

# Clinical Study on Minimally Invasive Sling Technique Fixation for the Treatment of Acromioclavicular Joint Dislocation with Double Endobutton by Bare-handed

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**Abstract:** *Objective:* To evaluate the clinical efficacy of minimally invasive, fluoroscopy-free, arthroscopy-free, coracoid tunnel-free double Endobutton plate sling technique for the treatment of acromioclavicular joint dislocation. *Methods:* A total of 60 patients with acromioclavicular joint dislocation admitted to our hospital between January 2021 and December 2023 were divided into two groups according to the treatment method. The control group underwent open reduction and internal fixation with a clavicular hook plate, while the study group received minimally invasive, fluoroscopy-free, coracoid tunnel-free double Endobutton plate sling fixation. The therapeutic outcomes were compared between the two groups. *Results:* All surgical outcome measures in the study group were superior to those in the control group ( $p < 0.05$ ). The improvement in Constant scores and the reduction in visual analog scale (VAS) pain scores was significantly greater in the study group compared to the control group ( $p < 0.05$ ). *Conclusion:* The minimally invasive, fluoroscopy-free, arthroscopy-free, coracoid tunnel-free double Endobutton plate sling technique for the treatment of acromioclavicular joint dislocation offers significant advantages, including minimal invasiveness, reduced trauma, reliable fixation, fewer complications, accelerated recovery, and improved joint function.

**Keywords:** Acromioclavicular joint dislocation; Bare-handed; Clavicular hook steel plate; Endobutton plate

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## 1. Introduction

Acromioclavicular joint dislocation is a common traumatic joint injury primarily caused by direct violence such as traffic accidents or falls<sup>[1]</sup>. Traditional treatment methods include manual reduction and clavicular hook plate internal fixation. However, these approaches often suffer from drawbacks such as significant trauma, slow recovery, and the need for secondary surgery to remove internal fixation devices<sup>[2]</sup>. Additionally, complications

may include loosening of internal fixation, erosion of acromial bone, postoperative shoulder pain, restricted joint mobility, and recurrence of joint dislocation after removal of internal fixation devices <sup>[3]</sup>.

In recent years, with continuous advancements in medical technology, the double Endobutton technique has emerged as a novel treatment method and has been increasingly adopted in clinical practice, demonstrating remarkable advantages <sup>[4]</sup>. This study applied the minimally invasive, fluoroscopy-free, arthroscopy-free, coracoid bone tunnel-free double Endobutton internal fixation technique in the treatment of patients with acromioclavicular joint dislocation, achieving significant outcomes. A detailed report was provided in this study.

## 2. Materials and methods

### 2.1. General information

A total of 60 patients with acromioclavicular joint dislocation were selected as the study participants between January 2021 and December 2023. The patients were randomly assigned to two groups using a random number table method. There were no statistically significant differences in baseline characteristics between the two groups ( $p > 0.05$ ), as shown in **Table 1**.

**Table 1.** Comparison of baseline characteristics between the two groups

| Group      | n  | Gender     |            | Age (years) |              | Injured Side |            |
|------------|----|------------|------------|-------------|--------------|--------------|------------|
|            |    | Male       | Female     | Range       | Ill-defined  | Present      | Male       |
| Study      | 30 | 12 (40.00) | 18 (60.00) | 21–66       | 41.42 ± 3.28 | 16 (53.33)   | 14 (46.67) |
| Control    | 30 | 13 (43.33) | 17 (56.67) | 22–65       | 42.86 ± 4.65 | 15 (50.00)   | 15 (50.00) |
| $\chi^2/t$ |    | 0.391      |            | 0.076       |              | 0.582        |            |
| $p$        |    | > 0.05     |            | > 0.05      |              | > 0.05       |            |

#### 2.1.1. Inclusion criteria

Diagnosed with acromioclavicular joint dislocation by imaging examination, and presenting with unilateral dislocation; No surgical contraindications; Signed informed consent.

#### 2.1.2. Exclusion criteria

Combined with open injury or fracture of the shoulder joint; Allergic to medications used during surgery; Unable to tolerate the surgical procedure.

### 2.2. Treatment methods

Both groups of patients underwent comprehensive preoperative evaluations to exclude any surgical contraindications. Thorough preoperative preparations were completed, including blood glucose management and psychological counseling.

#### 2.2.1. Control group

Open Reduction and Internal Fixation with a Clavicular Hook Plate. Patients were placed in the supine position under general anesthesia, with the upper body slightly elevated. The affected shoulder was supported with a pad, and the patient's head was turned to the opposite side. A 6–8 cm incision was made extending from the distal

clavicle to the acromioclavicular joint. A clavicular hook plate of appropriate height and length was inserted posterior to the acromioclavicular joint. Holes were drilled into the clavicle, and three to five screws of suitable length were inserted. The acromioclavicular ligaments were repaired, and after confirming correct reduction and fixation, the wound was irrigated and closed.

### **2.2.2. Study group**

Internal Fixation with the Double Endobutton Technique. The procedure was typically performed with the patient in the beach-chair position, with the affected shoulder elevated. Anesthesia, either cervical plexus block or general anesthesia was selected based on the patient's condition and surgical requirements. The surgical area was routinely disinfected and draped. A 3–5 cm incision was made from the distal clavicle to the acromioclavicular joint. Two 2.5 mm diameter holes were drilled into the clavicle, located 2 cm and 4 cm from the distal end of the clavicle at the acromioclavicular joint. Using a right-angle clamp, a No. 2 high-strength suture was passed closely along the medial cortex of the coracoid process, looped around its base, and brought out laterally. This suture was then passed through the two clavicular bone tunnels to introduce two double-stranded high-strength sutures, each preloaded with an Endobutton plate. Under direct visualization, the acromioclavicular joint was reduced. The two high-strength sutures were sequentially tightened and tied to secure fixation. The stability of the acromioclavicular joint was confirmed, and the joint capsule and ligaments were repaired. Finally, the incision was closed.

## **2.3. Observation items**

### **2.3.1. Comparison of surgical parameters**

Including intraoperative blood loss, operation time, incision length, and hospital stay.

### **2.3.2. Comparison of shoulder joint function**

Evaluated using the Constant-Murley score, which consists of a subjective section (total 35 points) and an objective section (total 65 points). A higher score indicates better shoulder function.

### **2.3.3. Comparison of pain intensity**

Assessed objectively using the Visual Analog Scale (VAS). Pain severity was graded from mild to severe as follows: Grade I: 0 points (no pain) Grade II: < 3 points (mild pain) Grade III: 4–6 points (moderate pain) Grade IV: 7–10 points (severe pain)

## **2.4. Statistical analysis**

Data analysis was performed using SPSS version 26.0. Measurement data is expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ) and were compared using the *t*-test. Enumeration data are presented as n (%) and analyzed with the chi-square test. A *p*-value of less than 0.05 was considered statistically significant.

## **3. Results**

### **3.1. Comparison of surgical parameters between the two groups**

All surgical parameters in the study group were significantly better than those in the control group ( $p < 0.05$ ), as shown in **Table 2**.

**Table 2.** Comparison of surgical parameters between the two groups ( $\bar{x} \pm s$ )

| Group    | n  | Hospital Stay (days) | Incision Length (cm) | Operation Time (min) | Blood Loss (mL)  |
|----------|----|----------------------|----------------------|----------------------|------------------|
| Study    | 30 | 7.15 $\pm$ 0.49      | 3.91 $\pm$ 0.44      | 48.93 $\pm$ 5.27     | 64.77 $\pm$ 6.15 |
| Control  | 30 | 9.28 $\pm$ 1.11      | 6.29 $\pm$ 1.03      | 55.46 $\pm$ 5.19     | 82.49 $\pm$ 7.04 |
| <i>t</i> |    | 8.094                | 10.065               | 5.468                | 11.494           |
| <i>p</i> |    | < 0.05               | < 0.05               | < 0.05               | < 0.05           |

### 3.2. Comparison of constant-Murley score differences

The improvement in Constant-Murley scores was significantly greater in the study group compared to the control group ( $p < 0.05$ ), as shown in **Table 3**.

**Table 3.** Comparison of cognitive scores between the two groups ( $\bar{x} \pm s$ )

| Group    | n  | Subjective       |                  | Objective        |                  | Total Score      |                  |
|----------|----|------------------|------------------|------------------|------------------|------------------|------------------|
|          |    | Pre-treatment    | Post-treatment   | Pre-treatment    | Post-treatment   | Pre-treatment    | Post-treatment   |
| Control  | 30 | 18.05 $\pm$ 3.26 | 22.20 $\pm$ 3.62 | 36.52 $\pm$ 3.21 | 45.14 $\pm$ 2.06 | 55.52 $\pm$ 5.12 | 67.25 $\pm$ 4.26 |
| Study    | 30 | 18.08 $\pm$ 2.62 | 30.20 $\pm$ 3.20 | 36.81 $\pm$ 4.15 | 57.62 $\pm$ 3.10 | 55.15 $\pm$ 5.32 | 87.95 $\pm$ 5.26 |
| <i>t</i> |    | 0.052            | 4.854            | 0.041            | 5.124            | 0.084            | 6.624            |
| <i>p</i> |    | > 0.05           | < 0.05           | > 0.05           | < 0.05           | > 0.05           | < 0.05           |

### 3.3. Comparison of VAS score differences between the two groups

The reduction in VAS scores was significantly greater in the study group compared to the control group ( $p < 0.05$ ), as shown in **Table 4**.

**Table 4.** Comparison of VAS scores between the two groups ( $\bar{x} \pm s$ )

| Group    | n  | Pre-treatment   | Post-treatment  |
|----------|----|-----------------|-----------------|
| Study    | 30 | 7.38 $\pm$ 0.54 | 2.17 $\pm$ 0.42 |
| Control  | 30 | 7.35 $\pm$ 0.69 | 4.51 $\pm$ 0.44 |
| <i>t</i> |    | 0.624           | 23.524          |
| <i>p</i> |    | > 0.05          | < 0.05          |

## 4. Discussion

Acromioclavicular joint dislocation is a common joint injury primarily caused by direct or indirect trauma leading to rupture of the acromioclavicular joint capsule and surrounding ligaments, resulting in upward displacement of the distal clavicle. Depending on the severity, it can be classified into different grades, ranging from mild pain to severe displacement<sup>[5]</sup>.

Clinical treatment options for acromioclavicular joint dislocation vary and include both conservative and surgical approaches. Conservative management mainly consists of four categories: cold and heat therapy, immobilization and bracing, medication, and functional exercises. It is typically indicated for patients with

Rockwood type I and II injuries. For those with type III or higher dislocations or acromioclavicular joint displacement exceeding 2 cm, conservative treatment often fails to achieve satisfactory outcomes, and surgical intervention is required<sup>[6]</sup>. The goals of surgery are to restore stability and function of the acromioclavicular joint, reduce pain, and prevent complications.

The Endobutton plate, also known as a loop plate or button plate, is a device used in the treatment of acromioclavicular joint dislocations by reconstructing the coracoclavicular ligament structure through elastic fixation. Its principle lies in reestablishing an anatomical structure between the clavicle and the coracoid process that mimics the coracoclavicular ligament, providing internal fixation through its unique stiffness and strength<sup>[7]</sup>. This elastic fixation method not only aligns with the micromotion physiological characteristics of the acromioclavicular joint but also preserves rotational movement of the clavicle, thereby restoring the physiological connection between the coracoid process and the clavicle to the greatest extent possible. Struhl first introduced the double Endobutton technique in 2007, with the original aim of reducing joint subluxation and fractures<sup>[8]</sup>. By implanting a suture-button construct between the coracoid process and the distal clavicle, stability of the acromioclavicular joint can be maintained. Furthermore, this construct offers advantages in strength and stiffness compared to normal ligaments<sup>[9]</sup>. Both Endobutton fixation and clavicular hook plate fixation demonstrate favorable clinical and radiological outcomes for the treatment of acromioclavicular joint dislocations<sup>[10,11]</sup>. A meta-analysis including 179 patients compared the efficacy of these two techniques and concluded that both are effective in improving joint function and alleviating pain. However, Endobutton fixation provided additional advantages in terms of postoperative pain relief compared to the hook plate fixation<sup>[12]</sup>. Another meta-analysis, which pooled data from 1,102 patients, thoroughly evaluated five surgical techniques, comparing their clinical efficacy, radiological outcomes, and safety. Although the clavicular hook plate is widely used for acromioclavicular joint dislocation repair, it is associated with more severe soft tissue trauma, greater blood loss, the necessity for a second surgery to remove the hardware, and a higher complication rate. The analysis concluded that its clinical application requires careful consideration<sup>[13]</sup>. Endobutton fixation, due to its elastic properties, better aligns with the biomechanical behavior of the acromioclavicular joint and preserves rotational movement of the clavicle<sup>[14]</sup>. This technique significantly reduces the likelihood of postoperative complications such as shoulder stiffness and subacromial impingement syndrome. As a result, Endobutton fixation has become an increasingly popular choice in recent years<sup>[15]</sup>.

This study applied a modified double Endobutton sling technique, which is a fluoroscopy-free, arthroscopy-free, and coracoid bone tunnel-free internal fixation method in the treatment of patients with acromioclavicular joint dislocation. As a minimally invasive procedure, it offers advantages such as a small incision, minimal tissue damage, reduced bleeding, shorter operative time, and faster postoperative recovery. Compared to the control group treated with clavicular hook plate fixation, the experimental group demonstrated superior outcomes across various surgical metrics, along with significantly greater improvements in Constant-Murley scores and Visual Analog Scale (VAS) scores ( $p < 0.05$ ). These results indicate that the double Endobutton sling technique achieves excellent therapeutic outcomes with fewer complications.

## 5. Conclusion

In summary, for patients with acromioclavicular joint dislocation, the minimally invasive, fluoroscopy-free, arthroscopy-free, and coracoid bone tunnel-free double Endobutton suspension fixation technique can achieve

superior clinical outcomes. This procedure is a safe, effective, minimally invasive, and efficient treatment option associated with fewer complications. It not only aligns with the biomechanical characteristics of the acromioclavicular joint but also preserves clavicular rotation, thereby maximizing the restoration of shoulder joint function.

## Disclosure statement

The authors declare no conflict of interest.

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