in this study.

Conclusion

Both the CHP and the arthroscopic-assisted TR techniques are effective methods for the management of acute ACJ dislocations with successful functional and radiological outcomes. However, the TR technique is associated with better CMS and VAS compared with the CHP technique.

Author Contributions

The author contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by M.H.K. and M.R.W.. The manuscript was written by M.H.K.

Ethics approval

Approval was granted by the Ethics Committee of Cairo University (Institutional Review Board (IRB) number: N-379-2023)

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Consent to publish

Patients signed informed consent regarding publishing their data and photographs.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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