

Transacromial loop plate versus clavicular hook plate for acute Rockwood type III–V acromioclavicular joint dislocation: a retrospective comparative study

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Abstract

Background

The clavicular hook plate is a standard surgical option for acute high-grade acromioclavicular joint (ACJ) dislocations, yet its rigid transarticular locking mechanism often leads to subacromial osteolysis, impingement pain, and high rates of secondary hardware removal. We therefore examined whether open reduction with transacromial loop plate fixation delivers dependable clinical outcomes and maintains radiographic reduction in acute high-grade ACJ dislocations.

Methods

Fifty-three patients with acute Rockwood type III–V ACJ dislocations who underwent surgery between January 2024 and July 2025 and completed at least 12 months of follow-up, with data collected through July 2026, were retrospectively reviewed. Patients received either transacromial loop plate fixation ($n = 23$) or standard clavicular hook plate fixation ($n = 30$). The two groups were compared for perioperative variables, visual analog scale (VAS) pain, Constant-Murley and University of California, Los Angeles (UCLA) shoulder scores, radiographic reduction loss, and complications.

Results

All patients completed at least 12 months of follow-up. The loop plate group showed significantly shorter incisions (4.14 ± 0.67 vs. 6.90 ± 0.79 cm) and hospital stays (6.12 ± 1.22 vs. 8.23 ± 1.09 d; both $P < 0.001$) and less reduction loss at 6 months (0.45 ± 0.45 vs. 2.45 ± 0.84 mm, $P < 0.001$). At 12 months, Constant-Murley and UCLA scores were significantly higher in the loop plate group (both $P < 0.001$). Complications occurred in 8.70% of the loop plate group versus 53.33% of the hook plate group ($P = 0.001$), with clear advantages in subacromial osteolysis and impingement ($P = 0.001$), obviating routine secondary hardware removal.

Conclusions

In the setting of open reduction for acute high-grade ACJ dislocations, transacromial loop plate fixation was associated with smaller incisions, shorter hospital stays, better maintenance of reduction, superior Constant-Murley and UCLA scores, and fewer complications than clavicular hook plate fixation, while obviating routine secondary hardware removal. These findings support transacromial loop plate fixation as a promising joint-preserving option for acute high-grade ACJ dislocations, although prospective comparative studies with longer follow-up are warranted.

Level of evidence

Background

Dislocation of the acromioclavicular joint (ACJ) is one of the more common injuries encountered in shoulder trauma practice, and it occurs disproportionately in young, physically active patients [1]. Most cases arise from a direct blow onto the point of the shoulder, while others follow force transmitted along an outstretched arm during a fall [2]. Under the Rockwood classification system, these injuries span types I to VI. Types I and II usually do well with conservative measures; types IV to VI, in which joint stability is lost entirely, are widely accepted as requiring operative treatment, whereas type III injuries are common, yet their management remains controversial because instability severity and patient functional demands vary widely [3, 4].

In the management of severe ACJ instability, traditional open reduction methods are commonly used. Common techniques include clavicular hook plate fixation and various ligament transfer procedures, such as the classic and modified Weaver-Dunn techniques [3, 5]. Earlier work showed that pairing a hook plate with coracoacromial ligament transfer restores dependable static alignment in acute Rockwood types III–V ACJ dislocations, and this combination has a long clinical track record [6]. However, the transarticular rigid locking design of the clavicular hook plate carries a considerable risk of complications [7]. By constraining physiological micromotion such as axial rotation of the ACJ, the hook tip produces long-term, high stress concentration at the point of contact beneath the acromion. The resulting complications include impingement beneath the acromion, acromial osteolysis and erosion, and tears of the adjacent rotator cuff [7–9]. Although surgeons have attempted to mitigate mechanical complications by optimizing the hook bending angle and depth of insertion [10], the stress-related complications and the mandatory secondary operation for hardware removal remain major drawbacks [11].

In recent years, arthroscopic techniques and minimally invasive fixation devices have made arthroscopic treatment of ACJ dislocations increasingly common [5]. Arthroscopic surgery provides magnified visualization of the surgical field and accurate operative positioning. It also minimizes surrounding soft-tissue trauma and accelerates postoperative rehabilitation. Among these approaches, arthroscopic-assisted knotless/non-drilling self-locking suture techniques are considered promising. By employing self-locking loop technology and non-drilling suture methods, they reduce the risk of fracture associated with conventional bone tunneling and are surgically simple and cost-effective [12]. Furthermore, arthroscopic-assisted single-portal techniques, coracoid sling suspension procedures, and triple suture-button fixation systems integrating high-strength sutures have yielded encouraging short-term results, with gains in both Constant-Murley and University of California, Los Angeles (UCLA) shoulder scores [13]. Subsequent arthroscopic coracoclavicular (CC) ligament reconstruction techniques have also shown good mechanical results on long-term follow-up and can control vertical joint instability [11, 14]. Nevertheless, blind bone tunnel creation during arthroscopic procedures for certain severe high-grade dislocations remains technically demanding [15]. Patients also face the potential risk of suture-induced

"windshield-wiper effects" within the clavicular tunnel, leading to tunnel enlargement and occult loss of reduction [16].

Several treatment options exist for ACJ dislocations. Selecting the optimal strategy requires individualized assessment of the dislocation pattern and the patient's functional demands [3]. Recently, concepts combining biological ligament reconstruction with flexible fixation have gained traction [17]. Biomechanical studies reveal that traditional vertical reduction techniques often have mechanical limitations: they correct vertical height but ignore horizontal and rotational instability, because they lack multi-directional counter-vectors [8, 9, 18]. Moreover, clinical evaluations emphasize that axial horizontal stability (anterior-posterior translation) post-dislocation is closely linked to long-term functional outcomes; neglecting the horizontal restraint frequently results in loss of reduction and suboptimal clinical results [9, 18].

To address the challenges of three-dimensional spatial instability in the setting of open reduction while overcoming the limitations of traditional hook plates (extensive incisions, high osteolysis rates, and mandatory secondary surgery), we propose transacromial loop plate fixation for acute high-grade ACJ dislocations. This technique moves fixation from rigid screw locking to flexible suspension anchored on the distal clavicle and acromion flanking the joint surfaces. Through a small (~ 4 cm) anterior-based transverse skin incision, minimally invasive transarticular dual bone tunnels are created 1 cm from the ACJ surfaces on both the acromial and clavicular sides with 2.5-mm Kirschner wires. A doubled fine steel wire is used to pull the clavicular sutures superiorly into an adjustable all-suture loop plate system, which is ultimately tensioned and fixed on the superior surface of the acromion, establishing a transarticular non-rigid flexible tension band suspension construct. Through this retrospective comparative study, we aimed to evaluate the clinical and radiographic outcomes of this technique versus traditional clavicular hook plate fixation in the open reduction setting, with respect to perioperative variables, shoulder function, maintenance of reduction, and complications.

Methods

Study design

The records of patients admitted from January 2024 to July 2025 were reviewed retrospectively. All patients were followed up through July 2026 to ensure a minimum full follow-up duration of 12 months. The study protocol was approved by the Ethics Committee of the First Hospital of Longyan City Affiliated to Fujian Medical University (approval number LYREC2026-K296-01). Because the analysis drew solely on historical clinical and imaging records and exposed patients to no additional risk, the requirement for written informed consent was waived by the Institutional Review Board. This study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Inclusion and exclusion criteria

Patients were eligible for inclusion if they (1) were aged 18 to 60 years; (2) presented with an acute closed Rockwood type III–V acromioclavicular (ACJ) dislocation, verified clinically and radiographically, with surgery within 21 days of injury; and (3) agreed to open reduction surgery with documented clinical consent.

Exclusion criteria: (1) injury-to-surgery duration >3 weeks; (2) concomitant severe ipsilateral rotator cuff tears; (3) concomitant severe distal clavicle fractures (fracture line <1.5 cm from the lateral end of the clavicle); (4) bone mineral density indicating severe osteoporosis (T-score<-2.5); and (5) presence of severe systemic comorbidities rendering the patient unfit for surgery.

Patient grouping and interventions

Fifty-three patients with acute Rockwood type III–V ACJ dislocations who completed treatment and follow-up during this period formed the study cohort, comprising 23 cases managed with the loop plate and 30 managed with a hook plate. Group allocation was determined chronologically rather than by randomisation: clavicular hook plate fixation was the standard procedure at our institution during the earlier part of the study period, whereas transacromial loop plate fixation was adopted in the later part after the technique was introduced, and eligible patients were thereafter managed consecutively with the loop plate technique. The transacromial loop plate fixation group underwent anatomical, flexible transarticular bridging using an adjustable all-suture loop plate system, which consists of high-strength ultra-high-molecular-weight polyethylene (UHMWPE) sutures combined with low-profile button plates to form an adjustable elastic loop. The hook plate group received standard anatomical clavicular hook plate fixation with cortical bone screws.

Surgical techniques

With the patient under general anesthesia or a brachial plexus block, surgery proceeded in a beach-chair position tilted to roughly 45°. The affected upper extremity was prepped from the shoulder region down to the elbow and draped with sterile sheets. The affected shoulder was positioned slightly off the edge of the operating table to facilitate intraoperative shoulder range of motion and fluoroscopic imaging.

Hook Plate Group: A curved incision approximately 7 cm in length was made extending from the distal clavicle toward the acromion (slightly longer in cases associated with distal clavicle fractures). The surgical field was exposed layer by layer. Torn, damaged intra-articular articular disc fragments and hematoma within the ACJ were thoroughly debrided. Following anatomical reduction of the dislocated ACJ, the hook of the plate was engaged under the posterior-inferior surface of the acromion, and the clavicular portion was securely fastened with multiple cortical screws. The disrupted joint capsule was repaired, and the wound was closed in layers.

Transacromial Loop Plate Fixation Group: A roughly 4 cm transverse incision was made over the anterior distal clavicle, through which the medial acromion, the ACJ, and the superior cortex of the distal clavicle were exposed. Under direct visualization, incarcerated and damaged articular disc soft tissues in the

joint space were completely cleared. Using 2.5-mm Kirschner wires, paired transarticular tunnels were then drilled about 1 cm from the ACJ surfaces on the acromial and clavicular sides, respectively. Following drilling, a doubled fine stainless steel wire was inserted into the clavicular bone tunnel. A shuttle suture was introduced from the inferior aspect of the clavicle and shuttled out superiorly. Maintaining the clavicular shuttle suture superiorly, the suture traversed the ACJ space into the subacromial space. The doubled fine steel wire was then introduced into the subacromial space from the acromion and used to pull the shuttle suture superiorly out of the acromion. Subsequently, the shuttle suture was knotted with the double-stranded limbs at the lead end of the adjustable all-suture loop plate system. The limbs were guided sequentially through the acromial tunnel, subacromial space, ACJ, superior cortical surface of the lateral clavicle, and clavicular tunnel to the inferior surface of the clavicle, where a button plate was mounted onto the double-stranded suture limbs. Detailed surgical path planning, bone tunnel creation, and refined step-by-step procedures involving alternating tensioning of the bidirectional suspension sutures are depicted in Figure 1. Satisfactory anatomical joint reduction was confirmed intraoperatively via fluoroscopy before final locking and knotting. Representative intraoperative photographs of the wound exposure, the final incision length, implant positioning, and the fluoroscopic assessment are shown in Figure 2.

Postoperative management and follow-up parameters

The postoperative rehabilitation schedule was tailored to the mechanical properties of each construct. Prophylactic intravenous antibiotics were routinely administered within 24 hours postoperatively. Because transacromial loop plate fixation provides flexible stabilization without transarticular rigid locking, patients in the loop plate group were permitted to initiate early passive shoulder flexion and extension under professional supervision at 2 to 3 days postoperatively, with progressive resistance and dynamic muscle strengthening added at 4 weeks. In contrast, patients in the hook plate group commenced gentle passive shoulder flexion and extension exercises at 2 weeks postoperatively, reflecting the more cautious loading allowed by the rigid hook-plate construct. Patients in the hook plate group underwent a secondary operation for hardware removal at 10 to 12 months, whereas hardware removal was not required in the transacromial loop plate group. Patients returned for review at 1, 3, 6, and 12 months after surgery. At each visit, standard AP, Zanca, and Alexander views were obtained to judge alignment and the maintenance of reduction.

Outcome measurements and inter-observer reliability

All radiographic and functional outcome measurements were performed by two surgeons who were blinded to the treatment allocation. Radiographs were randomly assigned between the two assessors and magnified 20× to facilitate precise identification of anatomic landmarks; the final measurement was confirmed and recorded at this magnification. All measurements were performed on digital radiographs using the built-in caliper tool of the picture archiving and communication system (PACS), calibrated to 0.1 mm. Loss of reduction was defined as the increase in the coracoclavicular (CC) distance on follow-up radiographs relative to the immediate postoperative measurement. Because the coracoid process

serves as a fixed scapular landmark, the CC distance was used as a validated surrogate of vertical reduction of the ACJ irrespective of the fixation construct, while horizontal alignment of the ACJ was qualitatively evaluated on the same views. Functional outcome scores, namely the Constant-Murley shoulder score, the UCLA shoulder score, and the visual analog scale (VAS) pain score, were recorded at each follow-up visit by one surgeon, and a randomly selected subset of 20 patients (10 from each group) was independently re-assessed by the other surgeon. To assess inter-observer reliability, the intraclass correlation coefficient (ICC) was calculated for the continuous variables (CC distance, loss of reduction, and Constant-Murley, UCLA, and VAS scores) using a two-way random-effects model for absolute agreement (single measures); a weighted kappa coefficient was used for the Rockwood classification, and unweighted kappa coefficients were used for the presence of subacromial osteolysis and the judgment of loss of reduction or subluxation. The reliability of the radiographic measurements was further verified by independent re-measurement of a randomly selected subset of 20 radiographs (10 from each group) by both surgeons. An ICC or kappa value above 0.75 was considered to indicate good agreement.

Statistical analysis

Statistical analyses were performed using SPSS 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation and compared between groups using independent-samples t-tests. The normality of continuous variables was assessed before analysis; the data were approximately normally distributed, and the t-test, which is robust to mild deviations from normality, was used for between-group comparisons. A non-parametric sensitivity analysis yielded consistent conclusions. Categorical variables were expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test when expected frequencies were below 5. In the baseline comparisons, all expected cell counts exceeded 5, and Pearson's chi-square test was therefore applied without continuity correction. All tests were two-sided, and a P value below 0.05 was considered statistically significant.

Results

Baseline demographic and clinical characteristics

Application of the above criteria identified 53 patients with acute high-grade ACJ dislocations for analysis, 23 treated with transacromial loop plate fixation and 30 with a clavicular hook plate. The two cohorts were comparable in age, sex, injured side, Rockwood type, and interval from injury to surgery (all $P>0.05$); the two groups were therefore well balanced at baseline (Table 1).

Table 1 Baseline demographic and clinical characteristics of the two groups

Item	Loop plate group (n=23)	Hook plate group (n=30)	Statistical value	P value
Age (years)	40.78 ± 7.81	42.63 ± 8.23	t=0.83	0.411
Gender [n (%)]			$\chi^2=0.05$	0.823
- Male	16 (69.6)	20 (66.7)	-	-
- Female	7 (30.4)	10 (33.3)	-	-
Rockwood classification [n (%)]			$\chi^2=0.86$	0.650
- Type III	9 (39.1)	10 (33.3)	-	-
- Type IV	9 (39.1)	10 (33.3)	-	-
- Type V	5 (21.7)	10 (33.3)	-	-
Injured side [n (%)]			$\chi^2=0.02$	0.875
Left	12 (52.2)	15 (50.0)	-	-
Right	11 (47.8)	15 (50.0)	-	-
Time from injury to surgery (days)	3.39 ± 0.56	3.49 ± 0.48	t=0.72	0.476

Perioperative parameters and hospital stay

Perioperative parameters are summarized in Table 2. Perioperatively, the transacromial loop plate group benefited from its less invasive approach, with a shorter mean incision (4.14 ± 0.67 cm vs. 6.90 ± 0.79 cm, $P < 0.001$) and a briefer hospital stay (6.12 ± 1.22 d vs. 8.23 ± 1.09 d, $P < 0.001$) than the hook plate group. Operative time showed no statistically significant difference between the two groups ($P = 0.090$). Intraoperative blood loss was also lower in the loop plate group (51.15 ± 16.80 mL vs. 66.09 ± 16.69 mL, $P = 0.002$).

Table 2 Comparison of perioperative indicators between the two groups

Indicator	Loop plate group (n=23)	Hook plate group (n=30)	t value	P value
Incision length (cm)	4.14 ± 0.67	6.90 ± 0.79	13.48	<0.001
Operation time (min)	61.52 ± 7.77	57.91 ± 7.38	1.73	0.090
Hospital stay (days)	6.12 ± 1.22	8.23 ± 1.09	6.64	<0.001
Intraoperative blood loss (mL)	51.15 ± 16.80	66.09 ± 16.69	3.22	0.002

Pain, functional scores, and radiographic outcomes

Inter-observer agreement was high across all outcome measurements (Additional file 1: Table S1). The ICC was 0.92 (95% CI 0.86–0.96) for the coracoclavicular (CC) distance and 0.89 (95% CI 0.81–0.94) for the loss of reduction, and 0.91, 0.88, and 0.86 for the Constant-Murley, UCLA, and VAS scores, respectively. The weighted kappa was 0.87 (95% CI 0.76–0.95) for the Rockwood classification, and the kappa coefficients were 0.91 (95% CI 0.78–1.00) for the assessment of subacromial osteolysis and 0.85 (95% CI 0.68–0.97) for the judgment of loss of reduction or subluxation. These findings indicate good to excellent inter-observer agreement, confirming the reliability of the reported measurements.

At the assessed follow-up time points, the loop plate group showed better pain control and functional recovery than the hook plate group (Table 3).

Table 3 Comparison of outcome measures at different time points between the two groups

Time point	Indicator	Loop plate group (n=23)	Hook plate group (n=30)	t value	P value
3 months postoperatively	VAS (score)	2.53 ± 0.83	3.38 ± 1.03	3.24	0.002
	Constant-Murley (score)	72.09 ± 6.64	64.60 ± 4.50	4.89	<0.001
6 months postoperatively	Loss of reduction (mm)	0.45 ± 0.45	2.45 ± 0.84	10.34	<0.001
12 months postoperatively	Constant-Murley (score)	93.03 ± 5.96	81.24 ± 7.18	6.37	<0.001
	UCLA (score)	33.26 ± 1.75	30.62 ± 1.88	5.20	<0.001
12 months postoperatively	RTP rate [n (%)]	19/23 (82.6%)	14/30 (46.7%)	Fisher	0.010

Note: Clavicular hook plate hardware was electively removed at 10 to 12 months. At the 12-month assessment, patients in the hook plate group were therefore evaluated with the implant either still in situ or shortly after removal, whereas all patients in the loop plate group retained the implant.

At 3 months after surgery, the loop plate group reported less pain on the visual analog scale (VAS) than the hook plate group (2.53±0.83 vs. 3.38±1.03, P=0.002) and also scored higher on the Constant-Murley scale (72.09±6.64 vs. 64.60±4.50, P<0.001).

At 6 months postoperatively, radiographic loss of reduction was minimal in the loop plate group (0.45±0.45 mm), whereas the hook plate group exhibited substantial loss of reduction (2.45±0.84 mm, P<0.001). Throughout follow-up, sequential radiographs of the loop plate group showed no evidence of bone tunnel widening, cortical cut-through, or construct failure.

At 12 months postoperatively: Constant-Murley scores in the loop plate group reached 93.03±5.96 (significantly superior to 81.24±7.18 in the hook plate group, P<0.001), and UCLA scores were 33.26±1.75 vs. 30.62±1.88 (P<0.001). The return-to-sports (RTP) rate was 82.6% (19/23) in the loop plate

group, higher than 46.7% (14/30) in the hook plate group (P=0.010). Complete sequential radiographic follow-up of a representative case treated with transacromial loop plate fixation is shown in Figure 3.

Complications and safety

Complications affected 2 of 23 patients (8.70%) after transacromial loop plate fixation and 16 of 30 patients (53.33%) after clavicular hook plate fixation, a significant difference (P=0.001). The gap was widest for subacromial osteolysis and impingement (P=0.001). In the hook plate group the common problems were subacromial osteolysis (incidence 36.67%), chronic pain, foreign body sensation, and post-removal traumatic acromioclavicular osteoarthritis. Table 4 details the anatomical distribution of complications and the statistical comparisons. Figure 4 shows representative cases in which high stress concentration at the hook tip produced subacromial stress erosion.

Table 4 Comparison of complications between the two groups

Complication type	Loop plate group (n=23)	Hook plate group (n=30)	Test statistic	P value
Overall complication rate	2 (8.70%)	16 (53.33%)	Fisher	0.001
- Subacromial osteolysis and impingement	0 (0.00%)	11 (36.67%)	Fisher	0.001
- Chronic pain and limited ROM	2 (8.70%)	9 (30.00%)	Fisher	0.089
- Others (wound infection / screw loosening)	0 (0.00%)	2 (6.67%)	Fisher	0.499

Note: Where the expected frequency of a sub-item fell below 5, P values were derived directly with Fisher's exact test; χ^2 values were not provided. Some patients experienced more than one type of complication; therefore, the sum of individual complication types exceeds the overall number of patients with complications.

Discussion

Flexible versus rigid fixation: clinical complication profile

Traditional clavicular hook plates provide reliable initial stability through rigid fixation in the treatment of acromioclavicular joint (ACJ) injuries, at the price of disrupting the physiological kinematics of the joint [10]. Under physiological conditions the normal ACJ shows subtle vertical displacement and axial rotation during daily activities. Transarticular rigid locking concentrates stress at point-contact areas, and this often produces complications such as subacromial osteolysis (SAO) and chronic impingement pain [9].

The adjustable all-suture loop plate system utilized in this study is designed to achieve flexible transarticular bridging through the elastic compliance of high-strength sutures [18]. The intended effect

is to maintain anatomical joint reduction while permitting physiological micromotion. We hypothesise that such controlled stress stimulation may promote orderly alignment of regenerating ligamentous fibres, although this biological mechanism remains to be confirmed. Notably, the UHMWPE sutures used in such constructs provide high abrasion resistance, and no suture breakage, cortical cut-through, or bone tunnel widening was observed on sequential radiographs during follow-up in this cohort.

Our follow-up data are consistent with this reasoning: complications were far less frequent after transacromial loop plate fixation (8.70%) than after clavicular hook plate fixation (53.33%, $P = 0.001$). Specifically, the novel technique showed a protective effect against common complications such as subacromial osteolysis and impingement ($P = 0.001$). Although the between-group difference in chronic pain and restricted shoulder motion did not reach statistical significance ($P = 0.089$), a clear trend favouring the loop plate was observed, most likely reflecting the limited statistical power of this small cohort. These clinical findings are consistent with the hypothesis that a flexible suspension construct permitting physiological micromotion reduces the stress concentration associated with transarticular rigid locking; direct mechanical testing will be needed to confirm this mechanism.

Maintenance of reduction and multiplanar stability

Acute Rockwood type III–V dislocations involve not only vertical instability but also horizontal displacement and rotational instability resulting from disruption of the acromioclavicular ligaments [8, 18]. Unlike conventional coracoclavicular suspension systems that primarily address vertical displacement, the transacromial construct directly bridges the acromioclavicular articulation, theoretically providing superior resistance against anteroposterior shear and axial rotational forces. Previous literature reports that isolated vertical fixation techniques frequently leave a high residual rate of posterior subluxation, which compromises long-term functional outcomes [9].

In the present study, the loop plate technique established dual bone tunnels approximately 1 cm from the joint surfaces and thereby achieved dual-planar constraint along both horizontal and vertical vectors. At 6 months postoperatively, radiographic loss of reduction in the loop plate group was minimal (0.45 ± 0.45 mm), superior to the hook plate group (2.45 ± 0.84 mm, $P < 0.001$). This difference is consistent with the intended multiplanar constraint of the dual-tunnel construct in resisting anterior-posterior shear forces at the ACJ, addressing a limitation of isolated vertical reduction, although this mechanistic interpretation remains inferential in the absence of direct biomechanical measurement (Table 3). Furthermore, by permitting controlled micromotion while offloading the coracoclavicular interval, the elastic transacromial bridging may provide a low-tension biomechanical microenvironment conducive to the intrinsic scar-healing capacity of the torn coracoclavicular ligaments, which is believed to be preserved once anatomical alignment is restored and shear stress is eliminated in the acute phase [13].

Within minimally invasive sports medicine, innovative arthroscopic applications of all-suture adjustable loop systems, termed the "N-way technique", are conceptually similar to our open transacromial loop plate approach. Multiple technical reports have confirmed that such arthroscopic approaches achieve

accurate three-dimensional anatomical reduction and multi-directional flexible locking, with good biological healing during perioperative and functional follow-ups [18].

The present study extends this concept of flexible transarticular bridging to an open reduction setting and provides clinical support for its role in controlling three-dimensional translation and rotation. Both approaches move away from rigid immobilization toward flexible, precise guidance. Although arthroscopic techniques continue to evolve rapidly, open reduction under direct visualization allows complete debridement of incarcerated articular disc fragments and soft tissue debris within the joint space. Anatomical reduction is therefore achieved under direct sight, which has practical value for community hospitals that lack specialized arthroscopic equipment. In addition, because the transacromial construct requires no drilling through the base of the coracoid process, it avoids the potential risks of coracoid fracture and iatrogenic neurovascular injury associated with coracoid tunnel preparation in arthroscopic coracoclavicular suspension techniques.

Functional recovery and patient-relevant benefits

Functional recovery is the primary concern for patients. In this study, the loop plate group demonstrated significant advantages as early as 3 months postoperatively, with lower VAS pain scores (2.53 ± 0.83 vs. 3.38 ± 1.03 , $P = 0.002$) and higher Constant-Murley scores (72.09 ± 6.64 vs. 64.60 ± 4.50 , $P < 0.001$). At 12 months postoperatively, the Constant-Murley score reached 93.03 ± 5.96 , the UCLA score achieved 33.26 ± 1.75 ($P < 0.001$), and the return-to-sports (RTP) rate was 82.6% (19/23) in the loop plate group versus 46.7% (14/30) in the hook plate group ($P = 0.010$). The higher RTP rate after loop plate fixation probably reflects faster functional recovery and the avoidance of a mandatory second operation for hardware removal. Patients treated with the loop plate technique had less pain, faster recovery of shoulder motion, and greater improvement in quality of life. Nevertheless, because earlier passive motion was allowed in the loop plate group and hook plate patients were assessed at 12 months either with the implant still in situ or shortly after removal, the contribution of these factors to the observed functional differences cannot be fully separated.

Minimally invasive approach and avoidance of secondary surgery

Conventional hook plate procedures typically require an extensive incision of approximately 7 cm, with substantial soft-tissue dissection and visible scarring. In contrast, the loop plate group used a small transverse incision of approximately 4 cm, which significantly reduced intraoperative blood loss (51.15 ± 16.80 mL vs. 66.09 ± 16.69 mL, $P = 0.002$) and shortened hospital stays (6.12 ± 1.22 d vs. 8.23 ± 1.09 d, $P < 0.001$), consistent with its minimally invasive design [7–9].

More importantly, the all-suture loop plate system obviates the need for routine secondary hardware removal, which spares patients the physical discomfort, anesthetic risks, and financial burden of a second operation. This approach lowers overall direct medical expenditures, shortens sick leave duration, and improves patient satisfaction. This economic benefit is substantial given current healthcare resource constraints.

Limitations

This study has several limitations. First, it was a single-centre retrospective analysis in which treatment allocation was chronological rather than randomised: clavicular hook plate fixation was performed before the transacromial loop plate technique was adopted at our institution. Although the two groups were comparable in baseline characteristics, this sequential design cannot exclude selection bias, surgeon learning-curve effects, or other time-dependent confounding. Second, the rehabilitation schedules differed between the groups, with earlier passive motion permitted after loop plate fixation; because the earlier functional recovery in this group may partly reflect the more accelerated rehabilitation rather than the implant itself, the independent contribution of the fixation technique to early outcomes cannot be precisely quantified. Third, the modest sample size (23 vs 30) limited statistical power for some secondary endpoints, such as chronic pain at the final follow-up ($P = 0.089$); these analyses should therefore be regarded as exploratory. Fourth, the maximum follow-up of 12 months precludes assessment of long-term joint stability and post-traumatic osteoarthritis, and because the hook plate was routinely removed at 10 to 12 months, functional comparisons at 12 months involved hook plate patients with the implant in situ or shortly after removal, whereas loop plate patients were assessed with the implant retained; follow-up extending well beyond hardware removal (e.g., 24 months) will therefore be required to compare the two constructs under comparable implant conditions. In addition, although the CC distance is a validated surrogate of vertical reduction, horizontal (anteroposterior) translation of the ACJ was assessed only qualitatively on Zanca and Alexander views and was not quantified with a dedicated metric. Finally, although the clinical results are consistent with the intended flexible-suspension behaviour of the construct, its mechanical performance was not directly evaluated in this study; finite element analysis or cadaveric and bench testing will be required to substantiate the biomechanical rationale underlying this technique.

Conclusions

In the setting of open reduction for acute Rockwood type III–V acromioclavicular joint (ACJ) dislocations, transacromial loop plate fixation maintained multiplanar reduction through a small, anterior-based incision of approximately 4 cm. With a flexible suspension design using an adjustable all-suture loop, this technique maintained reliable anatomical reduction while permitting physiological joint motion.

Compared with traditional clavicular hook plate fixation (which requires an incision of approximately 7 cm), transacromial loop plate fixation demonstrated advantages across several outcomes: reduced intraoperative blood loss, milder early postoperative pain, faster shoulder functional recovery (higher Constant-Murley and UCLA scores), lower rates of loss of reduction, and a reduced overall complication rate by eliminating subacromial osteolysis, chronic impingement, and associated long-term complications. Furthermore, this technique obviates routine secondary surgery for hardware removal, which substantially reduces secondary trauma, financial burden, and lost work time for patients.

These results are consistent with previous comparative studies [18] and suggest that transacromial loop plate fixation is a safe, effective, and reproducible option for the open reduction of acute high-grade ACJ dislocations. Because the present evidence is retrospective and non-randomised, these findings should be regarded as preliminary; prospective comparative studies with longer follow-up, ideally combined with biomechanical testing of the construct, are needed to confirm these results and to guide further refinement of the technique.

Abbreviations

ACJ: acromioclavicular joint; AP: anteroposterior; CC: coracoclavicular; CI: confidence interval; CT: computed tomography; ICC: intraclass correlation coefficient; PACS: picture archiving and communication system; RTP: return to sports; SAO: subacromial osteolysis; SD: standard deviation; SPSS: Statistical Package for the Social Sciences; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology; UHMWPE: ultra-high-molecular-weight polyethylene; UCLA: University of California, Los Angeles; VAS: visual analog scale.

Declarations

Ethics approval and consent to participate

This retrospective study was approved by the Ethics Committee of the First Hospital of Longyan City Affiliated to Fujian Medical University (approval number LYREC2026-K296-01) and was conducted in accordance with the Declaration of Helsinki and the STROBE guidelines. Owing to the retrospective nature of the analysis and the exclusive use of de-identified historical clinical and imaging records, the requirement for written informed consent was waived by the Institutional Review Board.

Clinical trial number: not applicable.

Consent for publication

Written informed consent for publication of their clinical images was obtained from the patients.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

W.Q.: Conceptualization, Methodology, Writing - original draft. W.L.: Data curation, Writing - original draft. X.Y.: Formal analysis, Data curation. X.T.: Investigation, Data curation. J.X.: Investigation, Data curation. Y.L.: Supervision, Project administration, Writing - review and editing. All authors read and approved the final manuscript.

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Declaration of generative AI use

During the preparation of this manuscript, the authors used Scribbr AI Proofreader and a large language model-based writing assistant to refine the language and grammar. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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Figures

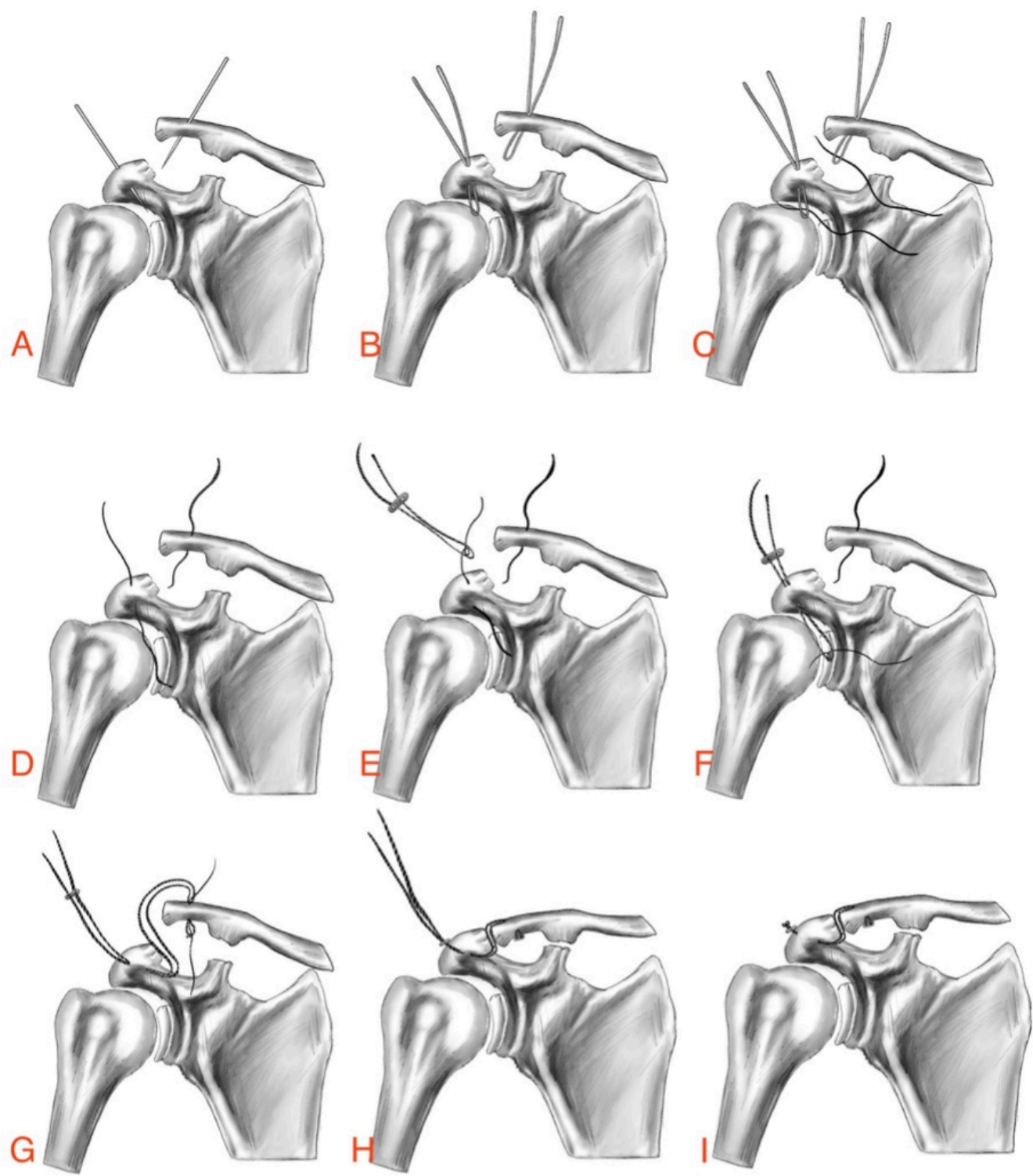


Figure 1

Schematic diagram of transacromial loop plate fixation

A. Bilateral minimally invasive trans-articular bone tunnels were created at the acromial end and distal clavicle approximately 1 cm from the acromioclavicular joint surface using a 2.5-mm Kirschner wires.

B. Folded traction fine steel wires were inserted anterogradely into the clavicular and acromial bone tunnels, respectively.

C–D. Using the folded steel wire as a guide, traction sutures were introduced from the deep surface of the clavicle and the subacromial space, respectively, and passed out above the bone tunnels.

E–G. The traction sutures were tied to the leading end of the adjustable all-suture loop plate system and sequentially passed along the trajectory of "superior acromial tunnel → subacromial space → acromioclavicular joint space → lateral superior clavicular cortex → clavicular tunnel." The double-strand suture ends were then guided beneath the clavicle, and the clavicular button plate was placed.

H–I. After confirming satisfactory anatomic reduction, the double-strand sutures of the suture button were alternately tightened for compliant tensioning, anchored and tied at the superior acromial end, and excess tail sutures were trimmed to complete the flexible suspension system fixation.

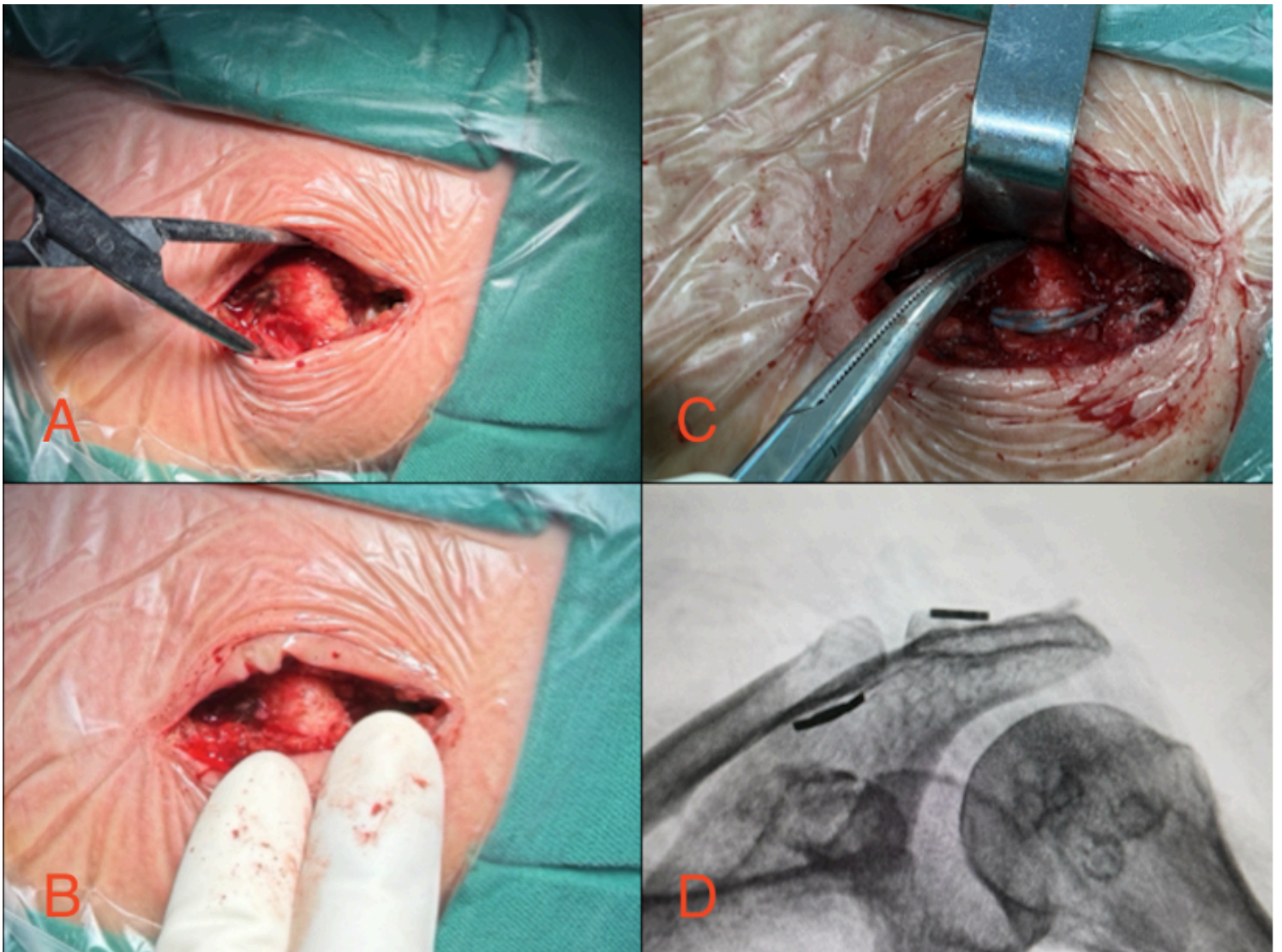


Figure 2

Intraoperative photographs of transacromial loop plate fixation

A. Exposure of the distal clavicle and the acromioclavicular joint through the transverse skin incision. **B.** The completed skin incision measured approximately two fingerbreadths in length, minimizing soft-tissue dissection. **C.** Passage and installation of the adjustable transacromial loop plate system after anatomical reduction of the acromioclavicular joint. **D.** Intraoperative C-arm fluoroscopy confirming satisfactory anatomical reduction and appropriate implant positioning prior to final locking and knotting.

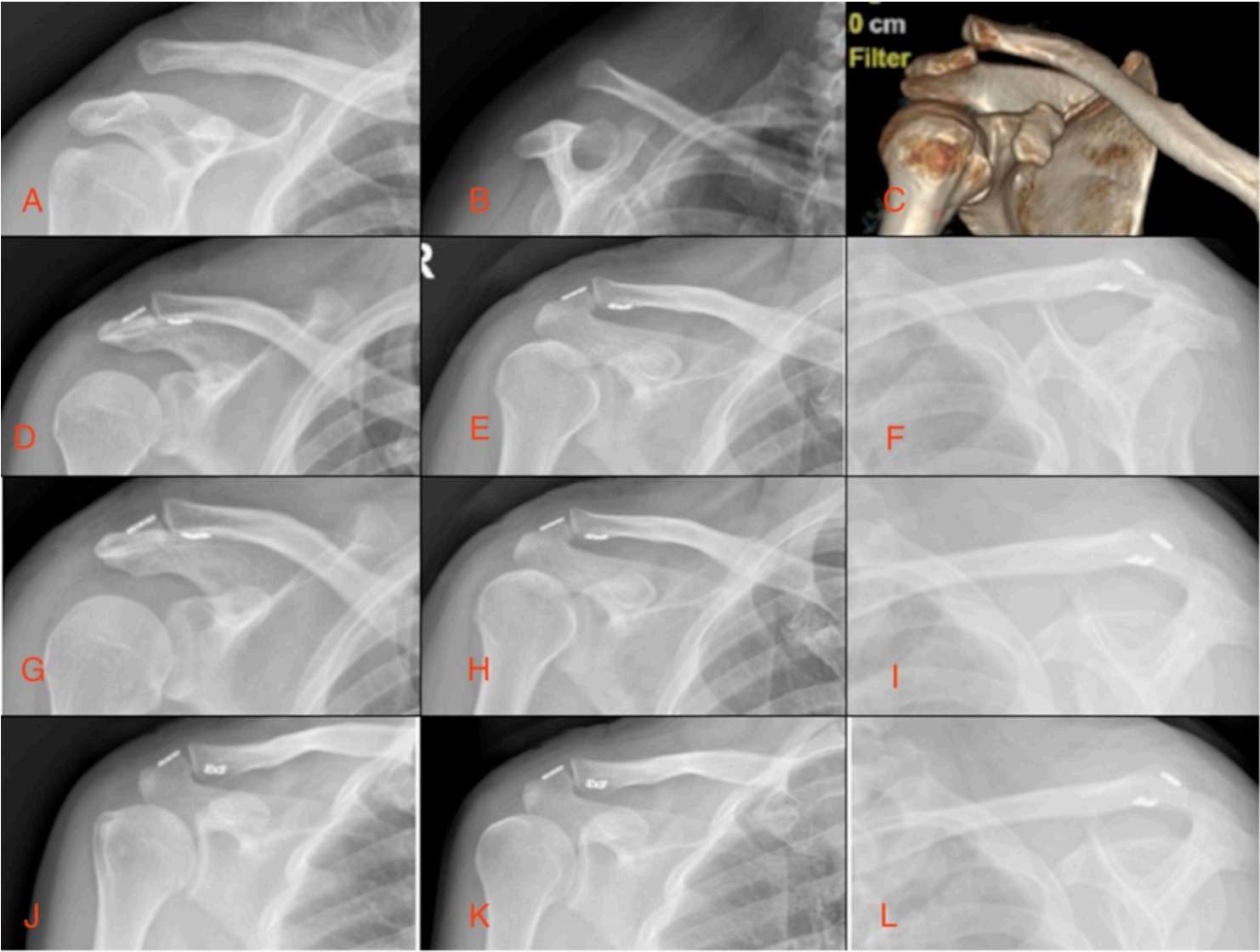


Figure 3

Representative imaging follow-up of a case treated with transacromial loop plate fixation

This 44-year-old man presented with a Rockwood type V acromioclavicular joint dislocation.

A–C. Preoperative imaging evaluation: Complete acromioclavicular joint dislocation with significant superior displacement of the distal clavicle and marked widening of the coracoclavicular interval was observed, a finding consistent with severe injury to the coracoclavicular ligament and acromioclavicular ligament complex. Anteroposterior (A), oblique (B), and three-dimensional CT reconstruction (C) views clearly demonstrated the dislocated joint status, with the coracoclavicular distance substantially increased compared with the contralateral side.

D–F. Postoperative imaging review on day 3: Anteroposterior, Zanca, and Alexander views showed satisfactory anatomic reduction with good alignment of the distal clavicle and acromial end. The coracoclavicular distance (CC distance) was restored to the normal anatomic range, and the trans-articular double bone tunnels together with the adjustable suture button system were well positioned.

G–I. Mid-term follow-up imaging at 6 months postoperatively: Anteroposterior, Zanca, and Alexander views showed symmetrical joint space with maintained stable anatomic reduction, no progressive loss of reduction or subluxation, no significant enlargement or loosening absorption around the bone tunnels, and no subacromial osteolysis or impingement lesions.

J–L. Final follow-up imaging at 12 months postoperatively: Demonstrated long-term three-dimensional imaging stability with good joint space, intact trans-articular flexible suspension system structure, normal subacromial space, and restored bilateral alignment to the normal contralateral level.

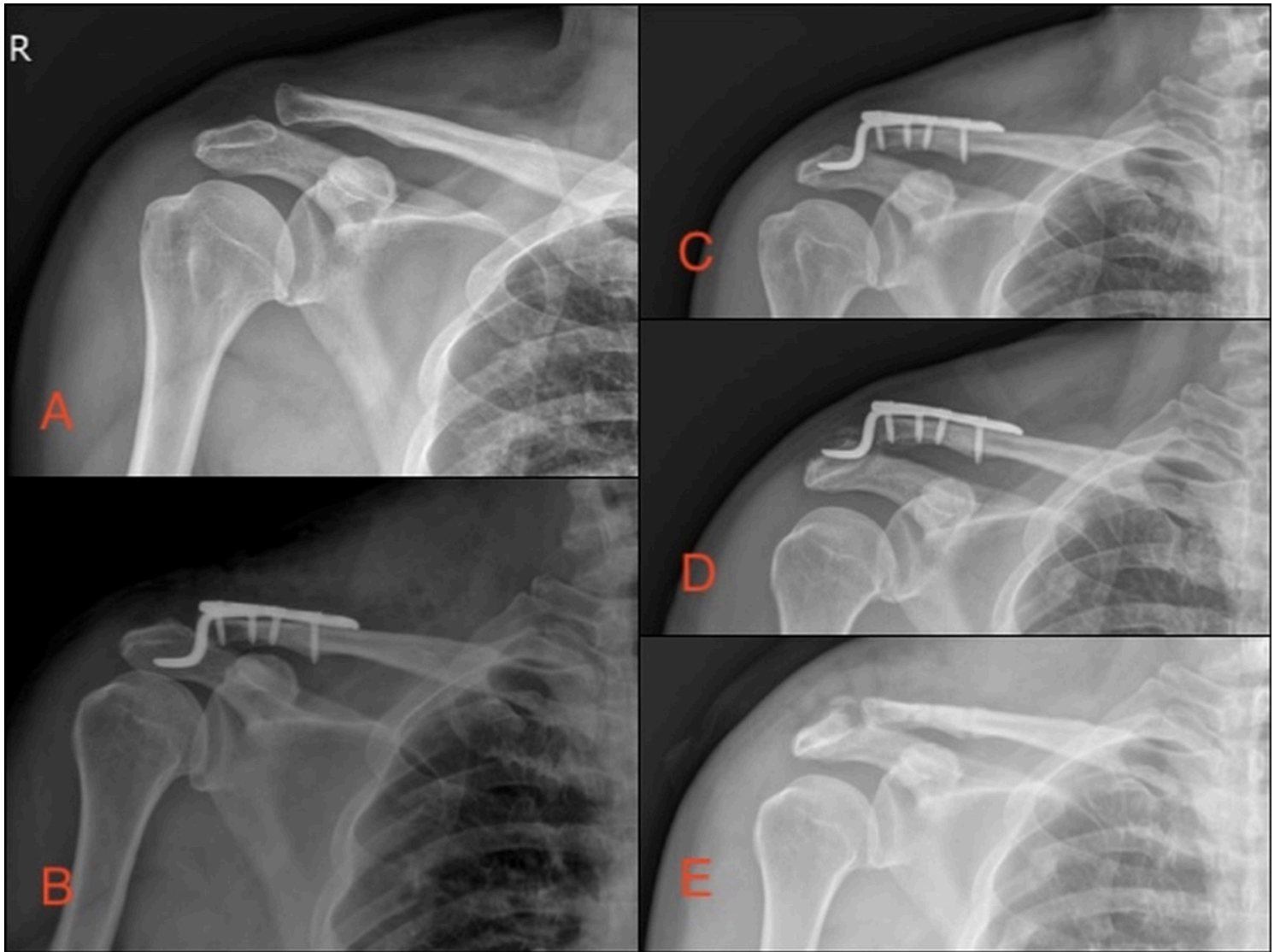


Figure 4

Representative complications after clavicular hook plate fixation

This 58-year-old man with a Rockwood type III dislocation developed subacromial osteolysis and residual subluxation after plate removal.

A. Preoperative anteroposterior shoulder radiograph: Typical Rockwood type III dislocation was demonstrated, with significant superior displacement of the distal clavicle and marked widening of the acromioclavicular joint and coracoclavicular space.

B. Immediate postoperative radiograph after clavicular hook plate fixation: Satisfactory anatomic reduction of the acromioclavicular joint was shown, with the hook tip placed at the posteroinferior pole of the acromion.

C. Mid-term follow-up radiograph at 3 months postoperatively: A localized lucent area began to appear at the hook tip contact surface, an early sign of subacromial stress-induced bone erosion and osteolysis

(SAO).

D. Mid-term follow-up radiograph at 8 months postoperatively: The osteolytic range further expanded, with obvious subacromial cortical absorption, presenting a significant "cup-shaped" high-stress bone defect sign.

E. Radiograph at 11 months postoperatively after internal fixation removal and revision surgery: The joint status after hook plate removal was demonstrated. Due to long-term hook tip compression leading to acromial bone absorption and erosion, transacromial bone tunnel fixation was not feasible, and coracoid anchor-based ligament suspension reconstruction was performed instead. The radiograph showed acceptable alignment of the acromioclavicular joint, but residual mild joint instability and morphological changes of subacromial stress-induced bone defect remained.