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Review Article

Management of Displaced Metacarpal Shaft Fractures: A Systematic Review and Meta-analysis ☆

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ABSTRACT

Background: Affecting mainly the working population, metacarpal shaft fractures account for up to 31% of hand fractures. To manage this entity, conservative management can be equal to operative management. However, surgeons tend to favor operative management in order to reduce the rate of complications, such as shortening and malunion. This meta-analysis was conducted to compare conservative to operative management of displaced metacarpal shaft fractures.

Methods: PubMed, Cochrane, and Google Scholar (pages 1-20) were searched until August 2023. The clinical outcomes consisted of postoperative shortening, Disabilities of Arm, Shoulder, and Hand (DASH) score, and mean grip strength.

Results: Only three studies were included in this meta-analysis. Operative management was shown to reduce postoperative shortening ($p<0.00001$). However, conservative management had a better postoperative DASH score ($p=0.001$).

☆ Level of Evidence: III

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Conclusion: Better DASH scores were seen in the conservative group, but there was a higher postoperative shortening. However, studies have shown that the shortening has no effect on the functional outcome. Nevertheless, more randomized controlled studies and cost-effectiveness studies are needed to confirm these findings.

Introduction

The incidence of hand fractures is around 19% of all fractures, and finger metacarpal fractures account for up to 31% of them [1]. Typically, metacarpal shaft fractures (MSFs) can manifest as either transverse, spiral, oblique, or comminuted injuries [2]. The majority of patients are of working age, which is why MSFs raise societal expenditures due to their inability to work while receiving treatment and recovering [2].

These fractures can be managed through nonoperative approaches involving early mobilization, closed reduction, or the use of splint or cast immobilization, or through surgical interventions employing external or internal fixation techniques [3]. Operative management can range from Kirschner wire (K wire) stabilization to an open reduction and internal fixation (ORIF) using a plate and screws [2]. The objective of treatment is to attain excellent hand functionality while maintaining appropriate alignment of the fracture, promoting robust bone fusion, and ensuring unrestricted movement [3].

Most hand fractures can be effectively treated without surgery, yielding favorable outcomes. Surgical intervention is typically recommended when there are concerns about potential issues like metacarpal shortening, which can result in weakness and tendon imbalance, or when there are worries about malrotation during union, which can lead to finger dysfunction where the affected digit crosses over or under an adjacent one [4]. Nevertheless, when shortening is accepted as a way to stabilize the fracture, conservative treatment can yield good results in terms of range of motion and grip strength [4].

There is still not enough evidence to indicate which management technique is better. Therefore, we conducted this meta-analysis to compare conservative to operative management in treatment-displaced MSFs.

Material and Methods

Search strategy

The research conducted in this study adhered to the PRISMA guidelines. The researchers searched PubMed, Cochrane, and Google Scholar from pages 1-20, using the keywords "metacarp*" AND ("conservative" OR "operat*") with Boolean operators, to identify relevant studies that compare nonoperative to operative management of MSFs. The search was updated until August 2023. The researchers also looked at reference lists from papers and conducted internet searches to gather additional literature. One researcher (MD) collected the data, and another researcher (AS) verified the chosen articles. The entire process is outlined in the PRISMA flowchart (Fig. 1).

To be included, the studies had to meet certain criteria: (1) the studies had to be comparative, which could be randomized controlled trials, retrospective comparative studies, or prospective clinical trials; (2) the patients being studied had MSFs; (3) one group had to be managed conservatively while the other group underwent operative management. However, studies with the following characteristics were excluded from this research: (1) case reports, narrative or systematic reviews, theoretical research, conference reports, meta-analysis, expert comments, and economic analysis; (2) out-

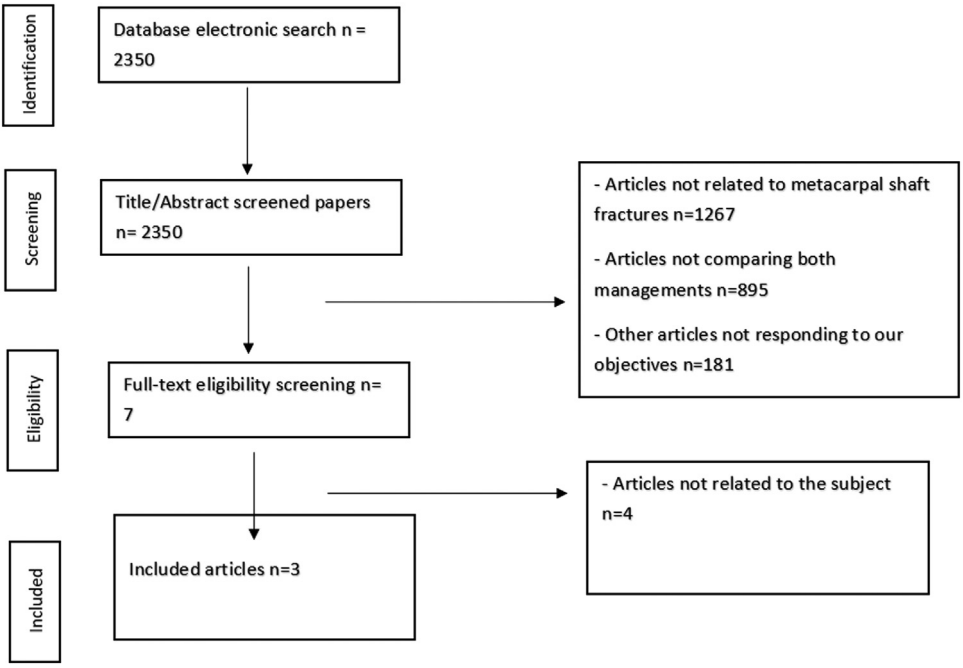

Figure 1. PRISMA flowchart for the article selection process.

comes that were not relevant; and (3) studies that compared operative to nonoperative management of metacarpal neck fractures.

Data extraction

Two reviewers assessed the eligibility of the studies independently. Data were extracted from the included studies and divided into two parts. The first part contained basic information, such as the name of the authors, title, publication year, journal, volume, issue, pages, study design, sample size, and size of each management group, as well as any suspected types of bias in each study. The second part focused on clinical outcomes, such as postoperative shortening, postoperative Disabilities of Arm, Shoulder, and Hand (DASH) score, mean grip strength, and mean grip strength compared to the contralateral hand. If there were any discrepancies between the investigators, they were resolved through discussion.

Risk of bias assessment

Two authors MD and AS, independently evaluated the risk of bias using the Cochrane risk of bias tool. They considered several factors, including random sequence generation, allocation concealment, blinding of participants and study workers to the research procedure, blinding of outcome assessment, inadequate outcome data, and selective reporting (Fig. 2A). Trials that had a high risk of bias in multiple key domains were considered to have a high risk of bias, while trials that had a low risk of bias in every key domain were considered to have a low risk of bias. Trials that did not meet either of these conditions were deemed to have an unclear risk of bias.

The ROBINS-I tool was used in retrospective studies to evaluate the bias [5]. Studies that had a critical risk of bias were excluded.

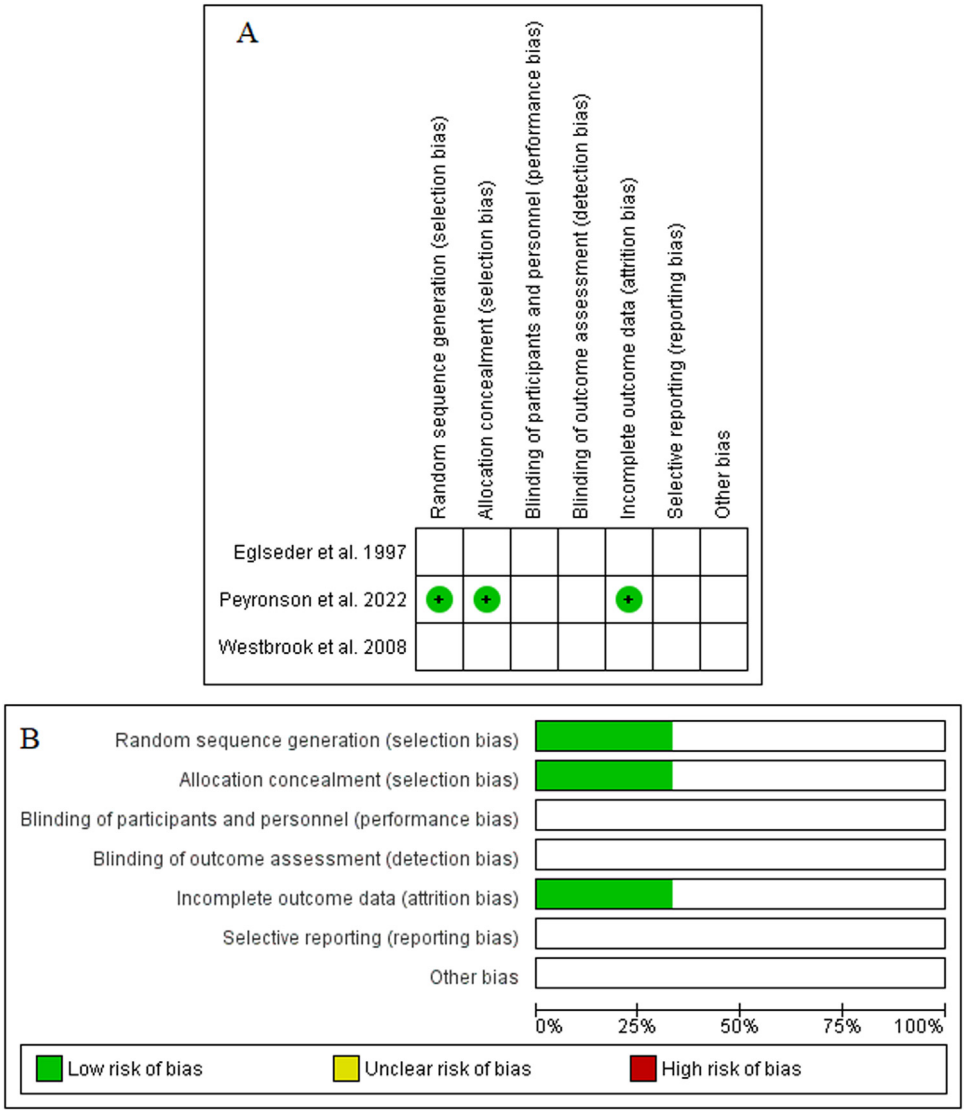

Figure 2. (A): Risk of bias item for each included study. (B) Risk of bias items presented as percentages across all included studies.

Statistical analysis

Review Manager 5.4 (The Cochrane Collaboration, 2020) was used for the statistical analysis. Continuous data were analyzed using standardized mean differences and 95% confidence intervals (CI), while dichotomous data were analyzed using risk ratios with a 95% CI. Heterogeneity was assessed using Q tests and I2 statistics, with considerable heterogeneity defined as $p \leq 0.10$ or $I2 > 50\%$. The random-effects model was used to account for high levels of variability in the variables, while the fixed-effects model was used if $p > 0.10$ or $I2 < 50\%$. Statistical significance was defined as p=0.053-
Results

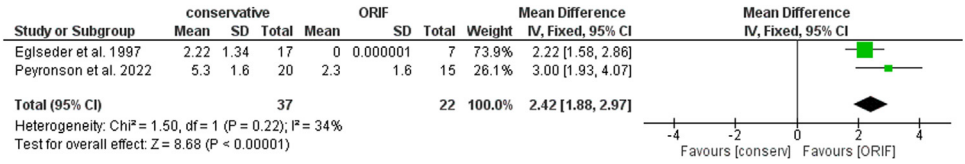

Figure 3. Forest plot showing the postoperative shortening in conservative management and ORIF.

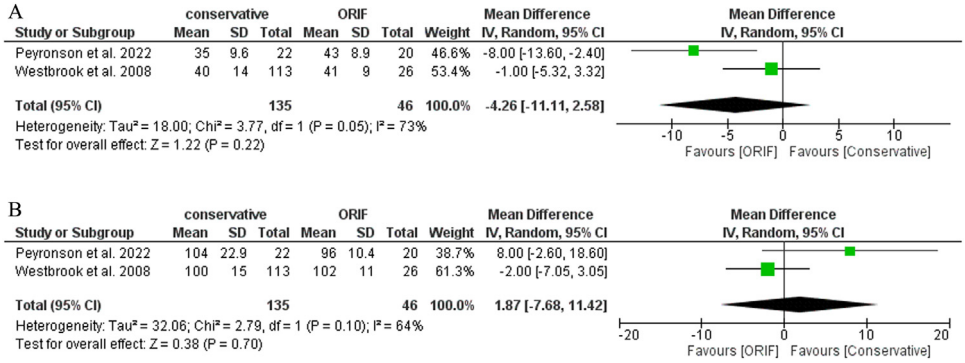

Figure 4. (A): Forest plot showing the mean grip strength in conservative management and ORIF. (B): Forest plot showing the mean grip strength compared to the contralateral hand in conservative management and ORIF.

Characteristics of the included studies

Only three studies [2,6,7] met the inclusion criteria and were included in the meta-analysis with one randomized controlled trial and two retrospective comparative studies. It involved 152 subjects in the conservative group and 53 subjects in the operative group. The main characteristics of the included studies are summarized in Table 1. The results of the Bias assessment for nonrandomized studies are summarized in Table 2 and Figure 2B for the randomized studies.

Shortening

Two studies on 59 subjects reported data on postoperative shortening. The results showed that when compared to conventional management, ORIF significantly reduces the shortening postoperatively (mean difference, 2.42; 95% CI 1.88–2.97, $p<0.00001$, Figure 3).

DASH score

Two studies on 181 subjects reported data on postoperative DASH scores. The results showed that, when compared to ORIF, conventional management significantly improves the postoperative DASH score (Mean Difference, −1.59; 95% CI −2.57 to −0.61, $p=0.001$, Figure 5). However, caution must be taken regarding this result since one of the included papers had a missing standard deviation (SD), and an imputed SD was used from similar studies.

Mean grip strength

Two studies on 181 subjects reported data on the mean grip strength and compared it to the contralateral hand. The results showed no difference between conservative and operative management (Mean Difference, −4.26; 95% CI −11.11 to 2.58, $p=0.22$, Figure 4A). Furthermore, when comparing it to the contralateral hand, the results showed no difference between conservative and operative management (Mean Difference, 1.87; 95% CI −7.68 to 11.42, $p=0.70$, Figure 4B).

Table 1
Main characteristics of the included studies.

	Methods	Participants		Mean age (SD)		Measured outcomes	Follow-up time
		Conservative	ORIF	Conservative	ORIF		
Eglseder et al. 1997	Retrospective comparison	17	7	27 28	27 28	Shortening	6 months
Peyronson et al. 2022	Randomized controlled trial	22	20	49 48	40 34	Median grip strength (% contralateral), median grip strength, radiographic shortening, rotational deformity, flexion deficit, extension deficit, median total active motion, median overall satisfaction, median pain under load, DASH, median cosmetic appearance, costs, sick leave, revision	12 months
Westbrook et al. 2008	Retrospective comparison	113	26	30 (12)	30 (15)	Palmar deformity, mean grip strength, mean grip strength (% contralateral), Cosmesis score, DASH score, Sports DASH, contribution of little finger to grip strength	50 months

DASH; Disabilities of the Arm Shoulder and Hand.

Table 2
Bias assessment of the included studies.

Studies	Confounding bias	Selection bias	Classification bias	Bias due to deviation from interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of reported results	Results
Eglseder et al. 1997	Low risk	Low risk	Low risk	Low risk	Low risk	Moderate risk	Low risk	Moderate risk
Westbrook et al. 2008	Low risk	Low risk	Low risk	Low risk	Low risk	Moderate risk	Low risk	Moderate risk

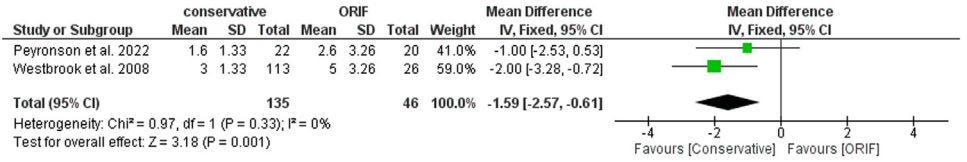

Figure 5. Forest plot showing the postoperative DASH score in conservative management and ORIF.

Discussion

Primarily affecting the working population, MSFs exert a significant influence on the overall quality of life. Operative management tends to be chosen over conservative management to avoid complications from malunion. Nevertheless, studies show comparable results when managing displaced MSFs conservatively and operatively. Thus, this meta-analysis is comparing both managements and it can be divided into three sections: Shortening, DASH score, and mean grip strength. ORIF was favored and showed a higher statistically significant benefit when compared with conservative management in shortening; however, conservative management had a better postoperative DASH score. Furthermore, there was no difference between the two groups in the mean grip strength.

Numerous techniques for surgically fixing MSFs are available. Given the array of operative options, surgeons often lean toward surgery, primarily because any malunion can significantly affect hand function and worsen the aesthetic outcome [6]. Surgical intervention typically yields superior outcomes for patients presenting with multiple fractures, polytrauma, irreducible fractures, open fractures, intra-articular fractures, segmental bony loss, rotational deformity, unacceptable angulation, and/or shortening [3]. Nevertheless, it's important to note that operative techniques are not without complications, which can be highly detrimental to the final functional and aesthetic result. These complications may include stiffness, nonunion, plate prominence, infection, and tendon rupture [8]. Even though our results showed a smaller postoperative shortening in the ORIF group, Eglseder et al. established that the degree of shortening in MSFs does not result in a functional limitation and showed that patients with up to a 6.9 mm of shortening did not have any complaints [7].

Most MSFs can be successfully managed with immobilization lasting approximately 3 to 4 weeks. Ensuring proper immobilization is crucial to maintaining reduction and preventing declines in functional outcomes caused by malunion [9]. When comparing various options such as casts, braces, and splints for immobilizing metacarpal fractures, they generally yield similar functional results [10]. The results of nonoperative treatment have been extensively reported, and typically, except for a slight cosmetic abnormality, excellent functional outcomes are commonly observed. However, nonsurgical treatment comes with its own set of complications, notably linked to the use of plaster or splint immobilization [11].

Several arguments support the use of nonsurgical treatment for MSFs. First, Westbrook et al. conducted a comparison between nonsurgical and surgical approaches for the management of metacarpal neck and shaft fractures. Notably, their study found no significant correlation between palmar angular deformities and both aesthetic and functional outcomes 2 years after surgery. Nevertheless, patients must be warned about this possible complication [6]. In fact, Westbrook et al. demonstrated that conservatively treated MSFs had better DASH and aesthetic scores, but a worse sports DASH score when compared to the operatively treated group [6]. The better DASH score is supported by our results as well. This may be explained by the complications faced in the surgery which are higher when compared to the conservative group [2,6]. Additionally, a conclusion was made stating that palmar angular malunions of up to 30-40° after conservative management do not affect the functional outcome as long as the patient does not mind having a visible deformity [6]. Furthermore, Peyronson et al. showed that the mean grip strength in the nonoperative group was above the noninferiority margin confirming the effectiveness of the conservative management [2]. Moreover, sick leave was lower in the conservative group as well as costs (12 days and 1,347 USD respectively) when compared with the operative group (35 days, and 3,834 USD respectively) [2]. This is an important outcome to consider in MSFs due to the fact that most of the patients are of working age. On the other hand, Strub et al.

have indicated that surgical intervention may offer a marginal advantage over nonoperative treatment, primarily in terms of achieving a more favorable cosmetic outcome due to reduced incidence of malunion [12]. Moreover, significant deformities can lead to functional issues such as metacarpal shortening or malunion, indicating a role for surgery, especially when nonoperative reduction cannot adequately address the deformity [11].

In conclusion, the discussion around managing MSFs reveals a multifaceted landscape. Nonsurgical approaches generally offer favorable outcomes, including better function and costeffectiveness, but carry the risk of malunion, particularly in cases of significant deformities [11]. On the other hand, surgical interventions, while carrying high risks, do have their indications, especially when addressing cosmetic concerns or complex deformities [12]. Therefore, individual factors and fracture characteristics should guide the choice of treatment, prioritizing optimal outcomes while minimizing complications.

Strengths and limitations

The study has several strengths, including being the first meta-analysis to compare conservative and operative management of displaced MSFs. Additionally, only comparative studies were included, which helps to reduce the risk of operative and matching bias. The selection process was also more selective, making the study less heterogeneous and decreasing the risk of bias. However, the study also had some limitations, such as the limited number of comparative studies available in the literature for inclusion. In addition, there were differences in the inclusion and exclusion criteria for patients. Furthermore, the number of included studies was limited, and the data used for analysis was pooled without access to individual patient data, which could limit more comprehensive analyses.

Conclusion

This is the first meta-analysis comparing conservative to operative management of displaced MSFs. It showed a better DASH score in the conservative group, but a smaller postoperative shortening in the ORIF group. However, studies have shown that the shortening has no impact on the functional outcome. Furthermore, ORIF can be associated with more complications, higher costs, and longer sick leaves, which may have a great impact on the working population. Nevertheless, more randomized controlled studies and cost-effectiveness studies are needed to confirm the superiority of conservative management in displaced MSFs.

Statements

Conflict of Interest Statement: There were no conflict of interest between the authors in this study.

Statement of Human and Animal Rights: It is not applicable since this is a systematic review/Meta-analysis and does not have any human subjects

Statement of Informed Consent: It is not applicable since this is a systematic review/Meta-analysis and does not have any human subjects

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Informed consent: Not applicable

Ethical approval: Not applicable

Contributorship: MD and MA researched literature and conceived the study. AG and JT were involved in protocol development. AS and SR were involved in data analysis as well as supervising the whole work. MD wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript

Conflicting interests

We declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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