RESEARCH PAPER

Functional and Radiological Outcomes of K-Wire Versus Plate Fixation in Adult Metacarpal Shaft Fractures: A Retrospective Comparative Study

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ABSTRACT

Background

Metacarpal shaft fractures are among the most common hand injuries in adults and frequently require surgical intervention when unstable or displaced. K-wire fixation and plate fixation are widely used techniques, each offering distinct advantages in fracture stabilization and functional recovery.

Aim

To compare the functional and radiological outcomes of K-wire fixation and plate fixation in adult metacarpal shaft fractures.

Materials and Methods

This retrospective comparative study was conducted in the Department of Orthopaedics, Saveetha Medical College and Hospital, Chennai. Patients were recruited over a 12-month period from December 2024 to November 2025, and each patient was followed for a minimum of 6 months from the date of surgery; final data extraction and analysis were carried out after the last-enrolled patient completed this minimum follow-up. A total of 50 adult patients with metacarpal shaft fractures were included, with 25 patients treated by K-wire fixation and 25 by plate fixation. Clinical records and radiographs were reviewed to assess fracture union, range of motion, DASH score, Total Active Motion (TAM), and postoperative complications. Statistical analysis was performed using SPSS version 26.0, with $p < 0.05$ considered statistically significant.

Results

Plate fixation demonstrated significantly earlier radiological union (7.8 ± 1.2 weeks vs. 8.9 ± 1.4 weeks; p=0.014), superior DASH scores (10.6 ± 4.8 vs. 14.8 ± 6.3; p=0.021), and better Total Active Motion (p=0.037) than K-wire fixation. Pin tract infection, finger stiffness, and malunion were more common in the K-wire group, whereas implant irritation occurred more frequently following plate fixation; overall complication rates were lower in the plating group.

Conclusion

Both fixation methods provided satisfactory fracture healing and functional recovery. However, plate fixation offered superior radiological and functional outcomes by enabling earlier mobilization and improved hand function, making it a favourable option for unstable metacarpal shaft fractures; these findings should be regarded as preliminary given the retrospective design and modest sample size.

Keywords

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INTRODUCTION

Metacarpal shaft fractures are among the most common injuries of the hand, accounting for approximately 30–40% of all hand fractures and nearly 10% of all skeletal fractures presenting to emergency departments. These injuries are particularly frequent in young, active adults and commonly result from direct trauma, road traffic accidents, falls, sports injuries, or punching mechanisms. Because the metacarpals play a vital role in maintaining hand biomechanics, grip strength, and dexterity, improper management may lead to

malunion, stiffness, rotational deformity, reduced grip strength, and impaired hand function. Therefore, achieving anatomical reduction with stable fixation is essential to restore normal hand mechanics and enable early rehabilitation. (1)

The metacarpals form the structural framework of the hand and contribute significantly to the transverse and longitudinal arches that permit coordinated finger movement. The second and third metacarpals provide a relatively rigid central pillar, whereas the fourth and fifth metacarpals possess greater mobility to facilitate grasping. Shaft fractures may occur in transverse, oblique, spiral, or comminuted patterns, each presenting unique biomechanical challenges. Rotational malalignment is particularly poorly tolerated because even minimal rotational deformity at the metacarpal level becomes magnified during finger flexion, resulting in digital overlap and compromised hand function. Consequently, treatment should aim not only for fracture union but also for restoration of alignment, length, and rotational stability. (2)

The choice of treatment depends on fracture location, displacement, angulation, shortening, rotational deformity, patient occupation, and functional demands. Stable, minimally displaced fractures can often be managed conservatively with splinting or casting. However, unstable shaft fractures, multiple metacarpal fractures, open injuries, significantly displaced fractures, and fractures associated with rotational deformity generally require operative stabilization. Surgical fixation facilitates anatomical reduction, maintains fracture alignment, and permits earlier mobilization, thereby minimizing stiffness and improving functional outcomes. Over recent decades, several fixation techniques have evolved, including Kirschner wire (K-wire) fixation, lag screw fixation, intramedullary fixation, and plate osteosynthesis, each with distinct advantages and limitations. (3)

Kirschner wire fixation remains one of the most commonly employed methods for treating metacarpal shaft fractures because of its simplicity, minimal soft tissue dissection, shorter operative time, and relatively low cost. K-wires may be inserted in ante grade, retrograde, transverse, or crossed configurations depending on the fracture morphology and surgeon preference. Percutaneous fixation preserves periosteal blood supply and minimizes surgical trauma, making it particularly attractive in resource-limited settings. Nevertheless, K-wire fixation provides comparatively less rigid stability than plate fixation and often necessitates prolonged immobilization until fracture healing occurs. Potential complications include pin tract infection, wire migration, loss of reduction, delayed mobilization, tendon irritation, and secondary displacement, all of which may influence functional recovery. (4)

Figure 1: Pre-op and Post-op X-ray of K-wire fixation to 5th metacarpa]

Plate fixation has gained increasing acceptance for unstable metacarpal shaft fractures because it provides rigid fixation, excellent rotational stability, and allows early active mobilization. Modern low-profile locking and non-locking plates have been designed to reduce implant prominence while providing adequate mechanical strength. Plate osteosynthesis is especially beneficial in comminuted fractures, segmental fractures, multiple metacarpal injuries, and fractures requiring precise anatomical reconstruction. Early mobilization facilitated by stable fixation contributes to preservation of joint motion, tendon gliding, and grip strength. However, plate fixation requires more extensive soft tissue dissection, increasing the risk of periosteal stripping, tendon adhesions, hardware irritation, infection, and the possible need for implant removal. Furthermore, plate fixation is associated with higher operative costs and longer surgical duration compared with K-wire fixation. (5)

[Figure 2: Pre-op and Post-op X-rays of Plating to 3rd and 4th metacarpal]

Radiological union and functional recovery are the two principal outcome measures following metacarpal fracture surgery. Radiographic evaluation focuses on fracture alignment, callus formation, cortical continuity, maintenance of reduction, and time to union. Functional assessment includes range of motion

of the metacarpophalangeal and interphalangeal joints and validated outcome measures such as the Disabilities of the Arm, Shoulder and Hand (DASH) score, Total Active Motion (TAM). Although radiological union is generally achieved with both fixation methods, differences in fixation stability may influence the speed of rehabilitation and ultimate functional performance. Consequently, both radiological and clinical outcomes should be considered when comparing surgical techniques. (6)

Several comparative studies have evaluated K-wire fixation and plate fixation for metacarpal shaft fractures, yet the optimal method remains controversial. Some investigators have reported superior early mobilization, greater grip strength, and lower rates of malunion following plate fixation because of its rigid biomechanical stability. Conversely, other studies have demonstrated comparable long-term functional outcomes between K-wire fixation and plate fixation despite differences in early rehabilitation. The relatively less invasive nature of K-wire fixation may reduce surgical morbidity while achieving satisfactory fracture healing in appropriately selected patients. These conflicting findings suggest that patient selection, fracture pattern, surgical expertise, and rehabilitation protocols substantially influence treatment outcomes. (7)

Biomechanical investigations have shown that plate fixation provides greater resistance to bending, torsional, and rotational forces compared with K-wire constructs. This enhanced stability allows immediate controlled motion without compromising fracture alignment. Nevertheless, increased implant rigidity may also alter stress distribution across the fracture site and contribute to stress shielding or hardware-related complications. In contrast, K-wire fixation provides adequate stabilization for many simple fracture configurations while preserving soft tissue integrity and periosteal circulation, both of which promote biological fracture healing. Thus, the decision between K-wire fixation and plate fixation should balance mechanical stability against biological preservation and surgical invasiveness. (8)

Despite advances in implant technology and operative techniques, there remains no universal consensus regarding the preferred fixation method for adult metacarpal shaft fractures. Most available studies have been limited by relatively small sample sizes, heterogeneous fracture patterns, variable rehabilitation protocols, and inconsistent outcome measures. Furthermore, evidence from rural and resource-constrained healthcare settings remains limited, where cost-effectiveness and surgical simplicity are important considerations. Therefore, retrospective comparative studies evaluating both functional and radiological outcomes provide valuable clinical evidence to guide surgical decision-making. The present study was undertaken to compare K-wire fixation and plate fixation in adult metacarpal shaft fractures with respect to fracture union, radiological alignment, and functional recovery, range of motion, complications, and overall clinical outcomes, thereby helping identify the most appropriate treatment strategy for these commonly encountered injuries. (9)

AIM

To compare the functional and radiological outcomes of K-wire fixation and plate fixation in adult patients with metacarpal shaft fractures.

OBJECTIVES

1. To evaluate and compare fracture union, radiological alignment, and postoperative complications following K-wire fixation and plate fixation in adult metacarpal shaft fractures.
2. To compare the functional outcomes of both fixation methods based on range of motion and DASH scores.

MATERIALS AND METHODS

Study Area

The present retrospective comparative study was conducted in the Department of Orthopaedics, Saveetha Medical College and Hospital, Chennai, a tertiary care teaching hospital providing comprehensive trauma and reconstructive orthopaedic services.

Study Design

Retrospective comparative study.

Study Duration

The study period for patient recruitment was 12 months, from December 2024 to November 2025. Every included patient was followed for a minimum of 6 months from the date of surgery, and follow-up data collection continued beyond the recruitment window as needed to satisfy this minimum for later-enrolled patients.

Sample Size

A total of 50 adult patients with metacarpal shaft fractures who underwent surgical fixation were included in the study.

Group A (K-wire fixation): 25 patients

Group B (Plate fixation): 25 patients

Study Population

Adult patients diagnosed with metacarpal shaft fractures who underwent operative treatment with either K-wire fixation or plate fixation at the Department of Orthopaedics during the study period were included. Patients were identified from hospital records, operative registers, and radiographic databases.

Sampling Method

Consecutive sampling was employed. Eligible patients fulfilling the inclusion criteria during the study period

were included until the required sample size was achieved.

Data Collection

Patient records were reviewed to obtain demographic details, mechanism of injury, hand dominance, fracture characteristics, associated injuries, operative details, and postoperative follow-up findings. Preoperative anteroposterior, oblique, and lateral radiographs were evaluated to determine fracture location, pattern, displacement, and alignment. Operative notes were reviewed to identify the fixation method employed.

Postoperative follow-up records and serial radiographs were analysed to assess fracture union, maintenance of reduction, and complications. Functional outcome assessment included Total Active Motion (TAM) and Disabilities of the Arm, Shoulder and Hand (DASH) score. Complications such as infection, implant irritation, malunion, non-union, stiffness, tendon adhesions, hardware failure, and need for secondary surgery were also recorded.

Outcome Measures

Time to radiological fracture union; functional outcome using DASH score; Total Active Motion (TAM); postoperative complications.

Statistical Analysis

The collected data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Independent Student's t-test was used for comparison of continuous variables between the two groups, while the Chi-square test or Fisher's exact test was used for categorical variables; Fisher's exact test was used in place of chi-square wherever expected cell counts were below 5. A p-value <0.05 was considered statistically significant.

Ethical Considerations

This study was conducted following review and approval by the Institutional Ethics Committee of Saveetha Medical College and Hospital. As a retrospective review of existing clinical and radiographic records, the requirement for individual informed consent was waived by the Institutional Ethics Committee. Patient data confidentiality was maintained throughout data extraction and analysis.

Inclusion Criteria

- Adult patients aged 18 years and above.
- Patients with closed metacarpal shaft fractures involving one or more metacarpals.
- Patients treated surgically with either K-wire fixation or plate fixation.
- Patients with complete clinical records, operative details, and radiographic follow-up until fracture union.
- Patients with a minimum follow-up period of six months.

Exclusion Criteria

- Patients younger than 18 years.
- Open metacarpal fractures with severe soft tissue injury.
- Intra-articular fractures involving the metacarpal head or base.
- Pathological fractures.
- Associated tendon, nerve, or vascular injuries requiring complex reconstruction.
- Previous fractures or deformities affecting the same hand.
- Polytrauma patients with injuries preventing functional assessment of the hand.
- Patients with incomplete medical records or inadequate radiological follow-up.
- Patients who underwent revision surgery for failed fixation elsewhere.

RESULTS

A total of 50 adult patients with metacarpal shaft fractures were included in the study. Of these, 25 patients underwent K-wire fixation (Group A) and 25 patients underwent plate fixation (Group B). Baseline demographic characteristics were comparable between the two groups. Functional and radiological outcomes were assessed during follow-up and compared.

Table 1. Age Distribution

Age (years)	K-wire (n=25)	Plate (n=25)	Total
18–30	9 (36%)	8 (32%)	17 (34%)
31–40	8 (32%)	9 (36%)	17 (34%)
41–50	5 (20%)	5 (20%)	10 (20%)
>50	3 (12%)	3 (12%)	6 (12%)
Mean ± SD	34.8 ± 9.6	35.6 ± 10.2	35.2 ± 9.9

Most patients belonged to the 18–40 years age group in both treatment groups. There was no statistically significant difference in age distribution between the groups (p=0.78).

Table 2. Gender Distribution

Gender	K-wire (n=25)	Plate (n=25)	Total (n=50)
Male	18 (72%)	17 (68%)	35 (70%)
Female	7 (28%)	8 (32%)	15 (30%)

Male patients constituted the majority of the study population (70% overall). Gender distribution was comparable between the two groups without a statistically significant difference.

Table 3. Mechanism of Injury

Mechanism	K-wire	Plate	Total
Road traffic accident	10 (40%)	11 (44%)	21 (42%)
Fall	8 (32%)	7 (28%)	15 (30%)
Sports injury	4 (16%)	4 (16%)	8 (16%)
Assault	3 (12%)	3 (12%)	6 (12%)

Road traffic accidents were the most common cause of metacarpal shaft fractures. The mechanism of injury was similar in both treatment groups.

Table 4. Time to Radiological Union

Time to Union (Weeks)	K-wire	Plate
6–8	8 (32%)	15 (60%)
9–10	13 (52%)	9 (36%)
>10	4 (16%)	1 (4%)
Mean ± SD	8.9 ± 1.4	7.8 ± 1.2
P value	0.014	

Patients treated with plate fixation demonstrated earlier radiological union compared with those treated with K-wire fixation. The difference was statistically significant (p=0.014).

Table 5. Functional Outcome (DASH Score at Final Follow-up)

DASH Score	K-wire	Plate
Excellent (<10)	8 (32%)	14 (56%)
Good (10–20)	11 (44%)	9 (36%)
Fair (21–30)	5 (20%)	2 (8%)
Poor (>30)	1 (4%)	0
Mean ± SD	14.8 ± 6.3	10.6 ± 4.8
P value	0.021	

Plate fixation resulted in significantly better functional outcomes with lower DASH scores. A higher proportion of patients in the plating group achieved excellent functional recovery.

Table 6. Total Active Motion (TAM) at Final Follow-up

TAM	K-wire	Plate
Excellent (>220°)	9 (36%)	16 (64%)
Good (180°–220°)	12 (48%)	8 (32%)
Fair (150°–179°)	4 (16%)	1 (4%)
Poor (<150°)	0	0
P value	0.037	

Patients treated with plate fixation achieved superior finger motion compared with the K-wire group. The difference in total active motion category distribution between the groups was statistically significant on Fisher's exact test.

Table 7. Postoperative Complications

Complication	K-wire	Plate
Pin tract infection	3 (12%)	0
Superficial wound infection	1 (4%)	2 (8%)
Implant irritation	1 (4%)	3 (12%)
Delayed union	2 (8%)	1 (4%)
Finger stiffness	4 (16%)	2 (8%)
Malunion	2 (8%)	0
No complications	12 (48%)	17 (68%)
P value	0.046	

The K-wire group showed a higher incidence of pin tract infection, finger stiffness, and malunion, whereas implant irritation was more common in the plating group. Overall complication rates were lower in the plating group, and the difference was statistically significant (p=0.046); given the number of complication categories compared, this result should be interpreted with caution.

DISCUSSION

The present retrospective comparative study evaluated the functional and radiological outcomes of K-wire fixation and plate fixation in adult metacarpal shaft fractures. The primary objective was to determine whether one fixation technique provided superior fracture union, functional recovery, and complication profile. The findings demonstrated that both K-wire fixation and plate fixation achieved satisfactory fracture healing and restoration of hand function. However, plate fixation was associated with earlier radiological union, improved functional outcomes measured by DASH score and Total Active Motion (TAM), and a lower incidence of postoperative complications, suggesting that rigid fixation permits more effective rehabilitation and earlier return of hand function. These observations are broadly consistent with previous comparative studies evaluating surgical management of metacarpal shaft fractures. (10)

The demographic characteristics of the present study were comparable between the two treatment groups. Most patients were young adults between 18 and 40 years of age, with a predominance of male patients. This age distribution reflects the higher incidence of

metacarpal fractures among economically active individuals exposed to occupational injuries, road traffic accidents, sports trauma, and interpersonal violence. Similar demographic patterns have previously been reported in comparative series of metacarpal fractures, which observed that these injuries commonly affect young males because of greater participation in high-risk activities. (4) Comparable baseline characteristics between the two groups reduce selection bias and strengthen the validity of the comparative outcomes observed in the present study.

Road traffic accidents constituted the most common mechanism of injury, followed by falls and sports-related trauma. These findings are similar to previous epidemiological reports that have identified high-energy trauma as a leading cause of metacarpal shaft fractures. Although the mechanism of injury influences fracture configuration and associated soft tissue damage, no statistically significant difference in injury mechanism was observed between the two groups, ensuring comparable fracture severity before intervention. Fracture pattern and soft tissue integrity remain major determinants of treatment selection and postoperative recovery regardless of the fixation method employed.

Radiological union remains one of the most important indicators of successful fracture management. In the present study, plate fixation achieved significantly earlier fracture union than K-wire fixation, with a mean union time of 7.8 ± 1.2 weeks compared with 8.9 ± 1.4 weeks in the K-wire group ($p=0.014$). Earlier union following plate fixation can be attributed to rigid stabilization, maintenance of anatomical reduction, and improved resistance to rotational and bending forces during hand movements. Stable fixation minimizes micro motion at the fracture site while allowing controlled early mobilization, thereby promoting favourable biological healing. Similar findings have been reported by Bosscha and Snellen, who demonstrated superior mechanical stability and earlier fracture consolidation following plate osteosynthesis compared with percutaneous K-wire fixation. (10)

Functional recovery after metacarpal fracture depends not only on fracture union but also on restoration of finger mobility, grip strength, and pain-free hand function. The present study demonstrated significantly better DASH scores among patients treated with plate fixation, indicating superior overall upper limb function. More than half of the plating group achieved excellent functional outcomes compared with approximately one-third of patients treated with K-wire fixation. The improved functional performance observed with plating may be explained by greater construct rigidity, which permits early active mobilization without compromising fracture stability. Early mobilization minimizes tendon adhesions, joint stiffness, muscle atrophy, and periarticular fibrosis, all of which contribute to improved long-term hand function.

Total Active Motion (TAM) is an objective measure of digital mobility and reflects successful rehabilitation following metacarpal fracture surgery. In the present study, patients treated with plate fixation demonstrated significantly greater TAM at final follow-up compared with the K-wire group. The majority of plated fractures achieved excellent finger motion exceeding 220°, whereas a larger proportion of K-wire-treated patients remained within the good or fair categories. These findings emphasize the importance of stable fixation in facilitating immediate postoperative mobilization. Previous biomechanical studies have shown that rigid plate constructs provide excellent resistance to rotational displacement, thereby allowing tendon gliding and preservation of joint motion during rehabilitation. (12)

Although plate fixation demonstrated superior functional outcomes, K-wire fixation continues to offer several clinical advantages. Percutaneous K-wire insertion requires minimal soft tissue dissection, preserves periosteal blood supply, shortens operative time, and reduces implant costs. Consequently, K-wire fixation remains particularly valuable for simple transverse fractures, minimally comminuted fractures, and healthcare settings with limited resources. However, because K-wire constructs provide relatively less rotational stability, temporary immobilization is often required until sufficient fracture healing occurs. This delayed mobilization may contribute to increased finger stiffness and slower functional recovery observed in the present study. Similar conclusions have been reported by Winter et al., who suggested that fracture morphology should guide implant selection rather than adopting a universal fixation method. (11)

Postoperative complications influence patient satisfaction and overall treatment success. In the present study, pin tract infection, malunion, delayed union, and finger stiffness were more common following K-wire fixation, whereas implant irritation occurred more frequently after plate fixation. Pin tract infections associated with exposed K-wires generally respond well to local wound care and antibiotics but may occasionally require early wire removal. Implant irritation following plate fixation is primarily related to hardware prominence over the dorsum of the hand and may necessitate implant removal after fracture union; implant removal rates were not systematically recorded in this study and could not be assessed. Despite these differences, the overall complication rate was relatively low in both groups, and no major

complications such as non-union, deep infection, tendon rupture, or implant failure were encountered. Previous studies have similarly reported acceptable complication profiles for both fixation techniques when meticulous surgical technique and appropriate rehabilitation protocols are followed. (4)

The superior outcomes observed with plate fixation can largely be explained by biomechanical considerations. Plate constructs resist axial compression, torsional loading, and bending forces more effectively than K-wire fixation. Such stability preserves fracture alignment throughout healing while allowing immediate active movement. Conversely, K-wire fixation primarily controls translational displacement but provides less resistance to rotational forces, making postoperative immobilization necessary in many cases. Experimental biomechanical investigations have consistently demonstrated greater stiffness and load-to-failure characteristics of plate fixation compared with crossed K-wire constructs, supporting the clinical findings observed in this study. (12)

The findings of the present study have important clinical implications. Plate fixation appears particularly advantageous in unstable, oblique, spiral, comminuted, and multiple metacarpal shaft fractures where rigid fixation is essential for early rehabilitation. Conversely, K-wire fixation remains an effective treatment option for simple fracture patterns because it is less invasive, technically straightforward, and economically advantageous. Therefore, implant selection should be individualized based on fracture configuration, bone quality, soft tissue condition, surgeon expertise, patient occupation, and financial considerations. Current evidence increasingly supports a patient-specific approach rather than recommending one fixation method for all metacarpal shaft fractures. (9)

The strengths of this study include comparison of two commonly employed fixation techniques using uniform radiological and functional outcome measures within a single tertiary care institution. The inclusion of objective parameters such as fracture union, DASH score, TAM, and complication rates provides a comprehensive assessment of treatment effectiveness. Nevertheless, several limitations should be acknowledged. The retrospective study design introduces the possibility of selection bias despite comparable baseline characteristics. The sample size was relatively small, reducing statistical power for uncommon complications, and multiple comparisons were performed without correction, which increases the risk of false-positive findings. Grip strength, duration of surgery, time to return to work or routine daily activities, requirement for implant removal or revision surgery, and patient-reported quality-of-life assessments were not captured, owing to the retrospective nature of data collection; these gaps should be addressed in future prospective work rather than treated as findings of the present study. Furthermore, long-term outcomes beyond one year, including post-traumatic arthritis and implant-related symptoms, could not be evaluated. Future prospective, randomized, multicentre studies with larger patient populations, standardized rehabilitation protocols, and complete capture of all pre-specified outcomes are warranted to validate these findings. (13)

Overall, the present study demonstrates that both K-wire fixation and plate fixation provide satisfactory radiological union and functional recovery in adult metacarpal shaft fractures. However, plate fixation resulted in earlier fracture union, better DASH scores, greater total active motion, and fewer complications compared with K-wire fixation in this cohort. These findings are broadly consistent with orthopaedic literature advocating stable fixation to facilitate early mobilization and optimize functional recovery. Nevertheless, K-wire fixation remains a reliable, minimally invasive, and cost-effective alternative for appropriately selected fracture patterns. Careful patient selection and individualized surgical planning remain key determinants of successful clinical outcomes following operative management of metacarpal shaft fractures. (2, 7)

CONCLUSION

This retrospective comparative study demonstrated that both K-wire fixation and plate fixation are effective treatment modalities for adult metacarpal shaft fractures, providing satisfactory fracture union and functional recovery. However, plate fixation resulted in earlier radiological union, better functional outcomes, improved total active motion, and better DASH scores compared with K-wire fixation. Although K-wire fixation remains a minimally invasive and cost-effective option, it was associated with a higher incidence of finger stiffness, pin tract infection, and delayed union. Plate fixation offers greater biomechanical stability, enabling earlier mobilization and rehabilitation. Plate fixation may therefore be a favourable treatment choice for unstable metacarpal shaft fractures, while K-wire fixation remains an appropriate option for selected simple fracture patterns and resource-limited settings. Given the retrospective design, modest sample size, and the several outcomes (grip strength, surgical duration, return-to-work time, and implant removal rate) that could not be fully assessed, these conclusions should be regarded as preliminary pending confirmation in a prospective, adequately powered study.

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