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In-Depth Exploration of the Efficacy of Hook Plate-Double Ligament Dynamic Fixation for HACD

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Abstract: *Objective:* To evaluate the therapeutic effect of dynamic fixation with a hook plate-double loop plate internal fixation system for high-energy acromioclavicular joint complex dislocation (denoted as HACD, i.e., Rockwood type III-V dislocation). *Methods:* Fifty-eight patients with HACD were selected and evenly divided by drawing lots. The experimental group underwent ligament reconstruction treatment, while the reference group received hook plate fixation treatment. The efficacy and other indicators were compared between the groups. *Results:* The overall effective rates between the groups were similar ($P > 0.05$). The experimental group had a longer surgical duration, lower pain scores at 6 months postoperatively, higher shoulder joint function scores, and a lower complication rate, with $P < 0.05$ when compared between groups. *Conclusion:* The effectiveness of the double loop plate internal fixation system ligament reconstruction treatment for patients with HACD is comparable to that of hook plate fixation treatment. Although the surgical duration is slightly longer, postoperative pain is milder, facilitating the recovery of shoulder joint function in patients and offering higher safety.

Keywords: Hook plate-double loop plate internal fixation system; HACD; In-depth efficacy; Shoulder joint function score; Complications

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1. Introduction

HACD, namely Rockwood type III-V dislocation, is a common type of acromioclavicular joint dislocation caused by external violence, resulting in the rupture of the coracoclavicular ligament or acromioclavicular ligament and complete dislocation of the acromioclavicular joint. Immediate surgical treatment is required to prevent adverse events such as joint deformity [1]. Hook plate fixation is a basic treatment for this condition, allowing direct exposure of the affected area with a relatively simple operational procedure and effective reduction. However, it has a high incidence of postoperative pain and can lead to restricted joint movement, thus presenting surgical

limitations. The treatment of ligament reconstruction using a double-loop plate internal fixation system, namely coracoclavicular and acromioclavicular ligament reconstruction, can maintain joint stability, eliminate the need for a second surgery, cause minimal trauma, and significantly improve long-term outcomes [2]. Therefore, this study enrolled 58 patients with HACD to evaluate the treatment differences of hook plate-double ligament dynamic fixation.

2. Materials and methods

2.1. General information

Fifty-eight patients with HACD admitted between October 2019 and October 2024 were selected and evenly divided by drawing lots. The basic data between the groups are as follows (**Table 1**).

Table 1. Basic data comparison between groups (*n*/%, mean ± SD)

Group	n	Gender		Age (years)	Injury-to-treatment (days)	Location		Rockwood classification		
		Male	Female			Left	Right	Type III	Type IV	Type V
Experimental	29	18 (62.07)	11 (37.93)	42.19 ± 4.95	4.45 ± 0.84	13 (44.83)	16 (55.17)	11 (37.93)	10 (34.48)	8 (27.59)
Control	29	17 (58.62)	12 (41.38)	42.28 ± 4.91	4.49 ± 0.81	14 (48.28)	15 (51.72)	10 (34.48)	12 (41.38)	7 (24.14)
χ^2/t	-	0.072	0.070	0.185	0.069	0.296				
P-value	-	0.788	0.945	0.854	0.792	0.862				

2.2. Methods

The experimental group received ligament reconstruction treatment using a double-loop plate internal fixation system: General anesthesia or cervical plexus and brachial plexus nerve block were selected to position the patient in a beach chair position. An arc-shaped incision was made at the outer one-third of the clavicular midline to expose the coracoid process and acromioclavicular joint, thereby revealing the coracoclavicular and acromioclavicular ligaments. Free blood clots or soft tissues were cleared, and the existing cartilage disc within the acromioclavicular joint space was preserved. A Kirschner wire was used to drill a tunnel through the coracoid process, and a loop plate was placed at the base of the coracoid process. A guidewire was then introduced, and Kirschner wires (2 mm) were placed at the cortical area of the posterior clavicle margin (5 mm away) and the distal clavicle (35 mm away), following the residual ends of the ligaments and opening the bone tunnel towards the base of the coracoid process. A self-made wire guide (with a hook) was used to pull the tail wire through the bone tunnel, and a loop plate was pressed onto the clavicle. The shoulder joint was abducted, and the anterior and posterior aspects of the distal clavicle were reduced. The tail wire was tied, and the conoid and trapezoid ligaments were reconstructed, followed by reconstruction of the acromioclavicular ligament. After hemostasis of the incision, the incision was sutured.

The reference group was treated with clavicular hook plate fixation; the anesthesia and positioning methods were the same as above. The curved incision was located at the outer one-third of the clavicular midline, exposing the distal clavicular joint and acromioclavicular joint. After clearing away necrotic tissue and blood clots, a clavicular hook plate was placed below the acromion, adhering to the clavicle, and the dislocation of the

acromioclavicular joint was reduced. Drilling was performed on the clavicle, and screws were inserted and fixed. Postoperative drainage and incision suture procedures were the same as above.

2.3. Observation indicators

(1) Surgical indicators: Indicators such as surgical duration and intraoperative blood loss were recorded. The pain level from 1 to 6 months postoperatively was assessed using the Visual Analog Scale, with a total score of 10 points, where higher scores indicated greater pain.

(2) Shoulder joint function score: The Constant-Murley scoring criteria were selected, including strength testing (25 points), daily activities (20 points), pain (15 points), and range of motion (40 points), with higher scores indicating better function.

(3) Complication rate: The incidence of complications such as acromioclavicular joint pain and subacromial bursitis was recorded.

2.4. Efficacy evaluation criteria

Excellent results were defined as no shoulder pain, normal range of motion and joint strength, and no impact on work and daily life; good results were defined as mild shoulder pain, a range of motion less than 180°, slightly decreased joint strength, and mild interference with work and daily life; poor results were defined as significant joint pain, abnormal range of motion and strength, and severe interference with work and daily life.

2.5. Statistical analysis

Data processing was completed using SPSS 28.0 software. Continuous variables were compared and tested using *t*-tests, while categorical variables were compared and tested using chi-square tests. A P-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of overall effectiveness rates between groups

The overall effective rate of the experimental group was close to that of the reference group ($P > 0.05$) (**Table 2**).

Table 2. Comparison of overall effective rates between groups (*n*/%)

Group	n	Excellent	Good	Poor	Total effective rate
Experimental group	29	17 (58.62)	11 (37.93)	1 (3.45)	96.55 (28/29)
Control group	29	12 (41.38)	13 (44.83)	4 (13.79)	86.21 (25/29)
χ^2					5.220
P-value					0.022

3.2. Comparison of surgical indicators between groups

The experimental group had a longer surgical duration and lower pain scores at 6 months postoperatively, with $P < 0.05$ in the intergroup comparison (**Table 3**).

Table 3. Comparison of surgical indicators between groups (mean ± SD)

Group	n	Operative time (min)	Intraoperative blood loss (mL)	Hospital stay (days)	Pain score		
					1 month after surgery	3 months after surgery	6 months after surgery
Experimental group	29	80.39 ± 7.94	55.21 ± 5.36	5.15 ± 0.97	5.44 ± 0.91	4.76 ± 0.41	1.48 ± 0.24
Control group	29	52.55 ± 5.38	54.75 ± 5.40	5.20 ± 0.94	5.49 ± 0.88	4.82 ± 0.45	3.40 ± 0.39
t-value		15.632	0.326	0.199	0.213	0.531	22.579
P-value		< 0.001	0.746	0.843	0.832	0.598	0.000

3.3. Comparison of shoulder joint function scores between groups

Before surgery, there was no significant difference in shoulder joint function scores between the groups, with $P > 0.05$ in all comparisons. At 6 months postoperatively, the experimental group had higher shoulder joint function scores, with $P < 0.05$ in the intergroup comparison (**Table 4**).

Table 4. Comparison of shoulder joint function scores between groups (mean ± SD, points)

Group	n	Strength test		Daily activity		Pain		Range of motion	
		Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op
Experimental group	29	10.95 ± 1.79	16.75 ± 2.53	6.29 ± 1.78	15.97 ± 2.05	5.09 ± 0.97	12.57 ± 2.95	16.45 ± 2.97	35.22 ± 3.75
Control group	29	10.99 ± 1.83	14.02 ± 2.34	6.32 ± 1.81	13.14 ± 2.02	5.11 ± 0.94	10.09 ± 2.82	16.49 ± 3.02	31.91 ± 3.70
t-value		0.084	4.266	0.064	5.295	0.080	3.273	0.051	3.384
P-value		0.933	0.000	0.949	0.000	0.937	0.002	0.960	0.001

3.4. Comparison of complication rates between groups

The experimental group had a lower complication rate, with $P < 0.05$ in the intergroup comparison (**Table 5**).

Table 5. Comparison of complication rates between groups (*n*/%]

Group	n	AC Joint Pain	Subacromial Bursitis	Joint Stiffness	Subacromial Osteolysis	Reduction Loss	Incision Infection	Re-dislocation	Total Incidence
Experimental group	29	1 (3.45)	0	1 (3.45)	0	0	0	0	6.90 (2/29)
Control group	29	2 (6.90)	1 (3.45)	1 (3.45)	1 (3.45)	1 (3.45)	1 (3.45)	1 (3.45)	27.59 (8/29)
χ^2 value									4.350
P-value									0.037

4. Discussion

HACD mostly involves Rockwood type III-V dislocations, caused by significant damage to the coracoclavicular ligaments at the distal end of the clavicle, including the trapezoid and conoid ligaments, primarily presenting

as ruptures. This leads to an upward tilt of the distal end of the clavicle, resulting in dislocation. The primary intervention for this condition is surgery, mainly involving internal fixation procedures such as clavicular hook plate fixation or Kirschner wire tension band fixation [3]. The clavicular hook plate allows for a small range of motion in the acromioclavicular joint and provides excellent fixation for dislocations. It utilizes leverage to generate stable and long-lasting pressure around the acromioclavicular joint, creating a tension environment that facilitates ligament reconstruction, promotes bone and muscle healing, and shortens the time to initiate postoperative functional exercises. However, this surgical approach requires plate removal, which can lead to shoulder pain or improper reduction of the coracoclavicular distance and increases the risk of postoperative complications, thus presenting certain surgical limitations.

The double-loop plate internal fixation system can effectively reduce joint dislocation, and its strength is similar to the normal physiological characteristics of the coracoclavicular ligament. Fixation and suture treatment of the clavicle and coracoid process can ensure the natural adherence of the coracoclavicular ligament, thereby enhancing its tensile resistance [4]. Additionally, during the incision healing process, the fixation sutures are non-absorbable, providing a long-lasting stabilizing effect on the acromioclavicular joint. Moreover, this procedure does not require a secondary operation, as the internal fixation device can be directly retained in the body, resulting in lower surgical risks. Furthermore, its relatively simple operation method contributes to high surgical feasibility.

The results showed that the total effective rate of the experimental group was close to that of the reference group ($P > 0.05$). The experimental group had a longer surgical duration but a lower pain score at 6 months postoperatively, with a statistically significant difference between the groups ($P < 0.05$). The reason for this is that both the double-loop plate internal fixation system and hook plate fixation surgery can improve the horizontal and vertical stability of the acromioclavicular joint by utilizing anatomical reduction and stabilizing the shoulder joint. The hook plate, with its rigid fixation, can significantly resist dislocation forces, thus providing strong short-term fixation effects. In contrast, the double-loop plate internal fixation system reconstruction can restore the dynamic stability of the acromioclavicular ligament and coracoid ligament, improving their physiological load-bearing function and achieving better therapeutic outcomes [5]. The reconstruction of two ligaments using the double Endobutton plate internal fixation system requires highly accurate separation of the two ligaments, along with bone tunnel positioning, threading, and fixation wire placement, which consequently increases the surgical duration. Compared to the placement of the hook plate and screw insertion in hook plate fixation, the procedure for the double Endobutton plate internal fixation system ligament reconstruction is relatively complex and technically challenging. During the surgery, it is necessary to avoid the nerves and vascular tissues beneath the clavicle, thus requiring a longer operative time. However, double ligament reconstruction can restore the natural tension of the ligaments around the shoulder joint, prevent the mechanical irritation in the subacromial space caused by hook plate fixation, and thereby avoid pain symptoms due to factors such as plate foreign body. Moreover, double ligament reconstruction involves a smaller dissection area, adequately preserves tissues such as the cartilaginous disc, and does not involve extensive manipulation of the clavicle or acromion region, thus reducing the degree of muscle attachment point injury and similarly facilitating pain improvement [6]. The postoperative shoulder function score of the experimental group was higher, with a between-group comparison of $P < 0.05$. The reason for this is that the double Endobutton plate internal fixation system ligament reconstruction allows the placement of the stabilization device at a mutually horizontal position of the acromioclavicular joint, which can prevent clavicular rotation. In the reconstruction of the coracoclavicular ligament using the double Endobutton plate internal fixation system, the fixation wires of the plate can effectively repair the nearby acromioclavicular ligament, significantly

enhancing the stability of the acromioclavicular joint.

Additionally, double ligament reconstruction fully considers the physiological characteristics of the patient. For instance, if the coracoid process is small, the space for screw placement is relatively limited. Therefore, in this study, only one anchor screw was placed to prevent coracoid fracture. The coracoclavicular ligament consists of the trapezoid and conoid ligaments, which have significantly different clavicular insertion points. Thus, during surgery, drilling is performed separately at the remnants of the conoid and trapezoid ligaments, and the two bundles of ligaments are reconstructed using the tail lines of the anchor screws. This restores the biomechanical characteristics of the joint area, enabling early postoperative rehabilitation training and thereby improving the patient's shoulder function [7]. The complication rate in the experimental group was low, with a between-group comparison of $P < 0.05$. The reason for this is that the double Endobutton plate internal fixation system ligament reconstruction prevents the irritation caused by implants such as the hook plate, reducing complications like incision infection or subacromial bursitis. Moreover, a second surgery is not required, so cases of reduction loss are rare. Furthermore, the double Endobutton plate internal fixation system ligament reconstruction allows physiological micromotion of the acromioclavicular joint and is not a rigid fixation method, resulting in a lower incidence of postoperative joint stiffness. More importantly, this technique protects the soft tissues around the shoulder joint, preventing significant damage to the fascial attachment points of muscles such as the deltoid or trapezius, thus resulting in milder symptoms such as acromioclavicular joint pain postoperatively [8]. Additionally, the double Endobutton plate internal fixation system ligament reconstruction utilizes both vertical and horizontal stabilization to restore the biomechanical characteristics of the natural ligaments, making it less likely to cause stress concentration and other issues, thereby reducing the risk of re-dislocation.

5. Conclusion

In conclusion, the overall effectiveness of using the double-looped plate internal fixation system for ligament reconstruction in the treatment of patients with HACD is nearly equivalent to that of hook plate fixation. However, the double-ligament approach typically results in milder postoperative pain, better recovery of shoulder joint function, and fewer postoperative complications, thus offering greater surgical advantages.

Disclosure statement

The author declares no conflict of interest.

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