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TECHNICAL NOTE

Blocking Screw Technique for Maintaining Reduction during Intramedullary Screw Fixation of Oblique Metacarpal Fractures

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Abstract

Intramedullary screw fixation provides a less-invasive means of surgically managing metacarpal fractures. While there are advantages to using this technique compared to CRPP and ORIF, disadvantages of intramedullary screw fixation include loss of reduction intraoperatively due to sagittal and coronal plane translation. The blocking screw technique has been previously described as a solution for this problem in intramedullary fixation of long bone fractures. We describe the blocking screw technique as applied to aid intramedullary screw fixation of metacarpals.

Level of evidence: V

Keywords: Blocking screw, Intramedullary screw, Fracture, Metacarpal, Treatment

Introduction

Metacarpal fractures account for 10-40% of all hand injuries and are historically managed with closed reduction percutaneous pinning (CRPP) or open reduction internal fixation (ORIF) with plate and screws[1–7] However, intramedullary screw fixation has been well-described for management of metacarpal fractures.[8] Risks of intramedullary fixation include nonunion, malunion, hardware migration, overcompression, and difficulty with controlling rotational stability and translation of oblique fractures.[9–11]

Intraoperative reduction of metacarpal fractures is obtained under fluoroscopic guidance with a guide wire inserted in a retrograde fashion in the center of the metacarpal head on a PA view and in the dorsal aspect of the metacarpal head in line with the intramedullary canal on a lateral view.[10] Screws can then be inserted in an anterograde or retrograde fashion over the guide wire [12]. Intramedullary fixation can also be performed via an anterograde approach using the dorsal metaphyseal cortex as the starting point.[13]

In the setting of oblique long bone fractures, especially those not involving the isthmus, intramedullary device fixation may result in malreduction with sagittal or coronal displacement of the fractures.[14–17] Poller or blocking screws have been used as supplemental fixation in long bone fractures as a means of preventing translation of both the fracture fragments and implants. Placement of blocking screws reduces the effective size of the medullary canal and guides the intramedullary implant, preventing translation.[14–17] However, this technique has not yet been described for metacarpal fractures.

Blocking screw or pin technique exhibits the same utility in intramedullary fixation of metacarpal fractures. The purpose of this study is to describe the use of blocking screws with intramedullary screw fixation for metacarpal fractures as an adjunct to improve fracture alignment.

Technical note

Anesthesia and patient positioning

Surgery is performed under general anesthesia or intravenous regional anesthesia with or without a tourniquet. The patient is placed in a supine position

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with operative hand on an arm board with palm facing downward.

Surgical technique

The fracture is initially reduced by closed traction and manipulation or percutaneous use of a reduction forceps. A mini-open or percutaneous approach is used to the metacarpal head. The metacarpophalangeal (MCP) joint is then flexed to 90 degrees and an appropriately-sized guide wire is then used to obtain a starting point (central and dorsal one-third on the metacarpal head on the AP and lateral respectively), and advanced across the fracture site to the base of the metacarpal. Once appropriate placement is confirmed under fluoroscopic imaging, a drill is advanced over the guide wire into the intramedullary canal and the guide wire subsequently removed to prevent damage during blocking screw placement.

A guide wire for a micro Accutrak II headless 2.0mm compression screw (Acumed, Hillsboro, OR, USA) is then placed in the concavity of the proximal fracture fragment to prevent radial or ulnar displacement of the fracture and placement confirmed under fluoroscopic imaging. The wire should lie off-center within the medullary space, leaving enough open medullary canal to allow for screw passage. This wire overdrilled, and then a bicortical headless compression screw is placed. The axial guidewire is replaced, and an axial intramedullary screw is then advanced over the guide wire into the intramedullary canal and position confirmed under fluoroscopic imaging.

Postoperative care and rehabilitation

The patient is placed in a bulky soft dressing and the patient is allowed to perform active range of motion of the digits as tolerated. Strengthening and progression to weight bearing may progress as the fracture consolidates usually around 6 to 8 weeks.

Complications

Fragmentation of the metacarpal shaft can occur if the blocking screw is placed too eccentrically, Over narrowing of the effective medullary canal can occur if the blocking screw is too close to the midline, resulting in overreduction or inability to pass the intramedullary screw. Surgeons may place an appropriately size intramedullary screw superficially and using fluoroscopic imaging estimate if the intramedullary canal can tolerate both a blocking and intramedullary screw.

Methods

To test the ability to stabilize oblique fractures in length unstable injuries we prepared six fresh-frozen cadaveric specimens. No metacarpals had evidence of deformity or prior fracture. After thawing to room temperature, the third metacarpal was dissected out for each specimen. The metacarpophalangeal (MCP) joint was then flexed to 90 degrees and a 0.035 guide wire was then used to obtain a starting point (central and dorsal one-third on the metacarpal head on the AP and lateral respectively). Once appropriate placement was confirmed under fluoroscopic imaging, a drill was advanced over the guide wire into the intramedullary canal and the guide wire subsequently removed. A sagittal saw with a 1 cm blade was then used to create a 45-degree osteotomy in the distal metaphysis of the long finger metacarpal with the osteotomy oriented proximal radial to distal ulnar and the distal fragment displaced radially to create a concavity.

A micro Accutrak II headless 2.0mm compression screw was then placed in the concavity of the proximal fracture fragment to prevent displacement of the fracture and placement was confirmed under fluoroscopic imaging [Figure 1A-B]. A 0.035 guide wire was placed into the previously drilled intramedullary canal. 3.5 mm Accumed® Acutrak 2 Standard (Acumed Inc, Hillsboro, OR) screw was then advanced over the guide wire into the intramedullary canal and screw position was confirmed under fluoroscopic imaging. Translation of the distal fragment on the proximal fragment was then measured. The blocking screw was then removed and translation of the distal fragment on the proximal fragment was again measured (control group) [Figure 2A-B]. Mean translation of the fracture site was 1.58 mm for the blocking screw group and 0.58 mm for the control group. There were no complications in either group, including fragmentation of the metacarpal shaft or malreduction.

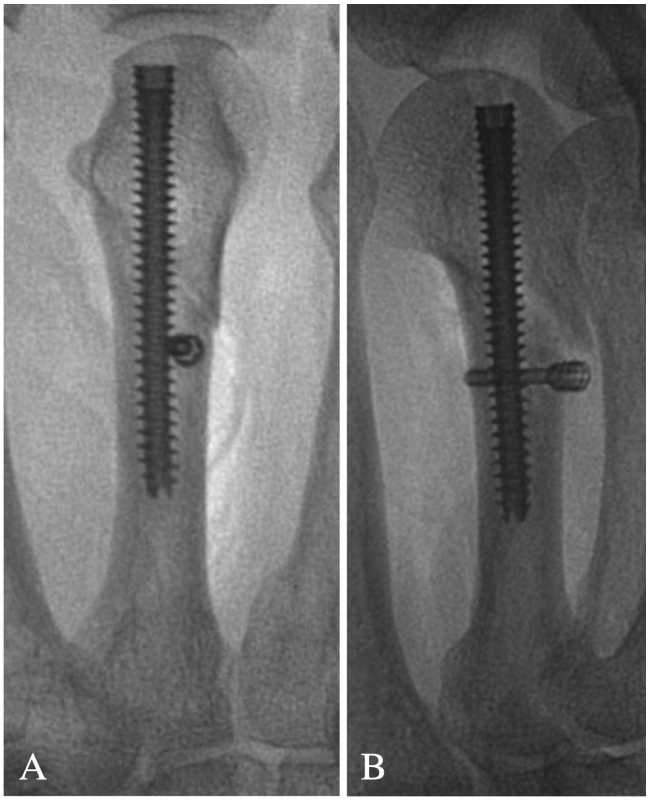

Figure 1A-B. Intramedullary screw fixation with blocking screw with A) anteroposterior (AP) view and B) oblique view.

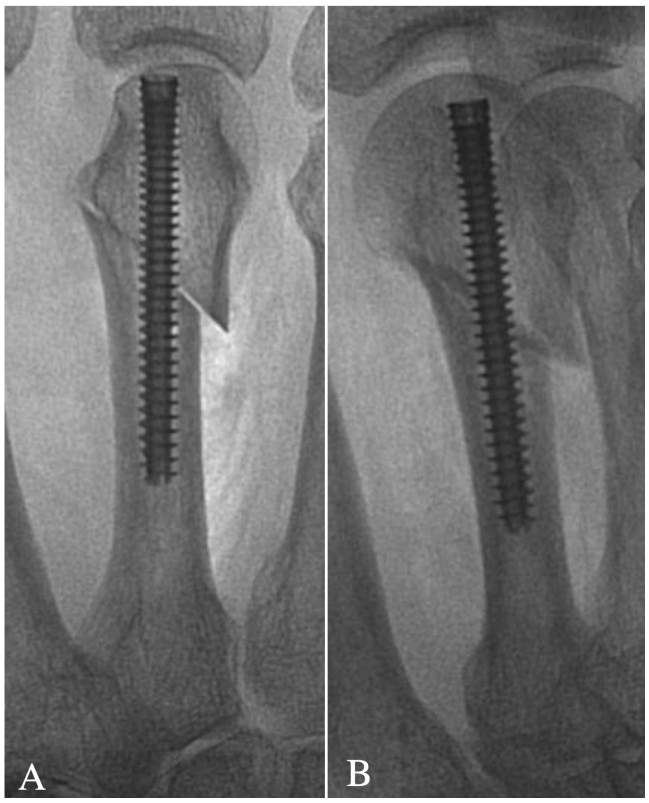

Figure 2A-B. Intramedullary screw fixation without blocking screw with A) anteroposterior (AP) view and B) oblique view.

Discussion

Intramedullary screw fixation is a commonly employed surgical technique for metacarpal fractures. However, translation of the fracture fragments in the sagittal and coronal planes can be difficult to control in metaphyseal bone where the intramedullary device has room to toggle withing the medullary canal.[9–11] Blocking screws can be used to reduce effective intramedullary canal size and minimize shear across the fracture site.

The use of blocking screws for intramedullary screw fixation in metacarpal fractures has not been described previously. The technique is well established, however, in intramedullary fixation of metaphyseal long-bone fractures. Krettek et al. reports the use of Poller screws to assist in intramedullary fixation of tibial fractures by reducing medullary cavity size and providing a physical block to prevent coronal translation and subsequent malalignment of the fracture.[14,15] Auston et al. found that blocking screws provided more stiffness and decreased horizontal translation at the fracture site in unstable supracondylar femur fractures.[18] Schumaier et al. reported factors predictive of blocking screw placement in femur fractures included greater cortical bone loss, greater medullary canal diameter, and shorter distal segments.[19]

Implants for intramedullary screw fixation of metacarpals vary in design. The Exsomed™ INnate™ ITS screw (Exsomed, Aliso Viejo, CA) is a threaded nail with uniform pitch designed to provide better canal fit. The theoretical advantage of the threaded nail is that blocking screws are unnecessary. However, threaded nails are expensive and have an imperfect fit, given the variability of metacarpal anatomy.

In conclusion, blocking screw technique may be useful as an adjunct to intramedullary screw fixation of metacarpal fractures. This technique is less invasive and imparts less soft tissue trauma compared to plate and screws. Furthermore, it minimizes the risk of malreduction traditionally associated with using a minimally invasive approach. Metacarpals with a large intramedullary canal width, cortical bone loss, and oblique metaphyseal fracture are likely to benefit from this technique.

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References

1. Meals C, Meals R. Hand fractures: a review of current treatment strategies. J Hand Surg Am. 2013;38(5):1021-1031; quiz 1031. doi:10.1016/j.jhsa.2013.02.017
2. Diaz-Garcia R, Waljee JF. Current Management of Metacarpal Fractures. Hand Clin. 2013;29(4):507-518. doi:10.1016/j.hcl.2013.09.004
3. Kollitz KM, Hammert WC, Vedder NB, Huang JI. Metacarpal Fractures: Treatment and Complications. Hand (New York, N,Y). 2014;9(1):16-23. doi:10.1007/s11552-013-9562-1
4. Black D, Mann RJ, Constine R, Daniels AU. Comparison

of internal fixation techniques in metacarpal fractures. J Hand Surg Am. 1985;10(4):466-472. doi:10.1016/S0363-5023(85)80067-8

5. Greeven APA, Bezstarosti S, Krijnen P, Schipper IB. Open reduction and internal fixation versus percutaneous transverse Kirschner wire fixation for single, closed second to fifth metacarpal shaft fractures: a systematic review. Eur J Trauma Emerg Surg. 2016;42(2):169-175. doi:10.1007/s00068-015-0507-y
6. Wong VW, Higgins JP. Evidence-Based Medicine: Management of Metacarpal Fractures. Plast Reconstr Surg. 2017;140(1):140e-151e. doi:10.1097/PRS.0000000000003470
7. Dreyfuss D, Allon R, Izacson N, Hutt D. A Comparison of Locking Plates and Intramedullary Pinning for Fixation of Metacarpal Shaft Fractures. Hand (New York, N,Y). 2019;14(1):27-33. doi:10.1177/1558944718798854
8. Ruchelsman DE, Puri S, Feinberg-Zadek N, Leibman MI, Belsky MR. Clinical outcomes of limited-open retrograde intramedullary headless screw fixation of metacarpal fractures. J Hand Surg Am. 2014;39(12):2390-2395. doi:10.1016/j.jhsa. 2014.08.016
9. Urbanschitz L, Dreu M, Wagner J, Kaufmann R, Jeserschek JM, Borbas P. Cartilage and extensor tendon defects after headless compression screw fixation of phalangeal and metacarpal fractures. J Hand Surg Eur Vol. 2020;45(6):601-607. doi:10.1177/1753193420919060
10. Jann D, Calcagni M, Giovanoli P, Giesen T. Retrograde fixation of metacarpal fractures with intramedullary cannulated headless compression screws. Hand Surg Rehabil. 2018;37(2):99-103. doi:10.1016/j.hansur.2017.12.005
11. Padegimas EM, Warrender WJ, Jones CM, Ilyas AM. Metacarpal Neck Fractures: A Review of Surgical Indications and Techniques. Arch Trauma Res. 2016;5(3):e32933. doi:10.5812/atr.32933
12. Hoang D, Vu CL, Huang JI. Evaluation of Antegrade Intramedullary Compression Screw Fixation of Metacarpal Shaft Fractures in a Cadaver Model. J Hand Surg Am. 2021;46(5):428.e1-428.e7. doi:10.1016/j.jhsa.2020.10.026
13. Orbay J. Intramedullary Nailing of Metacarpal Shaft Fractures. Tech Hand Up Extrem Surgy. 2005;9(2):69-73. doi:10.1097/01.bth.0000 167253.31976.95
14. Krettek C, Stephan C, Schandelmaier P, Richter M, Pape HC, Miclau T. The use of Poller screws as blocking screws in stabilising tibial fractures treated with small diameter intramedullary nails. J Bone Joint Surg Br. 1999;81-B(6):963-968. doi:10.1302/0301-620X.81B6.0810963
15. Krettek C, Miclau T, Schandelmaier P, Stephan C, Möhlmann U, Tscherne H. The mechanical effect of blocking screws ("Poller screws") in stabilizing tibia fractures with short proximal or distal fragments after insertion of small-diameter intramedullary nails. J Orthop Trauma. 1999;13(8):550-553. doi:10.1097/00005131-199911000-00006
16. Hannah A, Aboelmagd T, Yip G, Hull P. A novel technique for accurate Poller (blocking) screw placement. Injury. 2014;45(6):1011-1014. doi:10.1016/j.injury.2014.02.029
17. Ricci WM, O'Boyle M, Borrelli J, Bellabarba C, Sanders R. Fractures of the Proximal Third of the Tibial Shaft Treated With Intramedullary Nails and Blocking Screws: J Orthop Trauma. 2008;22(Supplement 3):S39-S45. doi:10.1097/BOT.0b013e31816c02a5
18. Auston D, Donohue D, Stoops K, et al. Long Segment Blocking Screws Increase the Stability of Retrograde Nail Fixation in Geriatric Supracondylar Femur Fractures: Eliminating the "Bell-Clapper Effect." J Orthop Trauma. 2018;32(11):559-564. doi:10.1097/BOT.0000000000001284
19. Schumaier AP, Southam BR, Avilucea FR, et al. Factors Predictive of Blocking Screw Placement in Retrograde Nailing of Distal Femur Fractures. J Orthop Trauma. 2019;33(6):e229-e233. doi:10.1097/BOT.0000000000001450