

Evaluation of the results of acute acromioclavicular joint reconstruction using Double Endobutton technique

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Background

Acromioclavicular joint (ACJ) dislocation is a common injury, which accounts for ~9% of all shoulder injuries. Surgical techniques for reconstructing or repairing ACJ dislocation have evolved over the last decades. Recent surgical techniques focus on reconstruction of the coracoclavicular ligament to recover the stability of ACJ.

Patients and methods

This was a prospective case series study that included 23 patients with acute ACJ dislocation, admitted to the Department of Orthopaedic Surgery and Traumatology, Faculty of Medicine, Kafr El Sheikh and Benha University. All cases were treated by coracoclavicular repair using Double Endobutton technique and Ethibond suture. The follow-up period ranged from 18 to 24 months postoperatively. Outcomes were assessed using Constant score and DASH score at 6 weeks, 3, 6, 12 months, and final follow up. Radiological assessment was done using Zanca view and stress anteroposterior radiographs of both shoulders to compare acromiohumeral interval at the end of follow up.

Results

This study included 23 patients that were admitted to our department. Their mean age were 34.2 ± 2.3 years. The average time between injury and surgery was 5.2 ± 1.4 days. There were 20 men and three females. Regarding DASH score it improved from preoperative value of 88.3 ± 11.2 points to 14.3 ± 2.4 points. Regarding Constant score, it improved significantly from preoperative value of 45.3 ± 2.2 points to a postoperative value of 92.3 ± 3.6 points. Regarding acromiohumeral interval, the mean distance was 9.3 mm immediate postoperative period, and it was 10.1 at the end of follow up ($P > 0.05$).

Conclusion

ACJ reconstruction using Double Endobutton technique is safe, easy, and effective technique in cases with acute ACJ dislocation with little postoperative complications and excellent clinical and radiological outcomes.

Keywords:

acromioclavicular joint dislocation, coracoclavicular ligaments reconstruction, Double Endobutton techniques

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Introduction

Acromioclavicular joint (ACJ) is a diarthrodial joint between acromion and lateral end of the clavicle. There is a fibrocartilaginous disc in between. The ACJ is stabilized mainly by acromioclavicular ligaments for posteroanterior stability and coracoclavicular (CC) ligaments for superoinferior stability [1].

Injury to ACJ can occur after falling on outstretched hand or more commonly after direct falling on the tip of the adducted shoulder. This injury produces a compressive and shear forces through the joint leading to separation and rupture of AC ligaments followed by CC ligaments and finally clavicle fascia. This leads to loss of suspensory function of upper limb. The shoulder joint displaced downwards by effect of the gravity [1,2].

ACJ dislocations are classified according to Rockwood and colleagues, into six types. In type I there is mild sprain to the AC and CC ligaments. The ligaments are intact and ACJ is stable. In type II, there is disruption of the AC ligaments, so the distal end of the clavicle is unstable in horizontal plane. However, vertical stability is preserved by the action of the intact CC ligaments. In type III, there is disruption of both AC and CC ligaments. The distal clavicle is displaced superiorly by 25–100% in comparison with other shoulder. In type IV, there is posterior dislocation of the distal end of

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the clavicle through the trapezius muscle. In type V, the distal clavicle is displaced superiorly and stripped from all its soft tissue attachments even deltotrapezoid fascia. The clavicle lies subcutaneously and displaced more than 100% in comparison with normal shoulder. In the last type (VI), the distal clavicle is displaced inferiorly. The mechanism of this type is usually hyperabduction injury with arm external rotation combined with retraction of the scapula [3].

There is a general agreement supporting the nonoperative management of types I and II. They can be both treated by initial period of immobilization then active rehabilitation. Other types of ACJ dislocation can be treated operatively. There are multiple techniques for repair of the ACJ dislocation; the Bosworth CC screw, tension band wiring of the ACJ, the hook plate, and the CC ligament reconstruction techniques.

Weaver-Dunn in 1972 reported transfer of the CA ligament to the distal end of the clavicle in chronic cases along with excision of the distal end of the clavicle [1,4-6].

Most current reconstruction techniques do not reproduce the original anatomy of the ACJ. There is continuous deforming force exerted by the arm weight on any fixation pavilion during biological healing [7].

CC ligament reconstruction can be done using Dacron loop, stainless steel wire, No. 5 Ethibond suture, autologous semitendinosus or gracilis, Mersilene tape. Wellmann *et al.* [8] performed ACJ reconstruction using two buttons to fix distal end of the clavicle to coracoid through a single tunnel. They used No. 5 Ethibond between two buttons.

In acute phase, after ligament disruption there is a strong healing reaction, and there is no need for grafting if the initial fixation stays firm during the whole journey of healing. In chronic phase, biological graft is mandatory for the construct to make sure of the durable permanence and longevity [9].

This study was done to evaluate the double button technique for the treatment of ACJ dislocation in the acute phase.

Patients and methods

This was a prospective case series study that included 23 patients with acute ACJ dislocation, admitted to the Department of Orthopaedic Surgery and Traumatology, Faculty of Medicine, Kafr El Sheikh and Benha University. All cases were adults and had complete ACJ (Rockwood types III, IV, and V). All

cases treated by CC repair using Double Endobutton technique and Ethibond suture.

Inclusion criteria: complete ACJ dislocation more than type II, acute closed injuries, age group between 18 and 59 years. Excluded cases were: chronic cases, very old patients, skeletally immature patients, compound injuries, open dislocations, and associated musculoskeletal injuries were excluded from the study.

All cases were operated in our hospital. The follow-up period ranged from 18 to 24 months postoperatively. Specific postoperative rehabilitation program was followed for all patients. Outcomes were assessed using DASH score [10] and Constant grading system [11] at 6 weeks, 3, 6, 12 months, and final follow up. Radiological assessment was done using Zanca view and stress anteroposterior radiographs of both shoulders to compare acromiohumeral distance at the end of follow up.

Surgical technique

The procedure was performed in a modified beach chair position. The patient was positioned as far lateral as possible on the table to allow free movement of the arm. A folded towel bump was placed behind the scapula to prevent protrusion of the scapula. Smoothly alternating the patient head away from the operative side to facilitate appropriate drilling trajectory. The patient is protected with an abdominal belt for more stability.

Draping was then trailed from sternum to umbilicus, then to neck and the ear, and then over upper back. Fluoroscopic imaging should be well located to allow suitable imaging intraoperatively. Zanca views were made on normal ACJ first and was used as reference for CC distance and ACJ reduction.

The coracoid tip was palpated, and 2 inches incision was made above it. Flaps were then raised medially and laterally. Deltoid fibers were opened and coracoid was recognized and dissected to its base. The articular disc of ACJ is debrided to allow suitable reduction. Physical reduction of the clavicle is then performed. A drill hole using 4.5 mm cannulated drill bit over a guide wire was done from clavicle to the base of the coracoid.

The Endobutton is loaded with Ethibond No. 5 and then shuttled from the clavicle to coracoid base. After Endobutton flipping below coracoid base, the clavicle is reduced manually and the other Endobutton is inserted over suture pairs exiting from clavicular hole. Firm downward pressure over clavicle by the assistant is mandatory during this stage before tying the sutures. Sutures are then tied over Endobutton. This jams the

Endobutton in place and then the reconstruction is finished.

Postoperative rehabilitation program

All cases were immobilized in broad arm sling for 6 weeks. Immediate pendulum exercises were started from day 2. Passive elbow and shoulder mobilization were started as tolerated by the patient. After 6 weeks, active movements were commenced, and full range of motion was then stressed.

Follow up

All cases were evaluated using DASH score [10] and Constant score [11] during follow-up visits. Range of motion was calculated using goniometer for Constant score. DASH score ranges from 0 to 100 with 0 is the best score and 100 is the poorest. Constant score ranges also from 0 to 100 with 100 indicated highest excellent results and 0 for least poor outcome. Sheets were completed at each follow up and complications were also recorded and assessed for marks of failure, impingement, or infection. Check radiographs were taken immediately postoperative and at the end of follow up to evaluate suture laxity and maintenance of ACJ reduction.

An informed consent was taken from every patient participated in the study and local ethics committee approval was taken from our institution before commencement of the study.

Statistical analysis

Stats were done using SPSS, version 20 (IBM SPSS Statistics for Windows, Version 20. IBM Corp., Armonk, NY). χ^2 test was used to compare qualitative data and nonparametric test were used to compare preoperative and postoperative values.

Results

This study included 23 patients that were admitted to our department. Their mean age were 34.2 ± 2.3 years (range, 20–48 years). The average time between injury and surgery was 5.2 ± 1.4 days. There were 20 men and three females.

Regarding mechanism of trauma, 19 cases sustained a direct fall on the shoulder and four cases fall on their outstretched hand with elbow locked in extension.

Most of the cases suffered injury in their left side (16) and only seven cases had right- sided injury.

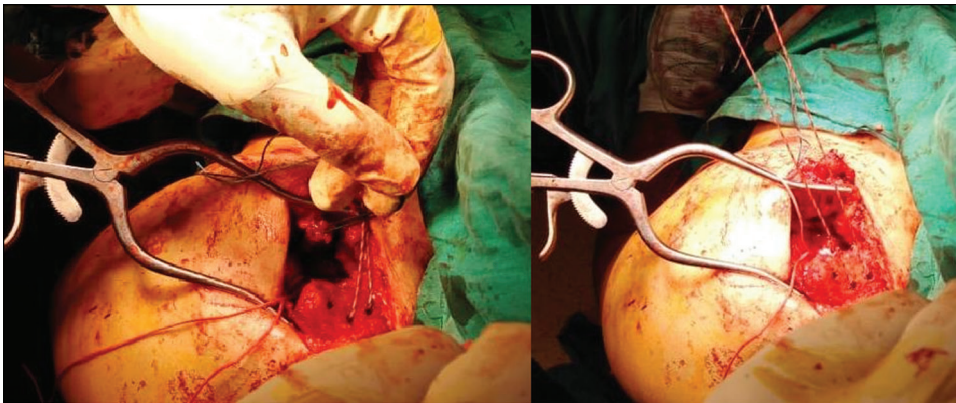
Regarding type of fracture, four cases were grade III, nine cases were grade IV, eight cases were grade V.

Regarding complications, only two cases had superficial infection and one case had some shoulder stiffness that was managed by physiotherapy.

Regarding DASH score it improved from preoperative value of 88.3 ± 11.2 to 14.3 ± 2.4 points. Regarding Constant score, it improved significantly form preoperative value of 45.3 ± 2.2 points to a postoperative value of 92.3 ± 3.6 points. Both improvements were statistically significant ($P < 0.05$).

Regarding acromiohumeral interval at the end of follow up, there was no significant difference between immediate and last follow-up Zanca view acromiohumeral interval. The mean distance was 9.3 mm immediate postoperative period, and it was 10.1 at the end of follow up ($P > 0.05$) (Figs 1–3).

Figure 1



Intraoperative photos showing clavicular tunnels.

Figure 2



Preoperative radiograph showing type III left ACJ dislocation and the postoperative radiographs after double button technique. A 29-year-old male patient sustained a left ACJ dislocation, Rockwood type III. Double Endobutton technique was done. Anatomical reduction was achieved. No increase in AHI was noticed till end of follow up. His DASH and Constant scores were excellent. He developed simple superficial skin infection that was managed by daily dressing and antibiotic therapy. ACJ, acromioclavicular joint; AHI, acromiohumeral interval.

Figure 3



Preoperative radiograph showing type III right ACJ dislocation and the PO radiographs after double button technique. A 42-year-old female patient sustained a right ACJ dislocation, Rockwood type III. Double Endobutton technique was done. Anatomical reduction was achieved. No increase in AHI was noticed till end of follow up. Her DASH score was 13 and her Constant score was 92 at the end of follow up. ACJ, acromioclavicular joint; AHI, acromiohumeral interval.

Discussion

In recent studies, surgical intervention for ACJ joint injuries has a substantially greater success rate; numerous trials have showed a successful outcome over nonoperative treatment [1,5].

There were issues with hardware failure such as the Bosworth screw and hook plate, necessitating a second procedure to remove the hardware. There have been several attempts to improve on the original Weaver–Dunn technique for stabilizing the ACJ with nonmetallic fixation. However, implant-related issues such as infection, soft tissue reactivity, and

fractures have been documented, despite the fact that many of these modifications have proven outstanding success [7].

Biomechanical investigations indicated that the ultimate strength, stiffness, and load elongation curves of the native complex were tested against various repair structures in order to restore the native architecture and find materials that can withstand cyclic loading without deformation or failure. To imitate postoperative settings, testing was carried out with both simple load to failure modes and response to cyclical loads [12].

The most frequent treatment for anatomically reconstructing the ACJ today includes stabilizing the joint by wrapping a cerclage material around the base of the coracoid and inserting it through a hole in the clavicle. However, thick, tough materials such as polythoxanone bands or massive tendon grafts have demonstrated comparable strength to the natural complex. Their load-elongation curves show that most of the evaluated materials have lower stiffness. Furthermore, nonanatomical methods such as cerclage fixation drag the distal clavicle anteriorly. The clavicle is dragged anteriorly even when the drill hole is placed within 2 mm of the anterior edge of the clavicle. During the healing phase, when constant cyclical stresses are applied to it, this malreduction is likely to weaken the construct and cause clavicle osteolysis at the level of cerclage [13].

Fixation placed in anatomically coned positions may improve implant stability and response to cyclical loads. Indeed, several newer techniques have been described that anatomically placed holes in the clavicle and coracoid followed by placing grafts or fixation devices to achieve stability [14].

A double endobutton technique was first introduced by Struhl and Wolfson [15]. The Endobutton device replicates the anatomically correct course of the conoid part of the CC ligament. Only the surface of the two metal Endobutton bears the deforming stresses of the arm's weight, not the suture material itself, hence the suture material has a lower likelihood of causing soft tissue reaction. Furthermore, drill holes should be kept short (4.5 mm) to avoid distal clavicle fracture [15].

The procedure is technically simple and requires a tiny incision with minimum soft tissue dissection. The study's goal was to assess the functional outcome of full ACJ injuries treated with a Double Endobutton and Ethibond No. 5. Twenty-three cases were done in our department using this technique with favorable outcomes and very low complication rate. DASH score improved from preoperative value of 88.3 ± 11.2 points to 14.3 ± 2.4 points. Regarding Constant score, it improved significantly from preoperative value of 45.3 ± 2.2 points to a postoperative value of 92.3 ± 3.6 points. Both improvements were statistically significant. Our results were comparable with the literature.

Struhl [16] used continuous loop double endobutton reconstruction for ACJ dislocation on 35 patients. At a mean follow-up of 5.2 years, the construct remained stable in all but one patient. The mean CC interval difference was 2.1 mm and was less than 2 mm in

87% of patients. The mean Constant score was 98; the mean University of California, Los Angeles Shoulder Rating Scale score was 34; and the mean American Shoulder and Elbow Surgeons Shoulder score was 98. No infections, fractures, or perioperative complications occurred [16].

Struhl and Wolfson [17] also used closed-loop Double Endobutton technique for repair of unstable distal clavicle fractures in eight patients. Their mean follow-up averaged 3.4 years. The mean Constant score was 97 at final follow-up. They found that the closed-loop Double Endobutton technique was reliable and effective in achieving fracture stability in all patients.

Zhang *et al.* [18] used a modified closed-loop Double Endobutton technique for repair of ACJ dislocation over 61 patients. The results were better for closed loop technique group than hook plate group. However, there was no significant difference between groups regarding radiographic results.

Xue *et al.* [19] used Double Endobutton technique in 25 patients with ACJ dislocation with at least 2-year follow-up. The mean follow-up was 34 ± 6.8 months. The visual analog scale and Constant scores revealed significant advancements from 5 ± 0.9 (range, 4–7) and 45 ± 5.6 (range, 30–54) scores preoperatively to 0 ± 0.5 (range, 0–2) and 95 ± 2.9 (range, 91–98) scores at 24 months postoperatively, respectively. The CC distance significantly decreased from 23 ± 5.4 mm (range, 16–34 mm) preoperatively to 8 ± 0.9 mm (range, 7–10 mm) at the final follow-up.

Wang *et al.* [20] evaluated the surgical treatment of acute Rockwood III ACJ dislocations using two flip-button techniques; the Tightrope and Endobutton techniques in 60 cases that were followed-up to 24 months. The incision length and operation time were shorter in tightrope group. There were no significant differences between the two groups regarding the Constant–Murley score at the final follow-up. No significant differences were found in the CC distance preoperatively, immediately postoperatively, and at the final follow-up.

However, Li *et al.* [21] stressed on that horizontal stability of the ACJ cannot be completely restored by reconstruction of CC ligaments. They combined AC ligament reconstruction with the original Double Endobutton technique of CC ligament reconstruction. The mean follow-up period was 33.6 ± 5.4 months. The mean Constant scores improved from 25.2 ± 6.6 preoperatively to 92.4 ± 6.5 postoperatively, while the mean visual analog scale score decreased from 5.9 ± 1.4

to 1.2 ± 0.9 . The final follow-up revealed that excellent outcomes were achieved in eight patients and good outcome in two patients.

Moreover, Wei *et al.* [22] used a Triple Endobutton technique for the treatment of acute complete ACJ dislocations to separately reconstruct the trapezoid and the coronoid portions of the CC ligament. All patients achieved a significant improvement in the pain and function of shoulder at a mean follow-up interval of 12 months (range, 8–14 months). Anatomical reduction of the ACJ was maintained with no loosening or breakage of the CL and Ethibond sutures and no displacement of endobuttons. The mean visual analog scale scores of all patients was 0.2 (range, 0–2) at the final follow-up evaluation. The mean Constant scores were 29.3 preoperatively and 91.3 at the time of the final follow up.

Lee *et al.* [23] compared ACJ reconstruction using button technique (35 cases) versus tendon graft reconstruction of CC ligaments (12 cases). Repairs without the use of graft resulted in eight (23%) cases of loss of reduction, while tendon graft augmented repairs resulted in five (42%). This difference was not statistically significant. No patients required reoperation. There was no statistical difference in the ASES and SANE scores between the two groups.

The limitations of this study include the small number of patients with short follow up period. Moreover, only acute cases were included with lack of control group.

ACJ reconstruction using Double Endobutton technique is safe, easy, and effective technique in cases with acute ACJ dislocation with little postoperative complications and excellent clinical and radiological outcomes.

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Conflicts of interest

There are no conflicts of interest.

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