

RESULTS OF INTRAMEDULLARY HEADLESS SCREW FIXATION FOR METACARPAL FRACTURES IN ADULTS

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Received 10/5/2025

Accepted 28/7/2025

Abstract

Purpose: To evaluate clinical outcomes of intramedullary headless (Herbert) screw fixation for metacarpal fractures in adults. **Methods:** This is a prospective cohort study, conducted at Sohag University Hospital from August 2024 to February 2025 and included patients with isolated metacarpal shaft fractures treated with intramedullary headless (Herbert) screw fixation. Clinical and radiological assessment was done at 4, 8 and 12 weeks postoperatively using VAS, Quick DASH score and Total Active Motion score (TAM). **Results:** This study included 20 patients (80% males). Average age of 32.6 ± 10.2 years. Pain levels significantly improved, with all patients became pain-free by 12 weeks ($p < 0.001$). Functional recovery showed progressive improvement, with 70% achieving "excellent" Quick DASH scores at 12 weeks ($p < 0.001$). TAM scores also improved significantly, with all patients achieving a "satisfactory" range by week 12 ($p < 0.001$). **Conclusion:** Intramedullary headless Herbert screw fixation of metacarpal fractures provides consistent pain relief and functional recovery. Existing research reinforces the effectiveness of this technique, but further studies are necessary to optimize rehabilitation strategies and minimize postoperative risks.

Keywords: Metacarpal fractures, Intramedullary fixation, Headless screw.

1. Introduction

Metacarpal fractures are the third most common fractures of the upper extremity, following fractures of the distal radius and [1-4]. These fractures can involve various parts of the metacarpal bone, including the head, neck, shaft, and base. The primary causes of metacarpal fractures are road traffic accidents, trauma from machinery, falls, crush injuries—especially during sports activities—and twisting forces [3-6]. Currently, there is no universally accepted method of fixation for metacarpal fractures, as no single technique has shown to be superior to others [7]. Minimally invasive techniques include K-wire fixation, lag screws, cerclage wiring, and external fixation. These techniques minimize soft tissue dissection but risk malunion, nonunion, infection, hardware removal, and stiffness [8-10]. In recent years, intramedullary screw fixation has been advocated as a

viable alternative to K-wire or plate fixation for the management of displaced and unstable metacarpal fractures. The goal of reconstruction is to achieve rigid fixation, allowing early range of motion. The headless Herbert screw offers rigid stability, allows early active motion, and is relatively easy to perform. Its minimally invasive nature results in improved patient outcomes, including better range of motion, quicker return to work, and fewer complications. However, some reported complications that may require surgical intervention include; stiffness, flexion contracture, and extensor lag [5,6]. The purpose of this study is to evaluate clinical and radiological results of headless Herbert screw of metacarpal fractures in adults while summarizing the pearls and pitfalls to maximize successful surgical outcomes.

2. Patients and Methods

This is a prospective cohort study of 21 patients diagnosed with metacarpal fractures and underwent IM headless Herbert screw fixation. Only one patient was lost during the follow-up. These patients were followed up for three months regarding recovery, clinical outcomes, and complications. The study took place at Orthopaedics and Traumatology department, Sohag University Hospital from August 2024 to February 2025. The study was approved from the ethical committee of Sohag Faculty of Medicine. A written informed consent was obtained from all patients before their participation in the study.

2.1. Inclusion criteria

- Adult patients.
- Metacarpal shaft fractures.
- Simple fractures.
- Recent fractures within 1-2 weeks.
- Isolated metacarpal fractures.

2.2. Exclusion criteria

- Pediatric fractures with open physis.
- Head-splitting fractures and Metacarpal basal fractures.
- Compound fracture increasing risk of infection.
- Medical illness or mental disorders affecting the follow-up examination.
- Association with other fractures fixed by methods that limit early range of motion.
- Pathologic fractures.

2.3. Preoperative assessment

The assessment included patient history (handedness, occupation, fracture chronicity, smoking, and medical conditions, especially diabetes). A physical examination evaluated rotation, shortening, and other factors. Radiographic evaluation used posteroanterior (PA), oblique, and lateral X- rays, including wrist and interphalangeal joints, to assess fracture comminution, location, and pattern (transverse, short/long oblique, butterfly segments). Bone width and medullary canal isthmus were measured, with the fourth metacarpal having the narrowest isthmus (2.6 mm) and the fifth the largest (3.6 mm). Laboratory tests included CBC, kidney function, INR, and prothrombin time.

2.4. Surgical technique

A preoperative 3rd generation cephalosporin antibiotic was given to all patients. The operation was performed under regional block with sedation or using wide awake local anesthetic. The patients were placed in the supine position. After preparation, closed red-

uction under fluoroscopy was performed. A longitudinal dorsal incision over the metacarpal head was made, fig. (1).



Figure (1) Longitudinal 1-2 cm incision over the 5th metacarpal head revealing extensor tendon expansion beneath.

Dissection proceeded to the extensor apparatus, where a longitudinal split in the extensor expansion was performed, ensuring less than 50% tendon involvement. Fluoroscopy confirmed the screw size, width, and length for proper fixation. The guidewire was advanced retrogradely to the fracture level under fluoroscopic guidance, positioned in the dorsal one-third of the metacarpal head. After confirming reduction, it was extended across the fracture to the metacarpal base, fig. (2).

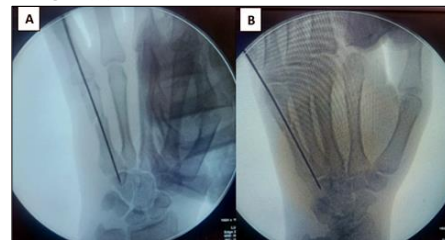


Figure (2) **a.** PA view, **b.** oblique view of reduction performed with retrograde guide wire passed through the fracture site to the base of metacarpals.

The screw length was determined by measuring the guidewire, typically subtracting 4-6 mm for the final size. The metacarpal was drilled just past the fracture site to ensure proper reaming of the narrowest part of the canal, fig. (3).



Figure (3) A cannulated drill is advanced over the guide wire, drilling through the medulla's narrowest segment and traversing the fracture site to reach the proximal portion of the 5th metacarpal.

The screw was hand-driven while the digits were flexed into the palm to maintain the correct flexion cascade and prevent rotational deformity. The screw engaged the intramedullary cortical bone with good purchase and was buried just beneath the subchondral bone. Placement was confirmed under fluoroscopy, fig. (4). The guide wire was then removed, and the extensor tendon and skin were closed. A soft dressing was applied with compression over dressing for a few minutes.

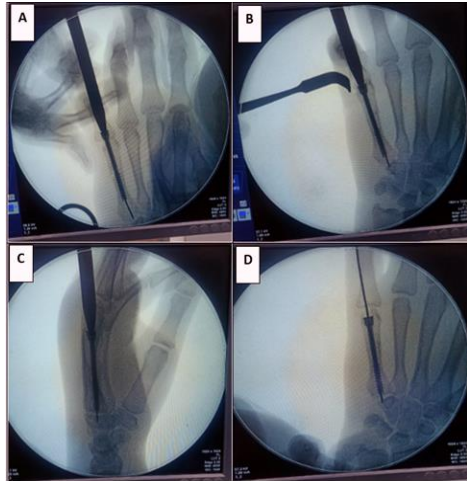


Figure (4) **a.** & **d.** PA view, **b.** oblique view, **c.** lateral view of the screw inserted over the guide wire, compressing the fracture as its distal serrations pass the fracture site completely, with the head secured subchondral to the metacarpal head.

2.5. Postoperative evaluation

The patient was closely observed in the recovery room for early signs of bleeding or nerve injury. A postoperative X-ray was performed to confirm screw positioning and fracture alignment. Pain management included oral analgesics for discomfort, along with hand elevation and ice packs for the first 48 hours to reduce swelling and promote recovery. Wound care and early rehabilitation were emphasized to prevent complications. The patient was instructed to monitor for signs of infection, including redness, warmth, or drainage. The first wound check was scheduled between 2 to 5 days post-surgery, during which early range-of-motion exercises were introduced to prevent stiffness and support functional recovery, particularly in the MCP and interphalangeal joints.

2.6. Follow-up schedule

- Week 2: Sutures were removed.
- Weeks 4-8: The patient was restricted from heavy lifting or high-impact activities.
- Complications (stiffness, nonunion, malunion) were evaluated during follow-ups.

2.7. Radiological assessment

By X-ray at 1, 4, 8, and 12 weeks to assess fracture healing and screw positioning.

2.8. Functional and pain assessment

Three standardized scales were used 4, 8, 12 weeks postoperative:

- Visual Analog Scale (VAS): Assessed pain levels (0–100 mm scale).
- Quick DASH Score: Evaluated upper extremity function and disability.
- Excellent (0–5), Good (6–15), Satisfactory (15–35), Poor (>35).
- Total Active Motion score (TAM): Measured finger mobility.
 - Satisfactory: ≥ 70 –80% of normal range (260–280°).
 - Unsatisfactory: <70%, requiring further intervention.

2.9. Statistical analysis

Data for this study were analyzed using SPSS to perform both descriptive and inferential statistical tests. Descriptive statistics were first applied to summarize the demographic characteristics and other key variables. This included calculating frequencies and percentages for categorical variables such as gender, fracture type, and treatment outcomes. Quantitative continuous variables included age, and screw length, for which means, standard deviations, and ranges were calculated. To analyze the associations between different categorical variables, the Chi-square test was conducted. A P-value less than 0.05 was regarded as a degree of statistical significance.

3. Results

The study included a total of 20 patients with metacarpal fractures, two-fifth (40%) of them aged between 18-25 years, 40% aged 35-45 years, and 20% aged 25-35 years, and with a mean age of 32.6 ± 10.2 years. Most patients (80%) were males and 20% were females. A total of 14 (70%) had their right hand as the dominant hand and 30% had their left hand as the dominant hand. 60% of individuals presented with no comorbidities, while 40% had diabetes mellitus as a comorbid condition. Regarding smoking status, 45% of the patients had never smoked, whereas a higher proportion, 55%, were current smokers, tab. (1). A total of 14 (70%) of our patients had their left hand injured and 30% injured their right hand. Most fractures (80%) were transverse and only (20%) were oblique. A total of 12 (60%) fractured their shaft fifth metacarpal and 40% fractured

their shaft fourth metacarpal. No concomitant injuries were recorded. The material of the screw used in our patients was titanium (100%). Three-fifth of the patients (60%) used a screw of 45 mm length and 40% used a screw of 50 mm length. The screw diameter was constant with 4 mm for the outer diameter and 3.5 mm for the core diameter, tab. (2). The mean operative time was 50 ± 5 (range 40 - 60) minutes, indicating a relatively consistent duration for the procedure. Radiographic union was achieved in an average of 4 ± 0.6 (range 4 - 5) weeks, suggesting a predictable healing process. Additionally, the mean time to return to work or daily activities was 4 ± 2.1 (range 3.6 - 6) weeks, reflecting variability in functional recovery among patients. As regard VAS score; at 4 weeks, the majority of patients reported mild pain (70%), while (20%) experienced moderate and (10%) had severe pain, with no patients reported no pain. By 8 weeks, the percentage of patients reporting no pain increased significantly to 70%, with only (20%) experienced mild pain and (10%) had moderate pain. By 12 weeks, all patients were pain free, p-value (<0.001). According to Quick DASH Score; at 4 weeks, the majority of patients had "satisfactory" scores (55%), followed by "good" (30%), with fewer reporting "excellent" (10%) or "poor" (10%). By 8 weeks, most patients improved to a "good" score (70%), with fewer reporting "excellent" (20%) and only a small percentage maintaining "satisfactory" scores (10%). By 12 weeks, a significant shift was observed, with 70% achieving "excellent" scores and 30% reporting "good," while no patients remained in the "satisfactory" or "poor" categories, p-value (<0.001). At 4 weeks, 40% of patients achieved a "satisfactory" TAM score, while the majority (60%) were categorized as "unsatisfactory." By 8 weeks, there was a notable improvement, with 75% of patients reaching

a "satisfactory" score and only 25% remaining "unsatisfactory." At the 12-week mark, all patients (100%) demonstrated "satisfactory" TAM scores, p-value (<0.001), tab. (3). A total of 5 patients (25%) had mild stiffness due to delayed postoperative movement and 3 (15%) intraoperative vertical iatrogenic fracture of proximal shaft due to narrow medulla. We used a screw longer than our screw by 5 mm in patients who had vertical iatrogenic fracture as the fracture line did not reach the carpometacarpal joint. The same trend was observed in the 25-35 age group, where all cases also remained unaffected. However, in the 35-45 age group, complications were present in 8 cases, while 12 cases experienced no issues (P-value = 0.003). Regarding gender, male patients showed an even distribution, with 50% facing complications and 50% remaining complication-free. In contrast, female patients had no recorded complications, with all cases being free from issues (P-value = 0.068). Also, the data on the dominant hand and its association with complications indicates no statistically significant difference, as evidenced by a p-value of 0.432. Among fractures located at the shaft of the fifth MCB, complications were observed in 33.3% of cases, whereas 66.7% remained complication-free. Similarly, for fractures at the shaft of the fourth MCB, the complication rate was 50%, with an equal proportion of cases experiencing no complications ($p = 0.456$). Regarding fracture type, transverse fractures exhibited a complication rate of 37.5%, whereas oblique fractures demonstrated a higher complication incidence of 50% ($p = 0.989$). Both 45 mm and 50 mm screws show similar complication rates, with 33.3% for 45 mm screws and 50% for 50 mm screws, indicating no clear trend favoring one over the other ($P=0.456$), tab. (4).

Table (1) Patients' demographic characteristics (n=20)

Parameter	Frequency (%)
Age (ys)	18-25
	8 (40%)
	25-35
	4 (20%)
Gender	35-45
	8 (40%)
	Mean: 32.6 ± 10.2 (18-44)
Dominant hand	Male
	16 (80%)
Associated comorbidities	Female
	4 (20%)
Smoking	Right
	14 (70%)
	Left
	6 (30%)
	No comorbidities
	12 (60%)
	Diabetes mellitus
	8 (40%)
	Never smoked
	9 (45%)
	Currently smoking
	11 (55%)

Table (2) Characteristics of the fracture and the screw

Parameter		Frequency (%)
Injured hand	▪ <i>Left</i>	14 (70%)
	▪ <i>Right</i>	6 (30%)
Fracture type	▪ <i>Transverse</i>	16 (80%)
	▪ <i>Oblique</i>	4 (20%)
Fracture site	▪ <i>Shaft fifth metacarpal</i>	12 (60%)
	▪ <i>Shaft fourth metacarpal</i>	8 (40%)
Concomitant injuries	▪ <i>None</i>	20 (100%)
Screw material	▪ <i>Titanium</i>	20 (100%)
Screw length	▪ <i>45 mm</i>	12 (60%)
	▪ <i>50 mm</i>	8 (40%)
Screw diameter	▪ <i>Outer diameter (mm)</i>	4
	▪ <i>Core diameter (mm)</i>	3.5

Table (3) Postoperative clinical outcomes including VAS, DASH, and TAM scores during the follow-up period (n=20).

	After 4 weeks	After 8 weeks	After 12 weeks	P-value
VAS score				
▪ No pain	0	14 (70%)	20 (100%)	<0.001
▪ Mild pain	14 (70%)	4 (20%)	0	
▪ Moderate pain	4 (20%)	2 (10%)	0	
▪ Severe pain	2 (10%)	0	0	
DASH score				
▪ Excellent	2 (10%)	4 (20%)	14 (70%)	<0.001
▪ Good	6 (30%)	14 (70%)	6 (30%)	
▪ Satisfactory	11 (55%)	2 (10%)	0	
▪ Poor	2 (10%)	0	0	
TAM score				
▪ Satisfactory	8 (40%)	15 (75%)	20 (100%)	<0.001
▪ Unsatisfactory	12 (60%)	5 (25%)	0	

Table (4) Associations between demographic and clinical characteristics and the incidence of complications.

Parameter		Complications		P-value
		Yes	No	
Age (ys)	▪ <i>18-25</i>	0	8 (100%)	0.003
	▪ <i>25-35</i>	0	4 (100%)	
	▪ <i>35-45</i>	8 (100%)	0	
Gender	▪ <i>Male</i>	8 (50%)	8 (50%)	0.068
	▪ <i>Female</i>	0	4 (100%)	
Dominant hand	▪ <i>Right</i>	5 (35.7%)	9 (64.3%)	0.432
	▪ <i>Left</i>	3 (50%)	3 (50%)	
Fracture site	▪ <i>Shaft 5th metacarpal</i>	4 (33.3%)	8 (66.7%)	0.456
	▪ <i>Shaft 4th metacarpal</i>	4 (50%)	4 (50%)	
Fracture type	▪ <i>Transverse</i>	6 (37.5%)	10 (62.5%)	0.989
	▪ <i>Oblique</i>	2 (50%)	2 (50%)	
Screw length	▪ <i>45 mm</i>	4 (33.3%)	8 (66.7%)	0.456
	▪ <i>50 mm</i>	4 (50%)	4 (50%)	

4. Discussion

Metacarpal hand fractures account for 33.3% of all hand fractures, indicating its prevalence [1]. The most frequent kind of fifth metacarpal fracture is boxer's fracture, which mostly affects the neck [7]. Intramedullary headless Herbert screw fixation has emerged as a less invasive option, providing biomechanical sta-

bility while minimizing complications and promoting quicker recovery. This method enables secure internal fixation without the need for external support, helping to maintain soft tissue integrity and lowering the chances of postoperative issues [8]. Our analysis demonstrated a significant reduction in VAS scores over a

12-week follow-up period following intramedullary headless Herbert screw fixation for metacarpal fractures, and all patients were pain free by week 12 with highly significant results ($P < 0.001$). Pain levels progressively decreased, with most patients experiencing no pain or only mild pain by the end of the follow-up, highlighting the effectiveness of this intervention in consistently alleviating pain. In the same line with our results, George et al. [9] also found that good range of motion after surgery, minimal rates of complications, moderate pain scores, and an acceptable return to function are all results of intramedullary screw (IMS) fixations. According to the VAS score, these results imply that IMS fixation for metacarpal fractures provides either better or comparable results in terms of postoperative pain metrics. In contrast, Barrera-Ochoa et al. [10] reported that no patient reported a clinically significant difference in the degree of pain in their affected versus unaffected hand at the three-month follow-up. None of the patients experienced any pain when the thumb base or MCP joint was compressed. Within a mean of 42 days (range 32-61) after surgery, all working patients returned to their full work responsibilities, whereas unemployed patients resumed their unrestricted leisure activities. We found that the table shows a progressive and statistically significant improvement in DASH scores over a 12-week follow-up period ($P < 0.001$). Similarly, Doarn et al. [11] demonstrated those patients transitioned from considerable functional limitations preoperatively to minimal or no functional limitations postoperatively. This highlights the effectiveness of the procedure in restoring hand and arm functionality across various demographic and occupational groups, regardless of tobacco use. Our results demonstrated that at 4 weeks, 40% of patients had "satisfactory" TAM scores, increasing to 75% at 8 weeks and 100% by 12 weeks. The percentage of "unsatisfactory" scores decreased from 60% at 4 weeks to 25% at 8 weeks and 0% at 12 weeks. The p-value (<0.001) confirms the improvement is statistically significant. Similarly, Al-alfy et al. [12] found that at the end of follow-up, the majority of patients (83.4%) expressed satisfaction with their TAM scores, whilst 16.6% expressed dissatisfaction. In their investigation of 16 cases of metacarpal fracture treated with intramedullary headless screw, Tobert et al. [13] found that all patients with total active mobility greater than 240 degrees had excellent functional outcomes. Within a

week following surgery, active motion was started. A good TAM score in patients with metacarpal fractures managed by headless Herbert screws strongly implies favorable results regarding extensor lag, as the surgical approach aims to preserve extensor function while maintaining fracture stability. Intramedullary headless Herbert screw fixation for metacarpal fractures offers significant clinical benefits, particularly in pain reduction and faster recovery. Studies highlight its effectiveness in managing pain, leading to improved rehabilitation and greater patient comfort. Additionally, this technique enhances functional outcomes, as seen in improved mobility and functional scores (e.g., DASH and TAM), enabling a quicker return to daily activities, work, and leisure for all patients. This intervention yields high patient satisfaction, reinforcing its value as a preferred treatment for metacarpal fractures. Its effectiveness in improving function, reducing recovery time, and enhancing quality of life supports wider clinical adoption while potentially lowering healthcare costs through faster rehabilitation. The complications rate in our study was (40%), including mild stiffness due to delayed postoperative movement (25%) and intraoperative vertical iatrogenic fracture of proximal shaft due to narrow medulla (15%). This rate was higher than Warrender et al. [14] who implemented a multi-centered case-series through retrospective assessment of all patients who underwent IM headless Herbert screw fixation of 160 metacarpal fractures. Only four complications (2.5%) were reported and no serious complication were detected. The joints next to the fractures showed no indications of arthritis in our study. The absence of arthritis in these joints indicates minimal disruption to joint surfaces and surrounding tissues, which is critical for maintaining long-term joint functionality and reducing the risk of post-traumatic complications. Poggetti et al. [15] presented the results of the Italian Multi-centric Intra-Medullary Experience, which comprise 173 cases of extra-articular unstable fractures treated with the intramedullary headless screw fixation (IHSF) (38 phalanges and 135 metacarpals). With just four cases of moderate stiffness, two cases of malunion, and one incidence of screw protrusion, the complication rate was minimal (1.7%). The findings of Tobert et al.'s [13] retrospective investigation is presented. They provide the findings of 18 metacarpal fractures that were fixed with intramedullary headless Herbert screw; active

mobility was feasible one week after the procedure, and there were no post-operative problems among the patients. In this study, older age group had a 50% complication rate, indicating older individuals are more susceptible to complications (P-value = 0.003). Balaram & Bednar [16] demonstrated that patients older than 40 experienced a greater rate of complications, such as stiffness and delayed healing, after suffering metacarpal fractures. The procedure in this study had a mean operative time of 50 ± 5 minutes (range: 40-60 minutes), indicating a consistent surgical duration. Radiographic union was achieved at an average of 4 ± 0.6 weeks (4-5 weeks), suggesting a predictable healing process. However, the return to work or daily activities showed greater variability, with a mean of 4 ± 2.1 weeks (range: 3.6-6 weeks), indicating differences in individual recovery rates. These findings suggest that Herbert headless screw fixation provides efficient fracture management with consistent operative times and predictable healing, though functional recovery may vary based on patient-specific factors such as occupation, rehabilitation, and overall health. Moon et al. [17] reported that Intramedullary nails offered a quicker return to work, a quicker recovery of range of motion, and a lower rate of complications when compared to K-wires. Ghazala et al. [18] found that nine (14%) delayed unions (>three months) and no non-unions were seen in a retrospective analysis of 66 metacarpal fractures fixed with intramedullary nails, with an average union duration of seven weeks. This study provides a detailed analysis of factors influencing metacarpal fracture outcomes, examining patient demographics, fracture details, screw specifications, and post-operative results. Its strength lies in its thorough evaluation, supported by statistically significant findings. However, limitations include a small sample size (20 patients), potential gender bias (80% male participants), and exclusive use of titanium screws. The absence of long-term follow-up limits insight into lasting functional recovery and complications, while the single-center design may restrict the generalizability of the findings to other healthcare settings.

5. Conclusion

Intramedullary headless Herbert screw fixation is an effective method for treating metacarpal fractures, providing reliable pain relief and functional recovery. Patients experienced steady improvement, with early mobilization enabling a timely return to daily activities and work.

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