

# Second Toe-to-thumb Transfer Using Intramedullary Screw Fixation after Traumatic Thumb Amputation

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**Summary:** Loss of the thumb secondary to trauma leads to significant disability due to the digit contributing 40% of overall hand function. Toe-to-thumb transfer has been a well-studied reconstructive method as a means to restore function after thumb amputation. First described in 1969 by Cobbett and colleagues, toe-to-thumb transfers have undergone several modifications in technique to better improve functional and aesthetic outcomes, including toe wrap-around flaps, trimmed great toe transfer, and second toe transfers. Although these methods have allowed patients to retain use of the thumb, traditional interosseous wire reattachment often leads to significant stiffness and need for prolonged rehabilitation to regain maximal function. Intramedullary screw fixation has been increasingly used in phalanx and metacarpal fractures, but its implementation outside of these contexts is not well reported. Here, we present a case of a patient who presented with traumatic thumb amputation and was treated with second toe-to-thumb transfer with intramedullary screw fixation, a novel mode of interosseous rigid fixation in toe-to-hand surgery. Postoperatively, our patient was able to begin mobilizing the new thumb immediately, which allowed for earlier return to work. We believe our technique can be applied to other cases of second toe, as well as great toe, transfers to improve length of recovery and rehabilitation postoperatively. (*Plast Reconstr Surg Glob Open* 2024; 12:e6032; doi: [10.1097/GOX.0000000000006032](https://doi.org/10.1097/GOX.0000000000006032); Published online 6 August 2024.)

## CASE REPORT

An IRB-approved case review was conducted for a 41-year-old right-hand-dominant male farmer with a history significant for partial amputation of his left middle finger a year prior and a one-pack-per-day smoking habit. He presented to the emergency department with traumatic partial amputation of the left index finger and the thumb at the metacarpophalangeal joint from a table saw. The severed digits showed evidence of avulsion, crush injury, and contusion, and the wound bed presented with crushed and avulsed neurovascular structures, dorsal skin avulsion, and necrotic muscle. For these reasons, the patient was considered a poor candidate for revascularization. He underwent preliminary debridement of devitalized bone and soft tissue with viable skin coverage over the index finger. The exposed thumb metacarpal was

covered with Integra. The patient's initial x-ray is shown in [Figure 1](#). He returned to the operating room 3 weeks later for second toe-to-thumb reconstruction. The patient's occupation as a farmer was especially important in surgical planning, as early return to motion after reconstruction was a priority. The pedal flap was marked ([Fig. 2](#)) and isolated on the dorsal and volar circulation of the dorsalis pedis artery; an osteotomy was made at the metatarsal with 2.5 cm of length. The metacarpal and metatarsal were initially joined using a Kirschner wire to ensure proper alignment at the site of osteosynthesis and proper level of the metatarsophalangeal joint. A cannulated drill was then used to drill over the wire, and an ExsoMed Innate intramedullary threaded nail (Acumed, Hillsboro, Oregon) with a length of 34 mm and a diameter of 2.8 mm was inserted over the wire ([Fig. 3](#)). The flexor pollicis longus, extensor pollicis longus, and extensor pollicis brevis tendons were repaired, the volar plate of the metatarsophalangeal joint was advanced to prevent hyperextension deformity, the dorsal radial sensory nerve was attached to the deep peroneal nerve, and the radial and ulnar digital nerves were repaired with nerve allograft. An end-to-side arterial anastomosis made into the princeps pollicis artery and adequate arterial and venous circulation was ensured. At the donor site, the intermetatarsal ligament and extensor retinaculum were reconstructed, and Kirschner wires

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were placed to secure the metatarsal bones together and prevent splaying. The patient recovered well immediately postoperatively.

He was allowed active and gentle passive range of motion on postoperative day 2 and strengthening as tolerated at 6 weeks. He was fully back to work by 3 months with no restrictions. However, he noticed pain over the index finger metacarpal due to internal pressure on the skin and scar tissue. As such, he underwent an index finger metacarpal ray resection. One month following this surgery, he was discharged from the clinic (Fig. 4).

### DISCUSSION

Toe-to-thumb transfer in humans was described in 1969 when Cobett, compounding on the prior work done in rhesus monkeys by Buncke, published the first case report using the great toe to reconstruct an amputated thumb.<sup>1,2</sup> Since then, several modifications have been made to this principle to better improve functional and aesthetic outcomes. In 1980, Morrison described the wrap-around flap utilizing a bone graft from the iliac crest to reconstruct the bony thumb with only soft tissue from the great toe to provide coverage of the graft.<sup>3</sup> Fu-Chan Wei and colleagues furthered this technique with the trimmed great toe transfer, which provided appearance more similar to the contralateral thumb.<sup>4</sup> The second toe transfer was introduced

### Takeaways

**Question:** What are better methods of interosseous fixation in toe-to-thumb transfer, which allow earlier return to movement?

**Findings:** Intramedullary screw fixation can improve functional outcomes in toe-to-thumb transfer compared with conventional methods of interosseous fixation, including Kirschner wires or 90-90 wires. Our patient reported excellent outcomes and return to work, with no restrictions in 3 months.

**Meaning:** Intramedullary screw fixation during toe-to-thumb transfer may provide improved outcomes and earlier return to normal function of the injured hand.

as a way to reduce donor site morbidity and allow the harvest of the metatarsal to recreate the metacarpal if the thumb was amputated proximal to the metacarpophalangeal joint.<sup>5</sup> A systematic review comparing these four techniques found no difference in functional outcomes of the hand.<sup>6</sup> Due to the loss of a significant portion of the metacarpal in the case reported above, the second toe was deemed the best option for this patient.

Throughout these advances, there has been less attention paid to interosseous fixation and methods to



Fig. 1. X-ray demonstrating the level of metacarpal injury to thumb.



Fig. 2. Initial markings of pedal flap.



**Fig. 3.** X-ray demonstrating fixation of metacarpal and metatarsal with intramedullary nail.



**Fig. 4.** Demonstration of postoperative grip.

improve postoperative stiffness and recovery. Interosseous Kirschner wiring and 90/90 wiring, which have been the default modality of osteosynthesis, require over a month of immobilization, lead to increased stiffness, and delay

functional recovery of the hand.<sup>7,8</sup> Intramedullary fixation is a method of rigid fixation that utilizes a screw in the intramedullary canal that is initially load bearing but gradually becomes load sharing as the bone heals.<sup>9</sup> It implements the use of Kirschner wires to serve as a guide to entering the intramedullary canal and relies on friction of the screw with the cortical bone to maintain fixation. There is minimal soft tissue dissection which decreases the risk of scarring and lessens operative time. Postoperatively, this method calls for minimal splinting and allows the patient to begin almost immediate hand therapy, thus facilitating earlier rehabilitation and return to work.<sup>10</sup> Risk of pin-site infection is also negated, and micromovement between the recipient and donor bone is also mitigated. Intramedullary fixation is becoming increasingly used in the treatment of phalanx and metacarpal fractures and has shown excellent results. However, its use in other contexts of interosseous fixation has not yet been well defined. Here, we report the first use of intramedullary fixation in toe-to-hand transfer for thumb reconstruction.

Following surgery, our patient started hand therapy with active and gentle passive range of motion on postoperative day 2, gradually increasing over 6 weeks, followed by strengthening as tolerated. After this point, the patient was allowed to return to activity as tolerated. He was able to return to work as a farmer in 3 months. He had an excellent functional outcome with subsequent imaging displaying continued appropriate alignment of the joined osseous segments. We believe this novel method of intraosseous fixation for toe-to-hand transfer for thumb reconstruction provides stable fixation and earlier return to work after a devastating injury. Future directions of research include long-term outcomes data using this method of osseous fixation in toe-to-thumb transfer.

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### DISCLOSURE

*The authors have no financial interest to declare in relation to the content of this article.*

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