ORIGINAL RESEARCH

Comparative Analysis of Therapeutic Outcomes Between Modified Loop Plate and Hook Plate for Treating Acute Acromioclavicular Joint Dislocation

Dongxin Qiu, MD; Minfeng Lai, MD; Yunqing Wang, BD

ABSTRACT

Objective • This study aimed to evaluate the clinical efficacy of an enhanced minimally invasive NICE joint technique combined with dual adjustable loop steel plate internal fixation for treating acute acromioclavicular joint dislocation.

Methods • A retrospective analysis was conducted on 63 surgical patients treated with acute acromioclavicular joint dislocation from May 2017 to March 2022. Among them, 33 cases were treated with the clavicle hook plate, and 30 cases were treated with the minimally invasive loop plate. We compared hospitalization duration, incision length, surgical duration, intraoperative bleeding, visual analogue pain scale scores, shoulder joint Constant scores at 6 months before and after surgery, and the incidence of complications between the two groups.

Results • The comparison between the two groups, including hospitalization duration, incision length, surgical duration, intraoperative bleeding volume, and shoulder joint Constant score at 6 months post-surgery, revealed statistically significant differences where the loop plate group had better results. One case (1/33) experienced postoperative complications in the hook plate group, including screw loosening and plate failure. Additionally, there were 8 cases (8/33) of subacromial osteolysis, 10 cases (10/33) of acromial impact, and 5 cases (5/33) of residual shoulder pain. Conversely, only 1 case (1/30) in the loop plate group had residual shoulder pain.

Conclusions • The surgical technique involving the reconstruction of the coracoclavicular ligament using an enhanced minimally invasive NICE junction combined with double adjustable loop steel plate placement in the clavicular small bone canal is characterized by simplicity, safety, minimal invasiveness, excellent functional recovery, fewer complications, and superior clinical efficacy compared to clavicular hook steel plates. (*Altern Ther Health Med.* 2023;29(8):924-928).

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INTRODUCTION

Acromioclavicular joint dislocation is a common bone and joint injury in clinical practice. It arises from direct or indirect stress transmission from the shoulder to the acromioclavicular joint, leading to damage to the coracoclavicular ligament.[1] Surgical intervention is typically necessary for most patients, and presently, the primary surgical techniques employed involve internal fixation using either the clavicular hook plate or the loop plate.[1,2]

In the literature, approximately 5% of patients using the loop steel plate technique have reported occurrences of coracoid process and clavicular canal splitting or fractures.[2] Studies suggest that a longitudinal arc incision from the coracoid process to the clavicle should be implemented to mitigate this risk. This approach exposes both the upper surface of the clavicle and the coracoid process, thereby enhancing the loop steel plate internal fixation technique. However, current literature about clinical efficacy against the clavicular hook steel plate internal fixation technique is scarce.

Therefore, we compared the clinical efficacy of the loop steel plate and clavicular hook plate internal fixation techniques in treating acute acromioclavicular joint dislocation. This study informs surgical decision-making by evaluating safer and more effective options for patients with this common joint injury.

Table 1. General Information And Comparison Between Two Groups of Patients

Group	Number	Gender (Example)		Age (Years)	Injured Side (Case)		Time From Injury To Surgery (Days)	Causes Of Injury			Rockwood Typing (Example)	
		Male	Female		Left	Right		Traffic Injury	Fall Damage	Crushing Injury	III	IV
Hook Plate	33	22	11	49.24 ± 11.71	12	21	3.82 ± 3.18	23	7	3	20	13
Loop Plate	30	17	13	48.60 ± 12.08	14	16	3.93 ± 3.58	25	3	2	21	9
Inspection Value	-	χ^2 = 0.666		t = 0.214	χ^2=0.688		t = -0.135	χ^2 = 1.744			χ^2 = 0.610	
P value	-	.414		.831	.407		.893	.418			.435	

Note: Rockwood Typing (Example): classifies the injuries according to the Rockwood classification system, with the number of cases categorized as "III" and "IV.

METHODS

Study Design

We employed a retrospective study design from May 2017 to March 2022 to investigate the clinical efficacy of two surgical techniques. Loop steel plate and clavicular hook plate internal fixation in the treatment of acute acromioclavicular joint dislocation. A total of 63 surgical cases were analyzed, with 33 patients treated using the clavicular hook plate method and 30 patients undergoing the minimally invasive loop plate procedure. The study precisely assessed various parameters, including hospitalization duration, incision length, surgical duration, intraoperative bleeding, visual analogue pain scale scores, shoulder joint Constant scores, and the incidence of postoperative complications, providing valuable insights into the optimal approach for managing this common joint injury.

Surgical Approach

Surgical Procedure for Clavicular Hook Plate Group. In the clavicular hook plate group, patients were positioned in a supine manner on the operating table, and general anesthesia was administered to ensure their comfort and immobility during the procedure. An appropriate incision was made over the acromioclavicular joint, allowing surgical access to the clavicle. Subsequently, the clavicular hook plate was introduced and accurately positioned to provide stable fixation across the joint. Surgical screws were utilized to secure the plate firmly to the clavicle. Following successful fixation, the incision was carefully closed, and wound dressings were applied. Postoperatively, patients were closely monitored and prescribed personalized rehabilitation regimens to facilitate their recovery and optimize functional outcomes.

Surgical Procedure for Minimally Invasive Loop Plate Group. In the minimally invasive loop plate group, patients were positioned in a supine manner, and general anesthesia was administered for pain management. We adopted a longitudinal arc incision extending from the coracoid process to the clavicle. This incision allowed for the exposure of both the upper surface of the clavicle and the coracoid process. This approach was implemented to enhance the loop steel plate internal fixation technique. Utilizing this exposed anatomy, the minimally invasive loop plate was carefully positioned to achieve secure internal fixation. Following the insertion of the loop plate, the longitudinal incision was carefully closed, and wound dressings were applied. Postoperatively, patients in this group underwent close monitoring and received personalized rehabilitation protocols to support their recovery and enhance functional outcomes. Subsequently, we conducted a comparative analysis, assessing its clinical efficacy in contrast to the clavicular hook steel plate internal fixation technique.

Table 2. Comparison of Intraoperative and Postoperative Indicators Between two Groups of Patients

Group		Hook Plate	Loop Plate	t value	P value
Number		33	30	-	-
Cut Length (cm)		7.24 ± 1.30	6.33 ± 1.03	3.058	.003
Surgical Duration (min)		56.93 ± 16.69	69.66 ± 19.47	-2.792	.007
BleedingVolume (ml)		49.85 ± 15.93	42.50 ± 10.57	2.134	.037
HospitalizationDays (days)		11.06 ± 4.60	8.47 ± 3.13	2.585	.012
Visual Analogue Pain Scale (VAS) Scores	Preoperative	4.82 ± 0.95	4.97 ± 1.00	-0.604	.548
	postoperative	0.58 ± 0.56	0.43 ± 0.50	1.056	.295
	t values	29.352	34	-	-
	P value	<.001	<.001		
Shoulder Joint Function Score	Preoperative	38.48 ± 4.68	37.27 ± 4.91	1.008	0.317
	postoperative	86.39 ± 4.04	92.33 ± 4.01	-5.849	<.001
	t values	-46.588	-60.37	-	-
	P value	<.001	<.001		

Statistical Analysis

Statistical analysis was performed using SPSS version 20.0 software. Two independent sample t tests were employed for comparing two sets of measurement data, while χ^2 tests were utilized for comparing counting data. A significance level of $P < .05$ was considered indicative of statistical significance.

RESULTS

Comparison of Preoperative Data

The comparison of preoperative general information between the hook plate group and the loop plate group revealed no statistically significant differences, indicating comparability, refer to Table 1.

Comparison of Postoperative Outcomes between two Groups

When comparing hospitalization duration, incision length, surgical duration, intraoperative bleeding, and the shoulder joint Constant score at the 6-month post-surgery mark between the two groups, the loop plate group exhibited superior outcomes, with a statistically significant difference ($P < .05$), refer to Table 2.

Comparison of Follow-Up Findings and Incident of Complications

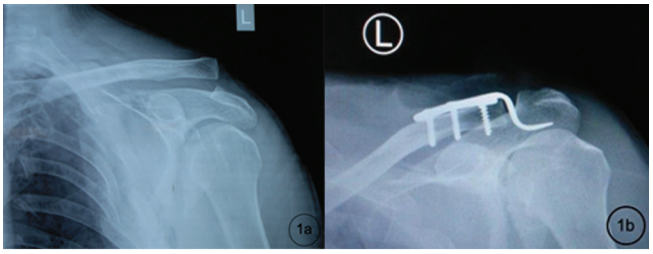
Throughout the follow-up period, neither group of patients experienced incision infections, internal fixation fractures, or fractures of the coracoid process or clavicle. However, post-surgery, partial reduction of the acromioclavicular joint was observed to be lost in a limited number of cases, with 3 cases (3/33) in the hook plate group and 4 cases (4/30) in the loop plate group. Additionally, one case (1/33) in the hook plate group encountered screw

Table 3. Postoperative complications in two groups of patients

Group	Number	Incision Infection	Iatrogenic Fracture	Endophytic Failure	Reset Part Lost	Subacromial Osteolysis	Acromion Impact	Residual Shoulder Pain
Hook Plate	33	0	0	1	3	8	10	5
Loop Plate	30	0	0	0	4	0	0	1

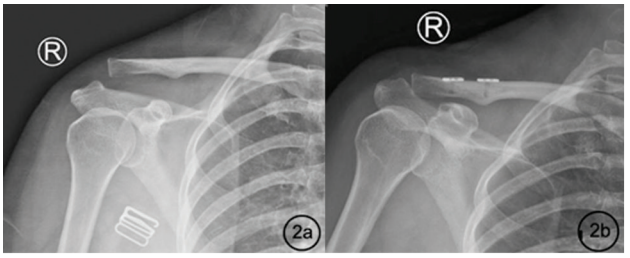
Note: A "0" in a specific category indicates no occurrences in the respective group.

Figure 1. Typical Cases of Clavicular Hook Plate Group



Note: Figure 1 illustrates typical cases from the Clavicular Hook Plate Group, showcasing clinical examples of patients treated with this surgical approach.

Figure 2. Typical Case Images of Loop Steel Plate Group



Note: Figure 2 displays typical case images from the Loop Steel Plate Group, providing visual representations of patients treated using this surgical approach.

loosening and plate failure, which was subsequently managed with minimally invasive double loop plate internal fixation. Notably, no implant failures occurred in the loop plate group; refer to Table 3.

In contrast, the hook plate group exhibited a higher incidence of postoperative complications, including 8 cases (8/33) of subacromial osteolysis, 10 cases (10/33) of acromion impact, and 5 cases (5/33) of residual shoulder pain after surgery. Meanwhile, the loop plate group reported only 1 case (1/30) of residual shoulder pain, signifying a significantly lower incidence of complications.

DISCUSSION

In clinical practice, acromioclavicular joint dislocation is relatively common, accounting for approximately 9% of shoulder joint injuries.[2] The acromioclavicular joint serves as the fulcrum for scapular movement, facilitating translation and rotation[3] and thereby playing a crucial role in shoulder joint function. Various classification methods exist for acromioclavicular joint dislocations, with the Rockwood classification being widely employed in clinical settings. Surgical intervention becomes necessary for injuries classified as type IV, V, and VI.

In current clinical practice, surgical treatment is increasingly recommended for type III injuries.[4] The most commonly utilized method is clavicular hook plate internal fixation.[5] This technology effectively stabilizes the acromioclavicular joint, promoting the healing of the coracoclavicular ligament and enabling early functional exercises for the affected shoulder. However, as its usage has become more widespread, the incidence of related complications, including subacromial impingement syndrome, acromion fracture, clavicle fracture, and steel plate fracture, has been on the rise.[6,7]

Simultaneously, the persistent shoulder pain experienced by many patients post-surgery, attributed to continuous stress from the hook end on the shoulder peak and the space-occupying effect beneath the shoulder peak, can significantly impact clinical treatment outcomes. Consequently, the timely removal of the steel plate through a secondary surgery becomes necessary.[8] In recent years, there has been a growing trend in the use of elastic fixation systems employing loop steel plates for the treatment of acromioclavicular joint dislocation. Clinical applications have demonstrated that employing double-loop steel plates for the anatomical reconstruction of oblique and conoid ligaments effectively preserves the stability of the acromioclavicular joint.[9]

In comparison to clavicular hook plate fixation, this system aligns more closely with the anatomical biomechanical state and mitigates irritation to the subacromial space, thereby significantly reducing the incidence of postoperative shoulder pain.[10] Nevertheless, this technology presents certain challenges, including difficulties in fully exposing the coracoid process, the potential for intraoperative coracoid process bone canal splitting, and even fractures, which can result in internal fixation failure.[2,11,12] Patients with osteoporosis face an increased risk of osteolysis in the bone below the loop steel plate, potentially leading to issues like loop steel plate displacement.[13]

The NICE knot, developed by doctors in the Nice region of France, is a double-stranded suture sliding self-locking knot known for its exceptional strength and secure hold. Crafted using a high-strength suture, it can achieve fixation strength akin to that of steel wire fixation.[14] Clinical scholars have achieved commendable clinical outcomes through various approaches, including the utilization of a single-loop steel plate combined with the NICE knot enveloped by the coracoid process to stabilize the acromioclavicular joint.[15] Additionally, the application of a double-loop steel plate system combined with the coracoid process surrounding it has been shown to provide ample strength from the NICE knot to meet the stability requirements of the acromioclavicular joint.[16,17]

In this study, we implemented technological enhancements rooted in the conventional Endobutton and Tightrope loop steel plate techniques. These advancements involve employing high-strength wire to encircle the coracoid process, thereby

securing the NICE knot as an anchor point. When encircling the coracoid process, we employ blunt tools along with wires, eliminating the necessity for bone channel drilling in the coracoid process. Only a 2 mm bone canal was required to be drilled in the clavicle, allowing for the introduction of the loop steel plate into the surface of the coracoid process.

The smaller bone canal notably minimizes damage to the clavicle's structural integrity and effectively mitigates the risk of the loop steel plate slipping out of the bone canal. We maintain that this enhanced technology obviates the necessity for precise positioning during coracoid process bone canal drilling in surgery, thus reducing the surgical complexity. This approach also eliminates the potential risk associated with coracoid process bone canal drilling, including the risk of coracoid process splitting and inadvertent vascular or nerve injuries due to deviations during the drilling process.

This approach reduces the necessity for frequent fluoroscopy procedures, leading to a reduction in surgical time. Furthermore, it serves as an effective remedial option when the original technique encounters difficulties in drilling the coracoid process bone canal. Analysis of follow-up results from treated cases reveals that, in comparison to the hook plate group, the loop plate group exhibited no postoperative fractures of the coracoid process or clavicular bone canal, no instances of the implant sliding out of the bone canal, and no implant failures.

Moreover, no patients in the loop plate group experienced subacromial osteolysis or impingement, resulting in a lower rate of postoperative residual shoulder pain. Shoulder joint function recovery was notably superior. As a result, we believe that the improved loop plate technique is a straightforward, dependable, and technically secure method for addressing acromioclavicular joint dislocation.

We assert that the enhanced loop plate technology offers several advantages over hook plate technology: (1) Smaller incisions, resulting in reduced surgical trauma and intraoperative bleeding; (2) Facilitates faster patient recovery and significantly shortens hospitalization duration; (3) Repairing the damaged coracoclavicular ligament is more favorable for ensuring the long-term stability of the acromioclavicular joint. (4) The implant's small size ensures that it does not intrude into the joint space, thereby preventing postoperative shoulder impingement, subacromial osteolysis, and irritation of the subacromial space, which can lead to chronic shoulder pain, foreign body reactions, and related issues.

(5) There is no requirement for secondary surgery to remove internal fixation, eliminating the associated post-surgical discomfort and reducing patients' medical expenses. (6) The technology aligns more closely with the requirements of anatomical biomechanics. Therefore, we believe that the improved loop steel plate technology, in comparison to traditional hook steel plate technology, represents a preferable surgical choice for addressing acromioclavicular joint dislocation. This preference is based on its minimal surgical impact avoidance of the stimulation of the subacromial space by hook steel plates, which fosters quicker recovery of shoulder joint function and reduces the likelihood of potential long-term complications.

However, this technology also has its limitations. Several studies have reported certain incidences of acromioclavicular joint loss or reduction following loop plate fixation surgery. This occurrence is often associated with surgical techniques and can be mitigated through technical enhancements[18]. For individuals who do not experience severe shoulder pain or dysfunction, specialized treatment is typically unnecessary.[10] In our study, among the four patients who experienced acromioclavicular joint reduction loss, the degree of loss observed was relatively mild (less than 50%). This mild loss did not compromise joint stability, nor did it significantly impact the patients' shoulder joint function. Consequently, no further treatment was deemed necessary.

When implementing this technology, it is essential to pay close attention to certain considerations. Firstly, during surgery, it is crucial to ensure that the lateral winding around the coracoid process remains as close to the bone as possible, particularly when passing through the inner and lower regions of the coracoid process. This precaution helps prevent the inadvertent wrapping of blood vessels and nerves located beneath the NICE knot, minimizing the risk of damage.

Secondly, in cases involving elderly patients with osteoporosis, steps can be taken to reduce the risk of the high-strength suture cutting into the coracoid process. It can be achieved by increasing the number of sutures, creating anchor piles, or substituting them with polymer-wide flat suture strips. These adjustments enhance the contact area between the sutures and bone, thereby reducing localized bone stress.

Thirdly, patients with coracoclavicular ligament injuries should, whenever possible, undergo surgical repair. This approach is advantageous for ensuring the long-term stability of the acromioclavicular joint and can reduce stress-related damage to the loop plate. During intraoperative acromioclavicular joint reduction, a slight degree of over-reduction is necessary to counteract the potential partial loss of joint reduction evident in postoperative imaging. Furthermore, postoperative immobilization of the upper limb on the affected side should be relatively strict to prevent excessive or premature movement, which could result in reduction loss.

Study Limitations

Several limitations should be acknowledged in this study. Firstly, the research was retrospective in nature, and while efforts were made to control for confounding variables, the inherent limitations of retrospective analysis, such as potential selection bias and incomplete data, cannot be eliminated. Secondly, the study's sample size may limit the generalizability of our findings to larger populations. Additionally, as with any surgical study, variations in surgical techniques among different surgeons could introduce heterogeneity in the data. Moreover, the follow-up period, although encompassing postoperative outcomes, may not

capture longer-term complications or outcomes. Finally, while we have strived to provide a comprehensive analysis of the loop plate technique, it is essential to recognize that surgical innovations and technologies evolve over time, and future research may uncover further refinements or insights into its application.

CONCLUSION

In conclusion, this study, despite its limitations as a retrospective analysis and the relatively short follow-up duration for the modified loop steel plate group, offers valuable insights into the clinical efficacy of this surgical technique for treating acromioclavicular joint dislocation. While we have drawn conclusions based on clinical experience, it is essential to acknowledge the absence of corresponding biomechanical research. Therefore, to strengthen and refine our findings, further investigation with robust biomechanical studies and longer-term follow-up is warranted. The technique's potential benefits in terms of reduced surgical trauma, quicker recovery, and fewer complications highlight its significance in the realm of acromioclavicular joint dislocation treatment, but ongoing research efforts will be vital for its continued refinement and broader applicability in clinical practice.

CONFLICTS OF INTEREST

The authors have no potential conflicts of interest to report relevant to this article.

DISCLOSURES

In compliance with the ICMJE uniform disclosure form, all authors declare the following:

HUMAN SUBJECTS

Consent was obtained or waived by all participants in this study.

PAYMENT/SERVICES INFORMATION

All authors have declared that no financial support was received from any organization for the submitted work.

FINANCIAL RELATIONSHIPS

All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.

OTHER RELATIONSHIPS

All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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