Review

Long term outcome comparison of cast immobilization methods in distal radius fracture: a systematic review of randomized controlled trials

Maria Florencia Deslivia[1,3], Claudia Santosa[1,3], Sherly Desnita Savio[1], Erica Kholinne[2,3], Made Bramantya Karna[1], Anak Agung Gde Yuda Asmara[1]

[1]Orthopaedics and Traumatology Department, Faculty of Medicine Udayana University, Prof. Dr. IGNG Ngoerah General Hospital, Bali, Indonesia

[2]Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia

[3]Department of Orthopedic Surgery, St. Carolus Hospital, Jakarta, Indonesia

Corresponding Author: Sherly Desnita Savio, Orthopaedics and Traumatology Department, Faculty of Medicine Udayana University, Prof. Dr. IGNG Ngoerah General Hospital, Jl. Diponegoro, Dauh Puri Klod, Denpasar, Bali 80113, Indonesia

E-mail: sherlydsavio@gmail.com

Received: August 21, 2024; Revised: September 14, 2024; Accepted: September 14, 2024

Published Online: Septmeber xx, 2024

Abstract

Objectives: The conservative treatment method for distal radius fracture typically involves closed reduction and immobilization with a plaster cast. However, there remains a lack of clear consensus regarding the optimal method and duration of immobilization. This study aimed to examine the functional outcomes of various methods of applying a plaster cast for the treatment of stable distal radius fracture.

Methods: A systematic search was performed in accordance with PRISMA guidelines for studies in the last 5 years. Inclusion criteria were Randomized Controlled Trials of non-operative treatment for distal radius fracture. We excluded short term follow-up (<3 months), ongoing trials, and studies not directly addressing the fracture. The use of sugar tong/ non-circular immobilization was also excluded. The outcomes assessed were subjective (Disabilities of Arm Shoulder and Hand score, Patient-Rated Wrist Evaluation score, Mayo Wrist Score, and Visual Analog Scale) and objective outcomes (complication rate and radiological parameter).

Results: We included 7 articles from 2017-2022 according to the inclusion criteria. There was a total of 542 fractures, all with greater female proportion and mean age of >50 years old. Short arm cast and long arm cast yield similar functional and radiological outcome. Longer immobilization period should be considered (>3 weeks) to prevent re-displacement.

Conclusion. In stable fractures treated conservatively, the use of short arm cast and long arm cast yielded comparable functional outcome in elderlies. Immobilization of at least 3 weeks is recommended, where it offered similar clinical and radiological outcomes compared to longer immobilization period (Level of evidence: Level 2A).

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

Introduction

Background

Distal radius fracture is one of the most common fractures presenting to emergency room [1]. In younger population, the mechanism of injury usually involves high-energy trauma, while in aging population, porotic bone renders them vulnerable to trivial trauma. Conservative method of treatment for a stable distal radius fracture in both groups is closed reduction and immobilization with 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 discussed variation of methods to apply plaster cast includes the length of the cast (above or below elbow) and the period of immobilization. Even when acceptable reduction cannot be achieved, previous literature show that well-known radiological parameters do not correlate with good functional outcome in elderlies. On the other hand, functional outcome signifies the patient's satisfaction towards treatment and should be the primary consideration[3].

Objectives

The aim of this study is to investigate the clinical and radiological outcome of various non-operative methods to treat distal radius fracture, in terms of cast length and immobilization period. It is hypothesized that the application of short arm cast and shorter immobilization period yield comparable clinical and radiological outcomes compared to long arm cast and longer immobilization period (>4 weeks).

Methods

Ethics statement

It is the literature-based study; therefore, neither approval by the institutional review board nor obtainment of informed consent is required.

Study design

It is a systematic review performed in accordance to PRISMA guidelines[4]. A review protocol was registered on PROSPERO (Registration Number: CRD42020212627).

Eligibilty criteria

All types of randomized controlled trials published as a full article were included in this study. The articles were selected based on the stated inclusion and exclusion criteria according to the PICO (Population, Intervention, Comparison, Outcome) method as depicted in Supplement 1.

Information sources

We performed a systematic search of English language literature on PubMed/MEDLINE, Cochrane Central Register of Controlled Trials (CENTRAL), and ClinicalTrials.gov published in the past 5 years.

Search strategy

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

Selection and data collection process

Included Randomized Controlled Trials (RCTs) were assessed in terms of quality by two independent reviewers based on 13-item of 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 chosen article screened independently by two reviewers. Disagreements between reviewers regarding whether to include or exclude a study will be resolved by consensus, and if necessary, consultation with a third reviewer.

Study risk of bias assessment

A critical appraisal was conducted on all potential studies to determine their eligibility, using a scoring system adapted from the Joanna Briggs Institute. Evaluated items were study population, exposures, confounding factors, outcomes, follow-up duration, and statistical analysis.

Effect measures

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

Synthesis methods

Variables collected include patient age, sex, fracture classification, interventions used, follow-up, disabilities of arm shoulder and hand (DASH) score, PRWE score, Mayo Wrist Score, VAS score, complication rate, and radiological parameters (volar tilt, radial inclincation, radial length, ulnar variance). The result was then tabulated into specific tables to draw conclusion from.

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

Note done.

Results

Study selection

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

Study characteristics

The preliminary electronic search of all databases resulted in 156 records. After a selection process, a total of 7 articles were included into the analysis.

Risk of bias in studies

All 7 studies were proven to be high quality with the "Yes" answer of more than 7 among all parameters, as depicted in Supplement 2.

Results of syntheses

Baseline characteristics

There was a total of 542 distal radius fracture analyzed in this study. All studies have greater female proportion with the age of >50 years old. Most of these fractures are stable extraarticular fractures with minimal displacements, however unstable fractures have also been described. The duration of follow-up ranges from 3 months to 18 months (Table 1).

Table 1. Baseline characteristic of studies

No	Author (year)	Intervention	Control	Sample size (n)	Gender (Male/Female)	Mean Age (years)	Fracture classification	Follow-up
Immobilization Methods Comparison								
1	Park MJ (2017)[13]	PC SAC	PC LAC	I: 36 C: 33	I: 2/34 C: 4/29	I: 66.1 C: 67.5	Stable fracture	6 months
2	Caruso (2019)[23]	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 months
3	Okamura (2021)[19]	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 months
Immobilization Period Comparison								
1	Christersson A (2018)[17]	PC 10 days	PC 10 days + 3 weeks	I: 54 C: 55	I: 7/47 C: 4/51	I: 67 C: 64.7	2R3A3/2R3C2/2R3C3	12 months
2	Bentohami (2018)[21]	PC 3 weeks	PC 5 weeks	I: 36 C: 36	I: 10/26 C: 13/23	I:>60 yo in 41.67% patients C: >60 yo in 50% patients	Stable fractures	12 months
3	Boersma (2022)[20]	PC 1 week	PC 4-5 weeks	I: 26 C: 14	I: 7/19 C:4/10	I: 52.3±16.2 C:56.5±9.6	2R3A/2R3B/2R3C	12 months
4	Olech (2022)[22]	PC 4 weeks	PC 6 weeks	I: 26 C: 24	33 Women + 17 Men	I: 71.34±4.99 C: 72.2±5.46	Stable fractures	12-18 months

PC: Plaster cast, SAC: Short Arm Cast, LAC: Long Arm Cast, I: Intervention, C: Control

Outcome of plaster casting

There was a total of 7 RCTs discussing plaster cast in terms of the cast length (short versus long arm cast) (n = 3) and the length of immobilization period (n = 4). The three

RCTs concluded that the clinical outcome is comparable between short arm cast (SAC) and long arm cast (LAC) application (Table 2). Regarding the radiological parameters, long arm cast and short arm cast demonstrated comparable radiological outcomes, as measured by volar tilt, radial inclination, radial height, and ulnar variance (Table 3).

Table 2. Comparison of clinical outcome

No	Author (year)	Conclusion	DASH	PRWE	Mayo Wrist Score	VAS	Complication
Immobilization Methods Comparison							
1	Park MJ (2017)[13]	SAC is as effective as a LAC for stable distal radius fractures in the elderly. Furthermore, it is more comfortable and introduces less restriction 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 (2019)[23]	Patients treated with SAC have comparable radiological and functional scores to those treated using LAC, with fewer complications secondary to immobilisation of the elbow joint.	SAC: 0.8 (0-2.1) LAC: 1.7 (0-2.5]	NA	NA	NA	NA
3	Okamura (2021)[19]	SAC demonstrated no difference in DASH outcome, comparable reduction maintenance, and less adverse effect compared to LAC	6 months: SAC: 9.88 LAC: 9.44	NA	NA	6 months (wrist): SAC:4.89 LAC: 7.03 6 months (shoulder): SAC: 2.69 LAC: 3.52	SAC: 9 LAC: 19 Most common: shoulder pain, malunion
Immobilization Period Comparison							
1	Christersson (2018)[17]	PC removal 10 days after reduction in moderately displaced DRF is not recommended.	NA	NA	NA	Insignificant pain difference at 12 months (p = 0.92)	NA
2	Bentohami (2018) [21]	Equal patient-reported outcomes between 3 weeks and 5 weeks 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 (2022)[20]	1 week of PC treatment for nonreduced DRF resulted in comparable functional outcome, pain score, complication rate, 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 weeks: 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 (2022) [22]	Similar VAS and Mayo Wrist Score between the two groups. The greatest volar tilt angle occurred after 6 weeks 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

PC: Plaster cast, SAC: Short Arm Cast, LAC: Long Arm Cast, NA, Not Available, I: Intervention, C: Control, DRUJ: Distal Radioulnar Joint, CRPS: Complex Regional Pain Syndrome

Table 3. Comparison of radiological outcome

No	Author (year)	Volar Tilt (º)	Radial Inclination (º)	Radial Length (mm)	Ulnar Variance (mm)
Immobilization Methods Comparison					
1	Park MJ (2017)[13]	3 months: • SAC: -0.2±6.0 • LAC: 3.9±6.2 6 months: • SAC: -3.6±5.6 • LAC:2.3±6.2	3 months: • SAC: 13.4±6.5 • LAC: 15.4±6.1 6 months: • SAC:10.1±7.1 • LAC:12.4±6.9	3 months: • SAC: 5.0±3.7 • LAC: 6.2±2.6 6 months: • SAC:3.1±3.9 • LAC:4.5±2.9S	NA
2	Caruso (2019)[23]	3 months: SAC: 0([-4.5)-8) LAC: 0 ([-4]-7.5)	3 months: SAC:22 (19-24.5) LAC: 21 (17.5-23)	3 months: SAC: 9 (7-10) LAC: 8 (6-10)	3 months: SAC: 0 (0-1) LAC: 0 ([0.5]-2.25)
3	Okamura (2021)[19]	SAC: -1.04 LAC: -1.27	SAC: 18 LAC: 16.31	SAC: 7.89 LAC: 7.49	SAC: 1.41 LAC: 1.93
Immobilization Period Comparison					
1	Christersson A (2018)[17]	12 months: 10 days group redisplaced 1.1º more (p=0.48) compared to 1 month group	12 months: 10 days group redisplaced 3.2º more (p=0.002) compared to 1 month group	12 months: 10 days group demonstrated 0.7mm more axial compression (p=0.02) compared to 1 month group	NA
2	Bentohami (2018)[21]	1 patient in each group showed secondary displacement			
3	Boersma (2022)[20]	NA	NA	NA	NA

4	Olech (2022)	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

PC: Plaster cast, SAC: Short Arm Cast, LAC: Long Arm Cast, NA, Not Available

Ten days immobilization was not proven to be efficient radiologically, as it promoted re-displacement in radial inclination and radial height compared to 1 month immobilization. However, this result is still controversial as one study proved similar outcomes between 1 week and 4-5 weeks plaster cast immobilization. In general, a minimum of 3 weeks immobilization in a plaster cast would provide sufficient clinical and radiological outcome 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 of the study outcomes.

Discussion

Interpretation

This study aimed to objectively compare conservative treatment methods for distal radius fracture. The findings showed that long and short arm cast were equally effective to prevent displacement with satisfactory functional outcome. However, less than 3 weeks period of immobilization resulted in wore radiological outcome, potentially resulting in worse final functional outcome.

Comparison with previous studies

Immobilization with casting is the common initial treatment for distal radius fracture. Even though the final radiographic alignment is not optimal, but the motion and patient-reported outcomes of casting in long term were found to be similar with surgical treatments[1,

6, 7]. To optimize the effect of casting, brachioradialis was originally identified as a major deforming force, hence a long-arm brace in supination is required to neutralize its action[8]. However, based on three RCTs synthesized in this systematic review, DASH score after long arm cast and short arm cast is not significantly different. We also report the result of studies regarding various period of immobilization.

Patient Reported Outcome Measures for Upper Extremity

PROMs are crucial in short-term follow-ups because recent evidence suggests they do not correlate with radiological measures[3, 9, 10]. However, it's important to use a consistently reliable measurement tool to ensure valid comparisons between different treatments. Previous research has demonstrated that the DASH and PRWE scales are reliable, valid, and responsive tools for evaluating upper limb injuries, making them preferable to other outcome measures [11, 12].

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

The main disadvantage of long arm cast is the limitation of forearm rotation and flexion–extension of elbow. It is also heavy and cumbersome, thus increasing the incidence of shoulder pain [13] and limitation of daily activities[14]. On the other hand, short arm cast have the potential advantage of less temporary disability and inconvenience than long arm casts, as elbow motion is allowed. However, long arm cast is known to maintain reduction better since it prevents long wrist flexors and extensors from deforming the fracture [14]. Some surgeons advised the use of long arm cast in unstable fractures, generally defined by Lafontaine criteria [15] (at least three of these criteria: dorsal angulation of more than 20 degrees, dorsal comminution, intra-articular radiocarpal fracture, associated ulnar fracture, and age over 60 years old), where it is believed that long arm cast prevented elbow motion and forearm rotation,

minimizing the risk of fracture displacement. However, this decision is still controversial as some other surgeons still favored short arm cast regardless fracture stability[13].

Current systematic review showed non-significant differences between short arm cast and long arm cast in terms of functional score in stable or extraarticular distal radius fracture. This tolerance for functional loss is known to be affected by age and activity level, with younger population shown to have better DASH score after a short-term follow-up. Many authors also reported that aging population is more tolerant of functional deficits or imperfect outcomes due to low functional demands[16].

Immobilization period is also an issue in non-operative treatment of distal radius fracture. Early plaster cast removal is intended to achieve faster functional recovery and improved clinical results. However, our literature search showed that removal of plaster cast before a 1 month period yielded worse functional [17] and radiological outcome[18]. It was also recommended to immobilize the arm in functional position [18].

Study strength and limitations

In previous systematic reviews, van Delft et al. (2019) [19] and de Bruijn et al. (2024)[20] examined the duration of cast immobilization for distal radius fractures. However, these reviews did not impose a time limit on study inclusions, potentially introducing bias. Moreover, they focused solely on cast duration without considering other parameters. Saka et al. (2022) [21] conducted studies comparing below and above elbow casts for this pathology, but the certainty of evidence was notably low. Similarly, Raj et al. (2023) [22] investigated various immobilization methods, but the wide variation in mean follow-up periods posed a risk of bias in their analyses.

This study aims to objectively compare clinical and radiological parameters regarding conservative treatment methods for distal radius fracture, from the application technique and

duration of immobilization. All studies included were recently published RCTs with a minimum follow-up period of 3 months, in which hopefully can provide high-quality overall analysis. However, there are still several limitations to our study. The number of RCTs investigating non-operative treatment methods for distal radius fracture is still limited. Among the available studies, the strength of evidence is not sufficient, with heterogeneity especially regarding types of fracture. In future studies, it is recommended to pool the outcome from RCTs with similar type of fracture. However, despite these limitations, this study provide the evidence for conservative treatment of distal radius fractures.

Conclusion

In patients with distal radius fracture, short arm cast and long arm cast yield similar functional and radiological outcome. An immobilization period of minimum 3 weeks should be considered to prevent re-displacement.

ORCID

Maria Florencia Deslivia: https://orcid.org/0000-0001-8726-3425

Claudia Santosa: https://orcid.org/0000-0003-1657-1193

Sherly Desnita Savio: https://orcid.org/ 0000-0003-4269-1156

Erica Kholinne: https://orcid.org/0000-0002-4326-8205

Made Bramantya Karna: https://orcid.org/0000-0001-5483-5132

Anak Agung Gde Yuda Asmara: https://orcid.org/0000-0002-3280-7613

Authors' contribution

Project administration: Deslivia MF, Savio SD

Conceptualization: Deslivia MF, Savio SD, Karna MB, Asmara AAGY

Methodology & data curation: Deslivia MF, Savio SD

Funding acquisition:: Deslivia MF, Santosa C, Asmara AAGY

Writing - original draft: Deslivia MF, Santosa C, Savio SD, Kholinne E

Writing - review & editing: Deslivia MF, Santosa C, Savio SD, Kholinne E, Karna MB, Asmara AAGY

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Funding

Not applicable.

Data availability

Not applicable.

Acknowledgments

Not applicable.

Supplementary materials

Supplement 1. Inclusion and exclusion criteria based on PICO.

Supplement 2. Quality assessment of included studies.

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FIGURE LEGENDS

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