Original Article

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Comparison of the long-term outcomes of cast immobilization methods in distal radius fractures: a systematic review of randomized controlled trials

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Consensus; Conservative treatment; Surgical casts; Visual analog scale; Wrist fractures

Objectives: Conservative treatment for distal radius fractures typically involves closed reduction and immobilization with a plaster cast. However, no consensus exists regarding the best method and duration for immobilization. This study investigated the functional outcomes associated with different plaster cast application techniques in the treatment of stable distal radius fractures.

Methods: A systematic search was performed in accordance with PRISMA guidelines for studies in the last 5 years. The inclusion criteria were randomized controlled trials that investigated non-operative treatments for distal radius fractures. We excluded studies with short-term follow-up (less than 3 months), ongoing trials, those that did not directly address fractures, and studies involving the use of sugar-tong splints or non-circular immobilization. The outcomes evaluated included subjective measures (Disabilities of the Arm, Shoulder and Hand score; Patient-Rated Wrist Evaluation score; Mayo Wrist Score; and visual analog scale) and objective outcomes (complication rate and radiological parameters).

Results: We included seven articles from 2017 to 2022. These studies reported a total of 542 fractures, predominantly in women, with a mean age of over 50 years. Both short and long arm casts demonstrated similar functional and radiological outcomes. A longer immobilization period (>3 weeks) should be considered to prevent re-displacement.

Conclusion: In stable fractures treated conservatively, the use of both short and long arm casts resulted in comparable functional outcomes in older patients. Immobilization for at least 3 weeks is recommended, as it provided similar clinical and radiological outcomes compared to longer periods of immobilization (level of evidence: 2A).

Introduction

Background

Distal radius fractures are among the most common fractures encountered in the emergency room [1]. In the younger population, these fractures typically result from high-energy trauma, whereas in older adults, weakened, porous bones make them susceptible to fractures from minor trauma. For stable distal radius fractures in both groups, the conservative treatment approach is

closed reduction followed by immobilization using a plaster cast [2]. However, there is still no clear guideline on the best method and immobilization period to apply plaster cast.

One of the most debated aspects of plaster cast application involves the length of the cast (above or below the elbow) and the duration of immobilization. Even when an acceptable reduction is unattainable, previous studies have demonstrated that well-established radiological parameters do not necessarily correlate with a favorable functional outcome in older patients. Conversely, functional outcome reflects the patient's satisfaction with the treatment and should be the primary consideration [3].

Objectives

The aim of this study is to investigate the clinical and radiological outcomes of various non-operative treatments for distal radius fractures, focusing on the length of the cast and the duration of immobilization. We hypothesize that using a short arm cast with a shorter period of immobilization will yield clinical and radiological outcomes comparable to those achieved with a long arm cast and a longer immobilization period (>4 weeks).

Methods

Ethics statement

This was a literature-based study; thus, neither institutional review board approval nor informed consent was required.

Study design

This systematic review was performed in accordance with the PRISMA guidelines [4]. A review protocol was registered on PROSPERO (registration number: CRD42020212627).

Eligibility criteria

All types of randomized controlled trials (RCTs) published as full articles were included in this study. The selection of articles was based on the stated inclusion and exclusion criteria, following the PICO (population, intervention, comparison, outcome) method as outlined in Supplement 1.

Information sources

We performed a systematic search of English-language literature from the past five years on PubMed/MEDLINE, Cochrane Central Register of Controlled Trials (CENTRAL), and ClinicalTrials.gov.

Search strategy

The search terms included, but were not limited to, "distal radius fracture," “Colles fracture,” “management,” “treatment,” “casting,” “immobilization,” and “nonoperative.”

Selection and data collection process

The quality of the included RCTs was assessed by two independent reviewers using the 13-item 2015 Updated Method Guideline for Systematic Reviews from Cochrane [5].

Data items

The data were extracted using a standardized data collection form by a research team, with each selected article being independently screened by two reviewers. Disagreements between

reviewers about whether to include or exclude a study will be resolved through consensus, and if necessary, by consulting a third reviewer.

Study risk of bias assessment

A critical appraisal of all potential studies was conducted to assess their eligibility, utilizing a scoring system adapted from the Joanna Briggs Institute. The evaluation criteria included study population, exposures, confounding factors, outcomes, follow-up duration, and statistical analysis.

Effect measures

Data were extracted from study reports and under appropriate conditions for each test to compare and identify associations.

Synthesis methods

The variables collected included patient age, sex, fracture classification, interventions used, follow-up, Disabilities of the Arm, Shoulder, and Hand (DASH) score, Patient-Rated Wrist Evaluation (PRWE) score, the Mayo Wrist Score, the visual analog scale score, the complication rate, and radiological parameters (volar tilt, radial inclination, radial length, ulnar variance). The results were then tabulated into specific tables for drawing conclusions.

Reporting bias assessment

The quality and reliability of potential studies were evaluated by four authors (MFD, CS, SDS, EK), as well as the published protocols and registrations.

Certainty assessment

No certainty assessment was done.

Results

Study selection

The identification of studies in the primary literature search and the flow diagram of the selection process, according to PRISMA guidelines, are presented in Fig. 1.

Study characteristics

The initial electronic search across all databases yielded 156 records. Following a selection process, seven articles were included in the analysis.

Risk of bias in studies

All seven studies were confirmed to be of high quality, each receiving a "yes" response for more than seven parameters, as shown in Supplement 2.

Results of syntheses

Baseline characteristics

A total of 542 distal radius fractures were analyzed. All studies reported a higher proportion of female participants over the age of 50. Most of these fractures were stable, extra-articular fractures with minimal displacement; however, unstable fractures were also observed. The follow-up period ranged from 3 to 18 months (Table 1).

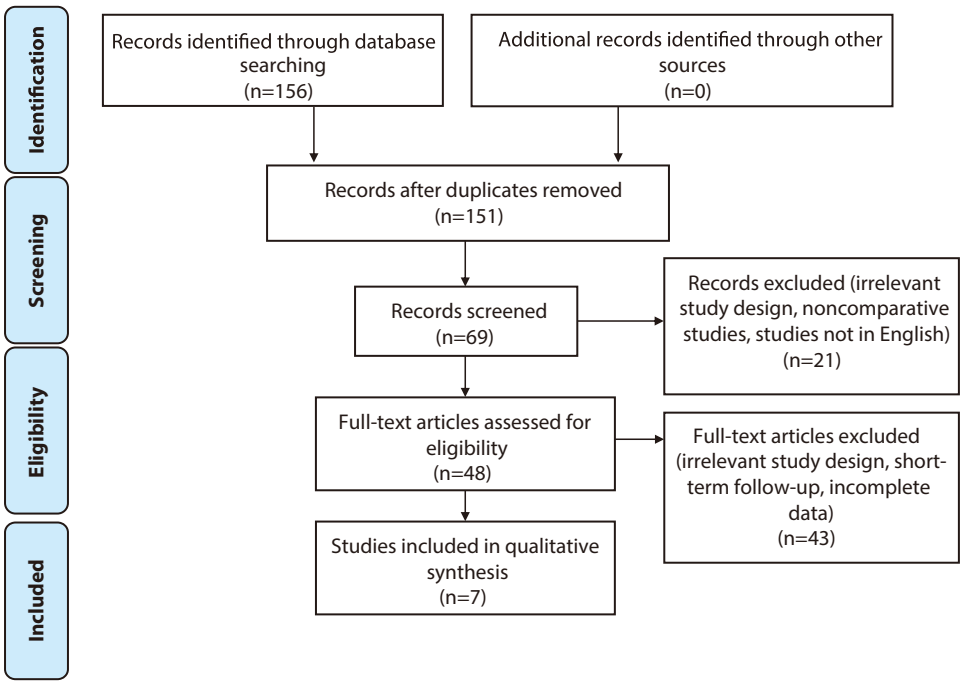

Fig. 1. Identification of studies in the primary literature search and the flow diagram of selection process according to the PRISMA guideline.

Table 1. Basic characteristics of studies

No	Author	Intervention	Control	Sample size (n)	Gender (male/female)	Mean age (yr)	Fracture classification	Follow-up (mo)
Immobilization methods								
1	Park et al. [6]	PC SAC	PC LAC	I: 36 C: 33	I: 2/34 C: 4/29	I: 66.1 C: 67.5	Stable fracture	6
2	Caruso [7]	PC SAC	PC LAC	I: 37 C: 37	I: 3/33 C: 4/32	I: 72.3 C: 69.5	Extra-articular and dorsal displacement (type 2R3A2.2)	3
3	Okamura et al. [8]	PC SAC	PC LAC	I: 64 C:64	I: 23/41 C: 17/47	I: 60.52±14.74 C: 62.97±13.03	2R3A2/2R3A3/2R3C1 /2R3C2/2R3C3	6
Immobilization periods								
1	Christersson et al. [9]	PC 10 d	PC 10 d+3 wk	I: 54 C: 55	I: 7/47 C: 4/51	I: 67 C: 64.7	2R3A3/2R3C2/2R3C3	12
2	Bentohami et al. [10]	PC 3 wk	PC 5 wk	I: 36 C: 36	I: 10/26 C: 13/23	I: >60 yr in 41.67% of patients C: >60 yr in 50% of patients	Stable fractures	12
3	Boersma et al. [11]	PC 1 wk	PC 4–5 wk	I: 26 C: 14	I: 7/19 C: 4/10	I: 52.3±16.2 C: 56.5±9.6	2R3A/2R3B/2R3C	12
4	Olech et al. [12]	PC 4 wk	PC 6 wk	I: 26 C: 24	33 women+17 men	I: 71.34±4.99 C: 72.2±5.46	Stable fractures	12–18

PC, plaster cast; SAC, short-arm cast; LAC, long-arm cast; I, intervention; C, control.

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Outcomes of plaster casting

The seven RCTs discussed plaster casts in terms of the cast length (short versus long arm cast; n=3) and the length of the immobilization period (n=4). Three RCTs concluded that the clinical outcomes were comparable between short arm casts and long arm casts (Table 2). Long arm casts and short arm casts demonstrated comparable radiological outcomes, as measured by volar tilt, radial inclination, radial height, and ulnar variance (Table 3).

Ten days of immobilization has not been proven effective radiologically, as it has been associated with redisplacement in terms of radial inclination and radial height compared

Table 2. Comparison of clinical outcomes

No	Author	Conclusion	DASH	PRWE	Mayo Wrist Score	VAS	Complication
Immobilization methods							
1	Park et al. [6]	SACs were as effective as LACs for stable distal radius fractures in older patients. Furthermore, they were more comfortable and introduced fewer restrictions on daily activities.	SAC: 30±15 LAC: 26.8±14.3	NA	NA	SAC: 2.5±1.2 LAC: 2.1±0.84	NA
2	Caruso et al. [7]	Patients treated with SACs had comparable radiological and functional scores to those treated with LACs, with fewer complications secondary to immobilization of the elbow joint.	SAC: 0.8 (0–2.1) LAC: 1.7 (0–2.5)	NA	NA	NA	NA
3	Okamura et al. [8]	SACs demonstrated no difference in DASH outcomes, comparable reduction maintenance, and fewer adverse effects than LACs.	6 mo: SAC: 9.88 LAC: 9.44	NA	NA	6 mo (wrist): SAC: 4.89 LAC: 7.03 6 mo (shoulder): SAC: 2.69 LAC: 3.52	SAC: 9 LAC: 19 Most common: shoulder pain, malunion
Immobilization periods							
1	Christersson et al. [9]	PC removal 10 d after reduction in moderately displaced DRFs is not recommended.	NA	NA	NA	Insignificant pain difference at 12 mo (P=0.92)	NA
2	Bentohami et al. [10]	Equal patient-reported outcomes between 3 wk and 5 wk of plaster cast immobilization.	I: 0 C: 12.5	I: 5.0 C: 8.8	NA	I: 3.1 C: 2.6	No complication in fracture healing, no non-union or CRPS
3	Boersma et al. [11]	1 wk of PC treatment for nonreduced DRFs resulted in comparable functional outcomes, pain scores, complication rates, and secondary displacement.	I: 4.6±9.5 C: 3.5±4.1	I: 2.9±6.6 C: 2.1±3.3	NA	4 wk: I: 2.2±1.7 C:1.9±2.0	I: 1 C: 4 Most common: ulnar sided wrist pain, DRUJ pain, CRPS
4	Olech et al. [12]	Similar VAS and Mayo Wrist Scores between the two groups. The greatest volar tilt angle occurred after 6 wk of PC. No significant differences in other radiological parameters between the two groups.	NA	NA	I: 58.46 ±21.24 C: 61.87 ±22.97	VAS pain: I: 2.53±3.06 C: 3.58±2.56 VAS activity: I: 7.61 ±1.83 C: 7.58 ±2.3	NA

DASH, Disabilities of the Arm, Shoulder, and Hand; PRWE, Patient-Rated Wrist Evaluation; VAS, visual analog scale; SAC, short arm cast; LAC, long arm cast; NA, not available; PC, plaster cast; I, intervention; C, control; DRF, distal radius fracture; DRUJ, distal radioulnar joint; CRPS, complex regional pain syndrome.

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Table 3. Comparison of radiological outcomes

No	Author	Volar tilt (°)	Radial inclination (°)	Radial length (mm)	Ulnar variance (mm)
Immobilization methods					
1	Park et al. [6]	3 mo: - SAC: −0.2±6.0 - LAC: 3.9±6.2 6 mo: - SAC: −3.6±5.6 - LAC: 2.3±6.2	3 mo: - SAC: 13.4±6.5 - LAC: 15.4±6.1 6 mo: - SAC: 10.1±7.1 - LAC: 12.4±6.9	3 mo: - SAC: 5.0±3.7 - LAC: 6.2±2.6 6 mo: - SAC: 3.1±3.9 - LAC: 4.5±2.9	NA
2	Caruso et al. [7]	3 mo: SAC: 0 ([−4.5]−8) LAC: 0 ([−4]−7.5)	3 mo: SAC: 22 (19−24.5) LAC: 21 (17.5−23)	3 mo: SAC: 9 (7−10) LAC: 8 (6−10)	3 mo: SAC: 0 (0−1) LAC: 0 ([0.5]−2.25)
3	Okamura et al. [8]	SAC: −1.04 LAC: −1.27	SAC: 18 LAC: 16.31	SAC: 7.89 LAC: 7.49	SAC: 1.41 LAC: 1.93
Immobilization periods					
1	Christersson et al. [9]	12 mo: the 10-d group exhibited 1.1° more redisplacement (P=0.48) than the 1-mo group	12 mo: the 10-d group exhibited 3.2° more redisplacement (P=0.002) than the 1-mo group	12 mo: The 10-d group demonstrated 0.7 mm more axial compression (P=0.02) than the 1-mo group	NA
2	Bentohami et al. [10]	1 Patient in each group showed secondary displacement			
3	Boersma et al. [11]	NA	NA	NA	NA
4	Olech et al. [12]	I: 9.13±7.12 C: 3.29±5.11	I: 1.9±1.62 C: 2.45±2.47	I: 0.55±2.84 C: 0.25±1.03	NA

SAC, short arm cast; LAC, long arm cast; NA, not available.

to 1 month of immobilization. However, these findings remain controversial, as one study demonstrated similar outcomes between 1 week and 4–5 weeks of plaster cast immobilization. Generally, a minimum of 3 weeks of immobilization in a plaster cast is sufficient to provide satisfactory clinical and radiological outcomes for up to 18 months of follow-up.

Reporting biases

All the studies reviewed were sourced from peer-reviewed journals. However, it was uncertain whether the reports fully disclosed all study outcomes.

Discussion

Interpretation

This study aimed to objectively compare conservative treatment methods for distal radius fractures. The findings indicated that both long and short arm casts were equally effective in preventing displacement and achieving satisfactory functional outcomes. However, an immobilization period of less than three weeks was associated with poorer radiological outcomes, which could potentially lead to inferior final functional results.

Comparison with previous studies

Immobilization with casting is the common initial treatment for a distal radius fracture.

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Although the final radiographic alignment may not be optimal, long-term motion and patient-reported outcomes from casting are similar to those of surgical treatments [1,13,14]. To optimize the effectiveness of casting, the brachioradialis was identified as a major deforming force, necessitating the use of a long-arm brace in supination to neutralize its action [15]. However, based on three RCTs analyzed in this systematic review, there is no significant difference in DASH scores between long-arm and short-arm casts. We also discuss the results of studies on various periods of immobilization.

Patient-reported outcome measures for the upper extremity

Patient-reported outcome measures are crucial in short-term follow-up because recent evidence suggests they do not correlate with radiological measures [3,16,17]. However, it is important to use a consistently reliable measurement tool to ensure valid comparisons between different treatments. Previous studies have shown that the DASH and PRWE scales are reliable, valid, and responsive tools for assessing upper limb injuries, making them superior to other outcome measures [18,19].

When to place a long arm cast and how long to immobilize the patient in a plaster cast?

The main disadvantage of a long arm cast is that it restricts forearm rotation and elbow flexion-extension. It is also heavy and cumbersome, which can increase the incidence of shoulder pain [6] and limit daily activities [20]. Conversely, a short arm cast may offer the advantage of causing less temporary disability and inconvenience, as it allows for elbow motion. However, a long arm cast is known to better maintain reduction because it prevents the long wrist flexors and extensors from deforming the fracture [20]. Some surgeons recommend using a long arm cast for unstable fractures, generally defined by the Lafontaine criteria, which include at least three of the following: dorsal angulation of more than 20 degrees, dorsal comminution, intra-articular radiocarpal fracture, associated ulnar fracture, and age over 60 years [21]. In these cases, it is believed that the long arm cast prevents elbow motion and forearm rotation, minimizing the risk of fracture displacement. However, this approach remains a matter of debate, as some surgeons still prefer short arm casts regardless of fracture stability [6].

The current systematic review revealed no significant differences in functional scores between short arm casts and long arm casts for stable or extra-articular distal radius fractures. Tolerance for functional loss appears to be influenced by age and activity level, with younger individuals demonstrating better DASH scores after short-term follow-up. Additionally, many authors have noted that older populations are more accepting of functional deficits or imperfect outcomes due to their lower functional demands [22].

The immobilization period is a significant factor in the non-operative treatment of distal radius fractures. Removing the plaster cast early is aimed at facilitating quicker functional recovery and enhancing clinical outcomes. However, our literature review indicates that removing the plaster cast before 1 month leads to poorer functional [9] and radiological outcomes [23]. It was also recommended to immobilize the arm in a functional position [23].

Strengths and limitations of the study

In previous systematic reviews, van Delft et al. [24] and de Bruijn et al. [25] explored the duration of cast immobilization for distal radius fractures. However, these reviews did not set a time restriction for the inclusion of studies, which could introduce bias. Additionally, their focus was limited to the duration of casting, without considering other relevant parameters. Saka et al. [26] compared the effectiveness of below-elbow and above-elbow casts for treating this

condition, yet the evidence provided was of low certainty. Similarly, Raj et al. [27] investigated various immobilization techniques, but the significant variation in mean follow-up periods raised concerns about potential bias in their findings.

This study aims to objectively compare clinical and radiological parameters concerning conservative treatment methods for distal radius fractures, focusing on the technique of application and the duration of immobilization. All included studies are recently published RCTs with a minimum follow-up period of three months, which should provide a high-quality overall analysis. However, our study has several limitations. The number of RCTs investigating non-operative treatment methods for distal radius fractures remains limited. Among the available studies, the strength of evidence is insufficient, with notable heterogeneity, particularly in terms of fracture types. Future studies should consider pooling outcomes from RCTs that involve similar fracture types. Despite these limitations, this study provides evidence supporting conservative treatment for distal radius fractures.

Conclusion

In patients with distal radius fractures, both short arm casts and long arm casts provide similar functional and radiological outcomes. To prevent re-displacement, an immobilization period of at least 3 weeks should be considered.

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Conflict of interest

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Data availability

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Supplementary materials

Supplementary materials are available from: https://doi.org/10.12771/emj.2024.e51.

Supplement 1. Inclusion and exclusion criteria based on the PICO
Supplement 2. Quality assessment of the included studies

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