Low Rate of Complications Following Intramedullary Headless Compression Screw Fixation of Metacarpal Fractures

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Abstract

Background: There has been a recent increase in the use of headless compression screws for fixation of metacarpal neck and shaft fractures as they offer several advantages, and minimal complications have been reported. This study aimed to evaluate the clinical complications and their solutions following retrograde intramedullary headless compression screw fixation of metacarpal fractures. We describe complications and the approach to their management. **Methods:** We performed a multicenter case series through retrospective review of all patients treated with intramedullary headless screw fixation of metacarpal fractures by 3 fellowship-trained hand surgeons. Patient demographics, implant used, type of complication, pre- and postoperative radiographs, operative reports, and sequelae were reviewed for each case. We defined complications as infection, loss of fixation, hardware failure, malrotation, nonunion, malunion, metal allergy, and any repeat surgical intervention. **Results:** Four complications (2.5%) were identified through the review of 160 total metacarpal fractures. One complication was a nickel allergy, one was a broken screw after repeat trauma, and 2 patients had bent intramedullary screws. Screw removal in 3 patients was simple and without complications or persistent limitations. One bent screw with a refracture was left in place. No serious complications were seen. **Conclusion:** Intramedullary screw fixation of metacarpal fractures is safe with a low incidence of complications (2.5%) that can be safely and effectively managed.

Keywords: metacarpal, fracture, screw, fixation, headless compression screw

Introduction

There has been a recent increase in the use of headless compression screws for fixation of metacarpal neck and shaft fractures as they offer several advantages, and minimal complications have been reported.^{1,2} When placed percutaneously, headless compression screws offer stable fixation with a minimally invasive surgery.^{3,4} They can be placed through the articular surface and, because of their small size and headless nature, can be buried in a subchondral location without interfering with joint motion.⁵

The degree of acceptable angulation of metacarpal neck fractures is still debated. Published guidelines consist of 15° at the index finger, 20° at the middle finger, 30° at the ring finger, and 40° to 50° at the small finger.⁶ Unstable fractures require open or closed reduction with supplemental fixation to maintain reduction and rotation.⁷ Similarly, the primary indication for fixation of metacarpal shaft fractures is to provide stability to an unstable fracture. Additional indications include open fractures, multiple fractures, and fractures associated with tendon lacerations.^{8,9}

Isolated metacarpal injuries can result in up to 3 to 6 weeks of missed time with nonoperative management alone.^{10,11} Therefore, optimizing treatment of these injuries may have significant benefits in both quality of life and return to work for these patients. Multiple techniques have been described in the literature for surgical fixation of metacarpal fractures. Implants commonly used include percutaneous Kirschner wires (K-wires),⁷ intramedullary devices,² and plate-screw constructs.¹² Percutaneous pinning is commonly used for metacarpal neck fractures and comminuted head fractures. Shaft and base fractures can be treated with pinning or dorsal plating. Intramedullary devices for meta-

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carpal neck and shaft fractures offer skeletal rigidity with minimal soft-tissue morbidity.

This study aimed to evaluate the clinical complications and their solutions following retrograde intramedullary headless compression screw fixation of metacarpal fractures. We describe complications and approach to their management. Our hypothesis is that intramedullary fixation of metacarpal fractures is safe, with rare complications that can be easily managed.

Materials and Methods

We performed a retrospective review of a multicenter series of all patients treated with intramedullary headless screw fixation of metacarpal fractures (*Current Procedural Terminology* code 26615) from 2007 to 2016 by 3 fellowship-trained hand surgeons at 3 institutions. Patient medical records, operative reports, and radiographs were reviewed. Patient demographics, implant used, type of complication, and sequelae were recorded for each case (Table 1). We had no specific exclusion criteria. We defined complications as infection, loss of fixation, hardware failure, malrotation, nonunion, malunion, scar tenderness, metal allergy, delay in return to activities of daily living, and any repeat surgical intervention. Follow-up in the cohort ranged from 2 to 84 weeks, with a mean of 21 weeks.

Results

Four complications (2.5%) were identified through a review of 160 total metacarpal fractures. In the 4 patients who had complications, the mean age was 26 years (range = 20-35 years), none of the patients had any comorbidities, all were right hand dominant, and 3 cases involved the right hand (Table 1). Three of the fractures initially involved the small finger metacarpal, and one involved the ring finger. Three were isolated injuries, and one was associated with 2 concomitant metacarpal fractures that required plating.

Implants

Three patients had their fractures fixed with a 3.0-mm headless cannulated screws (DePuy Synthes, Raynham, Massachusetts), while one had a 2.4-mm headless screw. All 4 screws were stainless steel placed retrograde through a split in the extensor tendon (Table 2).

Complications

No patient required return to the operating room for malrotation, malunion, delayed union, metacarpophalangeal (MCP) joint stiffness, or infection.

One complication was a presumed nickel allergy that occurred 2 weeks after surgery. The patient noted a rash and

Table 1. Patient Demographics.

	Complications	Overall
	n = 4	n = 150 (patients) n = 160 (fractures)
Dominant hand		
Right, n (%)	4 (100%)	130 (86.7%)
Injured hand		
Right, n (%)	3 (75%)	121 (80.7%)
Metacarpal injured		
Small, n (%)	3 (75%)	131 (82%)
Ring, n (%)	0 (0%)	25 (15.5%)
Middle, n (%)	0 (0%)	2 (1.25%)
Index, n (%)	1 (25%)	2 (1.25%)
Age, y		
Mean (range)	26 (20-35)	29 (15-69)
Sex		
Male, n (%)	4 (100%)	123 (82%)

swelling that was similar to a rash developed following a prior nickel exposure. Due to the reaction and failure of topical steroid management and direct temporal correlation and immunological confirmation, removal was planned once the fracture had healed. The screw was subsequently removed after fracture healing at 3 months after the index procedure, with no sequelae.

One patient presented 10 months after surgery with a broken screw after repeat blunt trauma to the surgical area. This was treated with removal of the broken intramedullary screw and plate fixation of the resulting refractured metacarpal (Figure 1).

Two patients had bent intramedullary screws. One of these patients had also sustained repeat blunt trauma to the surgical area 6 months after the index procedure. This was treated with removal of the bent hardware and plate fixation of the refractured metacarpal (Figure 2).

The final patient presented 18 months postoperatively for medical clearance to join the military with a bent screw but was completely asymptomatic; the fracture was healed and therefore the screw was left in place (Figure 3).

Surgical Technique for Removal

Screws that are not bent or broken are simple to remove with an approach similar to the index procedure. At 3 months, the hole in the articular cartilage is mostly filled in with fibrocartilaginous tissue (Figure 1) but is still easy to visualize. Cannulation of the screw is performed using intraoperative fluoroscopy especially in fractures that have complete fibrocartilage coverage of the screw entry point. The screw head must be cleaned meticulously to allow engagement of the cannulated screwdriver. Once engaged, screw removal is straightforward.

Table 2. Implant Summary.

Screw Parameter	n = 4
Screw type	4 (100)
Synthes headless compression, No. (%)	
Screw length	4 (100)
40 mm, No. (%)	
Screw diameter, mm	
2.4 mm, No. (%)	1 (25)
3.0 mm, No. (%)	3 (75)
Screw material	4 (100)
Stainless steel, No. (%)	

Broken screws require removal of the screw in parts. The distal end is removed as mentioned above. The proximal intramedullary portion of the screw is removed by exposing it through the fracture site. The space around the screw shaft is cleaned very carefully to allow placement of a grasping tool such as straight hemostat or needle holder. The screw is grasped and gently pulled out. If the purchase of the proximal screw threads in the isthmus is firm, then the screw needs to be removed by rotating it in a counterclockwise manner.

Discussion

As the popularity of use of intramedullary headless compression screws for metacarpal fracture fixation increases, it is important to understand the potential complications of this technique. To our knowledge this is the first large series to discuss the complications of this emerging technique. From this large series, we found that the rate of complications is low (2.5%). Of these, 1 was asymptomatic and 2 were patient-driven, secondary to repeat blunt trauma to the surgical area. There were no cases of infection or extensor tendon disruption.

The complication profile found in this study is very favorable compared with the known complications of existing methods of metacarpal fixation. The K-wire fixation offers the advantage of limited surgical dissection but requires supplemental postoperative immobilization which is associated with suboptimal functional outcomes and increased tendon adhesions and articular contractures.¹³ In addition, postoperative pin-track infection rates of 5.1% have previously been reported.¹⁴ And although burying the pin may reduce the infection risk, it necessitates return to the operating room for hardware removal.¹⁵

Open reduction internal fixation (ORIF) is also frequently used for metacarpal fracture fixation. Fusetti et al.¹⁶ looked at 129 consecutive patients with metacarpal fractures fixed with ORIF and found that 35% of patients had significant complications. These included difficulty with fracture healing (15%), stiffness (10%), plate loosening or

breakage (8%), complex regional pain syndrome (1.5%), and one patient who developed a deep infection (0.01%). Page and Stern examined 105 consecutive metacarpal fractures and found a 57% complications rate. Their reported complications included stiffness, nonunion, plate prominence, infection, and tendon rupture.¹⁷

Previous studies have also found limited open retrograde intramedullary fixation to be safe and reliable for metacarpal neck and shaft fractures. Specifically, this type of stable internal fixation allows for early postoperative motion without affecting union rates and obviates the need for immobilization and its associated stiffness, reoperation, and related complications.^{1,2,18}

Our study found 3 screw failures (2 broken, 1 bent). A recent biomechanical study by Avery et al. found peak load to failure was significantly higher in headless compression screws in 3-point bending (mean, 401.2 vs 205.3 N) and axial loading (mean, 467.5 vs 198.3 N) compared with K-wires. They concluded that headless compression screws for metacarpal neck fractures demonstrate excellent biomechanical stability in metacarpal neck fractures.³ Patients must be informed that refracture and broken hardware are possible under repeated supraphysiologic loading. This may be a reason to use stainless steel screws rather than titanium as they may fail sooner given their decreased stiffness. Interestingly, without a concomitant refracture a bent intramedullary screw may be asymptomatic and successfully managed with retaining the hardware.

Despite all 3 surgeons using an implant with no cross-locking option, there were no revisions performed for malrotation or malunion. While this does not rule out subtle malrotation or malunion accepted by the patient, screw purchase upon insertion of the implant seems to be robust enough to control rotation. One would not expect this to change with long-term follow-up as rotation would be noted immediately postoperatively and be stable upon bony union. Of note, locked intramedullary implants are available on the market.

Screws do not appear to leave a large cartilage defect. In our study, all screw entry sites had fibrocartilage fill with maintained congruence of the metacarpal head. One of the risks of intramedullary fixation of these fractures is creating a defect in the articular cartilage. However, looking at these revisions, it appears that fibrocartilage fills the defect, which is internationally placed dorsal to avoid the portion of the metacarpal head, which is involved in a functional arc of motion at the MCP joint.

Screw removal, when needed, can be performed safely and without much difficulty. However, broken screws that are buried (proximal portion) may pose a challenge.

To our knowledge, this is the first case series to report on the complications and their management following intramedullary screw fixation of metacarpal fractures.

Figure 1. (a) The injury film is shown. The index procedure was fixation of a fifth metacarpal shaft fracture with a headless compression screw, which successfully healed. (b and c) The fourth and fifth metacarpal were subsequently fractured due to postoperative blunt trauma. The screw was removed via the fracture site, and the joint was not opened. (d and e) Both fractures were repaired with a plate.

The limitations of this study include its retrospective nature. Only documented complications were included, which may have potentially missed more subtle issues. We

do not know whether long-term sequelae exist due to the creation of a defect in the joint surface, and long-term studies are needed to follow the development of degenerative

Figure 2. (a) The index procedure was fixation of a second metacarpal shaft fracture with a headless compression screw, which successfully healed. (b and c) The metacarpal was subsequently reinjured. The screw was removed via the fracture site, and the joint was not opened. (d-f) The screw was converted to a plate.

changes of the MCP joint. Anecdotally, the patient involved in the first case report of this technique was recently seen by one of us (CSM) for an unrelated complaint.⁴ Eight years after surgery, the patient has no complaints, has maintained her range of motion, and radiographs display a well-maintained joint space, with no obvious degenerative changes.

Given the results of this study and the prior advantages described in the literature,² intramedullary headless screws are a safe option for fixation of metacarpal neck and shaft fractures. Future work is needed to report on the long-term implant survivorship, functional outcomes, and arthritis rates of adjacent joints.

Figure 3. Radiographic appearance of a headless compression screw (a and b) prebending and (c and d) postbending. The patient was asymptomatic, and the screw was left in place. Courtesy of Chaitanya Mudgal, MD.

Ethical Approval

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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