Type of the Paper (Systematic review)

Functional and Radiological Outcomes of Transverse K-Wire Fixation for Unstable Metacarpal Fractures: A Systematic Review and Meta-Analysis.

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Abstract:

Introduction: Metacarpal fractures are among the most common hand injuries, often requiring surgical intervention for proper alignment and functional recovery. Transverse K-wire fixation is a widely used technique for treating unstable metacarpal fractures, but its efficacy and complication rates remain variably reported.

Methods: A systematic review and meta-analysis were conducted following the Reported Items for Systematic Reviews and Meta-Analyses guidelines. A search of PubMed, Scopus, and Web of Science was performed using MeSH terms and keywords related to metacarpal fractures, K-wire fixation, and transverse pinning. Inclusion criteria encompassed randomized controlled trials, non-randomized controlled trials, and prospective and retrospective studies assessing transverse K-wire fixation. Outcomes analyzed included TAM, QuickDASH score, grip strength, VAS pain score, healing time, and complication rates. Meta-analysis was performed using random or fixed models, depending on heterogeneity assessed via the I^2 statistic.

Results: 8 studies (N = 204 patients) were included. Mean TAM was 256.9°, indicating favorable postoperative motion. QuickDASH scores averaged 2.61, reflecting minimal disability. Grip strength: 95.67% of the unaffected hand, suggesting good functional recovery. VAS score was 0.98, indicating low pain levels. Healing time averages 6.69 weeks. Complication rate: 10.7%.

Conclusion: Transverse K-wire fixation provides excellent functional and radiological outcomes for unstable metacarpal fractures, with consistent healing times and low complication rates. However, significant heterogeneity was observed in several outcome measures, particularly grip strength, pain scores, and disability levels, suggesting variability in patient populations and surgical techniques. Further high-quality, randomized trials with standardized rehabilitation protocols are needed to refine the surgical indication.

Keywords: Metacarpal; Fracture, Transverse, k-wires, meta-analysis.

1. Introduction

Metacarpal fractures are among the most common hand injuries, often resulting from direct trauma. They vary in severity, with stable fractures typically managed conservatively through immobilization, while unstable fractures often require surgical intervention to restore alignment, maintain stability, and preserve hand function. The primary goal of surgical treatment is to promote proper healing, reduce complications, and help patients regain full use of their hand [1].

Several surgical techniques are available for fixing unstable metacarpal fractures, including Kirschner wire [K-wire] fractures, including Kirschner wire [K-wire] fixation, intramedullary nails, or, for complex fractures, open reduction and internal fixation (ORIF) with plates and screws [2]. Among these, K-wire fixation is one of the most commonly used approaches, with the transverse technique being a frequently used variation.

Transverse K-wire fixation involves inserting K-wires percutaneously at a perpendicular angle to the fracture site. This method provides stability to the fractured bone, ensuring proper alignment and facilitating healing. Many surgeons prefer this technique due to its technical simplicity, minimal soft tissue disruption, and effectiveness in treating fractures of the metacarpal neck [3].

Despite its widespread use, the best approach to managing unstable metacarpal fractures remains a topic of discussion in orthopedic and hand surgery. Clinical outcomes following transverse K-wire fixation can vary, making it essential to thoroughly evaluate its effectiveness and limitations. This meta-analysis aims to assess the clinical and radiological outcomes associated with transverse K-wire fixation for unstable metacarpal fractures. Key outcome measures include total active motion, pain levels, grip strength recovery, fracture healing time, and complication rates [4].

2. Methods

2.1. Search Strategy

A study search was conducted on three major databases: PubMed, Scopus, and Web of Science. To detect synonyms of the keywords used, Medical Subject Headings (MeSH) terms were employed. The search strategy was designed to identify studies that evaluate the outcomes of transverse K-wire as a method of fixation for metacarpal fractures. The search terms included a combination of the following keywords: "metacarpal fractures", "Surgical intervention", "K-wire fixation", and "transverse pinning". Boolean operators "OR, AND, NOT" were used to optimize the search strategy to allow retrieval of the highest amount of relevant studies. Furthermore, a manual search was conducted by looking through the reference lists of the final included studies to identify any additional studies that were missed during the initial database search.

2.2. Inclusion and Exclusion Criteria

- **Study design:** Randomized controlled trials, non-randomized controlled trials, prospective studies, and retrospective studies.
- **Population:** Patients with unstable metacarpal fractures treated with transverse K-wire fixation.
- **Intervention:** Transverse K-wire fixation as the primary treatment method.
- **Outcomes:** Studies reporting on one or more of the following outcomes: total active motion (TAM), QuickDASH score, VAS pain score, grip strength, healing time, or complications.
- **Language:** All studies published in English.

Studies were excluded if they were:

- Case reports or expert opinions.
- Studies including thumb metacarpal fractures.
- Studies that do not clearly specify transverse K-wire fixation or combine it with other interventions in a way that outcomes cannot be isolated.
- Studies with incomplete data or insufficient information for data extraction.

2.3. Study Selection

Selection and filtration of the studies were done by two independent researchers. Initially, screening was done based on the title and abstract of studies. A PRISMA flow diagram was used to show the study selection process.

2.4.Data Extraction

Done by at least 2 independent researchers by a standard form to extract data and included:

- **Study characteristics:** Author(s), year of publication, study design, number of participants, fracture location, and fixation method.
- **Patient characteristics:** Age, gender, and dominant hand affected.
- Intervention details: Surgical technique and post-operative protocol.
- **Outcome data:** TAM, QuickDASH score, VAS pain score, grip strength, healing time, and complications.
- Data on complications included the number and type of complications.

Any disagreements in the data extraction process were resolved through discussion and the senior researcher's opinion.

2.5.Quick Assessment

Appropriate tools of quality assessment were chosen based on the study design. For non-randomized studies, the Newcastle-Ottawa Scale (NOS) was used [6]. The quality assessment was performed by two independent researchers, and disagreements were resolved through discussion.

2.6.Data Synthesis and Statistical Analysis

Cochrane ReviewManager 5.4 [7] and Opened Analyst [8] were used for the data synthesis, and quantitative meta-analysis was performed using appropriate statistical software. For continuous outcomes (e.g., TAM, QuickDASH score, VAS pain score, grip strength, and healing time), mean differences were calculated with 95% confidence intervals (CIs). For dichotomous outcomes [e.g., complications], risk ratios (RRs) with 95% CIs were calculated.

Heterogeneity was assessed statistically using the I2 test;>50% I2 was considered significant heterogeneity, and a random effects model of DerSimonian-Laird was used. In contrast, a fixed effects model was employed when heterogeneity was below 50% [9].

In cases where mean and SD were not available, conversion of other forms of data (e.g., Median and range) to mean and SD was done using the method described by Shi et al [10].

2.7. Presentation of Results

The results of this meta-analysis were presented using tables and forest plots.

3. Results

3.1. Characteristics of included studies

A total of 8 studies were included in this analysis, with 204 patients. Detailed results of the search process and study selection according to the inclusion and exclusion criteria are presented in the PRISMA diagram (**Figure 1**).

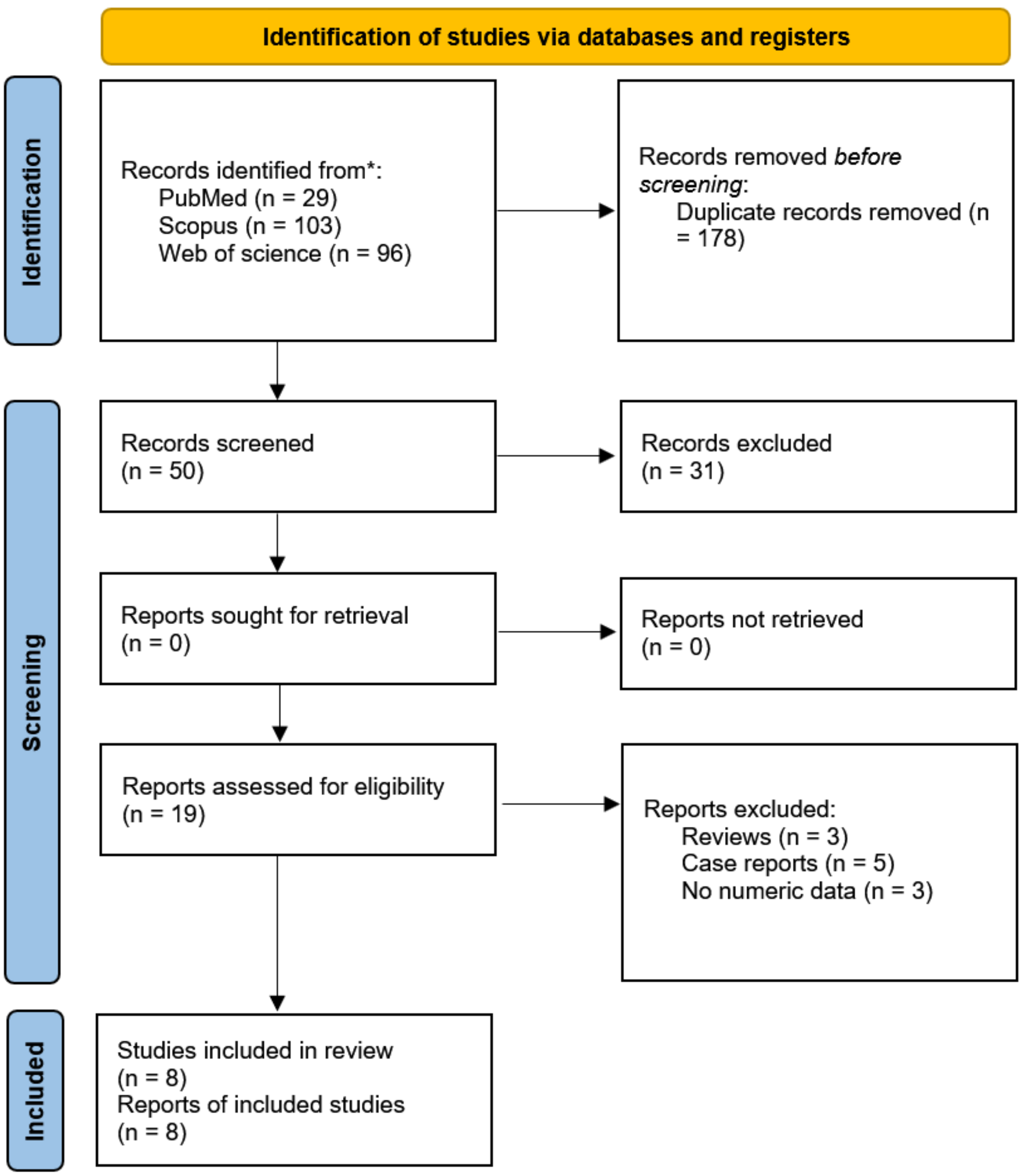

Figure 1: Prisma flow diagram showing the search process and selection of included studies.

Table 1. Characteristics of the included studies

Study	Location	Study Design	Mean Age (Range)	Gender (Male: Female)	Number of Participants (Transverse Pinning Group)	Follow-up Length
Wong 2006 [11]	Hong Kong, China	Non-randomized controlled clinical trial	23 years (range: 14–30)	27/2	29	24 months (range: 12–36)
Moon 2014 [12]	Korea	Retrospective study	34 (19-71)	19/3	22 patients	15w
Winter 2007 [13]	France	Prospective comparative randomized study	32 years (range: 20–49)	67% male	18 patients	2.7 months (range: 2–3)
Potenza 2012 [14]	Italy	Prospective cohort	38.4 years (range: 15–71)	25/3	28 patients	25 months
Sletten 2011 [15]	Norway	Retrospective study	31 years (range: 19–50)	Predominantly male	45 (transverse pinning group)	32 months
Essawy 2020 [4]	Egypt	Prospective study	30.9 (15-51)	22/3	25	12 months (10-16)
Choi 2006 [16]	China	Retrospective study	-	-	34 cases (39 fingers)	25 months (12 – 40)
Elazab, 2025 [17]	Egypt	Prospective study	36 years (19 – 56)	17/0	20 patients	6 months

Table 1 provides an overview of key demographic and methodological characteristics of studies investigating transverse K-wire fixation for metacarpal fractures. The studies were conducted across Asia (China, Korea), Europe (France, Italy, Norway), and Africa (Egypt), ensuring a diverse representation of patient populations and surgical practices. Study designs varied, with prospective [4, 13, 14] and retrospective studies [12, 15, 16], as well as a non-randomized controlled trial [11] and a prospective study [17]. The mean age of participants ranged from 23 years [11] to 38.4 years [14], with most studies focusing on young adults, which aligns with the typical epidemiology of metacarpal fractures. A significant male predominance was observed across all studies, reflecting the higher incidence of hand trauma in males due to occupational, sports, and trauma-related causes. Sample sizes varied, with the smallest cohort being 18 patients [13] and the largest being 45 cases [15].

Follow-up duration ranged from 2.7 months [13] to 32 months [15], with most studies ensuring at least one year of follow-up, allowing for adequate assessment of functional recovery, radiographic healing, and long-term complications.

3.2.Meta-analysis of outcomes

Total active motion

The pooled analysis revealed a mean TAM of 256.892 degrees (95% CI: 250.572, 263.212). While the overall estimate suggests a favorable restoration of TAM following transverse K-wire fixation, the substantial heterogeneity ($I2 = 77.83\%$, $p < 0.001$) indicates considerable variability in outcomes across the included studies. Individual study estimates ranged from 245 to 265 degrees [12, 15]. Notably, the study by Moon et al. [2014] showed the lowest mean TAM and the widest confidence interval, suggesting a potentially less precise estimate [12]. Conversely, Sletten et al. [2011] reported the highest mean TAM with a relatively narrow confidence interval, indicating a more precise estimate [15] (**Figure 2**).

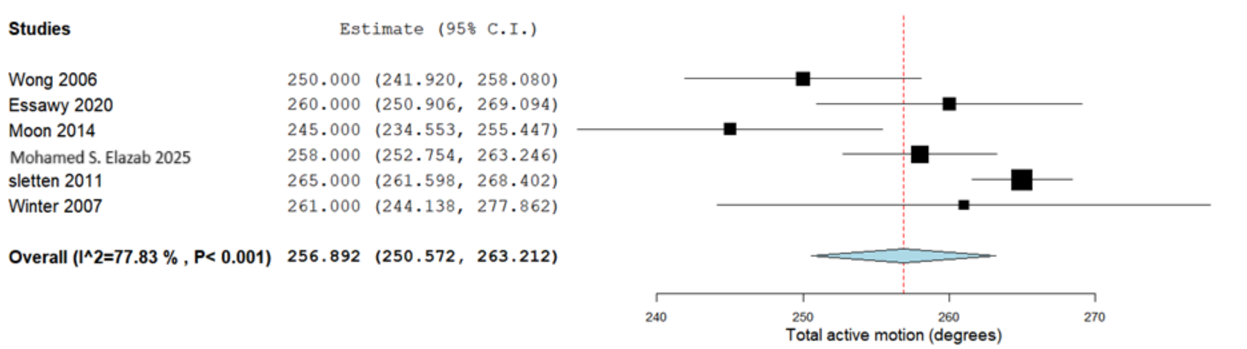

Figure 2: forest plot showing the result of the pooled analysis of total active motion.

DASH score

The pooled analysis revealed a mean DASH score of 2.608 (95% CI: 1.001, 4.215]. This result suggests a relatively low level of disability reported by patients following transverse K-wire fixation. However, the high degree of heterogeneity ($I^2 = 95.07\%$, $p < 0.001$) indicates considerable variability in DASH scores across the included studies.

Individual study estimates ranged from 1.300 [15] to 5.000 [14]. Notably, the study by Potenza et al. (2012) showed a significantly higher mean DASH score compared to the other studies, with a wide confidence interval [12]. Conversely, Sletten et al. [2011] reported the lowest mean DASH score, suggesting minimal disability in their patient population [15] (**Figure 3**).

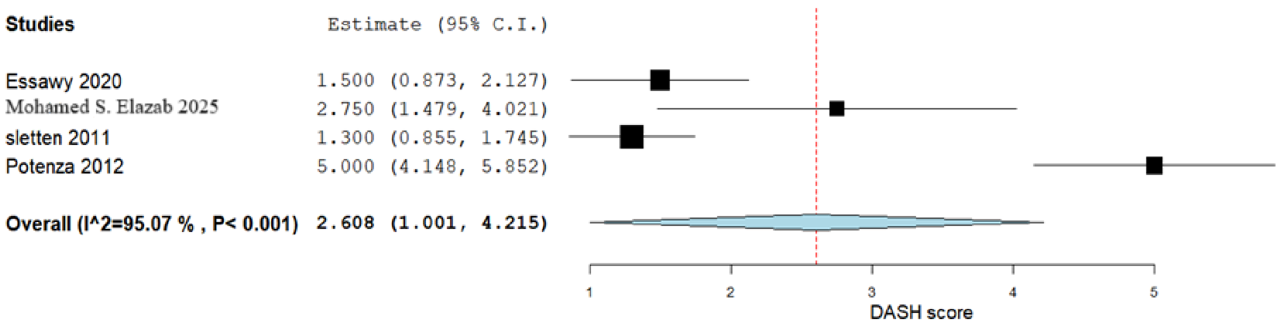

Figure 3: forest plot showing the result of the pooled analysis of the DASH score.

Grip strength

The pooled analysis revealed a mean grip strength of 95.671% (95% CI: 92.567, 98.776%] of the normal hand. This result indicates a generally good recovery of grip strength following transverse K-wire fixation. However, the substantial heterogeneity (I^2 = 89%, p < 0.001) suggests considerable variability in grip strength outcomes across the included studies. Individual study estimates ranged from 83% [13] to 100.370% [17]. Notably, the study by Winter et al. [2007] reported a significantly lower mean grip strength compared to the other studies, with a confidence interval that does not overlap with the pooled estimate [13]. Conversely, Elazab et al. (2025) reported a mean grip strength exceeding 100%, suggesting a potential overestimation or a patient population with unusually high grip strength postoperatively [17] (**Figure 4**).

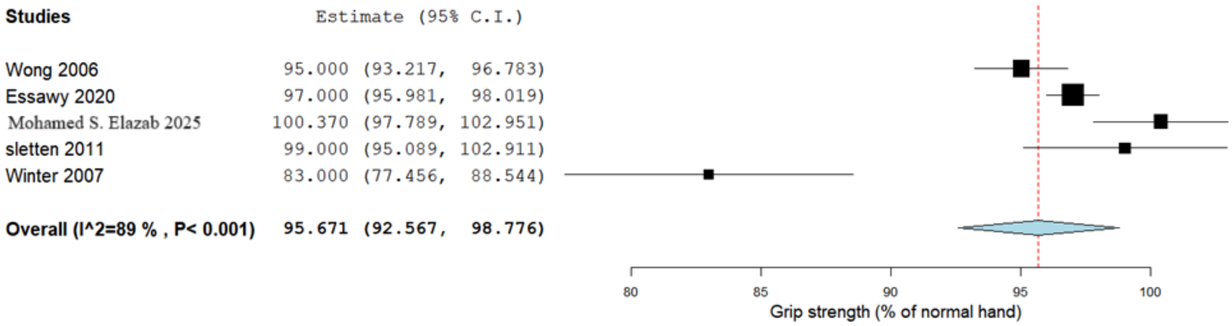

Figure 4: forest plot showing the result of the pooled analysis of grip strength.

Healing time

The pooled analysis revealed an overall mean healing time of 6.693 weeks (95% CI: 6.395, 6.991]. This result suggests a relatively consistent healing time across the included studies following transverse K-wire fixation with no significant heterogeneity detected ($I^2 = 0\%$, $p = 0.401$). Individual study estimates ranged from 5.8 weeks [Potenza 2012] to 7.2 weeks [11]. The narrow confidence intervals observed in all studies indicate relatively precise estimates of healing time within each study (**Figure 5**).

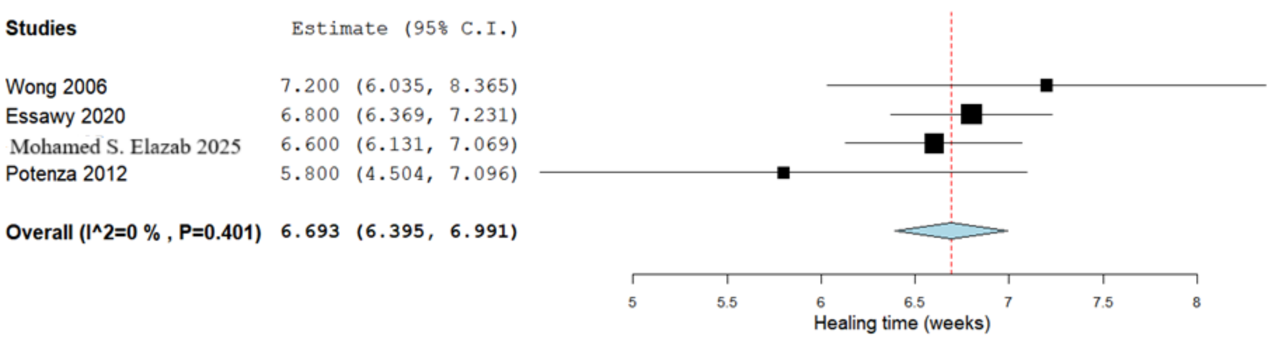

Figure 5: forest plot showing the result of the pooled analysis of healing time

VAS score

The pooled analysis, utilizing a random-effects model due to substantial heterogeneity (I^2 = 95.23%, p < 0.001), revealed a mean VAS score of 0.986 (95% CI: 0.480, 1.492). This result indicates a relatively low level of pain reported by patients following transverse K-wire fixation. However, the high degree of heterogeneity suggests considerable variability in VAS scores across the included studies. Individual study estimates ranged from 0.210 to 2.100 [12, 17]. Notably, the study by Moon et al. (2014) showed a significantly higher mean VAS score compared to the other studies, with a wide confidence interval [12]. Conversely, Elazab et al. (2025) reported the lowest mean VAS score, suggesting minimal pain in their patient population [17] (**Figure 6**).

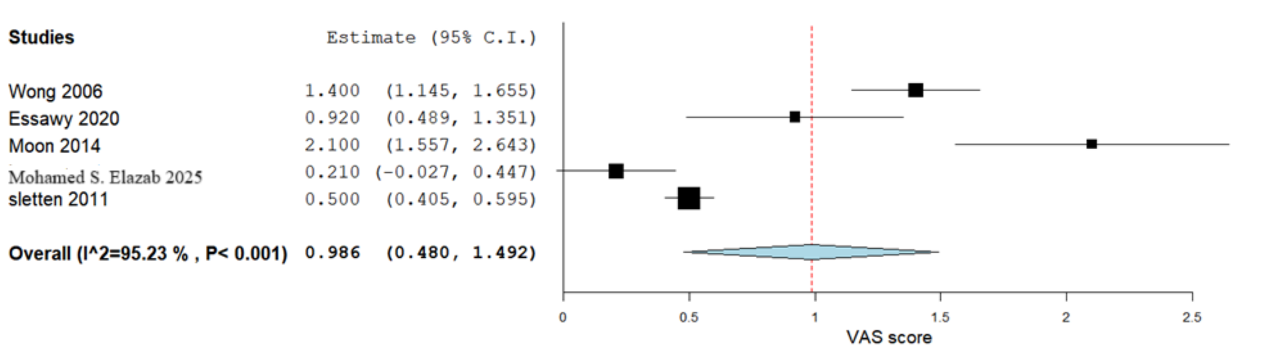

Figure 6: forest plot showing the result of the pooled analysis of the VAS score.

3.3.Complication rate

The pooled analysis revealed an overall complication rate of 0.107 (95% CI: 0.052, 0.162), indicating that approximately 10.7% of patients experienced complications following transverse K-wire fixation. Individual study complication rates ranged from 0.026 to 0.211 [13, 15]. Notably, the study by Sletten et al. (2011) reported a significantly higher complication rate compared to the other studies [15]. Conversely, Winter et al. (2007) reported the lowest complication rate, with no complications observed in the transverse K-wire group. An overall low heterogeneity was detected (I^2 = 46.55%, p = 0.070) [13] (**Figure 7**).

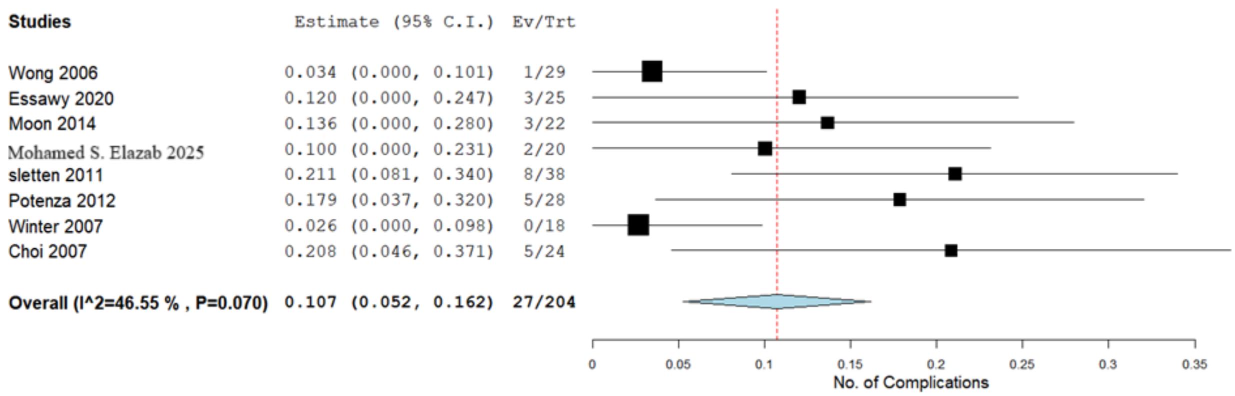

Figure 7: forest plot showing the result of the pooled analysis of the complication rate.

3.4.Heterogeneity Assessment

The degree of heterogeneity varied across the analyzed outcomes. Substantial heterogeneity was observed for VAS score ($I^2 = 95.23\%$, $p < 0.001$), DASH score ($I^2 = 95.07\%$, $p < 0.001$), and grip strength ($I^2 = 89\%$, $p < 0.001$), indicating significant variability in these outcomes across the included studies. Significant heterogeneity was also observed for TAM ($I^2 = 77.83\%$, $p < 0.001$), suggesting considerable variability in TAM outcomes. Moderate heterogeneity was observed for complication rate ($I^2 = 46.55\%$, $p = 0.070$), indicating some variability in complication rates; however, overall, the rate of complications was low. On the other hand, healing time showed an absence of significant heterogeneity ($I^2 = 0\%$, $p = 0.401$), suggesting relatively consistent healing times across studies; an average of 6 weeks is reported in all studies. Despite this statistically significant heterogeneity, the range of pooled mean values for these outcomes suggests that the observed differences may not be clinically significant. For instance, while statistically significant heterogeneity was present in the analysis of TAM, the pooled mean values indicate a generally good restoration of motion. Similarly, for VAS and DASH scores, the pooled means reflect relatively low levels of pain and disability, respectively, suggesting that the variability, though statistically significant, might not translate to clinically meaningful differences in patient experience or functional outcomes. Although statistically significant heterogeneity was observed, the clinical relevance of the magnitude of differences is questionable.

3.5.Meta-analysis pre- and post-operative angulation and shortening

Meta-analysis of the reduction in angulation following transverse K-wire fixation in metacarpal fractures across four studies [12, 14, 15, 17]. The pooled mean difference in angulation reduction is -32.30° (95% CI: -48.00 to -16.61, p < 0.0001), indicating a statistically significant improvement in fracture alignment postoperatively. Among the included studies, Potenza [2012] demonstrated the greatest reduction in angulation (-56°), suggesting a substantial corrective effect, followed by Moon et al. (2014) and Sletten et al. (2011), who reported moderate reductions of -35.40° and -21.00°, respectively [12, 15]. Elazab et al. (2025) observed the least reduction at -17.48°, though still clinically significant [17] (**Figure 8**).

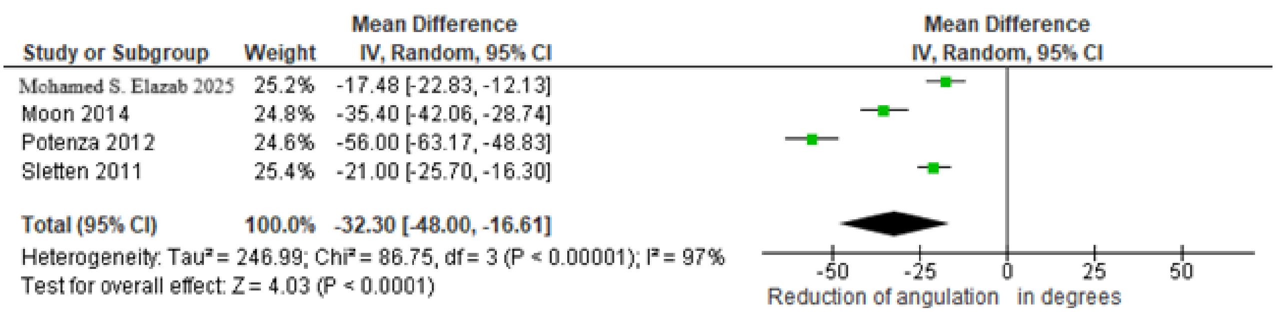

Figure 8: forest plot showing the reduction of angulation post-operatively.

The forest plot illustrates the reduction in metacarpal shortening following transverse K-wire fixation across three studies [12, 15, 17]. The pooled mean difference in shortening reduction is -4.26 mm (95% CI: -7.29 to -1.23, *p* = 0.006), indicating a statistically significant improvement in fracture alignment postoperatively. Among the included studies, Moon et al. (2014) reported the greatest reduction in shortening (-7.20 mm, 95% CI: -8.54 to -5.86), suggesting a notable corrective effect [12]. Elazab et al. (2025) and Sletten et al. (2011) demonstrated more moderate reductions of -3.26 mm and -2.40 mm, respectively [15, 17] **(Figure 9).**

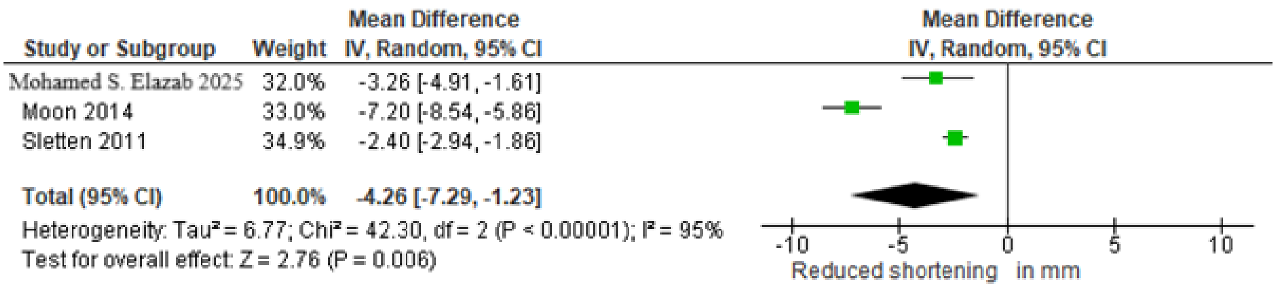

Figure 9: forest plot showing reduced shortening post-operatively.

3.6.Quality assessment of included studies

Most studies were considered to be of good quality, scoring 7 or higher, except for Choi 2007. The second item, "Selection of the non-exposed cohort," was marked as NA because it was not applicable in this meta-analysis. This is due to the study design, which assessed outcomes in a single-arm group—transverse fixation only—without comparison to other techniques or approaches (**Table 3**).

Table 3: The Newcastle Ottawa scale showing scoring of the different studies according to different quality assessment domains.

Study	Representativeness of the expected cohort [1]	Ascertainment of exposure [1]	Demonstration of the absence of the outcome of interest at the start of the study [1]	Comparability of cohorts based on the design or analysis [2]	Assessment of outcomes [1]	Follow-up long enough for the cohorts [1]	Adequacy of follow-up [1]	Total score
Wong 2006 [11]	*		*	**	*	*	*	7
Essawy 2020 [4]	*	*	*	**	*	*	*	8
Moon 2014 [12]	*		*	**	*	*	*	7
Elazab, 2025 [17]	*	*	*	**	*	*	*	8
Sletten 2011 [15]	*	*	*	*	*	*	*	6
Potenza 2012 [14]	*		*	**	*	*	*	7
Winter 2007 [13]	*	*	*	*	*	*	*	7
Choi 2006 [16]	*		*		*	*	*	5

4. Discussion

This meta-analysis summarizes the current evidence on transverse K-wires as a method of fixation of metacarpal fractures, assessing various outcomes and complications of the fixation method.

Metacarpal fractures are a common occurrence, representing a significant proportion of all hand fractures. Chung and colleagues found that metacarpal fractures account for 30-50% of all hand fractures. These fractures can result in substantial disability and could lead to long-term impairment, affecting the ability to work and daily activities [17].

The metacarpals are crucial for normal hand function, enabling finger flexion, extension, and grip strength. The index and middle finger metacarpals have limited movement at the carpometacarpal [CMC] joint. In contrast, the ring and small fingers exhibit more CMC motion. Fractures to these bones can disrupt the intricate biomechanics of the hand, potentially leading to long-term dysfunction [1].

Functional outcomes following transverse K-wire fixation are generally favorable, with several studies reporting a range of motion comparable to the uninjured hand [18, 19]. The findings of this meta-analysis further support these observations, as the pooled TAM was 256.892°. This suggests a good restoration of motion following transverse K-wire fixation.

Furthermore, these results align with previous findings that K-wire fixation offers superior active flexion compared to locking plates, achieving 97.7% mobility of the contralateral side versus 58.7% in the plate fixation group, despite a longer immobilization period in K-wire patients [2]. This suggests that K-wire fixation not only provides adequate stability but also facilitates early and more complete functional recovery, making it a valuable option for treating unstable metacarpal fractures [3].

Healing outcomes following metacarpal fracture fixation are generally favorable, with high rates of osseous union and functional recovery across various treatment methods. McCarthy et al. reported predictable healing rates of 90–100%, with osseous union typically occurring between five and eight weeks, regardless of treatment approach [20]. Similarly, percutaneous pinning, including K-wire fixation, has been associated with excellent bone healing, with union rates approaching 100% in multiple studies [4, 11]. The findings of this meta-analysis further support these observations, as the pooled analysis revealed an overall mean healing time of 6.693 weeks. The absence of significant heterogeneity suggests a consistent healing timeline across studies, with individual estimates ranging from 5.8 to 7.2 weeks [11, 14]. This consistency may be attributed to the standardized nature of transverse K-wire fixation techniques and postoperative care protocols, reinforcing its reliability as a surgical approach for unstable metacarpal fractures.

According to Kollitz et al. (2014), up to 6 mm of metacarpal shortening is considered tolerable, beyond which functional impairment, extension lag, and grip weakness may occur [2]. The pooled analysis demonstrated a mean shortening reduction of -4.26 mm, indicating a statistically significant improvement in fracture alignment. Notably, Moon et al. (2014) achieved the greatest correction (-7.20 mm) [12], slightly exceeding the acceptable threshold, while Elazab et al. (2025) and Sletten et al. (2011) reported more moderate reductions of -3.26 mm and -2.40 mm, respectively [15, 17], keeping shortening within functionally acceptable limits. These results suggest that transverse K-wire fixation is effective in maintaining metacarpal length, reducing the risk of extensor lag and grip strength deficits.

The tolerable limit for apex dorsal angulation, as defined by Kollitz et al. (2014), varies based on fracture location, ranging from 10° to 15° for the index and middle finger metacarpals, 30° for the ring finger, and up to 50–70° for the small finger [2]. For shaft fractures, acceptable angulation is 10° for the index and middle fingers and 20–30° for the ring and small fingers. In this meta-analysis, transverse K-wire fixation achieved a pooled mean angulation reduction of -32.3°, demonstrating significant realignment postoperatively. Among the included studies, Potenza et al. (2012) achieved the greatest reduction (-56°), followed by Moon et al. (2014) (-35.4°), and Sletten et al. (2011) (-21°) [12, 14, 15]. Elazab et al. (2025) reported the least reduction (-17.48°), though still clinically significant [17]. These findings suggest that transverse K-wire fixation is effective in correcting excessive angulation, particularly in fractures where the initial deformity exceeds acceptable limits.

The correction of both shortening and angulation is crucial for preserving grip strength, preventing pseudo-clawing, and avoiding rotational malalignment. The results of this meta-analysis indicate that transverse K-wire fixation reliably restores metacarpal length and alignment, keeping residual deformity within the limits considered acceptable for good functional recovery.

The DASH scores provide an important measure of functional outcomes following metacarpal fracture treatment. Westbrook and colleagues compared nonoperative treatment and surgical interventions (K-wires and plates) and found that, at two years, patients who underwent nonoperative management had normal DASH scores and aesthetic outcomes [18]. Notably, for metacarpal neck fractures, there was no significant difference in functional outcomes between operative and nonoperative groups, though the trend favored nonoperative treatment. As for shaft fractures, they fared better in the non-operative group regarding DASH and aesthetic scores. However, as Westbrook et al. acknowledge, the retrospective nature of their study may have introduced selection bias, as patients with less severe injuries were more likely to be treated nonoperatively [18, 19].

The findings of this meta-analysis align with these observations, as the pooled DASH score for patients undergoing transverse K-wire fixation was 2.608, indicating relatively low disability. However, substantial heterogeneity suggests considerable variability in functional recovery across studies. Individual study estimates ranged from 1.3 [15], reflecting minimal disability, to 5 [14], which indicated greater impairment.

While transverse K-wire fixation achieves good functional outcomes in most cases, these results suggest that certain patient groups may experience greater post-treatment disability, possibly due to variations in fracture severity, surgical technique, or rehabilitation protocols [20].

The comparison with Westbrook et al.'s (2008) findings raises an important consideration [18]. While surgical intervention is necessary for unstable fractures, nonoperative treatment may provide equivalent, if not superior, functional outcomes in select cases, particularly for neck fractures. This emphasizes the importance of patient selection, as unnecessary surgical intervention in borderline cases may not provide significant functional benefits.

Complications associated with metacarpal fractures, whether treated conservatively or surgically, can significantly impact functional outcomes [21]. In our study, the pooled complications rate was 10.7%, which agreed with several studies in the literature [2, 22, 23]. Malunion is a common issue, often resulting from inadequate reduction or stabilization, and may lead to deformities such as rotational malalignment, which is poorly tolerated due to its pronounced effect on hand function, particularly during flexion [2].

In our study, even minor rotational deformities can cause symptomatic scissoring and digital overlap, necessitating precise alignment during treatment. Extensor lag, another frequent complication, arises from metacarpal shortening, which disrupts the extensor mechanism's balance; every 2 mm of shortening can result in approximately 7° of extension lag [24]. Intra-articular fractures carry a risk of post-traumatic arthrosis if step-offs greater than 1 mm are not corrected, leading to joint degeneration and chronic pain. Additionally, stiffness is a prevalent concern following surgical intervention, particularly when rigid fixation limits early mobilization. Infection risks are heightened with exposed hardware, such as K-wires, emphasizing the importance of meticulous surgical technique and postoperative care [13, 22]. Overall, careful management of these complications is critical to preserving hand function and achieving optimal outcomes in patients with metacarpal fractures.

5. Conclusions

The findings of this meta-analysis support the effectiveness of transverse K-wire fixation in restoring functional and radiographic outcomes in metacarpal fractures. The pooled analysis demonstrated favorable total active motion (256.9°), high grip strength recovery (95.67% of normal), and low DASH scores (2.61), indicating minimal residual disability. Additionally, pain levels were generally low [VAS 0.98], and healing times remained consistent across studies, averaging 6.69 weeks.

Despite these favorable outcomes, complications were reported in approximately 10.7% of cases, with infection, wire discomfort, and minor malalignment being the most frequently observed issues. Importantly, heterogeneity was substantial for several outcomes, particularly DASH score, grip strength, and pain levels, suggesting variability in patient characteristics, surgical technique, and postoperative rehabilitation protocols. However, the observed statistical heterogeneity may not necessarily translate into clinically significant differences, as overall functional recovery remained favorable.

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Authors' contributions: HAK: Protocol development, Data revision. MSA: Data collection and analysis. MEE: Data management, Manuscript writing. All authors have read and approved the manuscript.

Conflicts of Interest: All authors confirm that there are no conflicts of interest.

AI declaration statement: None declared.

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