

# Mallet Toe of the Hallux Treated by Bridging Suture Technique Using Suture Anchors: A Case Report and Literature Review

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## Abstract

An avulsion fracture of the extensor hallucis longus at the distal end of the great toe is called “mallet toe” of the hallux. It is a rare injury and the treatment options are conservative treatment using a splint, percutaneous or open Kirschner wire fixation similar to that in the mallet finger, or suture anchor fixation. We present a case treated by the bridging technique using two suture anchors. A 57-year-old Japanese man injured his left great toe after a fall while walking barefoot on the bed. His great toe was forced into a hyperplantarflexion position. Plain radiography and computed tomography showed a small bone fragment at the base of the dorsal distal phalanx, suggesting an avulsion fracture of the extensor hallucis longus. He was treated by bridging suture technique with two suture anchors. At first, two suture anchors were inserted to the fracture bed of the distal phalanx, and then the bone fragment and extensor hallucis longus tendon were secured with two horizontal mattress sutures. Finally, bridging sutures were performed using the remaining sutures and the sutures used for mattress suturing. He obtained bony union and symmetric range of motion of the interphalangeal joint. This technique allowed us to fix the small bone fragment rigidly and mobilize the interphalangeal joint earlier to preserve the range of motion. It would be a valuable procedure when the bone fragment is small.

## Keywords

Mallet Toe, Hallux, Avulsion Fracture, Extensor Hallucis Longus, Suture Anchor

## 1. Introduction

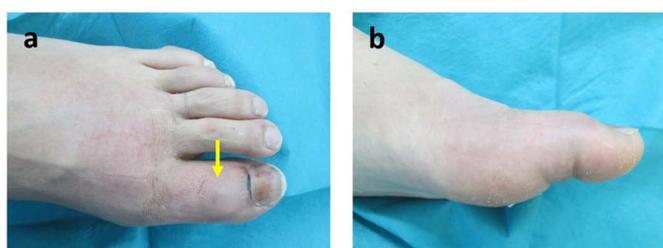
An avulsion fracture of the extensor hallucis longus at the distal phalanx of the great toe is called “mallet toe” of the hallux [1]. The underlying mechanism of injury is the plantarflexion of distal phalanx to the extended interphalangeal joint similar to that in the mallet injury of the finger [2] [3]. It is a rare injury and its treatment has been reported only in six case reports [1] [4] [5] [6] [7] [8]. These treatments included conservative therapy with a splint to prevent plantarflexion of the hallux [1] [4], Kirschner wire fixation similar to that in bony mallet finger [5] [6] [7], or open reduction and internal fixation with a suture anchor [8]. It is difficult to immobilize the interphalangeal joint in extension with a splint unlike in the mallet injury of the finger [5]. Kirschner wire fixation tends to be less invasive but temporary interphalangeal joint fixation is inevitable, though joint stiffness, osteoarthritis, and infection due to temporary fixation may be rare [5] [6] [7]. One case report described a technique using a suture anchor without transarticular immobilization of the interphalangeal joint [8]. We present a case treated by the suture bridging technique using two suture anchors. This technique allowed us to fix the small bone fragment rigidly and mobilize the interphalangeal joint earlier than the technique with Kirschner wires.

## 2. Case Report

A 57-year-old male banker presented with pain and swelling in his left great toe after a fall, while walking barefoot on the bed. His great toe was forced into a hyperplantarflexion position. On physical examination, he had swollen great toe and a bony prominence at the dorsal aspect of the interphalangeal joint (**Figure 1(a)**). His hallux was in a flexed position and he could not actively extend the great toe (**Figure 1(b)**). Plain radiography showed a small bone fragment at the base of the dorsal distal phalanx (**Figure 2(a)** and **Figure 2(b)**). The joint was congruent and subluxation was not observed. Computed tomography revealed the size and location of the fragment suggesting an avulsion fracture of the extensor hallucis longus (**Figure 2(c)** and **Figure 2(d)**).

Conservative treatment was denied and surgery was performed at two weeks after the injury in the supine position under general anesthesia with a thigh tourniquet. A T-shaped incision over the interphalangeal joint was used for exposure and fracture fixation. After identification of the small avulsed bone fragment and extensor hallucis longus tendon (**Figure 3(a)**), two 1.9 mm drill holes were created to the fracture bed and two suture anchors preloaded with two no. 1 nonabsorbable sutures (SUTUREFIX ULTRA, Smith and Nephew Inc., Mansfield, MA) were inserted (**Figure 3(b)**). The fragment and extensor hallucis longus tendon were secured with two horizontal mattress sutures in the interphalangeal joint extension with care to reduce the fragment properly to the fracture bed. In addition, bridging sutures were performed using the remaining sutures and the sutures used for mattress suturing (**Figure 3(c)** and **Figure 3(d)**).

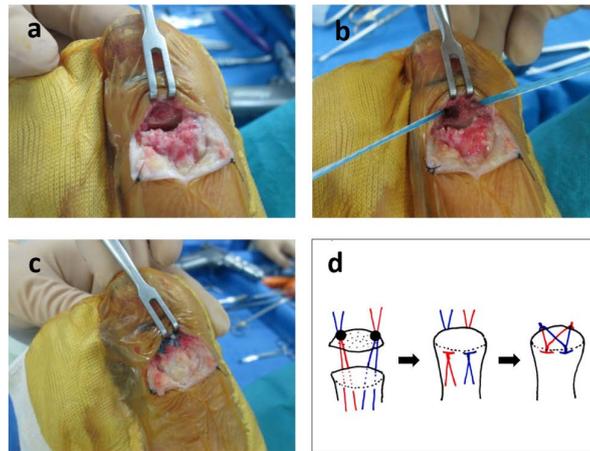
No complications were observed during surgery and the great toe was immobilized with buddy taping to the second toe to prevent plantarflexion of the interphalangeal joint for two weeks. Heel weight bearing was allowed the day after surgery and passive range of motion exercises were cautiously initiated once the wound was completely healed. At four weeks, partial toe weight bearing was allowed and full toe weight bearing was initiated at two months after the surgery. Three months after the surgery, bony union was confirmed both with plain radiography and computed tomography (**Figure 4**), and symmetric range of motion of the interphalangeal joint was obtained. At one year, the patient did not complain of any pain during walking and running. Written informed consent was obtained from the patient for publication of this case report and accompanying images.



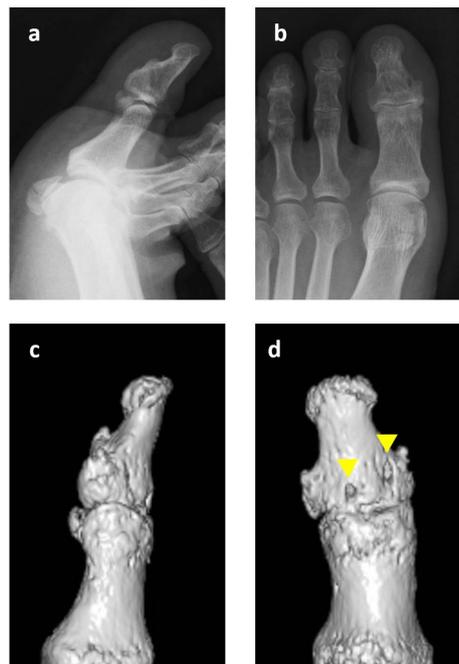
**Figure 1.** Macroscopic findings of the great toe. A bony prominence (arrow) at the dorsal aspect of the interphalangeal joint was observed (a), the great toe was in the flexed position active extension was not possible (b).



**Figure 2.** Plain radiographs and three-dimensional computed tomography of the great toe. Lateral (a) and anteroposterior (b) radiographs revealed a small bone fragment (arrow) at the dorsal base of the distal phalanx. Computed tomography of the lateral (c) and dorsal (d) aspects of the great toe indicated a small avulsion fracture of the extensor hallucis longus (arrowheads).



**Figure 3.** Surgical technique applied to the great toe. Intraoperative photographs after exposure of the fracture site (a), insertion of the two suture anchors (b) and fixation of the bone fragment with the bridging technique (c). Schematic illustration of the surgery (d).



**Figure 4.** Lateral (a) and anteroposterior (b) plain radiographs and lateral (c) and dorsal (d) aspect of the computed tomography at three months after the surgery. Bone union was achieved and two drill holes were observed (arrowheads).

### 3. Discussions

Mallet toe of the hallux is a rare entity and has been named as “mallet toe”, because its injury mechanism is similar to that of “mallet finger”. All previous reports have described that the injury occurs as a result of hyperplantarflexion or a stubbing mechanism such as falling down on the tip of the great toe like in our case and kicking an object in an extended position of the interphalangeal joint (Table 1) [1] [4] [5] [6] [7] [8].

**Table 1.** Summary of previously reported and present cases of mallet toe of the hallux.

	Age (Sex)	Mechanism of injury	Size of bony fragment	Treatment	Outcomes
Rapoff	36 (M)	Caught on the edge of the step	45% of JS	Rigid-soled sandal for 10 weeks to prevent plantarflexion	Returned at 16 weeks and 10% ROM restriction
Hennesy	45 (M)	Fall during descending stairs	Small	Dorsal thermoplastic extension splint for 8 weeks	50% ROM restriction and minor flexion deformity
Nakamura	51 (M)	Stubbed on the threshold of sliding door	Small	IP joint fixation with a K-wire for 5 weeks after failed conservative treatment	Slight limitation in flexion at 1 year
Wada	49 (M)	Caught on a carpet barefoot	More than 50% of JS	Extension block method with two K-wire for 4 weeks	Returned at 8 weeks and no description about ROM
Martin	16 (M)	Kicking a ball barefoot	40% of JS	Open reduction and fixation with two K-wire and temporal IP joint fixation for 5 weeks after failed closed reduction	Full activity except for sports at 3.5 months and symmetric ROM
Hong	1) 39 (F) 2) 46 (M)	1) Fall at the slope 2) Kicking an opponent	1) 40% of JS 2) 30% of JS	One suture anchor fixation with two drill holes into the fragment	Returned at 2 and 3 months and no and slight ROM limitation
Ando	57 (M)	Fall from the bed barefoot	Small	Two suture anchor fixation with suture bridging technique	Returned at 2 months and no ROM limitation

M, male; F, female; JS, joint surface; K-wire, Kirschner wire; IP, interphalangeal; ROM, range of motion.

Treatment options for the injury are conservative treatment [1] [4], percutaneous or open Kirschner wire fixation [5] [6] [7], or suture anchor fixation [8]. Rapoff *et al.* reported a case treated with a rigid soled sandal for ten weeks [4], and Hennesy *et al.* reported using a dorsal thermoplastic extension splint for eight weeks [1]. Although these studies reported acceptable results, restriction in range of motion, flexion deformity, and extensor lag of the hallux persisted after these treatments [1] [4].

Surgical treatment with Kirschner wires was described by three authors [5] [6] [7]. Nakamura reported a case treated with temporary interphalangeal joint fixation using a Kirschner wire after failed conservative treatment due to continued swelling and difficulty in maintaining the fragment in a reduced position [5]. Wada *et al.* reported a case treated with the extension block method using two Kirschner wires usually applied for the mallet finger [6]. Martin *et al.* reported a case treated with open reduction and fixation using two Kirschner wires and temporary interphalangeal joint fixation after failed percutaneous treatment [7]. These three case reports showed good clinical results, but the temporary transarticular fixation of the interphalangeal joint with a Kirschner wire and care of the surgical site for a few weeks is inevitable [5] [6] [7].

Hong *et al.* reported two cases treated with a suture anchor for reattaching the avulsed fragment without transarticular immobilization of the interphalangeal joint [8]. They reported that a suture anchor was inserted into the fracture bed of the distal phalanx and two drill holes were made into the avulsed fragment. Thereafter, the fragment was secured with sutures [8]. This technique is applicable when the avulsed fragment is large enough for two drill holes. However, it is difficult when the fragment is small for drilling holes directly into it, like in our case. The reported size of the fragment was divided into two groups, 30% to 50% of the joint surface [4] [6] [7] [8] or too small to measure as in our case [1] [5]. In the present case, two suture anchors were inserted into the fracture bed of the distal phalanx, and two mattress sutures were made just proximal to the avulsed fragment in the interphalangeal joint extension. Finally, the fixation was reinforced with bridging sutures. This technique provided sufficient fixation of the avulsed fragment to allow early postoperative mobilization of the interphalangeal joint and good clinical results were obtained without limitation of the interphalangeal joint range of motion. This technique can be a valuable procedure when the bone fragment is small.

#### 4. Conclusion

Bridging suture technique with two suture anchors allowed us to fix the small bone fragment rigidly and mobilize the interphalangeal joint earlier to preserve the range of motion.

#### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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