

RADIOLOGICAL AND FUNCTIONAL OUTCOME IN MANAGEMENT OF RADIUS SHAFT FRACTURE BY DIRECT LATERAL APPROACH – A PROSPECTIVE STUDY

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ABSTRACT

Radius shaft fractures require anatomical reduction and stable internal fixation to restore forearm rotation and upper limb function. The present prospective observational study evaluated the radiological and functional outcomes of radius shaft fractures managed through the direct lateral approach. A total of 20 adult patients with isolated radius shaft fractures or both-bone forearm fractures underwent open reduction and internal fixation with plate osteosynthesis. Operative duration, intraoperative blood loss, radiological union, postoperative complications, and functional recovery were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score and Grace and Eversmann criteria. Among the participants, 40% had isolated radius shaft fractures, while 60% had both-bone forearm fractures. Mean operative duration was 53.2 ± 5.1 minutes for isolated fractures and 105.4 ± 9.2 minutes for both-bone fractures, with corresponding blood losses of 115.4 ± 10.2 mL and 170.8 ± 18.4 mL, respectively. Radiological union occurred within 12 weeks in 80% of patients, while 85% demonstrated excellent or good radiological outcomes. Excellent or good functional recovery was observed in 85% of patients. Delayed union occurred in one patient (5%), without other major reported complications. The findings suggest that the direct lateral approach is a feasible surgical option for selected adult radius shaft fractures, although larger comparative studies with longer follow-up are warranted.

KEYWORDS: Radius shaft fracture; Direct lateral approach; Plate fixation; Radiological union; Functional outcome.

1. INTRODUCTION

Forearm shaft fractures are an important aspect of adult orthopaedic trauma, as they can impair the function and mobility of the upper limb. These injuries can occur to the radius or to both forearm bones and are often the result of a road traffic incident, fall or other trauma. CourtBrown and Caesar (2006) showed that fractures in adults are an epidemiological issue, and Alffram and Bauer (1962) showed that fractures of the forearm are age and bone strength related. High energy injuries are common among younger adults, while low energy fractures are common among older adults. The acquired disability highlights the need for adequate management of fracture and restoration of normal forearm function.

The forearm is a functional anatomical and biomechanical unit that includes the radius, ulna, proximal radioulnar joint, distal radioulnar joint, and interosseous membrane. Skahen et al (1997) showed how significant the interosseous membrane is for the stability of the forearm and for load transfer between the bones. The proper function of these anatomical structures is needed for normal pronation/supination for the ability to accomplish important activities in daily living. Matthews et al. (1982) showed that rotation movements are markedly impaired in the forearm with angular malalignment after fracture. In the same way, Schemitsch and Richards (1992) have defined the need for anatomical restoration of the radial bow to achieve good functional recovery. Therefore, proper bone length, alignment and rotational anatomy is still the key to treatment success.

Displaced fractures of the forearm shaft in adults is a commonly treated fracture with a well established treatment of open reduction and internal fixation (ORIF) using a plate osteosynthesis. Anderson et al. (1975) showed good bone union and function with compression plating. Stable internal fixation allows anatomical reconstruction, rotational stability and early mobilization, which helps to minimize complications of prolonged immobilization. Schulte et al. (2014) also pointed out that the alignment of the forearm and radial bow are crucial to a good result following surgery. However, good surgical management requires not only implant stability but selection of a suitable surgical approach that will allow for proper exposure of the fracture and preserve the surrounding neurovascular structures.

The volar Henry and dorsal Thompson approaches are conventional surgical approaches to the radius. While these methods offer reasonable exposure, careful identification and protection of surrounding neurovascular structures is essential during surgery. Bartoníček et al. (2015) presented the anatomical and biomechanical aspects of internal fixation of radial shaft fracture. The posterior interosseous nerve is to be considered particularly in the dorsal approach, particularly at its proximal exposure. Hohenberger et al. (2018) studied this nerve in the context of anatomical safety in the lateral and posterior approaches. The above factors have fostered the interest in other surgical approaches which could be easier to dissect without compromising access for fracture fixation.

The direct lateral approach is used to access the radial shaft between the intermuscular space of the brachioradialis and extensor carpi radialis longus. Haseeb et al. (2018a) reported good fracture union and functional recovery after lateral exposure, a benefit that may be useful to help reduce the operative complexity and allow plate fixation. In a follow-up study, Haseeb et al. (2018b) showed that lateral plating could result in beneficial clinical outcomes and acceptable radial anatomy restoration. However, more prospective clinical studies are needed to define the parameters of the operation, radiological healing, functional recovery, and complications after this procedure.

Validated clinical assessment systems are suitable to evaluate functional recovery after a radial shaft fixation. Hudak et al. (1996) created a Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire to measure upper extremity symptoms and functional disability. Grace and Eversmann (1980) developed a functional evaluation system that included fracture healing and restoration of forearm rotation. These are complemented by radiological assessment focusing upon fracture union, anatomical alignment and implant stability. Thus, the present prospective study with radiological and functional assessment of patients who had radius shaft fractures in adulthood treated by direct lateral approach was designed to assess the radiological and functional results of the treatment, as well as the length of the surgery, the amount of blood loss, the range of forearm rotation and the occurrence of postoperative complications, using DASH and Grace and Eversmann assessment.

2. MATERIALS AND METHODS

2.1. Study Design and Setting

A prospective observational study was done in the Department of Orthopaedics, Mahatma Gandhi Medical College and Research Institute (MGMCRI), Puducherry, to assess the radiological and functional results of radius shaft fractures treated by the direct lateral approach. This study was carried out from May 2025 until May 2026 after the Institutional Human Ethics Committee (IHEC) approval. The direct lateral approach for ORIF (open reduction and internal fixation) with plate osteosynthesis was studied in a prospective study on patients in terms of operative parameters, fracture healing, functional recovery and postoperative complications.

2.2. Study Population and Sample Size

The study included 20 adult patients clinically and radiologically diagnosed with isolated radius shaft fractures or both-bone forearm shaft fractures requiring surgical fixation. The sample size was determined using the formula:

$$n = \left(\frac{Z_{\alpha/2} \times SD}{d} \right)^2$$

Based on previously reported findings, the mean operative duration for radius shaft fixation through the direct lateral approach was 37.5 minutes, with a standard deviation of 5.2 minutes (Haseeb et al., 2018). Using a 95% confidence level, a Z-value of 1.96, and an allowable absolute precision of 2.3 minutes, the estimated sample size was 19.6, rounded to 20 patients.

2.3. Eligibility Criteria

Patients > 18 years of age with isolated radius shaft fracture or both-bone forearm shaft fracture who were to be treated with ORIF via the direct lateral approach were included. Those with ipsilateral fractures of the humerus, carpal bones and/or metacarpal bones; preoperative neurological deficits; compound fractures or malunited radius fractures were excluded.

2.4. Preoperative Clinical and Radiological Assessment

Patients who met the inclusion criteria were thoroughly assessed with a detailed clinical history, history of the injury, and a physical examination. Pre-surgical laboratory tests and radiological tests were undertaken on a regular basis. Standard anteroposterior and lateral radiographs of forearm were taken with the elbow and wrist joints to evaluate the characteristics of the fractures and associated injuries. A standardized data collection proforma was used to record the preoperative findings and the clinical information. Informed consent and patient confidentiality were observed when taking clinical photographs.

2.5. Surgical Procedure

Each patient was operated upon under the appropriate anaesthetic and under normal aseptic measures with the direct lateral approach and plate osteosynthesis. Surgical approach was to expose the radial shaft in the intermuscular space between the brachioradialis and extensor carpi radialis longus muscles. The treatment was performed by fracture reduction and internal fixation with plate osteosynthesis. Surgical parameters such as operative time and blood loss were documented in each patient for assessment of surgical parameters related to the approach.

2.6. Postoperative Management and Follow-up

Post-surgical status and fracture alignment were assessed for patients by clinical and radiological evaluation. All the patient's care was done according to the hospital's protocols, with antibiotics, analgesics and immobilisation of the limbs. Physiotherapy was recommended for functional recovery and increasing forearm mobility. Patients were followed at three-months after surgery. Follow-up evaluations included pain, forearm range of motion, fracture healing, and complications of surgery. Standard anteroposterior and lateral radiographs were obtained to assess radiological outcomes.

2.7. Outcome Measures

The clinical and radiographic data that were obtained at the time of follow-up were used to evaluate the radiological and functional results.

Functional Outcomes: Disabilities of the Arm, Shoulder and Hand score and the Grace and Eversmann were used to assess functional recovery. The DASH questionnaire was used to assess upper extremity symptoms and functional disability (Hudak et al., 1996). A system of evaluation for functional recovery was adopted based on the fracture healing and restoration of forearm rotations (Grace & Eversmann, 1980). The postoperatively forearm mobility was evaluated by assessing the pronation and supination.

Radiological Outcomes: Fracture alignment, evidence of fracture union and implant position were evaluated. The postoperative radiographs were reviewed for healing and stability of fixation.

Operative Outcomes and Complications: Operative time and blood loss were recorded. Follow-up was used for evaluation of postoperative complications (delayed union and other clinically identified complications).

2.8. Statistical Analysis

Data obtained were entered into Microsoft Excel and analysed statistically. Means and standard deviations were used to summarise quantitative variables, and frequencies and percentages were used to summarise categorical variables. A p-value of < 0.05 was considered to indicate statistical significance.

2.9. Ethical Considerations

The study was done after the approval of Institutional Human Ethics Committee of Mahatma Gandhi Medical College and Research Institute, Puducherry. All participants were informed and consented in writing. The data obtained were kept confidential, and patient information and clinical photographs were used solely for research.

3. RESULTS

A total of 20 adult patients who developed a radius shaft fracture were treated by direct lateral approach open reduction and internal fixation. Eight of the 20 cases (40%) had an isolated radius shaft fracture and 12 had both-bone forearm fractures. Results of the surgeries were examined separately in these fracture groups.

3.1. Demographic and Fracture Characteristics

Nine patients (45%) were aged 30–39 years, six (30%) were aged 20–29 years, and five (25%) were aged 40–49 years. 85% of the participants (17) were men. Eleven injuries were to the left forearm (55%) and nine injuries were to the right forearm (45%). The most common mechanism of injury was road traffic accidents (11 patients, 55%), followed by falling from height (5, 25%) and slip and fall (4, 20%). As seen in tables 1, 20% of cases were two-bone forearm fractures and 40% were isolated radial shaft fractures.

Table 1. Distribution of Fracture Types

Type of Fracture	Number of Patients (n)	Percentage (%)	P Value
Isolated Radius Shaft Fracture	8	40.0	0.031
Both Bone Forearm Fracture	12	60.0	0.031

3.2. Operative Characteristics and Plate Fixation

The mean operative time for isolated radius shaft fractures was 53.2 ± 5.1 minutes (range, 45–60 minutes) while it was 105.4 ± 9.2 minutes (range, 90–120 minutes) for both-bone forearm fractures. The original distributions of the operative durations are shown in Tables 2 and 3. The amount of mean blood loss during surgery was 115.4 ± 10.2 mL for fractures of one bone only and 170.8 ± 18.4 mL for the two-bone fractures. Ten patients (50%) received dynamic compression plates, 6 patients (30%) received limited-contact dynamic compression plates and 4 patients (20%) received locking compression plates.

Table 2. Operative Duration in Isolated Radius Shaft Fractures

Mean Duration (minutes)	Standard Deviation	Minimum Duration	Maximum Duration	P Value
53.2	5.1	45	60	0.001

Table 3. Operative Duration in Both-Bone Forearm Fractures

Mean Duration (minutes)	Standard Deviation	Minimum Duration	Maximum Duration	P Value
105.4	9.2	90	120	0.001

3.3. Radiological Union and Outcomes

Five patients (30%) achieved radiological union within 10 weeks, 10 to 12 weeks in 10 patients (50%), and over 12 weeks in 4 patients (20%). The union times are represented in graphical form in Figure 1. Eleven patients (55%) had excellent outcome grade, six patients (30%) had good, two patients (10%) had fair and one (5%) had poor outcome grade according to the radiological outcome grading recorded in the thesis as shown in Table 4.

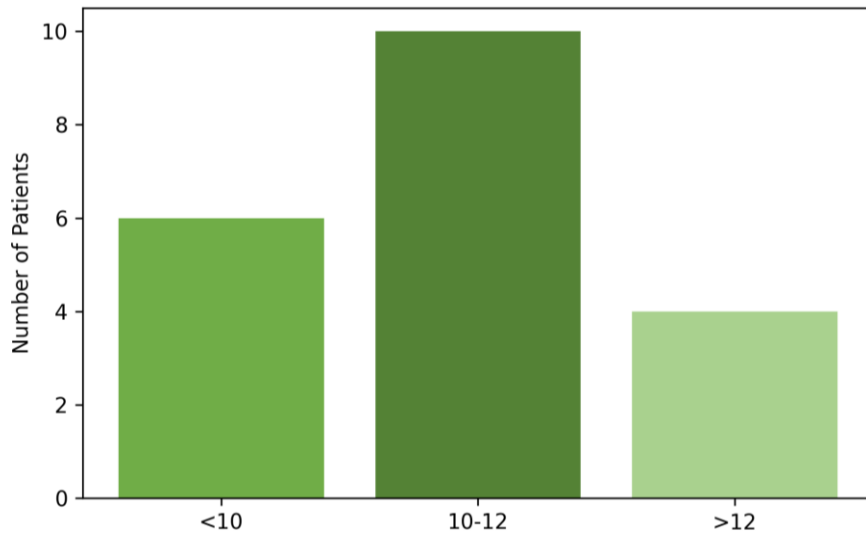


Figure 1. Time to Radiological Union

Table 4. Radiological Outcomes Following Fixation

Radiological Outcome	Number of Patients (n)	Percentage (%)	P Value
Excellent	11	55.0	0.001
Good	6	30.0	0.001
Fair	2	10.0	0.001
Poor	1	5.0	0.001

3.4. Functional Outcomes and Forearm Rotation

Seven patients (35%) had a score in the range of 10-14, eight patients (40%) in the range of 15-18, and five patients (25%) in the range of 19-22 on the postoperative DASH scores. The original score distribution is shown in Figure 2. As shown in Table 5, functional outcomes were excellent in twelve patients (60%), good in five (25%), acceptable in two (10%) and unacceptable in one patient (5%). Pronation ranged from 81° to 90° in fifteen patients (75%) and from 70° to 80° in five (25%). There were sixteen patients (80%) who had a supination range between 81° to 90° and four (20%) had a supination range of 70° to 80° (shown in Figure 3).

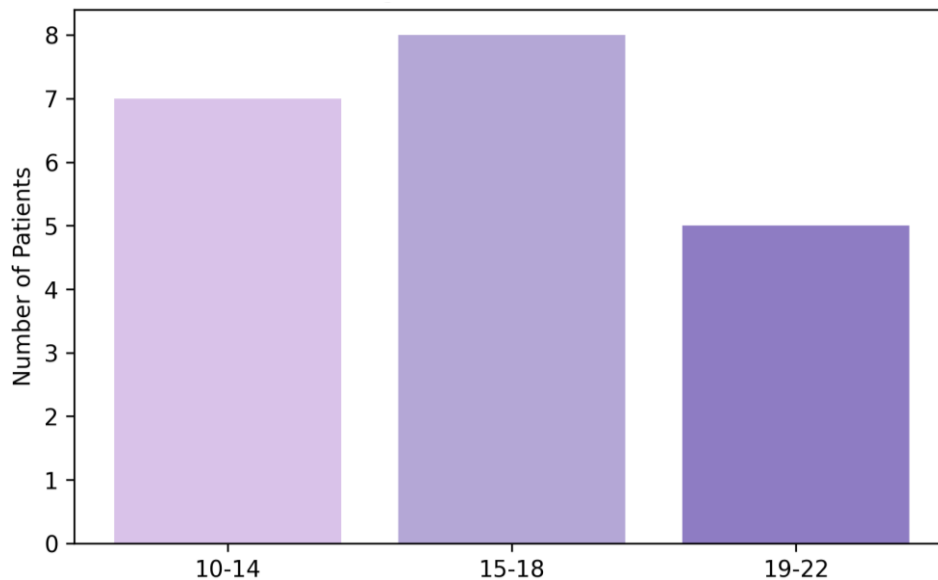


Figure 2. Distribution of Postoperative DASH Scores

Table 5. Functional Outcomes According to Grace and Eversmann Criteria

Functional Outcome Grade	Number of Patients (n)	Percentage (%)	P Value
Excellent	12	60.0	0.001
Good	5	25.0	0.001
Acceptable	2	10.0	0.001
Unacceptable	1	5.0	0.001

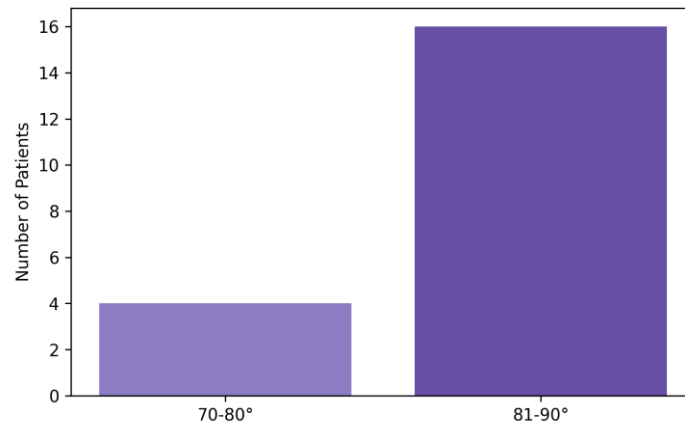


Figure 3. Postoperative Range of Supination

3.5. Postoperative Complications

Nineteen patients (95%) had no recorded postoperative complications. Delayed union occurred in one patient (5%), as recorded in the study. No postoperative infection, malunion, nonunion, implant failure, or neurovascular injury was reported in the original study.

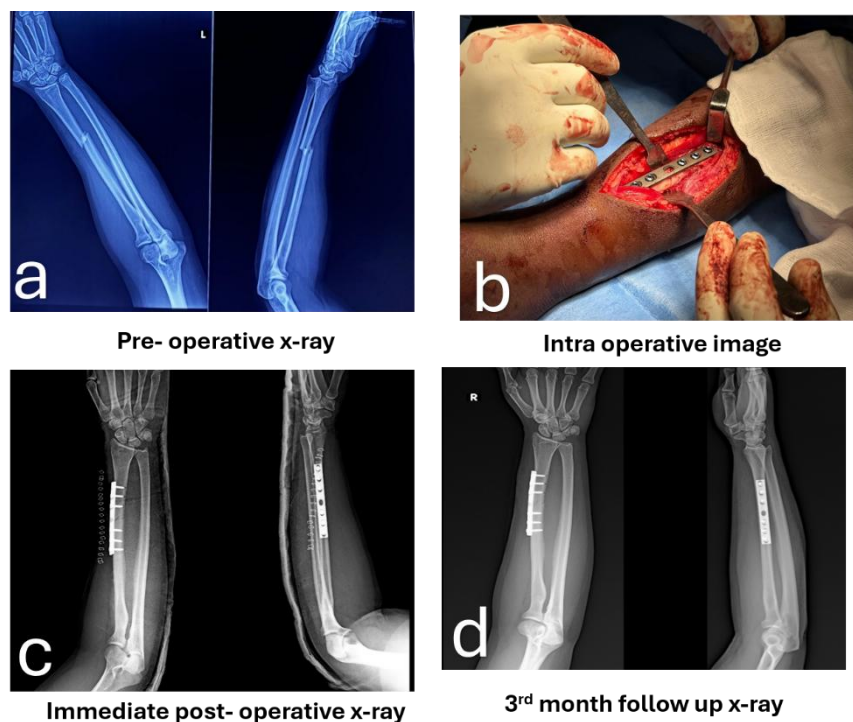


Figure 4: The preoperative radiographs, intraoperative plate fixation, immediate postoperative radiographs, and follow-up radiographs demonstrating fracture healing and maintained alignment are presented in Figure 4(a–d).

Figure 4. Radiological and intraoperative assessment of radius shaft fracture management through the direct lateral approach: (a) preoperative anteroposterior and lateral radiographs showing the radius shaft fracture; (b) intraoperative photograph showing plate fixation; (c) immediate postoperative radiographs demonstrating fracture reduction and internal fixation; and (d) follow-up radiographs showing maintained alignment and radiological healing.

4. DISCUSSION

The authors then assessed the radiological and functional results of the direct lateral approach in the treatment of radius shaft fractures in 20 adult patients in a prospective study. Results showed good fracture healing, acceptable postoperative forearm rotation and low incidence of reported complications. The majority of patients were male (85%) and the age group with the highest number was 30-39 years old (45%). Road traffic accidents caused 55% of the injuries with both-bone forearm fractures representing 60% of the cases. The results are similar to those reported by Court-Brown and Caesar (2006) who have reported significant numbers of traumatic fractures in adults.

We found differences in operative results when comparing isolated radius shaft fractures with both-bone forearm fractures. The mean operative time was 53.2 ± 5.1 minutes for isolated fractures and 105.4 ± 9.2 minutes for both-bone fractures. Intraoperative blood loss was 115.4 ± 10.2 mL and 170.8 ± 18.4 mL, respectively. Some of these differences may be attributed to the greater surgical exposure and fixation necessary for both bone injuries. The lateral approach has

been reported as having an operation time of 37.5 minutes for isolated radial fractures and 80.7 minutes for both bone fractures (Haseeb et al., 2018a). The fracture characteristics and the operating conditions may have affected the results in the present study, although the operative times were longer. In addition, Leung and Chow (2006) showed that plate fixation was clinically useful in the treatment of fractures of the forearm, focusing on stable fixation and good clinical results.

The 50% of patients that had radiological assessment had a median healing time of 10–12 weeks, with 30% healing in less than 10 weeks and 20% taking longer than 12 weeks. The results for the radiographs were excellent in 55% and good in 30% of patients. The results of this study indicate that there is satisfactory fracture healing after fixation using a direct lateral approach. The importance of stable internal fixation in achieving high union rates was highlighted by Anderson et al. (1975) who reported on high union rate after compression-plate fixation of adult forearm fractures. In the same way, 18 out of 19 cases of radial shaft fractures treated with lateral plating showed fracture union in Haseeb et al. (2018b). Schemitsch and Richards (1992) showed that restoration of anatomical alignment and radial bow is essential for successful healing and postoperative function.

Functional outcomes were good with DASH scores primarily in the 10–22 range (relatively low upper extremity disability). 60% of patients were judged as excellent, 25% good, 10% acceptable, and 5% unacceptable, according to Grace and Eversmann assessment. These results suggest that the majority of patients have good functional outcomes. Grace and Eversmann (1980) proved the rigid fixation and early mobilisation were important in restoring forearm function. Moreover, Kim et al. (2015) reported good functional results after plate fixation and it is clinically relevant in the case of fractures of the adult forearm. The present results also showed that 75% had a pronation angle of 81°–90° and 80% had a supination angle of 81°–90° of the forearm, indicating significant recovery of forearm rotational mobility. Matthews et al. (1982) stressed the importance of anatomical alignment to maintain pronation and supination after forearm fractures.

There were no significant complications recorded in 95% of the patients, and only one (5%) patient had delayed union. There were no reports of infections, nonunions, implant failure or neurovascular injury. These observations are in line with the positive clinical results reported by Haseeb et al. (2018a). However, these conclusions should be taken with a grain of salt because the sample size and follow-up period were small.

It has a few drawbacks, such as the small number of patients (20) and the single-centre design, as well as the lack of a traditional surgical approach comparator group and the three-month postoperative follow-up. These restrictions make these outcomes non-generalisable and non-conclusive for comparative surgical superiority. Overall, the results of this study suggest that the direct lateral approach may be an acceptable option for selected adult radius shaft fractures, although larger comparative studies with longer-term follow-up are needed to demonstrate its long-term effectiveness and safety.

5. CONCLUSION

The present prospective observational study showed that direct lateral approach open reduction and internal fixation of radius shaft fractures was related to favourable radiological and functional results in adult patients. Of 20 patients, 80% made radiological union within 12 weeks and 85% had excellent or good radiological results. Functional assessment was carried out according to the Grace and Eversmann criteria with excellent or good results in 85% of cases, with relatively low Disabilities of the Arm Shoulder and Hand (DASH) scores and satisfactory forearm pronation and supination. There were differences in surgical requirements with shorter operating time and less bleeding during the surgery in isolated radius shaft fractures compared to both-bone forearm fractures. No major neurovascular injuries, infections, or implant failures were reported and delayed union occurred in one patient. The results indicate that the direct lateral approach is a viable surgical option for selected cases of adult radius shaft fracture with enough exposure to allow safe and effective fixation and acceptable functional recovery. Conclusions about its superiority and long-term effectiveness are limited, however, due to the small sample size, single centre design, no comparator group, and limited follow-up. These results need to be confirmed in longer-term larger multicentre comparative trials.

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