ORIGINAL ARTICLE

Clinical study on treatment of TOSSY type III acromioclavicular joint dislocation with clavicular hook plate combined with coracoclavicular ligament repair

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ABSTRACT

Objective: To explore the treatment of TOSSY type III acromioclavicular joint dislocation with clavicular hook plate combined with coracoclavicular ligament repair and its clinical effect.
Methods: 80 patients with TOSSY type III acromioclavicular joint dislocation who were admitted to our hospital from January 2014 to January 2019 were selected. They were randomly divided into the control group (n = 39, treated with clavicular hook plate) and the observation group (n = 41, treated with clavicular hook plate combined with coracoclavicular ligament repair) by the random number table method. The clinical efficacy in 12 months after operation, related clinical indicators, 12-month postoperative recovery and postoperative complications were compared between the two groups.
Results: The excellent and good rate was 92.68% (38/41) in 12 months after operation in the observation group, which was higher than that (76.92%, 30/39) in the control group ($p < .05$). There were no significant differences in the duration of surgery, intraoperative blood loss and HLOS between the observation group and the control group ($p > .05$). In 12 months after operation, abduction activity and forward flexion activity of the observation group were higher than those of the control group, and visual analogue score (VAS) was lower than that of the control group ($p < .05$). The incidence of complications in the observation group was slightly lower than that in the control group, but there was no statistically significant difference between the two groups ($p > .05$).
Conclusions: For TOSSY type III acromioclavicular joint dislocation, clavicular hook plate combined with coracoclavicular ligament repair has a good clinical efficacy. It can improve shoulder joint function, alleviate shoulder pain and have fewer complications. It can provide a reference for clinical treatment of this type of acromioclavicular joint dislocation.

Key Words: Acromioclavicular joint, Joint dislocations, Clavicular hook plate, Coracoclavicular ligament repair

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1. INTRODUCTION

Acromioclavicular joint dislocation, which is a commonly seen shoulder injury, accounts for about 12% of the shoulder girdle injuries. It is mostly caused by direct violence.[1] Clinically, according to TOSSY classification standards, acromioclavicular joint dislocation can be divided into three types. TOSSY type I and II acromioclavicular joint dislocation are treated with the non-surgical therapy. However, patients with TOSSY type III type acromioclavicular joint dislocation generally suffer from coracoclavicular and acromioclavicular ligament rupture, discontinuity between the acromion and the clavicle, joint capsule injury and so on, leading to fracture or obvious dislocation, so that non-surgical therapies cannot accomplish the aim of stabilizing acromioclavicular joint. Therefore, surgical therapies are applied to the treatment of TOSSY type III acromioclavicular joint dislocation clinically.[2] It is recommended to properly dispose newly-happened TOSSY type III acromioclavicular joint dislocation. If disposed improperly, the poorly-repaired coracoclavicular ligament will lead to old dislocation and then affect patients' future life quality.[3] At the present stage, conventional internal fixation methods (such as internal fixation with screw and/or Kirschner wire) can easily lead to breakage or looseness of internal fixation, which will severely affect the prognosis. With the in-depth clinical study, clavicular hook plate has become a premier option for the treatment of acromioclavicular joint dislocation and been widely applied clinically. The design principle of clavicular hook plate is the anatomical structure of the distal clavicle. It can generate stable pressure to accelerate the healing of acromioclavicular and coracoclavicular ligament.[4] Nevertheless, the single use of clavicular hook plate can easily result in the occurrence of post-operative complications, such as acromioclavicular joint re-dislocation. Therefore, to explore an optimal treatment method is a clinically concerned focus. Clinically, non-absorbable suture is one of the commonly used fixation materials. Coracoclavicular ligament repair is performed by use of non-absorbable suture for fixation, in order to effectively fix patients' joint dislocations.[5] Hence, this study is designed to explore the treatment of TOSSY type III acromioclavicular joint dislocation with clavicular hook plate combined with coracoclavicular ligament repair and its clinical effect, so as to provide a new reference therapeutic schedule for the patients with TOSSY type III acromioclavicular joint dislocation.

2. DATA AND METHODS

2.1 General information

80 patients with TOSSY type III acromioclavicular joint dislocation who were admitted to Baogang Hospital of Inner Mongolia from January 2014 to January 2019 were selected. The research was approved by Ethics Committee of Baogang Hospital. Inclusion criteria: (1) patients with normally functioning acromioclavicular joint before injury; (2) patients diagnosed as TOSSY type III acromioclavicular joint dislocation through X-ray; (3) patients with clinical manifestations such as persistent shoulder pain and piano key sign of lateral clavicle; (4) patients with the injury time less than 3 weeks; 5) patients who were informed and had signed informed contents. Exclusion criteria: (1) patients with a medical history of shoulder injury or surgery; (2) patients with homolateral fracture of outer-end clavicle or scapula; (3) patients with obvious surgical contraindications, or who could not tolerate the surgery in the pre-operative examination; (4) patients with severe cardiac, hepatic, pulmonary or renal dysfunction; (5) patients with old acromioclavicular joint injury; (6) patients who could not cooperate with the follow-up visit; (7) patients with coagulation abnormalities. The included patients were randomly divided into the control group (n = 39) and the observation group (n = 41) by the random number table. There was no statistically significant difference in the general information between two groups of patients ($p > .05$). See Table 1 for details.

2.2 Surgical methods

(1) The control group was treated with clavicular hook plate, and the procedure was listed as follows: brachial plexus nerve block was used as the anesthesia method, and each patient was required to be in the supine position, with the surgical posture mat placed under his/her shoulder, and then turned his/her head to the healthy-shoulder side. The curved incision was made on the distal clavicle to incise the skin and the hypodermis to expose the acromioclavicular joint, extremitas acromialis of clavicle and the distal clavicle and clear the intra-articular hematoma and cartilage disc fragments. The hook of the pre-bending clavicular hook plate with a proper length was located the infero-posterior to acromioclavicular joint. The plate was pressed down to guarantee the acromioclavicular joint reduction. The surgical field was washed with normal saline, and then the incision was sutured layer by layer. (2) The observation group was treated with clavicular hook plate combined with coracoclavicular ligament repair. All procedures were the same as the control group until the placement of the plate was finished. After the coracoid was exposed, the superior border of the coracoid to the inferior border of clavicle was mobilized by the blunt dissection. It was required to perform an exploratory examination of coracoclavicular ligament completeness. Double-strand non-absorbable suture was threaded from the infero-anterior of coracoid to the coracoid, through coracoclavicular ligament, to the distal clavicle, in order to fix the joint. The

surgical field was washed with normal saline, and then the incision was sutured layer by layer. (3) The two groups of patients were given antibiotics to prevent from infection after surgery, and the internal fixation plate was required to be removed in 6-12 months after surgery. Rehabilitation exercise was recommended to start in 2d after surgery (after dressing change). Within one week after surgery, the exercise was mainly focused on the passive movement and the pendulum-like movement of the affected shoulder. The exercise was carried on according to patients' subjective feeling (slight pain). It was acceptable to gradually increase the activity of shoulder joint. In two weeks after surgery, the exercise was the active movement of the affected shoulder. Climbing wall movement can restore the abduction and the forward flexion of the affected shoulder. Doctors advised discharged patients to do rehabilitation exercise and asked about the rehabilitation every two weeks. It was permissible to begin the rehabilitation exercise in the early period of post-operation. Triangular bandage or forearm strap can be used to suspend the forearm for ground activities, and it was recommended to increase the active movement of forearm pronation and supination and the resistance wrist and finger exercise. It was acceptable to conduct some resistance exercises such as the passive movement and the pendulum-like movement of the affected shoulder, elbow joint pronation and supination (for the good of musculus biceps brachii and musculus triceps brachii). Besides, it was allowable to increase the shoulder movement. In two weeks after operation, it was permissible to increase some resistance exercises, for example, shoulder abduction, backward extension, extorsion, forward flexion, adduction and intorsion and other active movement and resistance exercises. Doctors advised discharged patients to do rehabilitation exercise and asked about the rehabilitation every two weeks.

Table 1. The comparison in general data between two groups of patients with TOSSY type III acromioclavicular joint dislocation

Group	n	Gender (n)		Age	Cause of injury (n)			Dislocation condition (n)	
		Male	Female	(year-old, $\bar{x} \pm s$)	Fall damage	Traffic injury	Crushing injury	Right-side dislocation	Left-side dislocation
Control Group	39	21	18	47.4 ± 8.5	17	10	12	19	20
Observation Group	41	24	17	48.7 ± 7.9	19	9	13	18	23

Note. The control group was treated with clavicular hook plate, and the observation group was treated with clavicular hook plate combined with coracoclavicular ligament repair

2.3 Indicator observation

(1) The clinical efficacy was evaluated in 12 months after operation according to Karlsson standards:[6] no pain, no deformity after operation, shoulder joint movement with ease, normal upper limb's muscle strength, X-ray results showing acromioclavicular joint space no more than 4 mm (excellent); slightly limited shoulder joint movement, no shoulder pain or mild pain, upper limb's muscle strength no less than Grade 4, X-ray results showing acromioclavicular joint space no more than 7 mm (good); limited shoulder joint movement, shoulder pain or moderate pain, upper limb's muscle strength less than Grade 4, X-ray results showing acromioclavicular joint space no less than 8 mm (bad). The excellent and good rate was equal to the excellent rate plus the good rate. (2) The related clinical indicators were compared, including the duration of surgery, the intraoperative blood loss and HLOS. (3) 12-month post-operative recovery conditions were compared, including abduction activity, forward flexion activity and pain situation. Visual analogue score (VAS)[7] was used to evaluate pain situation, with the score ranging from 0 to 10 (0 was for no pain, 10 was for sharp pain). Higher score indicated severer pain. (4) Two groups of patients were followed up by means of outpatient review in 12 months after operation, and the occurrence rates of postoperative complications were compared, including acromioclavicular joint re-dislocation after plate removal, wound infection, wound no-healing, internal fixation failure and so on.

2.4 Statistical treatment

SPSS 24.0 software was applied to statistical analysis, and the measurement data fitting to normal distribution was represented by $\bar{x} \pm$ s , and the categorical data was represented by percentage (%) using t test. The comparison between two groups was made by χ^2 test, with the test level of α = 0.05.

3. RESULTS

3.1 The comparison in the clinical efficacy in 12 months after operation

The excellent and good rate of the observation group in 12 months after operation was 92.68% (38/41), which was higher than that (76.92%, 30/39) of the control group. The difference was of statistical significance (χ^2 = 3.894, $p <$ .05). See Table 2 for details.

Table 2. The comparison in the clinical efficacy in 12 months after operation between two groups of patients with TOSSY type III acromioclavicular joint dislocation [n, (%)]

Group	n	Excellent	Good	Bad	Excellent & Good Rate
Control Group	39	14 (35.90)	16 (41.03)	9 (23.08)	30 (76.92)
Observation Group	41	20 (48.78)	18 (43.90)	3 (7.32)	38 (92.68)

Note. the control group was treated with clavicular hook plate, and the observation group was treated with clavicular hook plate combined with coracoclavicular ligament repair

Table 3. The comparison in related clinical indicators between two groups of patients with TOSSY type III acromioclavicular joint dislocation ($\bar{x} \pm s$)

Group	n	Duration of Surgery (min)	Intraoperative Blood Loss (ml)	HLOS (d)
Control Group	39	49.37 ± 10.58	52.41 ± 3.76	14.57 ± 1.31
Observation Group	41	52.09 ± 9.87	53.25 ± 3.83	14.83 ± 1.25

Note. the control group was treated with clavicular hook plate, and the observation group was treated with clavicular hook plate combined with coracoclavicular ligament repair

Table 4. The comparison in 12-month post-operative recovery conditions between two groups of patients with TOSSY type III acromioclavicular joint dislocation ($\bar{x} \pm s$)

Group	n	Abduction activity (°)	Forward flexion activity (°)	VAS (scores)
Control Group	39	80.57 ± 9.23	88.41 ± 9.37	2.27 ± 0.93
Observation Group	41	96.36 ± 11.79	109.25 ± 13.60	1.32 ± 0.58
t value		6.658	7.942	5.511
p value		< .001	< .001	< .001

Note. the control group was treated with clavicular hook plate, and the observation group was treated with clavicular hook plate combined with coracoclavicular ligament repair

3.2 The comparison in related clinical indicators

There were no statistically significant differences in the duration of surgery, the intraoperative blood loss and HLOS between the observation group and the control group ($p >$ .05). See Table 3 for details.

3.3 The comparison in 12-month post-operative recovery conditions

In 12 months after operation, abduction activity and forward flexion activity in the observation group were higher than those in the control group. VAS in the observation group was lower than that in the control group ($p <$ .05). See Table 4 for details.

3.4 The comparison in post-operative complications

Both groups of patients were followed up, with Grade A healing rate of the surgical incision and no symptoms of neurovascular injury and subclavian vascular injury. In the control group, there were 2 cases of internal fixation failure, 3 cases of wound infection and 2 cases of acromioclavicular joint re-dislocation, and the incidence of postoperative complications was 17.95% (7/39). In the observation group, there were 2 cases of incision fat liquefaction, 1 case of wound infection, and the incidence was 7.32% (3/41). The incidence in the observation group was slightly lower than that in the control group, but the difference was of no statistical significance (p = .151).

3.5 Classic case

A case of male patient, 37 years old, fell down when riding an electric vehicle, with left shoulder on the ground. Left shoulder anteroposterior film: left acromioclavicular joint dislocation, TOSSY type III. Fixation method: clavicular hook plate combined with coracoclavicular ligament repair. See Figure 1 for details.

4. DISCUSSION

Acromioclavicular joint is a type of amphiarthroses, which is made up of acromion and the distal clavicle. It is stabilized by the tendinous attachments of articular capsule to coracoclavicular ligament, acromioclavicular ligament, trapezius muscle and deltoid muscle.[8–10] Some researches have shown that coracoclavicular ligament can affect kinetic equilibrium and static stability of shoulder girdle, independently bear 75% of compressive stress from acromioclavicular joint, and help with clavicle rotation.[11] When acromion is affected by the direct action of top-down violence, the stabilizing device of acromioclavicular joint will be destroyed. How-

ever, when coracoclavicular ligament is completely ruptured, clavicle will shift over the rear due to the continuous action of sternocleidomastoid muscle, leading to TOSSY type III acromioclavicular joint dislocation. Because of unstable vertical direction, it is hard to adopt conventional therapies to maintain articular reduction. In addition, it is easily affected by environmental tension, leading to a slower healing of repaired coracoclavicular ligament and easy reoccurrence of dislocation.[12–14] Therefore, the only way to recover the normal anatomy of acromioclavicular joint is operative treatment. Clinically, there are various surgical treatment plans, mainly including distal clavicle excision, coracoclavicular screw fixation, double Endobutton internal fixation and clavicular hook plate fixation. Distal clavicle excision can lead to the loss of the front attachment point of deltoid muscle, affecting the function of the affected shoulder;[15] coracoclavicular screw fixation is prone to failure because of the inconformity to biomechanics;[16] Kirschner wire fixation easily leads to acromioclavicular joint re-dislocation due to wire breakage, looseness and removal;[17] double Endobuton internal fixation requires a long learning curve and a prolonged duration of surgery, and it is difficult to be applied clinically due to immature techniques.[18] Clavicular hook plate fixation is widely used in clinical practice by virtue of easy operation, less invasiveness and short duration of surgery. The design is more aligned with the anatomical features of acromioclavicular joint, so that the hook part under the acromion can generate a leverage effect on the plate part for fixing the distal clavicle and form a persistent and stable pressure around the acromioclavicular joint to reinforce the fixation. However, it is easily prone to various postoperative complications, such as the accumulation of inflammatory mediators, subacromial impingement syndrome, limited shoulder abduction and shoulder pain.[19, 20] Therefore, it is critically important to continuously optimize clavicular hook plate fixation for the treatment of TOSSY type III acromioclavicular joint dislocation. This study is designed to explore the therapeutic effect of clavicular hook plate combined with coracoclavicular ligament repair in order to look for a better surgical method.

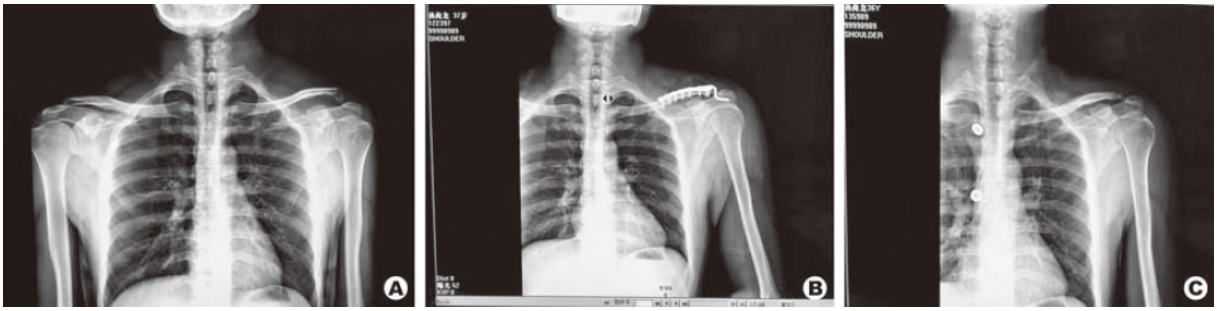

Figure 1. X-ray results of TOSSY type III left acromioclavicular joint dislocation before and after clavicular hook plate combined with coracoclavicular ligament repair
A: Before operation; B: In a week after operation; C: After plate removal

This study showed that the excellent and good rate in 12 months after operation of the observation group was higher than that of the control group, and VAS score in the observation group was lower than that in the control group. It is indicated that it is effective to apply this method to the treatment of TOSSY type III acromioclavicular joint dislocation to relieve patients' pain and restore upper limb's muscle strength. It is because this method can reconstruct biomechanical effects and the anatomical structure of coracoclavicular ligament. The stress-relief of clavicular hook plate can effectively guarantee the stability of acromioclavicular joint dislocation and facilitate patients' early recovery and shoulder joint functional exercise.[21] In addition, some researches also indicate that clavicular hook plate is designed according to the anatomical structure of the distal clavicle. It has a good conformity to the clavicle, so that it can be inserted along the inferior border of the acromion, which can intensely avoid the impact of extremitas acromialis. During the process of coracoclavicular ligament repair, double-strand non-absorbable suture can be used to make a multi-point fixation from the mechanics' angle. The stress-relief of acromioclavicular joint can easily recover the function of the affected shoulder and relieve the shoulder pain.[22] In this study, there were no statistically significant differences in the duration of surgery, the intraoperative blood loss and HLOS between the observation group and the control group. It is indicated that this treatment option cannot obviously increase the duration of surgery, the intraoperative blood loss and HLOS. As the operation was conducted by the same group of experienced physicians, during the process of operation, these physicians used double-strand non-absorbable suture to make a fixation quickly and faster reconstruct the

anatomical structure of coracoclavicular ligament, it showed no obvious effects on the duration of surgery, the intraoperative blood loss and HLOS. This research showed that abduction activity and forward flexion activity in 12 months after operation in the observation group were both higher than those in the control group. It is indicated that patients treated with clavicular hook plate combined with double-strand non-absorbable suture show a good reduction, so that it is beneficial to make an early shoulder joint functional exercise to recover shoulder joint function. The reasons may be probably that: (1) This method can promote the recovery of coracoclavicular ligament to maintain the static structure of shoulder girdle; it can also increase the stability of clavicular hook plate to prevent from the disconnection of the plate. At the same time, double-strand non-absorbable suture has a low cost, which conforms to the consideration from the economical aspect. (2) The design of the clavicular hook plate is consistent with shoulder biomechanical, anatomical and physiological structures, which can provide a stable and consistent pressure for the fracture localization of the clavicle. Meanwhile, it can also provide an instant stability, which is beneficial to the functional recovery of shoulder joint.[23,24] The research from Wu Wei and Zhang Shailin[25] has shown that the treatment of TOSSY type III acromioclavicular joint dislocation with clavicular hook plate has a secure fixation with a higher excellent and good rate of shoulder joint functional recovery and acquires a significant patient satisfaction, which conforms to this research results. This research showed that there was no statistically significant difference in the incidence of postoperative complications between the two groups. It is indicated that the clinical application of clavicular hook plate combined with coracoclavicular ligament repair is so safe that it cannot obviously increase the incidence of postoperative complications. However, the fixation with double-strand non-absorbable suture can prevent from coracoid bone resorption and reduce the incidence of acromioclavicular joint re-dislocation and internal fixation failure after plate removal. Therefore, the incidence of complications is slightly lower in the observation group. Nevertheless, it is needed to make a further study in the future due to the limited number of samples and short follow-up visit in this research.

In conclusion, for newly-happened TOSSY type III acromioclavicular joint dislocation, clavicular hook plate combined with coracoclavicular ligament repair has a good clinical effect on promoting patients' abduction activity and forward flexion activity and relieving the pain of the affected shoulder, with no obvious increase of post-operative adverse reactions. This method is worth being widely applied clinically.

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CONFLICTS OF INTEREST DISCLOSURE

The authors declared no conflicts of interest.

REFERENCES

[1] Trávník J, Kovařík J, Pavlacký T, et al. Comparison of Tension Banding and Modified Orthocord Sling in Acromioclavicular Dislocation Treatment-Non-Randomized Retrospective Study. Acta Chir Orthop Traumatol Cech. 2019; 86(2): 131-135.

[2] Zhu X, Teng X, Cai N, et al. Analysis of the curative efficacy of the locking band loop titanium plate combined with an-chors in the treatment of Tossy III acromioclavicular joint dislocation. Journal of Clinical Orthopaedics. 2018; 21(2): 225-227.

[3] Liu Q, Li Y, Fang Y, et al. The treatment of Tossy III acromioclavicular joint dislocation with Endobutton plate and acromioclavicular articular capsule suture. Journal of Practical Orthopaedics. 2018; 24(5): 456-459.

[4] Xu D, Luo P, Chen J, et al. Outcomes of surgery for acromioclavicular joint dislocation using different angled hook plates: a prospective study. Int Orhop. 2017; 41(12): 2605-2611. PMid:28852819. https://doi.org/10.1007/s00264-017-3611-2

[5] Ouyang J, Hui M, Ding W, et al. Clinical Effect of Combined Internal Fixation of Cannulated Screws, Locking Compression Plate and Non-absorbable Sutures for Posterior Cruciate Ligament Tibial Avulsion Fractures. Chinese Journal of Modern Operative Surgery. 2019; 23(1): 58-62.

[6] Hu J, Lv J, Wang W, et al. The treatment of Rockwood III-V acromioclavicular joint dislocation with double Endobutton plate. Zhejiang Clinical Medical Journal. 2016; 18(12): 2288-2289.

[7] Wang H, Huang F, Feng M, et al. Clinical observation of the message of Bachuo Rounian improving the VAS pain score of external humeral epicondylitis. Journal of Tianjin University of Traditional Chinese Medicine. 2017; 36(4): 271-273.

[8] Manohara R, Reid JT. Percutaneous endobutton fixation of acute acromioclavicular joint injuries and lateral clavicle fractures. JClin Orthop Trauma. 2019; 10(3): 492-496. PMid:31061575. https://doi.org/10.1016/j.jcot.2018.10.013

[9] Zhang Y, Zhou X, Fan L. Clinical comparative study of metaphyseal locking intramedullary nail and locking plate in the treatment of humeral surgical neck fracture. Journal of Chinese Physician. 2019; 21(11): 1684-1687, 1692.

[10] Masionis P, Bobina R, Ryliskis S. The Relationship Between the Clinical and Radiological Findings and the Outcomes of Early Surgical Treatment After Tossy Type III Acromioclavicular Joint Dislocation. Cureus. 2020; 12(1): e6681. https://doi.org/10.7759/cureus.6681

[11] Wang Z, Yilihamu T, Xu C, et al. Conjoined tendon and coracoacromial ligament transfer in the treatment of Rockwood III acromioclav-

icular joint dislocation: anatomical and clinical validation. Journal of Clinical Rehabilitative Tissue Engineering Research. 2015; 19(7): 1028-1035.

[12] Zhang S, Wang Z, Cui J. Clinical study on the belt loop button plate in the treatment of Tossy type III acromioclavicular joint dislocation. Journal of Hunan Normal University (Medical Sciences). 2017; 14(1): 159-161.

[13] Han B, Zhang C, Liu H, et al. The treatment of Tossy type III acromioclavicular joint dislocation with double-row suture anchor reconstruction. Journal of Clinical Rehabilitative Tissue Engineering Research. 2018; 22(23): 3615-3620.

[14] Qin S, Liu J, Wang Y, et al. The treatment of Tossy type III acromioclavicular joint dislocation with the suture anchor and hook plate. Modern Instruments & Medical Treatment. 2018; 24(2): 56-58.

[15] Lu W, Wang D, Han Y, et al. The treatment of severe shoulder joint degenerative changes with arthroscopic acromioplasty and distal clavicle excision. Chin J Joint Surg (Electronic Edition). 2010; 4(1): 129-131.

[16] Zeng J, Zhu L, Qian X, et al. Hook plate versus anatomic locking plate combined with coracoclavicular suture fixation for unstable distal clavicle fractures. Orthopedic Journal of China. 2018; 26(24): 2225-2229.

[17] Zhu Y, Chen J, Wan R. The treatment of Tossy type III acromioclavicular joint dislocation with TightRope button plate fixed by Kirschner wire. Chinese Journal of Bone and Joint Injury. 2019; 34(3): 292-294.

[18] Ye C, Guo Y, Wu Z, et al. A comparative study of double Endobutton technique and clavicular hook plate for acute acromioclavicular joint dislocation. Chinese Journal of Bone and Joint Injury. 2017; 32(9): 928-931.

[19] Hung LK, Su KC, Lu WH, et al. Biomechanical analysis of clavicle hook plate implantation with different hook angles in the acromioclavicular joint. Int Orthop. 2017; 41(8): 1663-1669. PMid:28097386. https://doi.org/10.1007/s00264-016-3384-z

[20] Hu J, Li H, Xu P, et al. The treatment of Tossy type III acromioclavicular joint dislocation with the placement of AO clavicular hook plate through acromion bone foramen. Orthopedic Journal of China. 2015; 23(16): 1530-1531.

[21] Müller D, Reinig Y, Hoffmann R, et al. Return to sport after acute acromioclavicular stabilization: a randomized control of double-suture-button system versus clavicular hook plate compared to uninjured shoulder sport athletes. Knee Surg Sports Traumatol Arthrosc. 2018; 26(12): 3832-3847. PMid:29980805. https://doi.org/10.1007/s00167-018-5044-x

[22] Gu H, Fu J, Song X, et al. Analysis on the causes of post-operative scapulohumeral pain after the treatment of clavicular distal end fracture and acromioclavicular joint dislocation with clavicular hook plate. Chinese Journal of Bone and Joint Injury. 2012; 27(7): 634-635.

[23] Li G, Liu T, Shao X, et al. Fifteen-degree clavicular hook plate achieves better clinical outcomes in the treatment of acromioclavicular joint dislocation. J Int Med Res. 2018; 46(11): 4547-4559. PMid:30092651. https://doi.org/10.1177/0300060518786910

[24] Yin J, Yin Z, Wang H, et al. Efficacy comparison between clavicular hook plate combined with coracoclavicular figment reconstruction and simple hook plate for acute acromioclavicular joint dislocation. Chinese Journal of Trauma. 2019; 35(2): 143-149.

[25] Wu W, Zhang S. The treatment of Tossy type III acromioclavicular joint dislocation with clavicular hook plate. Journal of Practical Orthopaedics. 2011; 17(11): 1012-1013.