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Original Research Article

Comparative Outcome of Distal Radioulnar Joint Instability in Galeazzi Fractures: Conservative Management versus K-wire Fixation

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ABSTRACT

Background: The Galeazzi fracture-dislocation, a fracture of the distal radial shaft with disruption of the distal radioulnar joint (DRUJ), accounts for 3–7% of forearm fractures. Persistent DRUJ instability after radial fixation is a recognized cause of chronic wrist pain, restricted forearm rotation and reduced grip strength, yet the optimal method of managing residual instability remains controversial.

Objective: To compare the functional and clinical outcome of DRUJ instability in Galeazzi fractures managed with above-elbow plaster-of-Paris (POP) immobilization in supination versus supplementary K-wire trans-fixation of the ulna to the radius, following rigid internal fixation of the radial shaft.

Methods: This prospective comparative study was conducted in the Department of Orthopedics, Andhra Medical College, Visakhapatnam, over 14 months (October 2022 – December 2023) on 30 adult patients with Galeazzi fracture and intra-operatively confirmed DRUJ instability, all treated with open reduction and 3.5 mm dynamic compression plating of the radius. Fifteen patients were managed post-operatively with above-elbow POP casing in full supination for 4–6 weeks, and fifteen with supplementary K-wire fixation of the DRUJ (also for 4–6 weeks). Patients were followed up at 1 week, 1 month, 3 months and 6 months. Outcome measures were wrist range of motion (goniometer), grip strength (hand dynamometer) and the Gartland and Werley wrist score.

Results: No statistically significant baseline difference was found between the two groups for age, gender, side or mode of injury ($p > 0.05$). At 6 months, 21 of 30 patients (70%) had an excellent functional score and 9 (30%) a good score, with no fair or poor outcomes in either group. Excellent results were seen in 10/15 (66.7%) of the conservative group and 11/15 (73.3%) of the K-wire group; this difference was not statistically significant ($p = 0.72$). Grip strength improved progressively and significantly within both groups (mean gain 6.0 kg conservative, 5.0 kg K-wire; both $p < 0.001$), from a mean of 18.0 kg (conservative) and 19.5 kg (K-wire) at 1 week to 24.0 kg and 24.5 kg respectively at 6 months. Wrist flexion, extension, pronation and supination did not differ significantly between groups, with no patient in either group demonstrating a fixed loss of forearm rotation.

Conclusion: Both above-elbow POP immobilization in supination and supplementary K-wire trans-fixation appeared to be effective methods of managing DRUJ instability after rigid plate fixation of Galeazzi fractures, with no statistically significant difference between them on any outcome measure at 6 months. Given the small sample size, this absence of demonstrated difference is not proof that the two methods produce equivalent outcomes. Treatment selection needs to be individualized, guided by the degree of intra-operative instability, patient compliance and surgeon preference.

Keywords: Galeazzi fracture; distal radioulnar joint instability; K-wire fixation; conservative management; Gartland and Werley score; forearm fracture.

INTRODUCTION

The distal radioulnar joint (DRUJ) is an inherently unstable articulation, owing to the mismatch in radius of curvature between the shallow sigmoid notch of the radius and the asymmetric ulnar head. [1,2] The bony architecture contributes only a small fraction of joint stability and the principal restraint is provided by the soft-tissue stabilizers - chiefly the triangular fibrocartilage complex (TFCC) and, to a lesser extent, the interosseous membrane, the extensor carpi ulnaris tendon sheath and the pronator quadratus. [3,4,5,6]

A fracture of the radial shaft occurring together with dislocation of the DRUJ constitutes a Galeazzi fracture-dislocation, first characterized systematically by Riccardo Galeazzi in 1934. [7] It is an uncommon injury, representing approximately 3–7% of all forearm fractures, and is frequently under-recognized at initial presentation because the DRUJ injury may be radiographically subtle. Left unrecognized or inadequately stabilized, persistent DRUJ instability produces ulnar-sided wrist pain, restriction of pronation - supination and diminished grip strength, and is a major determinant of an unsatisfactory outcome. [8,9]

While anatomical reduction and rigid plate fixation of the radial shaft restores length and rotational alignment in most cases, a subset of patients demonstrates residual DRUJ instability on intra-operative stress testing after radial fixation. Management options for this residual instability include above-elbow immobilization in supination, trans-fixation of the ulna to the radius with Kirschner (K)-wires, and open or arthroscopic repair of the TFCC. [9,10] The relative merits of conservative immobilization versus K-wire trans-fixation remain debated, with limited comparative prospective data. This study was undertaken to compare the clinical and functional outcome of these two treatment strategies.

Aims and Objectives

- To assess the functional outcome of DRUJ instability in Galeazzi fracture patients treated with conservative management versus K-wire fixation.
- To assess the clinical outcome associated with each treatment modality with respect to

a) wrist range of movement,
b) grip strength, and
c) the Gartland and Werley wrist score. [11]

MATERIALS & METHODS

Study Design and Setting

This was a hospital-based prospective comparative study conducted in the Department of Orthopedics, Andhra Medical College and King George Hospital, Visakhapatnam, Andhra Pradesh, over a period of 14 months (October 2022 to December 2023), following approval of the Institutional Ethics Committee, Andhra Medical College. Written informed consent was obtained from all participants.

Sample and Eligibility Criteria

Thirty adult patients presenting with a Galeazzi fracture and intra-operatively confirmed DRUJ instability were enrolled consecutively and allocated randomly to one of two treatment groups of 15 patients each.

Inclusion criteria

- Adults above 18 years of age

- Male and female patients
- DRUJ instability in Galeazzi fracture managed with radial shaft plating
- Willingness to provide informed consent

Exclusion criteria

- Compound (open) fractures
- Children with Galeazzi fracture
- Refusal of informed consent
- Non-compliance to follow-up

Pre-operative Protocol

Patients presenting to the casualty were initially stabilized, given analgesia and immobilized in an above-elbow splint. Anteroposterior and lateral radiographs of the forearm and wrist were obtained (fig 1,2), together with a complete blood count, renal function tests, HbA1c, HIV and HBsAg serology, fasting blood sugar, electrocardiogram, blood grouping and 2D-echocardiography where indicated. Appropriate antibiotics and pre-anaesthetic medication were administered prior to surgery.

Surgical Technique

With the patient supine and the forearm supported on a side-arm table, regional anaesthesia was administered and the limb prepared and draped in standard fashion. A volar modified Henry approach was used, with dissection carried out between the brachioradialis and flexor carpi radialis tendons to expose the fracture site. Fracture ends were freshened, the hematoma evacuated and anatomical reduction achieved with reduction forceps. A 3.5 mm dynamic compression plate was applied to the volar aspect of the distal radius, and reduction confirmed under fluoroscopy. After radial fixation, DRUJ stability was formally assessed using standard provocative stress tests.

Figure 1: Antero posterior and lateral radiograph of forearm with wrist showing distal Galeazzi fracture. Post-operative radiograph with radius plating and DRUJ K wire

Figure 2: Preoperative antero-posterior and lateral radiograph showing Galeazzi fracture. Post-op X-ray with conservative management of DRUJ.

Where DRUJ instability was confirmed, patients were allocated randomly to one of two management groups:

- Conservative group (n = 15): above-elbow POP casing with the forearm held in full supination, continued for 4–6 weeks.

- K-wire group (n = 15): trans-fixation of the ulna to the radius with a 1.6/1.8 mm K-wire passed approximately 2–3 cm proximal to the distal radial articular surface, with the forearm held in full supination; the wire was removed at 4–6 weeks.

The wound was thoroughly irrigated and closed in layers in both groups.

Post-operative Protocol and Follow-up

- Limb elevation, analgesics and antibiotics administered post-operatively
- Active finger movement encouraged from the first post-operative day
- Discharge on post-operative day 5 following wound inspection
- Review at day 12 for wound inspection and suture removal
- POP cast / K-wire removed at 4–6 weeks in the respective groups
- Structured follow-up at 1 week, 1 month, 3 months and 6 months

At each follow-up visit, wrist range of motion was measured with a goniometer, grip strength with a hand-held dynamometer, and functional outcome graded using the Gartland and Werley wrist scoring system. [11]

Statistical Analysis

Data were entered in Microsoft Excel 2013 and analysed using SPSS version 16. Quantitative variables were expressed as mean ± standard deviation and qualitative variables as frequencies and percentages. Baseline categorical characteristics (gender, side of injury, mode of injury, age group) were compared between the two treatment groups using Fisher's exact test. Grip strength and Wrist- forearm range of motion was compared between groups at each follow-up interval using the independent-samples t-test. The Gartland and Werley functional score was compared between groups using the Mann–Whitney U test.

RESULTS

Thirty patients with Galeazzi fracture and DRUJ instability were studied, 15 managed conservatively and 15 with K-wire fixation. Table 1 provides a breakdown of the age distribution among patients who underwent Conservative or K wire treatment methods. A total of 30 patients were categorized into four age groups: 18-30 years, 31-40 years, 41-50 years, and 51-60 years. The 18–30-year age group was the most frequently represented (50% of the cohort), reflecting the young, active demographic typically sustaining high-energy forearm trauma. The subsequent age groups, 31-40 years, 41-50 years, and 51-60 years, each comprised 5 patients, distributed slightly differently between the treatment methods. Out of 30 patients, 22 were male and 8 were female. Specifically, the Conservative treatment group consisted of 10 males and 5 females, while the K wire group included 12 males and 3 females. Among the 30 patients, 20 sustained injuries on the right side, with 11 receiving Conservative treatment and 9 treated with K wire. Conversely, 10 patients had injuries on the left side, with 4 managed conservatively and 6 with K wire. Out of 30 patients, 17 experienced RTAs, with 8 receiving Conservative treatment and 9 K wire. Meanwhile, 13 patients sustained injuries from self-falls, with 7 managed conservatively and 6 treated with K wire. (table 2)

Table 1. Age distribution of patients (years)

Age group (yrs)	Conservative (n)	K-wire (n)	Total (n)
18 – 30	8	7	15
31 – 40	2	3	5
41 – 50	2	3	5
51 – 60	3	2	5
Total	15	15	30

Table 2. Patient demographics and injury characteristics

Baseline Characteristics	Conservative (n=15)	K-wire (n=15)	Total (N=30)	Percentage (%)
gender				
Male	10	12	22	73.3
female	5	3	8	26.7
Side of injury				
Right	11	9	20	66.7
Left	4	6	10	33.3
Mode of injury				
Road traffic accident	8	9	17	56.7
Self-fall	7	6	13	43.3

None of the baseline characteristics differed significantly between the two treatment groups: gender (Fisher's exact test, $p = 0.68$; odds ratio 0.50, 95% CI 0.10–2.63), side of injury ($p = 0.70$; odds ratio 1.83, 95% CI 0.39–8.57), mode of injury ($p = 1.00$; odds ratio 0.76, 95% CI 0.18–3.24), and age-group distribution (Freeman–Halton exact test, $p = 1.00$).

Table 3 details the range of movements observed in patients treated with Conservative and K wire methods. Both groups achieved functional ranges of wrist and forearm motion, with a similar small proportion (2/30) in each rotational category falling below the lowest range band. Range of motion was compared between groups using the independent-samples t-test on the group-wise mean ± SD for each movement (Table 3b); no statistically significant between-group difference was found for wrist flexion, wrist extension, pronation or supination (all $p > 0.6$).

Table 3. Wrist and forearm range of motion at final follow-up (goniometric, degrees)

Movement	Range (°)	Conservative (n)	K-wire (n)	Total (n)
Wrist flexion	55 – 65	10	9	19
Wrist flexion	45 – 55	5	6	11
Wrist flexion	< 45	0	0	0
Wrist extension	45 – 55	11	10	21
Wrist extension	35 – 45	4	5	9
Wrist extension	< 35	0	0	0
Pronation	65 – 75	10	9	19
Pronation	55 – 65	4	5	9
Pronation	< 55	1	1	2
Supination	75 – 85	11	10	21
Supination	65 – 75	3	4	7
Supination	< 65	1	1	2

Table 3b. Wrist and forearm range of motion at final follow-up — group-wise between-group comparison

Movement	Conservative (mean ± SD)	K-wire (mean ± SD)	Mean difference (95% CI)	p-value
Wrist flexion (°)	56.7 ± 3.9	56.0 ± 4.2	0.7 (-2.4 to 3.7)	0.656
Wrist extension (°)	47.3 ± 3.6	46.7 ± 3.9	0.7 (-2.1 to 3.5)	0.630
Pronation (°)	66.0 ± 5.6	65.3 ± 5.7	0.7 (-3.6 to 4.9)	0.750
Supination (°)	76.7 ± 5.5	76.0 ± 5.6	0.7 (-3.5 to 4.8)	0.744

Table 4. Mean grip strength over time (kg, hand dynamometer)

Follow-up interval	Conservative (mean ± SD)	K-wire (mean ± SD)	Between group mean difference	95% Confidence Interval	F value	p-value	Partial η^2
1st week	18.0 ± 0.5	19.5 ± 1.0	1.5kg	0.90 to 2.10 kg	—	< 0.001	—
1st month	20.5 ± 1.5	21.0 ± 1.2	0.5kg	-0.52 to 1.52 kg	—	0.323	—
3rd month	22.0 ± 1.5	22.5 ± 1.0	0.5kg	-0.46 to 1.46 kg	—	0.293	—
6th month	24.0 ± 0.7	24.5 ± 1.25	0.5kg	-0.27 to 1.27 kg	—	0.190	—
Time effect	Both groups	—	—	—	420.83	<0.001	0.938
Group effect	Conservative vs K-wire	—	—	—	0.20	0.661	0.007
Time × Group interaction	Both groups	—	—	—	14.09	<0.001	0.335

The grip strength for the Conservative group increased from 18.0 ± 0.5 kg at the 1st week to 24.0 ± 0.7 kg at the 6th month, whereas the K-wire group showed an increase from 19.5 ± 1.0 kg at the 1st week to 24.5 ± 1.25 kg at the 6th month. Both groups exhibited progressive, statistically significant improvement in grip strength over time ($p < 0.001$). On independent-samples t-testing at each tracking interval, the K-wire group had a significantly higher grip strength at 1 week (mean difference: 1.5 kg; 95% CI: 0.90 to 2.10 kg; $p < 0.001$). However, the between-group difference was not statistically significant at 1 month (95% CI: -0.52 to 1.52 kg; $p = 0.323$), 3 months (95% CI: -0.46 to 1.46 kg; $p = 0.293$), or 6 months (95% CI: -0.27 to 1.27 kg; $p = 0.190$). When within-group change was evaluated, the Conservative group's absolute gain (+6.0 kg, 95% CI 5.72 to 6.28 kg, $p < 0.001$) was significantly larger than the K-wire group's (+5.0 kg, 95% CI 4.50 to 5.50 kg, $p < 0.001$).

A two-way mixed repeated-measures ANOVA demonstrated a significant effect of time on grip strength, $F(3,56) = 420.83$, $P < 0.001$, partial $\eta^2 = 0.938$, indicating a very large improvement in grip strength across the four follow-up assessments. There was no significant main effect of treatment group, $F(1,28) = 0.20$, $P = 0.661$, partial $\eta^2 = 0.007$, indicating that the overall mean grip strength across follow-up was not significantly different between the conservative and K-wire groups.

However, a statistically significant time × treatment-group interaction was observed, $F(3,56) = 14.09$, $P < 0.001$, partial $\eta^2 = 0.335$, demonstrating that the trajectory of grip-strength recovery differed significantly between treatment groups. Descriptively, grip strength increased from 18.00 ± 0.50 to 24.00 ± 0.70 in the conservative group and from 19.50 ± 0.10 to 24.50 ± 1.25 in the K-wire group between 1 week and 6 months.

Bonferroni-adjusted post-hoc analysis demonstrated statistically significant improvements between every pair of consecutive and non-consecutive time points (all adjusted $P < 0.001$).

Overall, these findings indicate a marked improvement in grip strength over the 6-month follow-up period in both treatment groups, with a statistically significant difference in the pattern of recovery between groups.

Serial assessment of functional scores showed an upward trend in overall patient recovery from 1 week to 6 months post-treatment (fig 3). At the initial 1-week assessment, a majority of patients achieved excellent or good outcomes, with only 1 patient in each treatment group scoring as fair. No poor outcomes were recorded at any stage of the study. By the final 6-month evaluation, all patients in both treatment columns achieved either excellent or good functional outcomes, with the K-wire group having a slight predominant absolute count of excellent scores (n=11) compared to the Conservative group (n=10). The Mann-Whitney U test showed no statistically significant between-group difference in functional score at any interval (1 week ($U = 105.5$, $p = 0.76$; rank-biserial $r = 0.06$, 95% CI -0.30 to 0.43), 1 month ($U = 109.0$, $p = 0.89$; $r = 0.03$, 95% CI -0.33 to 0.40), 3 months ($U = 109.5$, $p = 0.90$; $r = 0.03$, 95% CI -0.33 to 0.36) and 6 months ($U = 105.0$, $p = 0.72$; $r = 0.07$, 95% CI -0.27 to 0.40)). However, since the confidence intervals are wide this should be read as "no difference detected" rather than as evidence of equivalence between the two treatments. (table 5)

Table 5: Comparison of Functional Scores Over Time (1 Week to 6 Months)

Time Interval	Treatment Group	Excellent (n)	Good (n)	Fair (n)	Poor (n)
1 Week	Conservative	7	7	1	0
	K-wire	8	6	1	0
1 Month	Conservative	8	6	1	0
	K-wire	8	7	0	0
3 Months	Conservative	9	5	1	0
	K-wire	9	6	0	0
6 Months	Conservative	10	5	0	0
	K-wire	11	4	0	0

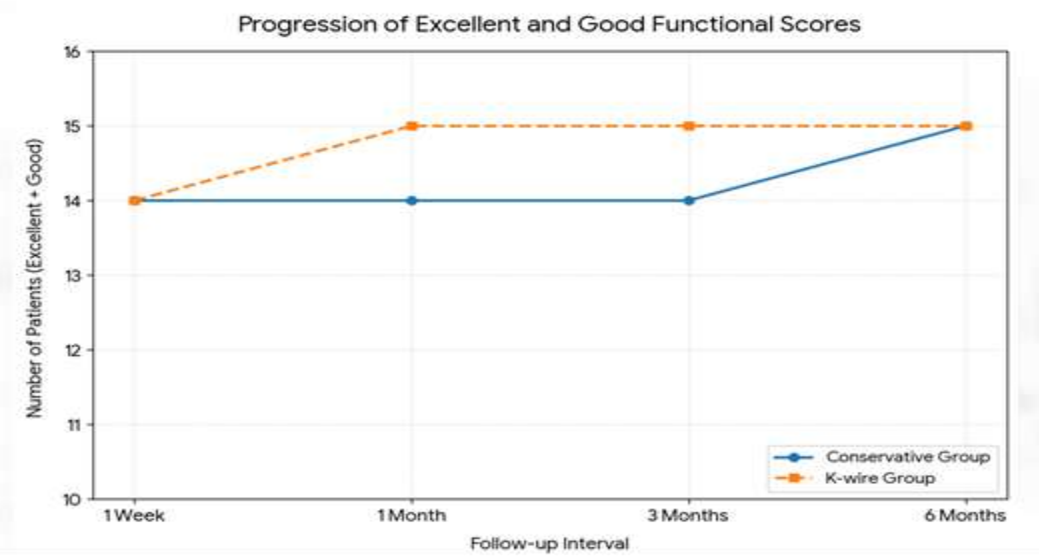

Figure 3: progression of functional scores

DISCUSSION

The distal radioulnar joint (DRUJ) as bony constraints provide less than 20% of joint stability, meaning the articulation relies heavily on soft-tissue structures. [10] In a classic Galeazzi fracture-dislocation, a displaced fracture of the radial shaft causes structural shortening and disruption of the forearm skeleton arc. This mechanical failure transmits axial and rotational loads directly across the TFCC foveal insertion, tearing the ligaments and driving acute DRUJ displacement. [12] Historically, acute Galeazzi injuries in adults were managed via closed reduction and long-arm casting. However, landmark historical literature confirmed that conservative treatment of adult radial shaft fractures yields unacceptably poor functional outcomes in over 90% of cases, primarily due to secondary displacement from muscular forces like the pronator quadratus. [13,14]

The current gold-standard protocol requires rigid open reduction and internal fixation (ORIF) of the radial shaft with plate osteosynthesis. Landmark studies demonstrate that anatomically restoring radial length and rotation often naturally reduces the DRUJ by re-tensioning secondary soft-tissue stabilizers. [13,15]. Controversy persists regarding the optimal management of the DRUJ after the radius is securely plated. Standard algorithms dictate that DRUJ stability must be evaluated intraoperatively through a clinical "stress test" in maximum supination and pronation. [16]

Proponents of non-operative DRUJ management argue that if the joint is reducible and stable within a specific rotational arc (typically supination), supplemental surgical fixation is redundant. Recent clinical trials indicate that simple long-arm cast immobilization for 4 to 6 weeks provides long-term functional recovery profiles equivalent to surgical stabilization, avoiding the risks of pin-site infection or hardware migration. [17]

Conversely, several surgical series argue that when gross or persistent micro-instability is felt after radial plating, percutaneous trans fixation pinning is mandatory. Surgical literature shows that mechanical pinning provides a highly predictable healing environment, reducing the rate of latent secondary subluxation. [18] This allows for earlier digital mobilization and avoids the rigid constraints of heavy long-arm casts.

In the present study both treatment groups achieved comparable and functional ranges of wrist flexion, extension, pronation and supination, with no patient demonstrating a fixed block to forearm rotation. This is broadly consistent with the improvements in wrist mobility reported by Kumar et al. [19] following volar plating, and with the mean flexion and extension angles of 61.3° and 71.8° respectively reported by Sahin and Cepni[20] for isolated distal radius fractures, and 56.7° and 64.6° for those with associated DRUJ instability.

Grip strength improved progressively and significantly within both groups across the six-month follow-up period, rising from a mean of 18.0–19.5 kg at 1 week to 24.0–24.5 kg at 6 months (within-group gain of 6.0 kg in the Conservative group and 5.0 kg in the K-wire group, both $p < 0.001$). The Conservative group started from a lower 1-week grip strength and converged with the K-wire group by 6 months. Although direct grip-strength values were not reported by Sahin and Cepni, [20] their use of the Modified Mayo Wrist Score and DASH score to capture overall hand function showed good functional recovery in patients managed with K-wire trans-fixation, broadly corroborating the trend observed here. Similarly, Varma et al. [21] reported good functional outcome by DASH score in 58% of their Galeazzi fracture cohort, and Kumar et al. [19] reported excellent Mayo Wrist Score outcomes in 80% of patients — both consistent with the steady functional gains observed in the present series irrespective of the method used to manage DRUJ instability.

At each follow-up interval, the proportion of excellent and good outcomes rose progressively, culminating in 70% excellent and 30% good results at 6 months, with no fair or poor outcome in either group. This is comparable to, and in this cohort marginally better than, the 84% good-to-excellent outcome reported by Sahin and Cepni[20] using the Modified Mayo Wrist Score, the 58% good outcome reported by Varma et al. [21] using the DASH score, and the 80% excellent outcome reported by Kumar et al. [19] using the Mayo Wrist Score. Taken together, these comparisons - despite the use of differing outcome instruments across studies - support the conclusion that rigid radial fixation combined with an appropriately chosen strategy for residual

DRUJ instability, whether immobilization in supination or supplementary K-wire trans-fixation, yields a favorable functional result in the great majority of patients.

On formal between-group testing, neither treatment arm was statistically significantly superior to the other on grip strength (beyond the 1-week interval), range of motion, or Gartland and Werley score at any follow-up interval. The K-wire group showed a marginally higher mean grip strength and a slightly greater proportion of excellent Gartland and Werley scores at 6 months.

CONCLUSION

Both above-elbow POP immobilization in supination and supplementary K-wire trans-fixation were associated with favorable functional recovery after rigid plate fixation of Galeazzi fractures - 70% excellent and 30% good Gartland and Werley scores overall at 6 months, with no fair or poor outcomes in either group - and no statistically significant between-group difference was demonstrated on any outcome measure from 1 month onward. Given the small sample size (n = 30) and the absence of a pre-specified equivalence margin, this finding should be interpreted as no difference having been demonstrated in this cohort rather than as proof that the two strategies are clinically equivalent; a larger, purpose-designed non-inferiority trial would be required to establish true equivalence. Our findings show that with meticulous anatomical reduction and rigid fixation of the radial shaft, an individualized strategy for residual DRUJ instability and diligent structured follow-up are the key determinants of a satisfactory outcome in Galeazzi fracture-dislocation.

Limitations

- Relatively small sample size (n = 30) from a single centre, limiting statistical power to detect modest between-group differences.
- The study was designed as a comparative study, not as a formal equivalence or non-inferiority trial; consequently, the non-significant difference between-group p-values reported here indicate that no difference was detected, not that the two treatments have been shown to be equivalent. A pre-specified clinically meaningful margin and a correspondingly larger sample would be needed to support an equivalence claim.
- Follow-up limited to 6 months; longer-term outcomes, including late DRUJ arthrosis, were not assessed.
- Absence of a routine TFCC repair arm precludes direct comparison with ligamentous repair strategies described in the literature.

Declaration by Authors

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