

## Case Study:

Multiple Metacarpal Fracture Fixation & Reconstruction with the INnate™ Intramedullary Threaded Nail for Gunshot Wound

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Jozef Zoldos, MD

Arizona Center for Hand to Shoulder Surgery  
Phoenix, AZ

Pre-op



Intra-op



## Case Presentation

Patient was a 47-year-old male who worked as a registered nurse in the trauma department at a Level I Trauma Center. He was cleaning his 9mm handgun when it accidentally discharged into his non-dominant left hand. He presented with multiple open fractures and significant associated soft tissue injuries: an oblique displaced metacarpal neck fracture on the left index finger; an avulsive continuity defect of the left middle finger metacarpal shaft with a comminuted base fracture; a displaced metacarpal shaft fracture of the left ring finger; a large cavitary soft tissue defect of the dorsum of the hand; a complete transection of both flexor tendons to the middle finger in Zone III (palm of the hand); and a complete transection of the extensor tendon to the middle and the index fingers in Zone VI (dorsum of hand).

## Pre-op Plan

Because of the complex array of bony injuries combined with corresponding, significant constellation of soft tissue damage, Dr. Zoldos decided to use the INnate intramedullary nail for bony stabilization. The nail would provide an opportunity to obtain a precise reduction of the metacarpal fractures with rigid fixation in order to facilitate the motion necessary to rehabilitate the soft tissue component of the injury. Unlike compression screws or K-Wire fixation techniques, the nail's proprietary, non-compressive design would effectively restore metacarpal length, which was an important consideration due to the degree of comminution and concerns of additional shortening. INnate would also enable quicker early active and passive range of motion to facilitate therapeutic intervention and minimize the cost and inconvenience of a potential secondary procedure.

## Operative Findings and Approach

Dr. Zoldos preferred a staged reconstruction for this injury. Each surgical procedure was performed within 1-2 days of the previous procedure until the treatment was complete.

1 Week Post-op



9 Months Post-op



The first operation consisted of exploration, debridement, decompression and preliminary bony stabilization. The injury was thoroughly debrided. Next the median and ulnar nerves were decompressed at the level of the wrist. After thoroughly exploring the wound to examine the nature and extent of the bony and soft tissue injury, Dr. Zoldos finally used simple, longitudinal, intramedullary K-wires to perform preliminary bony stabilization.

The next operation consisted of definitive bony stabilization with INnate and repair of the flexor tendon injuries. The index and ring finger metacarpal fractures were repaired with routine intramedullary techniques. Because there was a continuity defect in the middle finger metacarpal with a comminuted base fracture, the length of the metacarpal was re-established and maintained with INnate. He approached retrograde from the distal aspect of the distal fragment of the middle finger metacarpal to span the carpometacarpal joint into the capitate for additional bony stability proximally. This functioned similarly to bridging hardware that could be performed with conventional techniques. No attempt was made to address the bony continuity defect of the middle finger metacarpal at this stage. He used 4.5mm x 55mm INnate nails to stabilize the 4<sup>th</sup> and 2<sup>nd</sup> metacarpals and a 4.5mm x 75mm INnate nail for the 3<sup>rd</sup> metacarpal. The flexor and extensor tendons were also repaired during this stage with conventional tendon repair techniques.

The next operation consisted of dorsal soft tissue defect reconstruction with free tissue transfer. Dr. Zoldos chose the gracilis free muscle flap that was surgically anastomosed both to the dorsal branch of the radial artery in an end-to-side fashion and to the dorsal branch of the radial vein in an end-to-end fashion. Flap inset was only performed temporarily.

The final operation consisted of bone grafting of the continuity defect in the middle finger metacarpal; elevating, inseting, and debulking of the gracilis flap; and skin grafting. Non-vascularized bone autograft was harvested from the iliac crest.

9 Months Post-op



Cortico-cancellous iliac crest strut graft was press-fit into the continuity defect for structural support, and any of the residual interstices were grafted with morselized particulate iliac crest graft.

## Follow-up

Postoperative therapeutic protocol included the modified Duran program for flexor tendon rehabilitation which involved early passive motion of all the digits (all joints) using place-and-hold exercises to incorporate active flexor tendon function. Dr. Zoldos followed up bony healing with serial radiographs and CT scans to confirm bony bridging. Patient experienced functional range of motion (ROM) within 3 months. Due to some residual tendon adhesions which occurred as a result of initial therapeutic limitation from the soft tissue component of the injury, eventual extensor tenolysis was performed at 9 months after the initial injury. Postoperative therapeutic protocol was only limited by the nature and extent of the soft tissue injury and not by bony stability. Full recovery and 100% ROM were achieved by 9 months.

## Discussion

Dr. Zoldos continues to see the INnate nail as a game changer that enables him to easily and quickly achieve consistent, reproducible, positive outcomes otherwise unattainable with alternative solutions. It is minimally invasive, non-compressive, and allows more rapid recovery. His patients experience early mobilization and can often avoid the cost and burden of physical therapy or taking time off from work. Additionally, because secondary procedures are less necessary or no longer performed, Dr. Zoldos discovered that the efficient technique of INnate has decreased operative time and anesthesia requirements, resulting in overall lower cost of care for his practice.