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ORIGINAL STUDY

Minimally invasive procedure of acute acromioclavicular joint dislocation: one suture-button device versus two suture-button devices

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The purpose of this study was to assess the clinical results of patients treated with either one suture-button device or two suture-button devices for acute acromioclavicular (AC) joint dislocations. Eighty patients were randomized to operative stabilization either by one suture-button device (OSB, 40) or by two suture-button devices (TSB, 40). Postoperative complications, the Constant, VAS and SST scores, patient subjective satisfaction result were reviewed.

The total incidence of complications was similar in both groups (16/40 vs. 17/40, P =0 .820). There were no significant differences in the length of hospitalization, the Constant, VAS and SST scores, and the ability to return to previous work between the two groups. However, the patients of TSB group had longer incision length, more blood loss, more operative and radiation time and more hospitalization costs (P < 0.01). The radiological evaluation showed no significant difference in the CC distance between the two groups (P = 0.557).

Our results indicated that one suture-button device could achieve the same good radiological and clinical results as two suture-button devices did.

Keywords : Shoulder ; dislocation ; acromioclavicular injury ; suture-button.

INTRODUCTION

Anatomical coracoclavicular (CC) ligament reconstruction has been a popular method for acute acromioclavicular (AC) joint dislocations *(9,12,14,15,19,21,22)*. Multiple techniques of providing fixation between the coracoid and the clavicle, with or without ligament transfer, have been reported *(2,3,9,13,19-21)*. The suture-button device is one of them. Evidenced by both biomechanical and clinical studies, anatomic ligament reconstruction treating with the suture-button device has been proven to be a satisfactory technique for the treatment of acute AC joint dislocations *(2,6,7,9,12,22)*. Good results are reported either using one suture-button device or two suture-button devices *(2,6,9,14,17,18,21)*. In early practice, using one suture-button device is

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frequently proposed *(2,6,13,18)*. Afterward, some authors believe one unit of suture-button is not strong enough and two devices may have better outcomes *(17,21)*. Although the biomechanical strength of two suture-button devices is superior to that of one suture-button device *(11,24)*, no study has confirmed its clinical advantages over the other.

Our aim was to compare the radiographic and clinical outcomes of acute AC joint dislocations treated with either one suture-button device or two suture-button devices. We hypothesized that two suture-button devices had less postoperative complications, better radiological and functional results compared with one suture-button device.

MATERIALS AND METHODS

After approval from Ethics Committee of our hospital and informed consent from all patients before operation, in accordance with the inclusion criteria and exclusion criteria, eighty patients with Rockwood type III–V AC joint dislocation were treated with one suture-button device (OSB, 40 cases) or with two suture-button devices (TSB, 40 cases) between February 2010 and December 2013. The following patients were included: (1) age from 18 to 50 years, (2) acute dislocations (within 2 weeks after injury), (3) no osteoporosis, (4) follow up time of at least 12 months, (5) Rockwood type III patients with higher requirements for functional recovery such as manual laborers and athletes, (4) Rockwood IV or V dislocations. The exclusion criteria were: (1) previous shoulder complains or surgery, (2) open dislocations and old dislocations, (3) combined with nerve or vascular injury, (4) associated with fractures and/or dislocation of other parts of the ipsilateral limb, (5) associated with vital organs damage. At admission, type of management was chosen at random by computer allocation and assigned to patients prospectively through sequentially numbered opaque envelopes. No significant difference between the two groups was found in the patient demographics and dislocation classification (Table I).

All operations were performed by the same group of surgeons. Patients were placed in the bench chair under regional anesthesia associated if necessary with a general anesthesia. Prophylactic antibiotic was administered appropriately before the operation.

All operations were performed using mini-open technique. For one suture-button, a 2 cm incision was made above the edge of the clavicle and a second 2 to 3 cm incision perpendicular to the clavicle towards the coracoid process would allow direct visualization of its base. The clavicle was manually reduced by direct pressure and this reduction was then maintained with a temporary K-wire. The Zanca *(25)* and axillary views were taken to identify the reduction of the AC joint. A 2.0-mm guide pin was placed through the clavicle and coracoid in anatomical positions, while ensuring that the hole was at the anatomical origins of the conoid ligaments. Two 4.0-mm bony tunnels were drilled over the pin through the clavicle and the coracoid. Subsequently, a suture-button device (TightRope; Arthrex) was inserted to independently replace the conoid ligaments and held the AC joint in reduction. The TightRope™ device consisted of a round clavicular titanium button and a long coracoidal titanium button connected by a No. 5 nonabsorbable suture (FiberWire®, Arthrex, FL,

Table I. — Demographics between the two groups

Characteristics	OSB group	TSB group	t/χ^2	P
Age (yrs)	34.2±11.5	36.6±13.0	0.87	0.385
Sex (male: female, n)	25:15	29:11	0.91	0.340
The affected side (left: right, n)	31:9	30:10	0.58	0.446
Cause of injury (road accident: fall, n)	23:17	29:11	1.98	0.160
Rockwood type (III: IV: V, n)	24:11:5	22:12:6	0.22	0.895
Injury to surgery time (d)	3.5±3.5	4.0±2.0	0.78	0.435
Follow-up time	34.1±6.8	34.9±7.3	0.51	0.614

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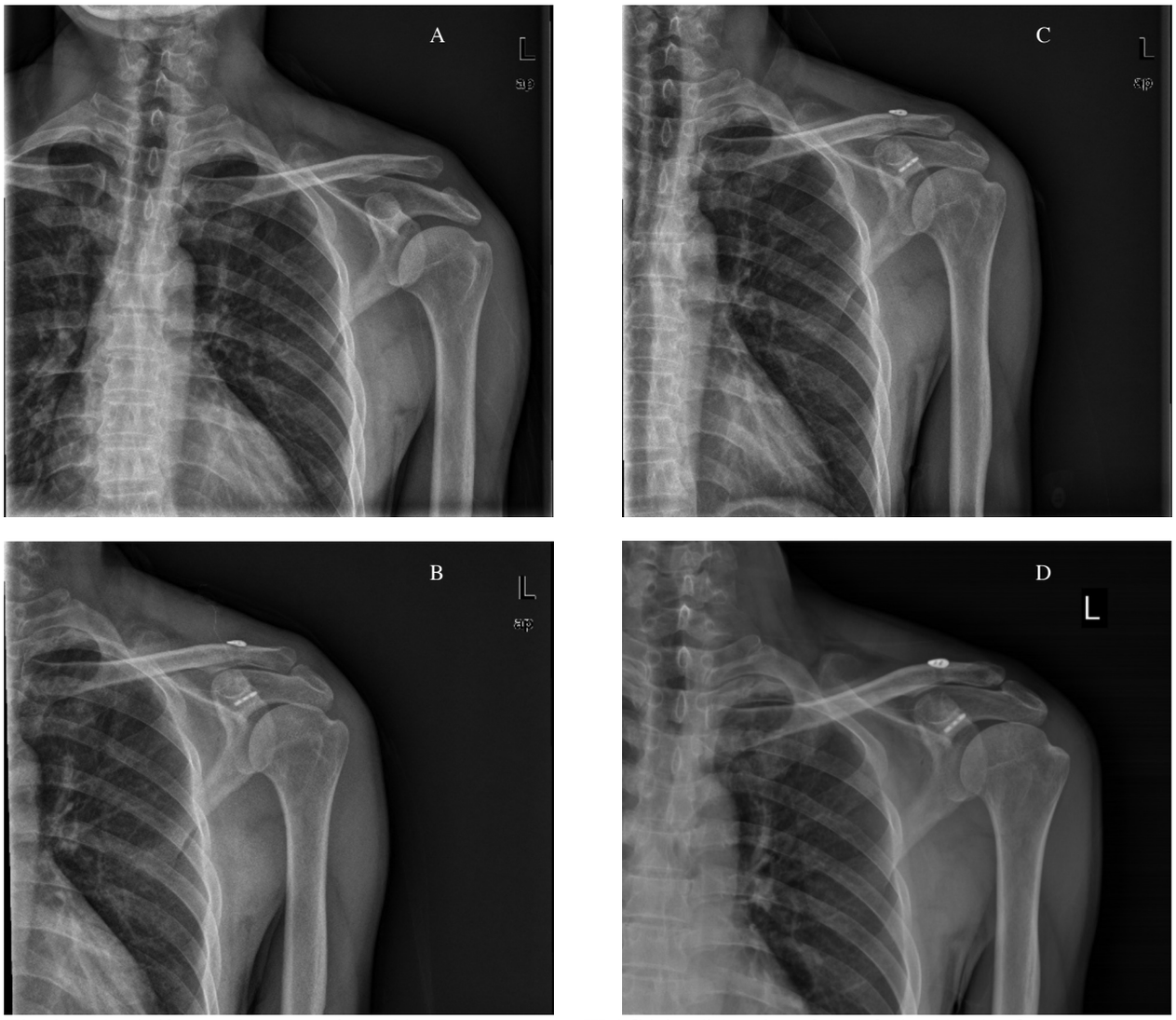

Fig. 1. — 1a. A 49-year-old male patient with a Rockwood type III AC joint dislocation of the left shoulder. 1b. One suture-button device were used to reconstruct the coracoclavicular (CC) ligament. Two days after operation X-ray film showed a good reduction of the affected AC joint. 1c-1d. Postoperative AP radiograph at six months (1c) and at one-year follow up (1d) indicated the button position remained unchanged. The AC joint also maintained a satisfactory reduction. The figures both did not show a loss of reduction compared with figure 1b.

USA) organised as a pulley. The button plate was tightened by aid of the pulley system and secured by alternating knots in a reduced and fluoroscopically controlled position of the AC joint (Figure 1a-1d). The K-wire used for temporary fixation of the AC joint was pulled out. The trapezius and deltoid were repaired.

The surgical procedure of two suture-button devices was similar to that of one suture-button device. The only difference was that we used another suture-button device to replace the trapezoid ligament through the anterlateral drill hole (Figure 2a-2c, Figure 3a-3c). The trapezoid coracoidal tunnel should be anterolateral to the conoidal tunnel leaving a bony bridge between tunnels of at least 10 mm.

Postoperative rehabilitation was started in 2 days by encouraging gentle passive and active-

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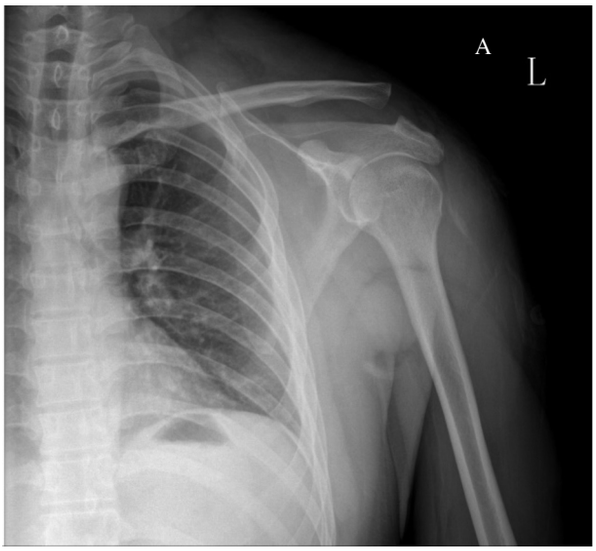

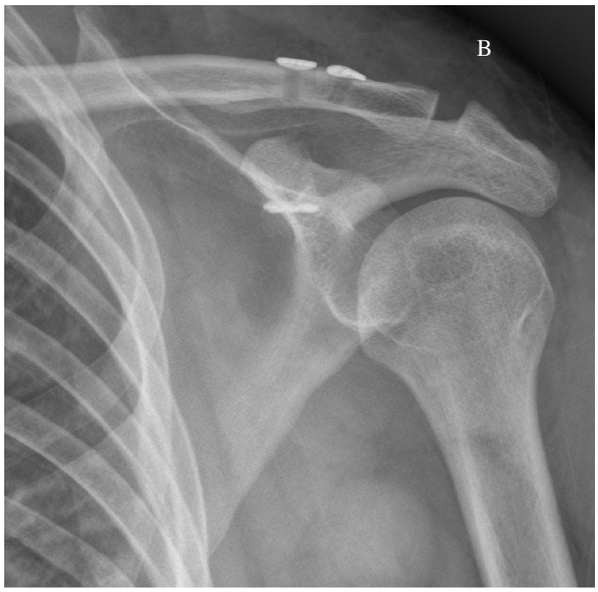

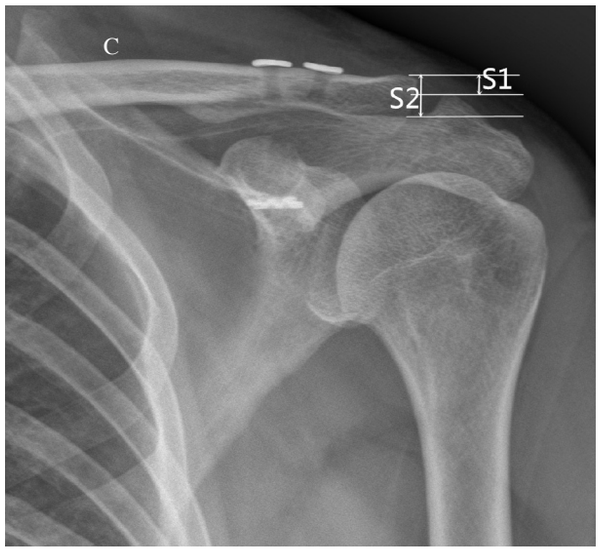

Fig. 2. — 2a. A 34-year-old male patient with Rockwood type III injury. 2b. The coracoclavicular (CC) ligament of the injured AC joint was reconstructed using two suture-button devices. Radiograph at two days after operation demonstrated an anatomical restoration of the AC joint. 2c. Radiograph at three months showed a slight loss (S1/S2<50%) of reduction compared with figure 2b.

assisted shoulder exercises while wearing an arm sling for protection. On the sixth postoperative week, the sling was discontinued and progressive resistance exercises were encouraged to enhance muscle power. Daily activities are performed from 3 months after surgery. Return to contact sports activities was allowed after 6 months.

At each postoperative follow-up visit, radiographs were analyzed specifically by the operative surgeons and a radiologist. Clinical and radiological follow-up was at 2, 4 and 8 weeks and then at 3, 6 and 12 months and the last follow-up.

We obtained AP and Zanca views of both shoulders. Preoperative data such as age, sex, affected side, cause of injury, Rockwood classification and time from injury to surgery were collected for each patient. Intraoperative variables like incision length, blood loss, the operative time and the radiation time, length of hospitalization and hospitalization costs for each group were noted after procedure. Complications, the Constant, VAS and SST scores, time from surgery to return to work and length of follow-up were also recorded. For data collection, the operative time was defined as the time from the skin incision to skin closure. Fluoroscopy time was obtained from the fluoroscopy logger. Heterotopic ossifications within the CC ligaments were classified as absent, minor or major; minor ossifications were represented by spots or small ossicles located in the CC ligaments, whereas major ossifications were considered as almost complete bridging between the clavicle and the coracoid process (12).Functional outcome was assessed using the Constant score (4), Visual Analogue Scale (VAS) score (0 representing no pain and 10 representing maximal imaginable

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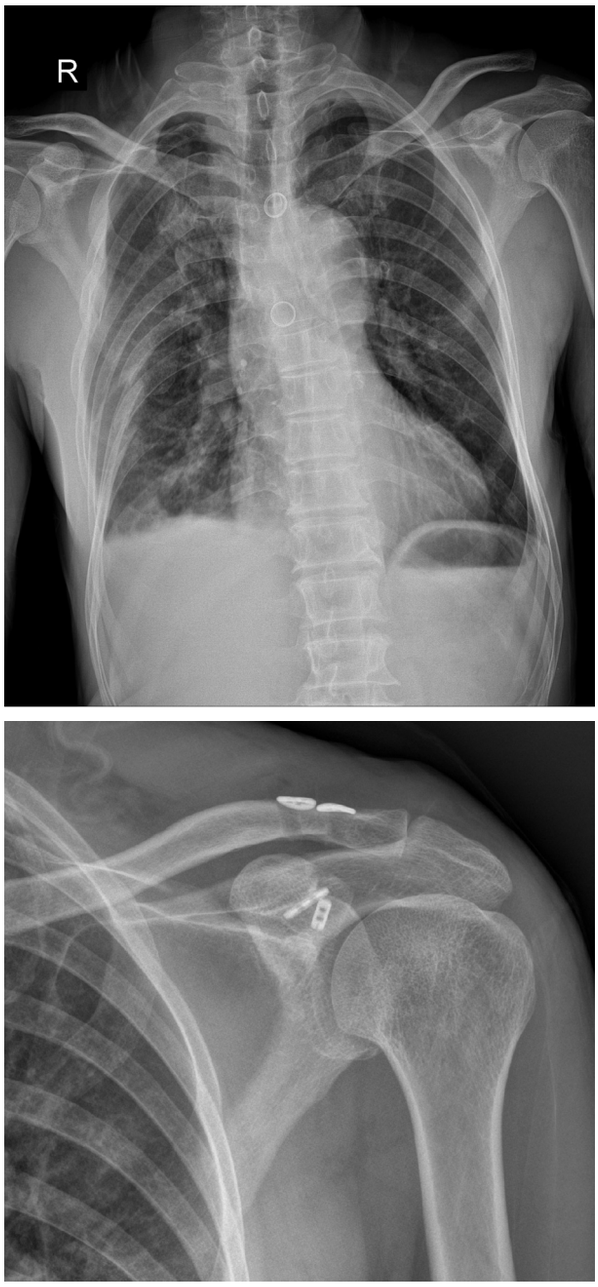

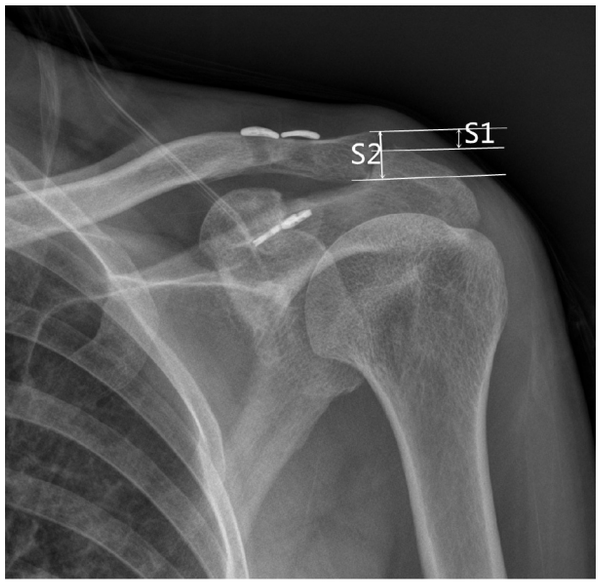

Fig. 3. — 3a. A 61-year-old male patient with the left AC joint dislocation. 3b. Using two suture-button devices to reconstruct the coracoclavicular (CC) ligament. Postoperative X-ray on the third day showed an anatomical restoration of the affected AC joint. 3c. Radiograph at three months demonstrated a slight loss of reduction (S1/S2<50%) compared with figure 3b

pain), simple shoulder test score (SST) score (1) by an independent reviewer at the last follow-up. A patient satisfaction questionnaire was completed at the final visit (1=dissatisfied, 2=moderate, 3=good, 4=excellent). Excellent and good were considered to be successful. The vertical distance between the anterior–inferior border of the clavicle and the superior border of the coracoid process (CC distance) was preoperatively surveyed on standard AP views of the AC joint, and at final follow-up on both shoulders.

Statistical analysis was performed using SPSS software, version 11.0 (SPSS, Inc., Chicago, IL, USA). Two tests were used for statistical analysis. The patient demographics (sex, injured side, causes of injuries and postoperative complications) and Rockwood type were compared using the Pearson's chi-square test for nonparametric categorical variables. Independent sample t test was used to compare the patients' age, time from injury to operation, incision length, blood loss, operative time, radiation time, length of hospitalization, hospitalization costs, follow-up time, radiological results, Constant, VAS and SST score. A value of $P < 0.05$ was considered statistical significant.

RESULTS

The mean period of follow-up time in OSB group was 34.1 ± 6.8 months (range, 28 to 42 months), versus 34.9 ± 7.3 months (range, 27 to 43

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months) in TSB group (P = 0.614). No significant differences between the two groups was found in the length of hospitalization. However, the patients of TSB group had longer incision length (5.3 ± 0.5 vs. 4.3 ± 0.6 cm, P < 0.01), more blood loss (45.0 ± 7.2 vs. 36.4 ± 9.5 ml, P < 0.01), more operative (65.6 ± 7.1 vs. 53.2 ± 6.6 min, P < 0.01) and radiation time (20.4 ± 5.5 vs. 15.8 ± 4.0 sec, P < 0.01) and more hospitalization costs (36000 ± 1700 RMB vs. 22800 ± 1500 RMB, P < 0.01). (Table II).

The overall incidence of complications in OSB group is comparable to that of TSB group (16/40 vs.17/40, P = 0.820) (Table III). In the OSB group, one patient of redislocation was diagnosed by radiographs on the second postoperative day and was successfully revised in 2 days after primary surgery. Slight loss of reduction, defined as less than 50% of the width of the clavicle, was observed in 12 cases (5 in the OSB group versus 7 in the TSB group). Obvious loss of reduction, defined as more than 50% of the width of the clavicle, was noted in 5 cases (3 in the OSB group versus 2 in the TSB group). Without secondary surgical intervention, the loss of reduction had no significant influence on their functional outcomes. Small scale osteolysis, mainly in the clavicular side, occurred around the plate in 8 patients (4 in the OSB group versus 4 in the TSB group). Three patients of the OSB group and 4 patients of the TSB group developed heterotopic ossification. But it didn't cause loss of motion or other symptoms.

The postoperative Constant score averaged 93.5 points (range, 72 to 100) in the OSB group and 94.3 points (range, 73 to 100) in the TSB group at the last follow-up. The postoperative mean VAS score was 0.32 points (range, 0 to 2) in the OSB group and 0.28 points (range, 0 to 2) in the TSB group. The postoperative average SST score was 11.7 points (range, 5 to 12) in the OSB group and 11.9 points (range, 6 to 12) in the TSB group. According to subjective satisfaction questionnaire about the results of the surgery, the outcomes of the OSB group were determined as excellent in 29 patients, good in 7 patients, moderate in 3 patients and dissatisfied in 1 patient. In the TSB group, thirty patients stated that they were excellent with the results, 8 were good, 2 were moderate and no patients were dissatisfied. All patients returned to their former work at a period of 6 months after operation. The clinical results, when comparing Constant score, VAS score, SST score and subjective results, did not differ significantly

Table II. — Intraoperative data between two groups

	OSB group	TSB group	t	P
Incision length (cm)	4.3±0.6	5.3±0.5	8.10	0.000
Blood loss (ml)	36.4±9.5	45.0±7.2	4.56	0.000
Operative time (min)	53.2±6.6	65.6±7.1	8.09	0.000
Radiation time (sec)	15.8±4.0	20.4±5.5	4.28	0.000
Length of hospitalization (d)	5.6±2.5	6.0±2.1	0.77	0.441
Hospitalization costs (RMB)	22800±1500	36000±1700	36.82	0.000

Table III. — Postoperative complications between two groups

	OSB group	TSB group	χ^2	P
Redislocation	1	0	0.00	1.000
Loss of reduction Slight	5	7		
Obvious	3	2	0.07	0.785
Osteolysis	4	4	0.14	0.701
Heterotopic ossification	3	4	0.00	1.000
Total complications	16	17	0.05	0.820

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Table IV. — Functional and radiological outcomes between two groups

	OSB group	TSB group	t/χ^2	P
Constant Preoperative	32.4±6.3	33.9±7.1	1.00	0.320
Postoperative	93.5±4.1	94.3±3.2	0.97	0.334
VAS Preoperative	4.6±1.4	4.8±1.7	0.57	0.567
Postoperative	0.32±0.4	0.28±0.5	0.40	0.694
SST Preoperative	2.8±2.2	2.9±2.1	0.21	0.836
Postoperative	11.7±0.6.	11.9±0.5	1.62	0.109
Subjective results Excellent	29	30	0.18	0.671
Good	7	8		
Moderate	3	2		
Dissatisfied	1	0		
CC distance Preoperative	20.6±3.4	20.9±3.2	0.41	0.686
Postoperative	12.5±3.2	12.0±4.3	0.59	0.557

between the two groups (P = 0.334, P = 0.694, P = 0.109, P = 0.671, respectively) (Table IV).

At final follow-up, the mean last CC distance was 12.5 mm (range, 11.5 to 22 mm) in the OSB group in comparison with 12.0 mm (range, 11.3 to 21 mm) in the TSB group. The radiological assessment showed that there was no significant difference in the CC distance between the two groups (P=0.557) (Table IV).

DISCUSSION

Currently, AC joint reconstruction devices have concentrated on anatomical restoration of the CC ligaments to offer biomechanical conditions that restore the initial structure and function of the normal AC joint complex *(1,3,6,9,13,17,19,22)*. Suture-button device permits reconstruction of the CC ligament to be in an anatomical position as much as possible. It also contributes to maximum reservation of the minimal motion of the AC joint. The theoretical strength of suture-button device is superior to the original strength of the CC ligaments by biomechanically withstanding forces equivalent to tensile strength *(16,17,22)*. As a result, good clinical outcomes could be anticipated. The literatures in recent years frequently reported that reconstruction using one suture-button device to treat these injuries yielded good short-term or mid-term outcomes *(2,13,14,20)*. However, a few complications also appeared, like loss of reduction, redislocations, implant looseness and displacement, and even failure *(6,18)*. Some authors attributed these to not strong enough strength fixed by one suture-button device, so they recommended using two units to treat the dislocations *(17,21)*. Though the biomechanical experiments have confirmed fixation effects with two units of suture-button is more stable than with one, no randomized controlled study have given evidence whether its clinical results is still better than those of one.

There were significant differences in the most perioperative variables between the two groups. Due to the additional use of one unit of suture-button device, the cost thus increased significantly in the TSB group. In addition, in order to placing additional unit of suture-button device, we had to make another incision and needed more operative and radiation time in the TSB group. Followed by them, the amount of blood loss also increased in the TSB group. From our statistical data (Table II), TSB technique had no obvious advantages over OSB technique in the perioperative variables, and even had more disadvantages.

As for complications, the total incidence of complications was similar in both groups (16/40 vs. 17/40, P = 0.820) (Table III). There were no patients with coracoid fracture, intraoperative

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neurovascular injury, AC joint osteoarthrosis and deep infection in both groups. The most common complication was still the loss of reduction (Figure 2c, 3c). The reported rate of loss of reduction ranged from 12% to 28% *(17,18,21)*. However, this complication did not significantly differ between the two groups (8/40 vs. 9/40, P = 0.785). Some authors believed that the anatomic position of the conoid ligament might be more important than the anatomic position of the trapezoid ligament for maintenance of reduction. This was also supported by biomechanical studies *(5,7)*, which have demonstrated that the conoid ligament was the most important structure resisting superior translation and that the trapezoid ligament contributed only 15% of the total resistance to superior translation. Consequently, there was not much use for sustaining a reduction even using an additional suture-button device to reconstruct the trapezoid ligament. We believed that the main reason of loss of reduction was determined by surgical tips, rather than by the number of suture-button plates. Precise positioning and drilling, accurate placement of suture-button plates, reasonable choosing the length of the loop and proper rehabilitation are important factors in preventing loss of reduction. Redislocation were also sporadically reported *(8,24)*. Only one patient in our group suffered this complication. We believed skilled surgical techniques were crucial for reducing this complication. Osteolysis and heterotopic ossification along the course of the CC ligaments were also relatively common complications. Despite their irregular incidence, they did not affect the final outcomes. We also found the incidence of these complications were not statistically significant between the two groups (Table III).

The reported average Constant scores of one suture-button device technique fell in the range of 61 to 100, the average VAS scores from 0 to 2, the average SST scores from 5 to 12 and the subjective result was 95-100% *(2,6,13,14,18,20)*. The reported average Constant score of two device technique was within the range of 60 to 100, postoperative pain VAS scores ranged from 0 to 2.7, the average SST scores ranged from 6 to 12 and the subjective result was 93.3-100% *(17,21)*. The scores of our series were all within the scope of the data reported in the previous papers *(2,6,12-14,17,18,21)*. We also found the clinical outcomes and the radiological assessment both revealed no significant difference between the two groups (Table IV). From this, we could conclude the clinical results of these two techniques were comparable.

There were several limitations of the current study. First, it was single-center study with a small patient collective of 80. To further support these results, high quality randomized controlled trials with larger sample size were still needed. Second, although patients were allocated randomly to either surgical group, it was impossible to perform blindness to both the surgeon and patients, which might influence the results.

CONCLUSIONS

In conclusion, our results indicated that one suture-button device could achieve the same good radiological and clinical results as two suture-button devices did. Thus, we recommended it was unnecessary to use another suture button device.

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