

**Research** Article

# Clinical efficacy of Endobutton combined with mini-plate in the treatment of Neer IIB (IIC) type distal clavicle fracture

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ORCID iDs of the authors: B.L. 0009-0000-0064-9756; Y.D. 0009-0006-4499-9153; L.W. 0009-0002-4905-0693; Y.D. 0009-0008-4047-926X; W.H. 0009-0009-7687-9035; X.Z. 0009-0004-2500-7206. ABSTRACT

*Objective:* This study aimed to investigate the clinical outcomes of employing Endobutton with a mini-plate for managing Neer IIB (IIC) type distal clavicle fractures.

Methods: A retrospective case-control approach was utilized, examining clinical data from 62 patients with Neer IIB (IIC) type distal clavicle fractures treated at our institution from January 2018 to December 2022. Patients were divided into 2 groups: 32 treated with an Endobutton and a mini-plate (study group) and 30 with a clavicular hook steel plate (control group). Surgical metrics such as duration, incision length, and hospital stay were documented. Follow-up assessments included fracture healing, postoperative complications, and the necessity for secondary internal fixation removal. Preoperative and postoperative concolcal distances (CCD) were recorded at various intervals. Pain and shoulder joint functionality were evaluated using the Visual Analog Scale (VAS) and Constant-Murley score.

**Results:** All patients successfully underwent surgery and were followed up. The follow-up period for the study group was 12-23 months ( $18.7 \pm 2.7$ ), and for the control group, it was 12-22 months ( $15.8 \pm 1.6$ ). The surgery duration was significantly shorter in the control group [( $65.12 \pm 9.88$ ) minutes] compared to the study group [( $82.58 \pm 7.36$ ) minutes, P < 0.05]. In comparison, the incision length in the control group group was longer than that in the study group [( $69.58 \pm 6.43$ ) mm vs.  $58.24 \pm 4.83$  mm, P < .05]. There were no significant differences in hospital stay and fracture healing time between the 2 groups (P > .05). In the control group, all patients required secondary removal of internal fixation, while in the study group, only 1 patient needed it. Complications such as subacromial bone erosion, distal clavicle osteolysis, subacromial impingement with shoulder pain, and skin irritation were observed in the control group (P < .05). Postoperative CCD improved significantly in both groups. At the final follow-up, the increase in CCD was greater in the control group ( $18.19 \pm 0.97$  mm) compared to the study group ( $0.274 \pm 0.18$  mm, P < .05). The study group showed better VAS scores at 6months ( $1.22 \pm 0.96$ ) and the last follow-up [ $(12.2 \pm 0.96)$ , ( $0.68 \pm 0.57$ ) points] compared to the control group [ $(2.97 \pm 0.86)$ , ( $1.98 \pm 0.84$ ) points, P < .05]. The Constant-Murley functional scores were also better in the study group [ $(81.67 \pm 5.54)$ , ( $90.45 \pm 3.42$ ) points] than in the control group [ $(91.45 \pm 3.44)$ , ( $94.21 \pm 1.43$ ) points, P < .05].

**Conclusion:** The use of an Endobutton combined with a mini-plate for Neer IIB (IIC) type distal clavicle fractures offers significant advantages, including improved recovery of shoulder joint function, fewer postoperative complications, and reduced need for secondary internal fixation removal. This approach is a viable treatment option for Neer IIB (IIC) type distal clavicle fractures.

Level of Evidence: Level III, Therapeutic study.

#### Introduction

The distal clavicle fracture refers to a fracture of the lateral third of the clavicle,<sup>1</sup> accounting for 21%-28% of all clavicle fractures<sup>2</sup> and 30%-45% of all non-union cases.<sup>3</sup> Clinically, the Neer classification<sup>4</sup> is commonly used to describe adult distal clavicle fractures. Among these, Neer type II fractures are further categorized into types IIA and IIB based on the location of the fracture line. In type IIA, the fracture line is located medially to the coracoclavicular (CC) ligament, with no ligament rupture. In type IIB, the fracture line is situated between the CC ligaments, with the trapezoid ligament intact but the conoid ligament ruptured. There are also cases where the fracture line is located lateral to the trapezoid ligament, resulting in rupture of both ligaments. This type has been termed "extremely lateral" by Cho et al<sup>5</sup> corresponding to type IIC.

Neer IIB (IIC) fractures are a special category of distal clavicle fractures, characterized by both vertical and horizontal stress at the fracture site. This leads to significant displacement of the fracture fragments and the presence of a short distal fragment, making it an extremely unstable fracture. This increases the difficulty of fixation and predisposes to malunion and non-union.6 In the study of Oh et al7 the overall nonunion rate following non-surgical treatment was as high as 33%, compared to just 1.6% after surgical fixation. Therefore, surgical treatment is generally recommended for patients with Neer IIB (IIC) fractures. A variety of surgical methods have been reported, including CC ligament reconstruction,<sup>8</sup> fracture fixation (using clavicular hook plates, locking compression plates, Kirschner wires with tension bands, etc.<sup>9</sup>), and combined fixation methods (LCP+CC reconstruction, HP+CC reconstruction, etc.<sup>10</sup>), but consensus has yet to be reached.<sup>11,12</sup> To identify a more suitable internal fixation method, we conducted a retrospective case-control study analyzing the clinical data of 62 patients with Neer type IIB (IIC) distal clavicle fractures treated at our hospital from January

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Content of this journal is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License. 2018 to December 2022. This study aims to investigate the clinical efficacy of Endobutton combined with mini steel plates in the treatment of Neer type IIB (IIC) distal clavicle fractures. The results are reported as follows.

# Material and Methods

### Patients

We, in this study, retrospectively reviewed 62 cases of Neer IIB (IIC) distal clavicle fractures treated in our hospital from January 2018 to December 2022. We assessed the clinical efficacy of Endobutton combined with a mini-plate. The study was approved by Dongyang People's Hospital's ethics committee, and informed consent was obtained from all patients. Approval No.: Dongyang People's Hospital 2024-YX-020. Date: February.09.2024

Inclusion criteria include (1) age  $\geq 18$  years; (2) isolated fresh closed Neer IIB (IIC) distal clavicle fractures; and (3) normal shoulder joint function pre-injury. Exclusion criteria include (1) concurrent ipsilateral acromioclavicular joint dislocation, proximal humeral fractures, or other complications affecting postoperative recovery; (2) associated vascular or nerve injuries; (3) pathological fractures; and (4) lost to follow-up or follow-up duration <12 months.

#### Preoperative examination

Preoperative radiographic assessment for both groups included bilateral clavicle anteroposterior x-ray and 3-dimensional computed tomography reconstruction of the affected shoulder joint.

#### Surgical procedure

The surgeries were performed by the same medical team of 3 doctors, with the same surgeon acting as the lead surgeon. The surgeries were performed under general anesthesia with the patient positioned in a beach-chair position. The affected shoulder was elevated, and the head and neck were slightly extended and turned to the contralateral side.

#### Study group

A 5-7 cm incision was made at the distal clavicle, extending laterally to the acromioclavicular joint. The fracture ends and part of the anterior insertion of the deltoid muscle on the clavicle were exposed. The deltoid muscle was bluntly dissected to the base of the coracoid process. A 2.0 mm Kirschner wire was inserted at the midpoint of the medial and lateral borders of the coracoid base to create a bone tunnel. A 4.0 mm hollow drill was used along the guide wire to open the tunnel. After reducing the fracture, a 3.0 mm Kirschner wire was placed at the midpoint of the anterior and posterior borders of the clavicle, approximately 3-3.5 cm from the acromioclavicular joint, to

#### HIGHLIGHTS

- Neer IIB (IIC) distal clavicle fractures are highly unstable due to significant displacement and a high risk of non-union, often requiring surgical intervention. This study aims to evaluate the clinical efficacy of Endobutton combined with mini steel plates for treating Neer IIB (IIC) distal clavicle fractures.
- The Endobutton with mini-plate group demonstrated better postoperative shoulder function and lower pain scores compared to the clavicular hook plate group (P < .05). Additionally, the study group had fewer complications and a significantly lower need for secondary fixation removal, making it a promising alternative for treating Neer IIB (IIC) distal clavicle fractures.
- The results indicate that Endobutton with a mini-plate improves shoulder function, reduces complications, and minimizes the need for secondary fixation, making this approach a viable treatment option for Neer IIB (IIC) distal clavicle fractures.

establish the clavicular tunnel. The length from the clavicular surface to the tunnel below the coracoid process was measured, and a loop steel plate with a suitable length of loop wire was passed through the coracoid tunnel to the tunnel beneath the coracoid process. The loop plate was then pulled back, and its side hole, which contained high-strength suture, was tightened horizontally beneath the coracoid process. The other end of the loop wire was passed through the clavicular tunnel and fixed to the clavicle using a mini-steel plate (2.4 mm metacarpal plate). The side hole with high-strength suture was fixed to the insertion point of the trapezoid ligament on the clavicle, forming a triangular fixation. Finally, screws were placed to provide additional compression and secure the fracture fragments. Intraoperative fluoroscopy (C-arm) confirmed good fracture reduction and internal fixation. The incision was closed layer by layer (a typical case is shown in Figure 1).

#### Control group

Clavicular hook plate fixation was performed following conventional surgical steps.

# Postoperative management

Postoperatively, the injured limb was supported with a sling for 3-4 weeks. On the first day after surgery, early rehabilitation exercises within the tolerable range of pain were initiated, including forceful fist clenching and finger extension, flexion and extension of the wrist and elbow joints, and pendulum-like movements of the shoulder joint under suspension. After 1 week, patients gradually progressed to active shoulder joint adduction and flexion-extension exercises under suspension. At 3-4 weeks postoperatively, shoulder lifting activities were recommended. All patients were allowed to return to work at 12 weeks postoperatively.

# **Observational parameters**

The following parameters were recorded for each patient: operative time, incision length, and hospital stay duration. Regular follow-up assessments were conducted to evaluate postoperative outcomes, including fracture healing, complications, and whether removal of internal fixation was required in a second-stage procedure. The clinical outcomes were assessed at preoperative, 3-week, 6-month, and final follow-up visits, with measurements of the affected side's coracoclavicular distances (CCDs) (i.e., the vertical distance between the lowest point of the inferior clavicle surface and the highest point of the superior coracoid surface). The change in CCD (final follow-up CCD–3-week postoperative CCD) was recorded. Additionally, the patients' shoulder pain, clinical function, and range of motion were scored using the VAS for pain and the Constant-Murley Shoulder Score for shoulder function.

# Statistical analysis

Statistical analysis was performed using SPSS version 25.0 (IBM SPSS Corp.; Armonk, NY, USA). Continuous data conforming to a normal distribution are presented as mean  $\pm$  standard deviation ( $x \pm s$ ) and were compared using the independent *t*-test. Categorical data were analyzed using the chi-square ( $X^2$ ) test, and non-continuous variable rank data were analyzed using the Mann–Whitney *U*-test. A *P*-value less than .05 was considered statistically significant.

#### Results

The study involved 62 cases of Neer IIB (IIC) fractures treated at Dongyang People's Hospital from January 2018 to December 2022. Divided into a study group (Endobutton with a mini-plate, 32 cases)



Figure 1. Endobutton combined with mini-plate fixation technique: (A) preoperative anteroposterior x-ray of the bilateral clavicle; (B) a transverse incision exposes fracture ends and the coracoid base, highlighting the rupture of the conoid ligament and detachment at the clavicular side of the trapezoid ligament; (C) a 2.0 mm Kirschner wire is used for precise coracoid base tunnel placement, followed by tunnel enlargement with a 4.0 mm hollow drill; (D) an appropriately lengthened looped wire mini-plate is inserted through the tunnel to the opposite side of the coracoid base; (E) the fracture ends are realigned, and the looped wire is secured to a 2.4 mm mini-plate on the clavicle; (F) 2 days post-operation x-ray showed that the coracoclavicular distances returned to normal.

and a control group (clavicular hook plate, 30 cases), the cohort included 34 males and 28 females, aged 20-70 (44.71  $\pm$  13.7) years. Injury causes included traffic accidents (31 cases), falls (29 cases), and other causes (2 cases). Fractures were classified as Neer IIB (49 cases) and IIC (13 cases), with an average time from injury to surgery of 2-14 (3.35  $\pm$  2.36) days.

All patients successfully underwent surgery and completed followup. The mean follow-up duration for the study group was 18.7  $\pm$ 2.7 months (12-23 months), and for the control group, it was 15.8  $\pm$  1.6 months (12-22 months). No complications such as nonunion, wound infection, plate fracture or displacement, coracoid fractures, or neurovascular injuries occurred in either group. There were no statistically significant differences between the 2 groups in terms of gender, age, cause of injury, associated injuries, length of the distal fracture end, time from injury to surgery, or fracture classification

Table 1 Ceneral information data							
Group	Study group (n=32)	Control group (n=30)	t-value	Р			
Sex		( )					
Male	18	19	0.957	.373			
Female	14	11					
Age (years)	$44.75\pm12.74$	$46.27 \pm 14.0$	-0.257	.63			
Cause of injury							
Traffic accident	14	17	2.657	.314			
Fall	16	13					
other	2	0					
Associated injury							
Present	22	23	0.343	.578			
Not present	10	7					
Length of distal fracture (mm)	$16.24\pm3.16$	$18.02\pm3.34$	0.382	.737			
Time from injury to surgery (d)	$3.66\pm3.34$	$2.97 \pm 1.76$	1.225	.354			
Fracture type			0.915	.455			
Neer IIB	24	25					
Neer IIC	8	5					

(P > .5) (Table 1). The operating time for the control group was shorter than that for the study group  $[65.12 \pm 9.88 \text{ minutes vs.} (82.58 \text{ minutes vs.})]$  $\pm$  7.36) minutes]. The surgical incision length in the control group was longer than in the study group [69.58  $\pm$  6.43 mm vs. (58.24  $\pm$ 4.83) mm, P < .05]. All patients in the control group required secondary removal of internal fixation, while only 1 patient in the study group required secondary removal of the mini-steel plate due to skin irritation caused by significant weight loss; the loop steel plate under the coracoid process was retained. In terms of postoperative complications, 6 patients in the control group experienced isolated subacromial bone erosion, 4 had distal clavicle resorption, and 7 had subacromial impingement resulting in shoulder pain. Additionally, 5 patients in the control group experienced skin irritation. In the study group, only 1 patient had skin irritation. These differences between the 2 groups were statistically significant (P <.05). No statistically significant differences were observed between the 2 groups in terms of hospital stay duration and fracture healing time (P > .05). Details are shown in Table 2.

Both groups showed significant improvement in the CCD on the affected side postoperatively compared to preoperative values. At 3 weeks post-surgery, the CCD for the control group was ( $7.45 \pm 1.20$  mm), and for the study group, it was ( $7.89 \pm 1.37$  mm). At the final follow-up, the CCD for the control group was ( $9.24 \pm 1.38$  mm) and for

Table 2. Clinical outcomes and operation related indexes						
Group	Study group (n=32)	Control group (n=30)	<i>t</i> -value	Р		
Surgical duration (minutes)	$82.58\pm7.36$	$65.12\pm9.88$	5.358	.000		
Incision length (mm)	$58.24 \pm 4.83$	$69.58 \pm 6.43$	-5.561	.000		
Number of internal fixations removed	1	30	28.14	.000		
Complications						
Present	1	22	19.58	.000		
Not present	31	8				
Hospital stay (days)	$9.53\pm3.73$	$8.17 \pm 2.67$	0.378	.584		
Fracture healing time (week)	$12.12\pm1.37$	$12.88 \pm 1.87$	-0.543	.862		

 Table 3. Comparison of coracoclavicular distances, Visual Analog Scale scores, and Constant-Murley scores on the affected side between the study group and the control group patients

Group	Study group (n=32)	Control group (n=30)	<i>t</i> -value	Р		
CCD (mm)	. ,					
Preoperative	$16.43 \pm 2.40$	$17.32\pm2.24$	0.057	.846		
Postoperative 3 weeks	$7.89 \pm 1.37$	$7.45 \pm 1.20$	1.773	.064		
Final follow-up	$8.15 \pm 1.17$	$9.24 \pm 1.38$	-1.729	.068		
CCD increase	$0.274 \pm 0.18$	$1.819\pm0.97$	-6.515	.000		
VAS score (points)						
Preoperative	$6.25\pm0.77$	$6.10\pm1.15$	1.657	.077		
Postoperative 6 months	$1.22\pm0.96$	$2.97\pm0.86$	-4.557	.000		
Final follow-up	$0.68\pm0.57$	$1.98 \pm 0.84$	-2.923	.006		
Constant-Murley Score						
Preoperative	$39.34 \pm 3.52$	$40.87 \pm 4.21$	-1.425	.146		
Postoperative 6 months	$91.45\pm3.44$	$80.85\pm5.56$	6.173	.000		
Final follow-up	$94.21 \pm 1.43$	$90.45\pm3.42$	2.213	.041		
CCD, coracoclavicular distances; VAS, Visual Analog Scale.						

the study group, it was  $(8.15 \pm 1.17 \text{ mm})$ . No significant differences were observed between the groups (P > .05). However, the increase in CCD at the final follow-up was significantly greater in the control group (1.819  $\pm$  0.97 mm) compared to the study group (0.274  $\pm$  0.18 mm) (P < .05). Both groups showed significant improvement in their VAS and Constant-Murley function scores postoperatively. At the 6-month follow-up and final follow-up, the VAS scores for the control group were (2.97  $\pm$  0.86) and (1.98  $\pm$  0.84), respectively, while the VAS scores for the study group were  $(1.22 \pm 0.96)$  and  $(0.68 \pm 0.57)$ , respectively. The Constant-Murley scores for the control group were  $(81.67 \pm 5.54)$  and  $(90.45 \pm 3.42)$ , and for the study group, they were  $(91.45 \pm 3.44)$  and  $(94.21 \pm 1.43)$ , respectively. The study group demonstrated better outcomes compared to the control group, with significant differences between the 2 groups (P < .05). Detailed results are shown in Table 3, and a typical case is illustrated in Figure 2.

# Discussion

In this study, 32 patients with Neer type IIB (IIC) distal clavicle fractures who underwent Endobutton combined with mini-plate fixation achieved both clinical and radiological union. The incidence of postoperative complications was relatively low, and all patients regained near-normal function with no pain. Ultimately, all patients achieved bony union and maintained the CCD. These results are consistent with other reported studies using combined fixation methods for distal clavicle fractures.

# Feasibility and advantages of endobutton combined with mini-plate treatment

The main challenge in treating Neer type IIB (IIC) fractures lies in the associated rupture of the CC ligaments, which leads to instability of the fracture ends in both the horizontal and vertical directions. Additionally, the distal fracture fragment is short and has weak cortical bone, further complicating treatment. Conservative treatment has a high rate of nonunion, making surgical internal fixation the



Figure 2. A 62-year-old female patient admitted due to pain and limited mobility in the left shoulder following a car accident. (A) clavicle x-rays upon admission, revealing a Neer IIC type distal clavicle fracture, with the distal fragment measuring 0.8 cm and the CCD being 23.5 mm on the injured side; (B) 1 year postoperatively, x-ray displayed a CCD of 8.2 mm with no significant loss; (C,D) 12-month follow-up, the shoulder joint motion revealed a Constant-Murley score of 96 and a VAS score of 0, indicating excellent recovery of shoulder joint function.

standard approach.<sup>13</sup> In our cases, the average length of the distal fracture fragment was only 1.74 cm, with the longest fragment measuring 2.2 cm and the shortest just 0.8 cm. This presented significant challenges for fixation. Even when fixed, it was difficult to facilitate early functional rehabilitation, often requiring 4 weeks of suspension immobilization, which is detrimental to the postoperative recovery of shoulder joint function.

To address this challenge, our study employed a fixation technique that best aligns with the biomechanical requirements of the human body. This method not only restores the CC ligaments but also strengthens the fixation of the fracture ends. It has become one of the most popular fixation techniques in recent years.<sup>14</sup> For the reconstruction of the CC ligaments, we selected the current mainstream technique for tendon reconstruction-elastic fixation using the Endobutton system. By tightening the loop and fixing it to a mini-plate above the clavicle and a loop plate beneath the coracoid process, we anatomically reconstructed a strong, stiff, and biomechanically appropriate CC ligament. This technique does not require secondary removal and indirectly reduces and stabilizes the fracture by reconstructing the CC ligaments.<sup>15,16</sup> Some researchers have used Endobutton alone for CC ligament reconstruction to stabilize this type of fracture. However, without additional fixation at the fracture ends, this can fail to effectively control horizontal displacement, increasing the risk of nonunion and failure of internal fixation.<sup>17,18</sup> Other researchers have opted to use K-wires through the acromion to fix the fracture ends, thereby controlling horizontal displacement. However, prolonged external retention of K-wires carries risks such as local skin irritation, pin tract infection, and loosening or displacement of the K-wire, and it also complicates early functional rehabilitation due to the fixation crossing the shoulder joint.<sup>19,20</sup> Additionally, some studies have used 5# Ethibond non-absorbable sutures in a NICE knot technique to tie and fix the fracture ends, which can help control horizontal displacement to a certain extent and improve the effectiveness of Endobutton fixation.<sup>21</sup> However, this method is only suitable for fractures with a length greater than 1.5 cm and oblique fractures. Suturing techniques may be applied to fix smaller, fragmented bone fragments but should not be used as a routine sole fixation method due to insufficient stability for early functional rehabilitation.

For the fixation of fracture ends, the traditional choice has primarily been the 3.5 mm locking plate system.<sup>22</sup> However, for fractures with very short distal fragments, it is difficult to insert enough screws to provide adequate fixation. Additionally, due to the unique shape of the distal clavicle, the plate often does not fit well, leading to skin irritation and the need for secondary removal. In this study, we chose a 2.4 mm mini-plate (commonly used for metacarpal fractures). Prevel et al<sup>23</sup> have confirmed, from a biomechanical perspective, that the 2.4 mm mini-plate provides superior strength, fracture stability, and pressure control across the fracture ends compared to other internal fixation devices. In our study, the role of the mini-plate primarily acts as an enhancement to the Endobutton fixation, as its strength and screw retention are sufficient for the required fixation.

Compared to the 3.5 mm locking plate and K-wires, the mini-plate offers the following advantages: First, it can accommodate at least 2 screws for fixation as long as the distal fragment is longer than 0.5 cm. Second, it does not cross the joint, preserving joint mobility. It also provides better resistance to rotation and shear forces than K-wires and sutures. Third, the stability of the screw-plate fixation system and its compressive effect on the fracture ends contribute to better fracture alignment, more secure fixation, and enhanced

healing. Moreover, the mini-plate is thin, compact, and highly malleable, causing minimal irritation to the skin when placed on the clavicle, and it does not require removal. The mini-plate can replace the conventional Endobutton technique for the loop plate above the clavicle, reducing medical costs to some extent. Lastly, it offers additional stability in the vertical direction, reducing the pressure on the coracoid process from the loop plate beneath it, thereby lowering the risk of coracoid fractures postoperatively.

#### Differences from traditional combined fixation methods

Traditional combined fixation methods typically involve first reducing and fixing the fracture ends, followed by CC ligament reconstruction and reinforcement. In these methods, CC fixation serves as an enhancement to the fracture fixation, as reported by Hohmann et al.<sup>24</sup> However, we believe that for Neer IIB (IIC) type fractures, the forces acting in the vertical direction are greater than those in the horizontal direction. Therefore, overcoming the vertical forces is more crucial. Our method begins by using the Endobutton to reposition and fix the fracture in the vertical direction, which not only counters the vertical forces but also indirectly addresses some of the horizontal shear forces, achieving basic reduction and fixation of the fracture ends. Then, the fixation is reinforced with the plate system, providing stronger stabilization, which allows for early functional rehabilitation and promotes shoulder joint recovery. In our study group, all patients began gradual rehabilitation exercises on the first postoperative day, with no need for postoperative immobilization. All patients achieved satisfactory function, though it should be noted that our technique still lacks biomechanical research support.

Furthermore, traditional CC ligament reconstruction and reinforcement usually involve using suture anchors or buttons with a suture system to anchor the ligament to the clavicle or plate surface. In contrast, our technique directly passes a mini-plate with a loop through the ligament and fixes it onto the clavicle surface, which reduces the risk of loosening associated with square knot techniques. Additionally, our method involves drilling holes to secure the loop plate at the base of the coracoid process rather than wrapping it around the bone. This approach allows for more precise selection of the appropriate loop length through measurement and also avoids the complications associated with suspension loop techniques.

In summary, the use of Endobutton combined with mini-plates for treatment is significantly superior to the clavicular hook plate. The former provides more sustained and stable fixation, allowing for early functional rehabilitation, which leads to satisfactory recovery of shoulder joint function. Additionally, it helps avoid a series of postoperative complications, eliminates the need for secondary internal fixation removal, and reduces the risk of secondary trauma for the patient. Thus, this method is a better choice for treating IIB (IIC) type distal clavicle fractures. However, the main limitation of our study lies in its retrospective and non-comparative design, with no random grouping, which may introduce selection bias. Furthermore, the sample size is relatively small, and the follow-up duration is short. Future large-sample, multi-center, or prospective clinical studies are needed to further validate the efficacy of this fixation method.

Data availability statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics committee approval: This study was approved by the Ethics Committee of Dongyang People's Hospital (Approval no.: Dongyang People's Hospital 2024-YX-020, Date: February.09.2024).

**Informed consent:** Informed consent was obtained from the patients who agreed to take part in the study.

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