

Comparative Analysis of Functional Outcomes Following Axial versus Transverse Pinning in Boxer's Fractures

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Background: In this cross-sectional study, 60 patients with fifth metacarpal fractures underwent surgical fixation using either axial or transverse pinning techniques. Functional outcomes were assessed using Total Active Motion (TAM) and the Iranian version of the Quick DASH questionnaire. Radiographic evaluation focused on angular deformity and complications, including nonunion and malunion.

Materials and Methods: In this cross-sectional study, 60 patients with fifth metacarpal fractures underwent surgical fixation using either axial or transverse pinning techniques. Functional outcomes were assessed using Total Active Motion (TAM) and the Iranian version of the Quick DASH questionnaire. Radiographic evaluation focused on angular deformity and complications, including nonunion and malunion.

Results: No significant differences were observed between the axial and transverse pinning groups with respect to Total Active Motion (TAM) scores, Quick DASH results, or radiographic measures of angular deformity ($P > 0.05$). Similarly, the incidence of complications, including nonunion and malunion, did not differ significantly between the two techniques (all $P > 0.05$).

Conclusion: Axial and transverse pinning techniques yield comparable functional and radiographic outcomes in Boxer's fractures, indicating that both methods are effective and viable surgical options.

Keywords: Boxer's fracture; Axial pinning; Transverse pinning; Hand trauma

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Introduction

A Boxer's fracture is a fracture of the neck of the fifth metacarpal, typically resulting from direct impact or a fall onto the hand. Approximately 25% of these fractures occur during athletic activities (1–3). Metacarpal fractures account for roughly 40% of all

acute hand injuries and about 20% of fractures distal to the elbow (4, 5). These injuries are markedly more common in males, particularly those aged 10–19, followed by individuals aged 20–29, with an overall male-to-female ratio of approximately 5:1 (6). The primary mechanism involves axial loading of the metacarpal with a clenched fist, most often during



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punching, rather than from falls on an outstretched hand (6). Impact with hard surfaces, such as walls or cabinets, or less commonly being struck by a hard object, can produce this fracture pattern (7).

Initial management of Boxer's fractures typically involves closed reduction followed by immobilization with a cast or splint. While many stable, closed fractures heal successfully with conservative treatment, certain cases necessitate surgical intervention (8, 9). Surgical options include Kirschner wires (K-wires), plates, intramedullary nails, or external fixators (10–12). Over the past three decades, substantial advancements have been made in the surgical management of metacarpal fractures (5, 13). Surgical fixation is particularly important to prevent complications such as rotational malalignment of the fifth digit, which can result in finger overlap during fist formation.

Several surgical techniques have been proposed to achieve optimal stabilization of Boxer's fractures. Foucher et al. advocated for intramedullary fixation using axial pinning (14), whereas Berkman and Miles recommended transverse pinning, which involves inserting K-wires transversely across the fourth and fifth metacarpals (15).

Achieving optimal surgical outcomes, especially for manual laborers and athletes, requires selecting a fixation technique that promotes rapid and complete functional recovery. Although both axial and transverse pinning are commonly used, no prior comparative studies have evaluated differences in angular correction on frontal and lateral radiographs or assessed their respective impacts on functional hand outcomes. This study aims to address this gap by comparing the clinical and radiographic results of axial versus transverse pinning in patients with Boxer's fractures.

Materials and methods

This analytical cross-sectional study included patients aged 18 years and older with fractures of the fifth metacarpal neck (Boxer's fractures) who presented to Shahid Beheshti Hospital in Babol between 2019 and 2022. Surgical treatment was performed using either the axial or transverse pinning technique, with all procedures carried out by the same orthopedic surgeon

to ensure consistency and minimize technical variability. Patients were randomly assigned to one of the two treatment groups. Figure 1 illustrates both the axial (reciprocal/mirror) and transverse pinning techniques.



Fig. 1. (a) Transverse pinning method; (b) Reciprocal (mirror) method.

The sample size was determined based on the findings of Galal et al. (16), considering the expected differences between the two surgical techniques and ensuring adequate statistical power. Consequently, a minimum of 30 patients was included in each group, yielding a total of 60 participants.

Inclusion criteria were established to enroll patients with clinically significant fractures requiring surgical intervention. Eligible patients had acute fifth metacarpal neck fractures with apex dorsal angulation exceeding 45°, rotational deformity greater than 10° (scissoring), fracture shortening of more than 5–6 mm, or associated carpometacarpal (CMC) dislocation. Patients were aged 15–65 years, had no underlying bone disease, and no prior metacarpal fractures.

Patients were excluded if they had a history of diabetes mellitus, intra-articular fracture extension, previous trauma to the same hand, or were managed non-surgically. Additional exclusion criteria included poor adherence to postoperative care, failure to complete follow-up visits, or development of nonunion.

All participants were informed about the study objectives and procedures, and written informed consent was obtained. The study was approved by the Ethics Committee of Babol University of Medical

Sciences (Approval Code: IR.MUBABOL REC. 1401. 141) and conducted in accordance with the Declaration of Helsinki.

Results

Of the 74 patients initially enrolled, 10 were excluded due to loss to follow-up and 4 met the exclusion criteria, leaving 60 patients for the final analysis. Among these, 54 patients (90%) were male and 6 (10%) were female, with a mean age of 37.63 ± 11.14 years (range: 18–65 years; median: 37). There were no statistically significant differences between the axial and transverse pinning groups regarding age or gender distribution ($P > 0.05$; Table 1). Functional outcomes, including Total Active Motion (TAM) and QuickDASH scores, were compared between the axial and transverse pinning groups (Table 2).

The mean TAM in the lateral view was $204.37 \pm 15.41^\circ$ in the axial group and $198.40 \pm 14.19^\circ$ in the transverse group, with no significant difference

observed ($P = 0.124$). Similarly, QuickDASH scores were comparable between the groups (29.26 ± 6.47 vs. 27.73 ± 4.99 ; $P = 0.311$).

Radiographic assessment of union and alignment outcomes revealed no statistically significant differences between the axial and transverse pinning groups (Table 3). Nonunion occurred in one patient in the axial group, while no cases were observed in the transverse group ($P = 1.000$). The incidence of sagittal, rotational, and coronal malunion was similar between the two groups (all $P > 0.05$).

All patients achieved a TAM score above 120° , with no instances of poor functional outcome. Qualitative assessment of TAM in the lateral view indicated that 88.3% of patients had a good outcome ($121\text{--}220^\circ$), while 11.7% achieved excellent motion ($\geq 220^\circ$) (Figure 2). Comparison between the axial and transverse pinning groups showed no significant difference in the distribution of good and excellent outcomes ($P = 0.424$; Table 4).

Table 1. Comparison of demographic characteristics (age and gender) between patients treated with axial and transverse pinning methods for fifth metacarpal neck fractures.

Variables	Total Frequency (n/%)	Axial Pinning (n/%)	Transverse Pinning (n/%)
Age (≥ 37)	32 (53.3%)	15 (50.0%)	17 (56.7%)
Age (< 37)	28 (46.7%)	15 (50.0%)	13 (43.3%)
Male	54 (90.0%)	28 (93.3%)	26 (86.7%)
Female	6 (10.0%)	2 (6.7%)	4 (13.3%)

Table 2. Comparison of functional outcomes (TAM scores) and upper limb disability (QuickDASH scores) between axial and transverse pinning groups, assessed in the lateral (profile) view.

Variables	Axial Pinning (Mean \pm SD)	Transverse Pinning (Mean \pm SD)	P value
TAM in profile view (degrees)	204.37 ± 41.15	198.40 ± 14.19	0.124
QuickDASH (of 100)	26.29 ± 6.47	27.73 ± 4.99	0.311

Table 3. Radiological comparison of postoperative complications, including nonunion and malunion (sagittal, rotational, and coronal), between axial and transverse pinning methods.

Variants	Total (n/%)	Axial Pinning (n/%)	Transverse Pinning (n/%)
Nonunion in face and profile view	1 (1.7%)	1 (3.3%)	0 (0.0%)
Sagittal malunion	4 (6.7%)	1 (3.3%)	3 (10.0%)
Rotational malunion	8 (13.3%)	3 (10.0%)	5 (16.7%)
Coronal malunion	2 (3.3%)	1 (3.3%)	1 (3.3%)

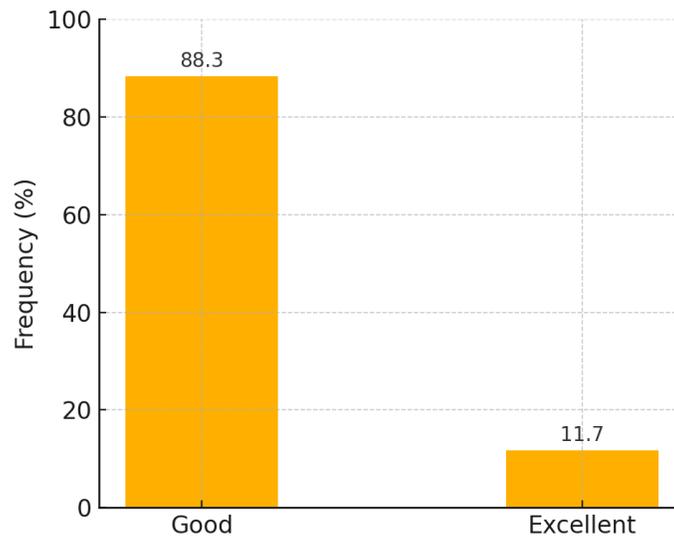


Fig. 2. Distribution of qualitative Total Active Motion (TAM) outcomes in the lateral view among patients undergoing pinning for Boxer's fractures.

Table 4. Qualitative assessment of Total Active Motion (TAM) outcomes between axial and transverse pinning techniques in the lateral (profile) view.

TAM in profile view	Total (n/%)	Axial Pinning (n/%)	Transverse Pinning (n/%)
Good (121–220 degrees)	53 (88.3%)	25 (83.3%)	28 (93.3%)
Excellent (≥ 220 degrees)	7 (11.7%)	5 (16.7%)	2 (6.7%)

Discussion

This study compared the clinical and radiographic outcomes of axial versus transverse pinning for the surgical management of fifth metacarpal neck fractures. The results revealed no statistically significant differences between the two techniques with respect to functional outcomes, as measured by Total Active Motion (TAM) and QuickDASH scores, or radiographic complications, including nonunion and sagittal, rotational, or coronal malunion. These findings indicate that both axial and transverse pinning are effective and reliable options for the treatment of Boxer's fractures.

Our findings are consistent with those of Galal et al. (16), who reported comparable safety and efficacy between transverse and intramedullary pinning for fifth metacarpal neck fractures. Similarly, Zhu et al. (22) and Melamed et al. (23) found no significant differences in long-term functional outcomes between pinning and

plating techniques, supporting the idea that multiple surgical approaches can yield satisfactory results when properly applied.

However, not all studies have reached the same conclusion. For instance, Yi et al. (24) reported superior functional outcomes with antegrade intramedullary pinning compared to retrograde fixation. Variability across studies may reflect differences in surgical technique, patient demographics, or outcome assessment criteria. Saied et al. (25) observed comparable outcomes between cross-pinning and intramedullary methods, whereas Haddad et al. (26) reported favorable results using a hybrid technique combining antegrade and transverse pinning.

In our study, the lack of significant differences in malunion and nonunion rates further supports the equivalence of axial and transverse pinning techniques. While Galal et al. (16) reported a lower complication rate with transverse pinning, their comparison was with intramedullary pinning rather than axial pinning,

limiting the direct applicability of their findings to our results.

Although healing time and complication rates were not specifically assessed in the present study, these parameters may serve as important outcomes in future research. In clinical practice, the choice of surgical technique often depends on surgeon expertise, patient characteristics, and resource availability. The comparable baseline characteristics of our study population, particularly age and gender, enhance the internal validity of our findings.

A key strength of this study is its dual assessment of both lateral and frontal radiographic views, enabling a comprehensive evaluation of angular deformities. Additionally, functional outcomes were measured using both qualitative and quantitative assessments of Total Active Motion (TAM), enhancing the reliability of the functional analysis. The similar distribution of good and excellent TAM scores between the axial and transverse pinning groups supports the conclusion that both techniques provide comparable clinical efficacy. Future studies should evaluate recovery timelines, including the return to daily activities at 3- and 6-month follow-ups, and examine operative times and complication rates associated with each technique to further optimize treatment protocols.

In conclusion, this study demonstrates that both axial and transverse pinning are effective and reliable surgical options for managing Boxer's fractures, with no clear superiority of either technique in terms of radiographic alignment or functional recovery. Nevertheless, due to its technical simplicity, minimal invasiveness, and potential for faster rehabilitation without requiring secondary procedures, transverse pinning may offer practical advantages in selected clinical scenarios. Ultimately, the choice of technique should be guided by patient-specific factors and the surgeon's expertise.

Study Limitations

One limitation of this study was the presence of incomplete or inconsistent documentation in hospital records, which may have affected the comprehensiveness and availability of certain clinical data.

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