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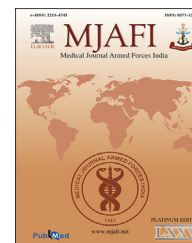
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Original Article

Managing acute acromioclavicular joint dislocation during COVID 19 pandemic by minimally invasive technique with suture anchor and miniplate: A pilot study

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ABSTRACT

Background: Acromioclavicular (AC) joint dislocation is common in sportsmen and physically active population. Its management depends upon the grade of injury and functional demands of the patient. A variety of surgical procedures have been described with different limitations and advantages. The present study has assessed the clinical and radiological outcome of acute AC joint dislocation managed with a 3.5 mm Titanium suture anchor and 2 mm miniplate construct which requires lesser dissection, surgical time and thus contact with the patient as mandated by COVID-19 pandemic.

Methods: We enrolled 10 patients of Rockwood type-III, IV and V acute AC joint injury (<3 weeks old) reporting at this hospital from Feb 2020 to May 2021. All were tested for COVID-19 using reverse transcriptase polymer chain reaction test (RT-PCR) and managed by closed/open reduction and fixation with a 3.5 mm Titanium Suture Anchor and a 2 mm Titanium miniplate construct. Follow-up was done at 3, 6 and 9 month post-operatively.

Results: The average age of patients was 31 yrs. RT-PCR test for COVID-19 was negative in all patients. Median surgical time was 25 min (Interquartile Range[IQR] = 16–34 min) and median follow-up duration was 36 weeks (IQR = 33–39 weeks). Median visual analogue scale score and IQR at pre-operative, 3 month, 6 month and 9 month follow-up was 7(IQR = 6–8), 3.5(IQR = 2.5–4.5), 2(IQR = 0) and 1(IQR = 0), respectively. Median constant score at pre-operative, 3 month, 6 month and 9 month follow-up were 34(IQR = 25–43), 65.5(IQR = 60.5–70.5), 82.5(IQR = 77.5–87.5) and 88(IQR = 81–95). There was significant improvement in clinical status (non parametric-Friedman test $p < 0.001$). Radiographs showed no loss of reduction, fracture or implant failure till last follow-up.

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Conclusions: Minimally invasive technique with a 3.5 mm Ti-suture anchor and 2 mm plate is an easy, fast and reliable construct for the management of acute AC dislocation in physically active population.

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Introduction

Acromioclavicular (AC) joint dislocations are common injuries of the shoulder girdle in young and active population accounting for nearly half of all shoulder injuries among athletes,¹ especially during contact sports such as football, handball and basketball^{2,3}. Clinical presentations depend upon the degree of separation of the joint and are categorized by Rockwood's classification system into 06 types.⁴ Type-1 and 2 dislocations are usually managed conservatively whereas type 4, 5 and 6 are suitable for surgical procedures. The management of type 3 is controversial.⁵

Treatment modalities range from conservative methods by strapping and sling immobilization to a variety of surgical procedures like fixation with trans-articular pins, tension band wiring, fixation with washer and screw, suspensory fixation devices, clavicular hook plate and Weaver–Dunn procedure. Various studies mention the role of surgery in restoring the strength of the ligaments, the controversy of surgical treatment in type-3 injuries^{6,7} and also their own specific advantages and disadvantages, but no clear superior option has been established as yet.⁸ However, physically active young adults with type-3 injury seem to have a slight advantage in outcome when treated operatively.⁹

In the recent past, a viral pandemic (COVID-19) which was first reported in December 2019 as a cluster outbreak in Wuhan, China has spread across various countries.¹⁰ India officially entered global havoc on 30th January with its first registered COVID case.¹¹ This highly transmissible viral infection has a diverse presentation ranging from an asymptomatic carrier state to life threatening pulmonary as well multiple organ system involvements leading to a large number of deaths. During this pandemic, a survey of international surgeons¹² revealed significant changes in trauma management and orthopaedic practice worldwide have led to the formation of new guidelines by various orthopaedic societies to reduce operative intervention where possible.¹³

We had been practising hook plate fixation for acute AC joint injuries requiring surgical stabilization with satisfactory outcomes till before the pandemic. With new guidelines in place and acknowledging the grudging consumption of valuable OT time mandated by hook plate removal even before the pandemic, we thought of using suspensory fixation for AC joint injuries. We recommend a method to address stability in acute AC joint dislocation using a single 3.5 mm suture anchor and mini-plate construct which is easy and fast to perform and also negates the need for subsequent implant removal. We found the technique to be less time-consuming with reliable fixation till functional recovery.

Material and methods

We conducted this study involving 10 physically active male patients sustaining AC joint dislocation reporting to our Tertiary care Orthopaedics centre from February 2020 to May 2021. An initial approval from the institutional ethical committee was obtained. Patients were enrolled with the following criterion.

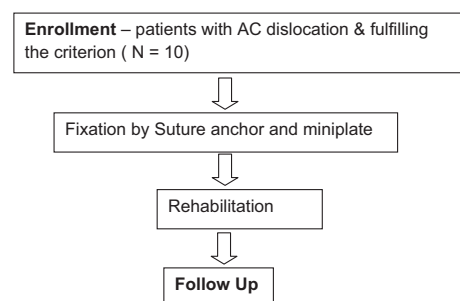
Inclusion criteria

- Rockwood type –III, IV and V-AC Joint Dislocation
- High-demand patients (athletes, soldiers)
- Acute injury (<3 week duration)
- Willing to follow rehabilitation protocol

Exclusion criteria

- Associated upper limb or neurological injury
- Injury more than 3 week old.
- Polytrauma.

Written informed consent was obtained from all the study subjects after fully explaining the surgical procedure, its risks and benefits to their satisfaction, in both English and vernacular language (as per GCP guidelines). Clinical assessment was followed by radiological analysis by Zanca, axillary lateral and stress views of both shoulders to differentiate type-3 from type-2 injuries. Coraco-clavicular (CC) distance of both shoulders was compared. Screening for COVID-2019 using reverse transcriptase polymer chain reaction (RTPCR) of nasal and pharyngeal swab was done prior to surgery. Pre-operatively, the ways of wearing a shoulder sling and post-operative shoulder motions in the sling were fully demonstrated to the patients. The importance to abide by the post-operative rehabilitation protocol was fully informed (Fig. 1).



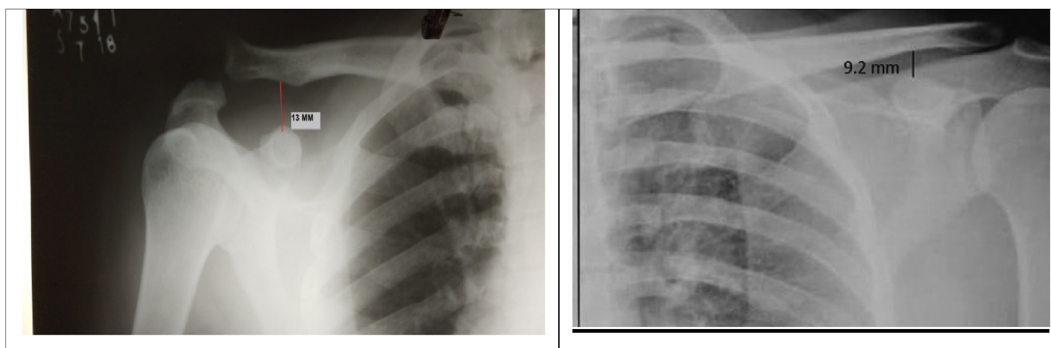


Fig. 1 – Radiograph of involved and uninvolved shoulder showing Grade-III AC joint dislocation.

Surgical technique

All patients were subjected to fixation with a 3.5 mm Titanium suture anchor and a 2 mm Titanium plate (2 hole). The surgical team consisted either of two orthopaedic consultants. Patients were anesthetized by regional anaesthesia (interscalene nerve block) with Inj. Bupivacaine + Inj. Lignocaine with Adrenalin + Inj. Dexamethasone. General anaesthesia was avoided considering the pandemic. The whole team used personal protective equipment.

The procedure was performed with the patient in beach chair position and C-ARM was adjusted accordingly (Fig. 2). The possibility of closed reduction was assessed by applying pressure over the lateral end of the clavicle. In case of the irreducible AC joint, open reduction by removing the entrapped meniscal disc, capsular muscle was done. Open reduction was done in 3 patients, one with type-IV and two with type-V injury. A small incision (approximately 25 mm) was given 3 cm medial to AC joint over the lateral clavicle and the shaft was exposed (Fig. 3a). A 2 mm guide wire directed towards the base of coracoid process was passed in the centre of the lateral clavicle shaft after reduction of the AC joint by direct pressure over the lateral end of the clavicle while lifting the arm under C-ARM guidance, followed by bicortical over drilling with 4.5 mm canulated drill bit. The blunt end of the guide wire was passed through this hole to locate the centre of

the coracoid base (by feeling the medial and lateral extent of base with guide wire) under C-ARM guidance (Fig. 3b). A 3.5 mm sleeve was passed over guide wire & pressed firmly over the coracoid base. Keeping the sleeve in place a unicortical hole was made in a coracoid base with a 2.4 mm drill bit (Fig. 3c) followed by implantation of a pre-loaded 3.5 mm Titanium suture anchor (Fig. 3d). Firm fixation of the anchor was confirmed by pulling the threads together. Threads of the anchor were passed separately through either of the holes of the miniplate (Fig. 3e). AC joint was reduced as mentioned before & knots were tied over a mini-plate placed over the clavicular shaft (Fig. 3f). The delto-trapezial aponeurosis was not repaired. Only vertical stability of AC joint was addressed even in cases requiring open reduction to maintain uniformity of procedure. The reduction was reassessed and the wound was closed in layers (Fig. 4).

Rehabilitation

The upper limb was supported with an arm sling pouch for 6 weeks. Gradual pendulum exercises were started as per pain tolerance after 3 weeks of surgery. Active and assisted Range of motion exercises were allowed incrementally within a painless range after 6–8 weeks aiming to achieve a full range of motion. Heavy lifting and resistive exercises were not allowed for 3 months post-surgery. After that, loading of the limb was initiated as per the pain tolerance of the individual.

Follow-up

Patients were discharged from the hospital at around one week post operatively and suture removal was done after healing of the wound (approximately 2 weeks after surgery). Reassessment was done at 3, 6 and 9 months after the surgery by visual analogue scale, Constant–Murley score¹⁴ and radiographic analysis. Statistical analysis was done with SPSS 21 software.

Results

Total of 10 patients with AC joint dislocation were enrolled as per the inclusion criterion. All were male with an average age of 31yrs. Out of 10 patients, six patients (60%) had Type-III, one had (10%) Type-IV and three (30%) had Type-V dislocation.



Fig. 2 – Position of patient and C-ARM.

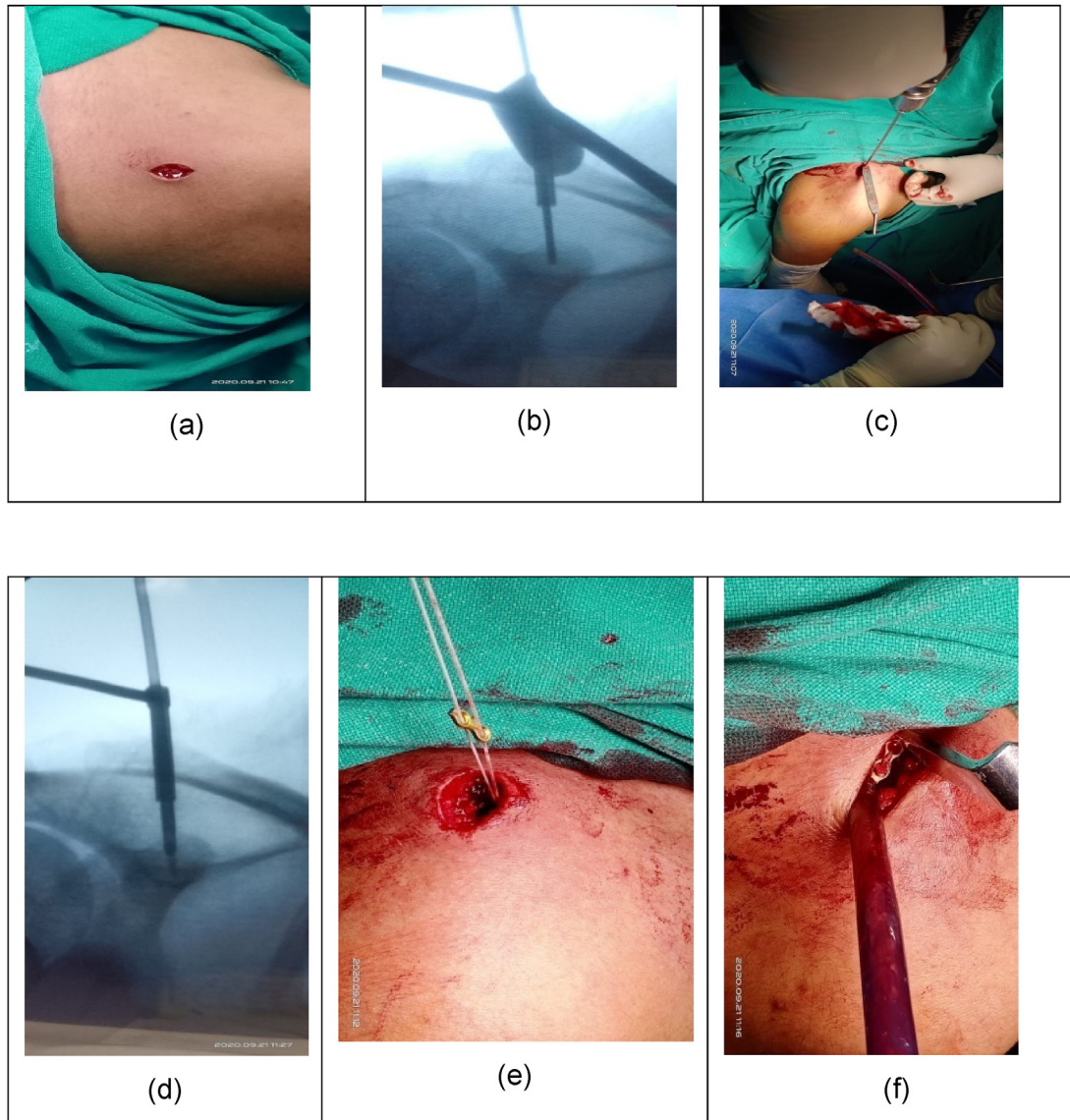


Fig. 3 – Surgical steps.

50% of patients sustained the injury during games like volleyball, badminton, and basketball, 30% due to falls and 20% due to road traffic accidents.

The RTPCR test for COVID-19 performed prior to surgery was negative in all patients. The average duration between

injury and surgery was 2.1 weeks (1–3 weeks). 0.40% of patients had an injury on the dominant side. The average surgical time was 25 ± 4.92 min. Postoperative stay in the hospital was kept minimal to 7 ± 2 days and suture removal was done on 14th post-operative day. The average follow-up duration

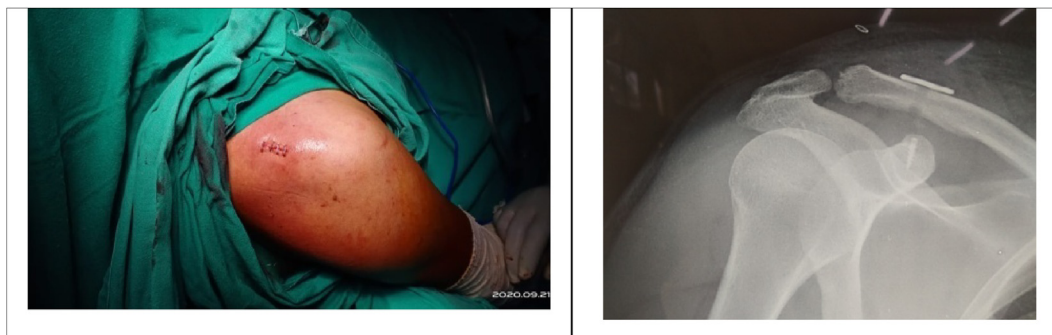


Fig. 4 – Picture of post operative wound and radiograph.

Table 1 – VAS and constant score.

Score	VAS		Constant	
	Mean	Median	Mean	Median
Pre op	6.8 ± 0.78 (SD)	7 (IQR = 6–8)	33.40 ± 5.68 (SD)	34 (IQR = 25–43)
3 month	3.6 ± 0.69 (SD)	3.5 (IQR = 2.5–4.5)	67.20 ± 2.61 (SD)	65.5 (IQR = 60.5–70.5)
6 month	2.2 ± 0.42 (SD)	2 (IQR = 0)	82.10 ± 3.60 (SD)	82.5 (IQR = 77.5–87.5)
9 month	0.9 ± 0.56 (SD)	1 (IQR = 0)	88.80 ± 4.89 (SD)	88 (IQR = 81–95)
Friedman test	<0.001		<0.001	

was 35.5 ± 4.13 weeks. Visual analogue scale and Constant score measured at pre-operative, 3, 6 and 9 month follow-up are mentioned in Table 1.

All patients achieved full range of motion of the shoulder joint at 9 month follow-up with substantial improvement in pain, the strength of the muscles and ability to perform activities of daily living. The mean CC distance of operated and healthy shoulder was 9.06 ± 1.44 mm and 8.9 ± 1.08 mm respectively. No significant change was observed in CC distance at subsequent follow-up. There was no evidence of loosening of the suture anchor, displacement of miniplate, fracture of coracoid or clavicle till the last follow-up.

Discussion

AC joint dislocation is categorized by Rockwood into 6 types.⁴ Management of type-1 and 2 is usually conservative whereas management of type 3 injury is controversial. Its surgical management is considered to confer some benefit to the physically active young population. Type 4–6 injuries are usually managed operatively. Our study population consisted of young soldiers in field areas staying in isolated groups. They were involved in physical training and few sports activities, depending on the restrictions due to the pandemic.

A vast range of surgeries has been described for their management with varied limitations and levels of success. More than 150 surgical techniques have been described,¹⁵ ranging from a fixation with trans articular K-wires to reconstruction of the coracoclavicular ligament. For acute injuries,

K-wire fixation is an easy and rapid surgery; however, it is usually associated with complications like the migration of pin, breakage of implant and pin track infections.¹⁶ Fixation with the help of coracoclavicular screw also has limitations such as obligatory screw removal and frequent hardware failure which has decreased its popularity.¹⁷ The use of hook-plates has shown promising and reproducible results;¹⁸ however, compulsory implant removal after an interval is its major drawback which leads to slower functional recovery. It is also associated with complications like subacromial impingement and acromial osteolysis. In the case of tight rope, there is a risk of damaging the neurovascular structures while passing a loop underneath the coracoid process.¹⁹ Other sophisticated surgeries like ligament reconstruction as well as muscle transfer surgeries require a steep learning curve and are time-consuming.

The underlying principle of most of the prevailing surgical procedures for the treatment of acute AC dislocation is to maintain the anatomical relationship between the lateral end of the clavicle and acromion for a period of post-operative time until healing (reliable for loading the joint) occurs at the coracoclavicular interval and AC joint.²⁰ Therefore, techniques of coracoclavicular fixation with suspensory devices such as fixation by suture anchor with metallic button and fixation with tight rope were evolved. These techniques are optimal for the repair of acutely torn ligaments, providing stabilization to allow native ligaments to heal and do not require implant removal.²¹

The protocols for surgical procedures were changed drastically due to the upsurge of COVID cases.¹² Restricting

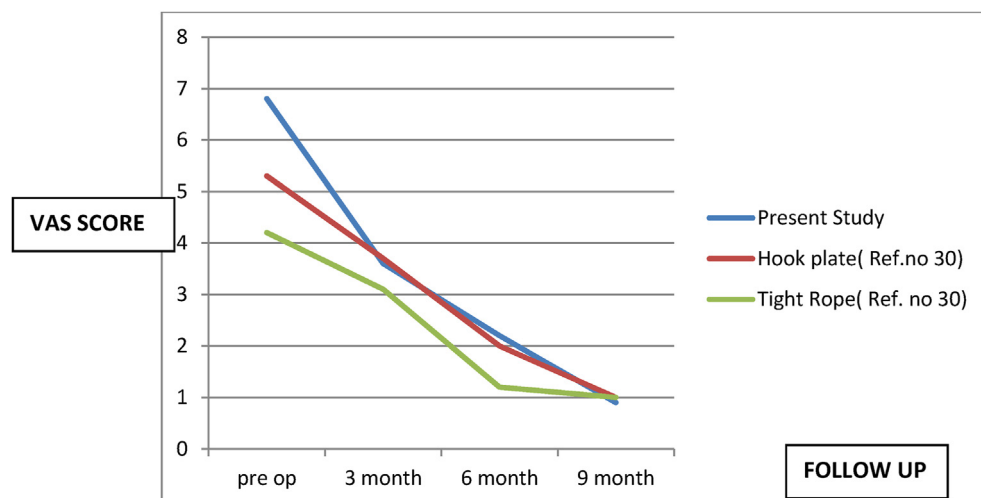


Fig. 5 – Comparison of VAS score of different studies.

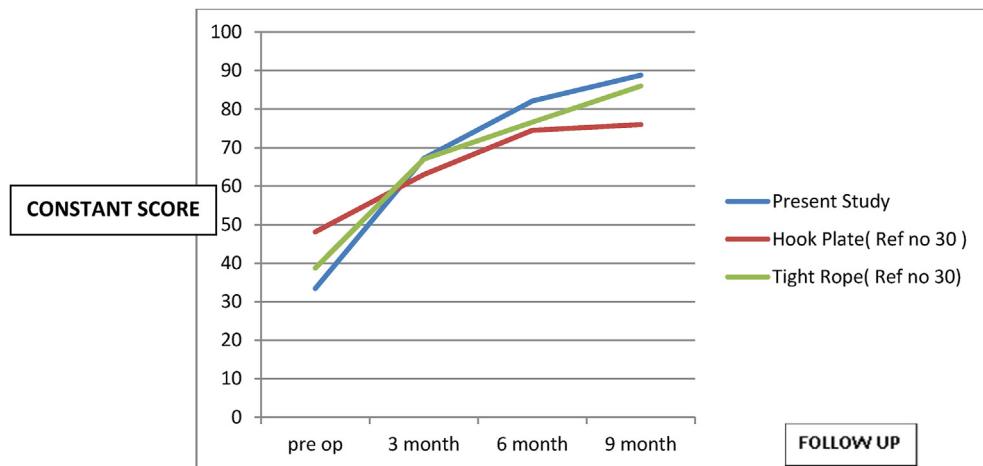


Fig. 6 – Comparison of constant score of different studies.

Table 2 – Surgical time of various techniques.

Author	Technique	Average surgical time
Present study	Fixation with 3.5 mm suture anchor and miniplate	25.5 ± 5.1 min
Mishra et al ²⁴	Fixation with 5.5 mm suture anchor and metallic button	35 min (30–55 min)
Bin Abd Razak et al, ³⁰	Comparative study of tight rope and hook plate fixation	Tight rope 75 ± 18 min; Hook plate 58 ± 15 min
Galasso et al, ³¹	Modified weaver dun	51.7 ± 2.7 min (range, 47–58 min)

operative interventions to only as really necessary to prevent long-term morbidity and limiting exposure time in case of unavoidable procedures was the norm to avoid transmission of infection. Although negative RTPCR tests were the norm for patients undergoing surgery, the reliability of these tests was questionable.²²

A biomechanical study evaluated eight different AC reconstruction techniques and found that suture anchor fixation in the base of the coracoid process restores the anatomy best.²³ The technique has been trialled successfully in past using a 5.5 mm titanium suture anchor and titanium metallic button construct.²⁴ The practical difficulty one is expected to encounter is locating the exact centre of base of coracoid for fixing a 5.5 mm suture anchor, as the average base height of coracoids process (superoinferior) is 15.94 ± 1.33 mm whereas base width of the coracoid process (mediolateral) is 25.48 ± 1.46 mm.²⁵ Therefore, surgical time as well as chances of fracturing the coracoid process likely to increase due to eccentric placement of a large diameter suture anchor.

The pullout strength of a 3 mm titanium suture anchor is $335.26 \text{ N} \pm 135.6 \text{ N}$ ²⁶ (and that of a 3.5 mm suture anchor is expected to be more), which is sufficient to withstand the forces acting across during a protected loading situation till healing takes place.²⁷ For fixation of 3.5 mm anchor, a comparatively smaller diameter hole is required, which has already been recommended by many authors to reduce fractures either at clavicle or coracoids.^{28,29}

Considering these facts an easy and swift technique which does not require implant removal is the need of the hour to reduce the patient contact time as well as repeated hospital admissions. Our technique maintained CC interval and AC joint

reduction with the help of a 3.5 mm suture anchor fixed in the base of the coracoid and fibre wire tightened over a miniplate placed above the lateral clavicle. Due to the ease of this method, the average surgical time in our study has been found to be shorter i. e., 25.5 ± 5.1 min than the others (Table 2).

During follow-up, a sustained improvement in functional recovery was observed; an average CS of 90 was attained by most of the patients by 9 months allowing the high-demand individual to return to sports activity which was found in 7 out of 10 patients in our study. They returned to preinjury level of physical activity by the last follow-up; however, 3 patients had difficulty in performing vertical rope climbing and chin-ups (one each of type-3, type-4 and type-5 injuries) (Figs. 5 & 6).

The limitations of our study are the small sample size and a short duration of follow-up, whereas the major advantage of our study is a homogenous population group of soldiers with the similar functional requirement. This pilot study has proved the efficacy of a single 3.5 mm anchor in restoring AC joint stability following an acute injury in Type-3 dislocation. The results in higher grades of injury are questionable. A randomized controlled trial is needed to validate the findings of our study.

Conclusion

Acute AC joint dislocations are being managed by a variety of procedures; however, no single surgical technique has demonstrated superior results over others. The method described in the present study was found to be easy and less time-consuming. There was no need for implant removal and

the results were impressive in our physically active young patients. It restores the vertical stability of the AC joint by minimal dissection and provides sufficient strength to hold the distal clavicle to the coracoid process for CC and AC ligament healing with results comparable to other techniques.

Disclosure of competing interest

The authors have none to declare.

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