



# Claw Toe With Dislocated Second Metatarsophalangeal Joint: Treated by Plantar Plate Tenodesis and Release of Collateral Ligaments

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**Abstract:** Claw toe deformity of the second toe is a common forefoot deformity faced by foot and ankle surgeons. Frequently, it develops as the result of plantar plate insufficiency and subsequent metatarsophalangeal (MTP) joint instability. As the disease deteriorates, the MTP joint can be dislocated. Reduction of the MTP joint without metatarsal osteotomy seems to be a logical approach unless there is excessively long second metatarsal. However, adequate peri-articular soft-tissue release including the dorsal capsule, collateral ligaments and extensor tendon is needed to reduce the intra-articular pressure and minimize the risk of joint degeneration. The purpose of this Technical Note is to describe the details of plantar plate tenodesis and release of collateral ligaments for correction of claw second toe associated with dislocation of the metatarsophalangeal joint.

Claw toe deformity of the second toe is a common forefoot deformity faced by foot and ankle surgeons. Frequently, it develops as a result of plantar plate insufficiency and subsequent metatarsophalangeal (MTP) joint instability.<sup>1,2</sup> As the joint instability progresses and hyperextension of the MTP joint increases, the vector of pull of the interossei shifts dorsal to the center of rotation of the MTP joint and becomes an ineffective flexor of the joint. As the disease deteriorates, the MTP joint can be dislocated.

Surgical treatments of claw toe deformity include soft-tissue balancing procedures or bony procedures (metatarsal/phalangeal osteotomy, arthrodesis and excisional arthroplasty) or their combination.<sup>3</sup> Toe

amputation can be considered if chronic ulceration and osteomyelitis have already developed. Soft-tissue procedures aim at MTP joint stabilization by periarticular soft-tissue release, tendon release, or transfer and plantar plate repair. The Girdlestone-Taylor flexor-to-extensor tendon transfer is a common surgical procedure for the correction of claw toe deformity. However, there is significant risk of postoperative stiff toe syndrome.<sup>2,4-7</sup> As the primary pathology is plantar plate deficiency, plantar plate repair is a logical surgical treatment choice and has been shown to be as effective as tendon transfer in the stabilization of the MTP joint, with less postoperative stiffness and discomfort.<sup>5,8</sup> Plantar plate repair can be either primary repair with or without the use of suture anchor or repair by distal advancement of the plate to the base of the proximal phalanx through bone tunnels via the plantar or dorsal approaches.<sup>2,3,7,9-18</sup> These open approaches require extensive soft-tissue dissection, which may induce peri-articular fibrosis. Plantar plate tenodesis, an arthroscopically assisted dynamic repair of the plantar plate, can stabilize the attenuated or ruptured plantar plate through suturing the plantar plate and fibrous flexor tendon sheath to the long extensor tendon of the second toe.<sup>15-21</sup> This minimally invasive technique allows magnified arthroscopic visualization of the operative field without the need of extensive soft-tissue dissection or metatarsal osteotomy. This technique is still feasible in case of severe

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**Table 1.** Indications and Contraindications of Plantar Plate Tenodesis and Release of Collateral Ligaments for Correction of Claw Toe Deformity of the Second Toe With Dislocated Second MTP Joint

Indications	Contraindications
1. Symptomatic claw toe deformity with dislocated second MTP joint that is recalcitrant to conservative treatment.	1. The MTP joint is degenerated. 2. The MTP joint is irreducible by closed mean. 3. There is Morton's neuroma at the lateral side of the deformed toe. 4. The deformity is caused by bony deformities of the metatarsal or the proximal phalanx.

MTP, metatarsophalangeal.

tears or attenuation of the plantar plate, as the fibrous flexor sheath is included in the repair. Incorporation of arthroscopic release of lumbrical tendon and plication of the attenuated lateral capsuloligamentous complex into the plantar plate tenodesis make this arthroscopic technique to be an effective minimally invasive treatment choice of severe crossover toe deformity.<sup>8,21</sup> In this Technical Note, we further modify the technique of the plantar plate tenodesis to correct claw toe deformity with dislocated second MTP joint. It is indicated for symptomatic claw toe deformity with dislocated second MTP joint that is recalcitrant to conservative treatment. An important prerequisite is that the dislocated second MTP joint should be reducible by the closed method. It is contraindicated if the MTP joint is degenerated or irreducible by closed means, or there is Morton's neuroma at the lateral side of the deformed toe, or the deformity is caused by bony deformities of the metatarsal or the proximal phalanx (Table 1).

## Surgical Technique (With Video Illustration)

### Preoperative Assessment and Patient Positioning

A preoperative standing radiograph of the foot is useful to document the severity of the deformity and confirm the presence of the second MTP joint dislocation. Degeneration or destruction of the involved MTP joint or the presence of any bone deformity of the metatarsal or proximal phalanx can be assessed on the radiograph. There should not be any clinical evidence of Morton's neuroma of the second toe web.

The patient is placed in the supine position with the legs spread. A thigh tourniquet is applied to provide a bloodless operative field. A 1.9-mm 30° arthroscope (Henke Sass Wolf GmbH, Tuttlingen, Germany) is used

for this procedure. Fluid inflow is driven by gravity, and no arthropump is used. Continuous toe traction is not needed.

### Portal Placement

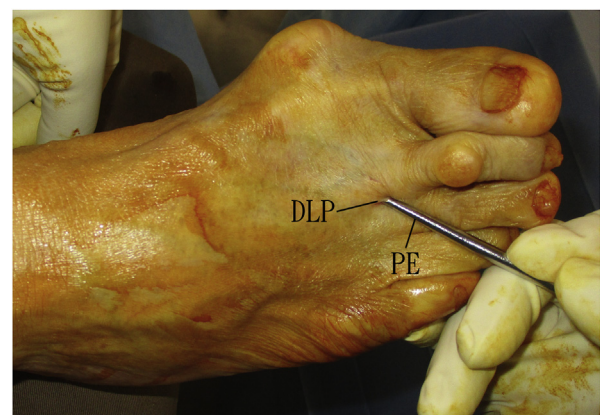
The portals used are the standard dorsomedial and dorsolateral portals of second MTP arthroscopy at the medial and lateral side of the long extensor tendon, respectively. The second MTP joint level is determined after closed reduction of the joint and the portals are located at the joint level. Three- to four-millimeter skin incisions are made at the portal sites. The subcutaneous tissue is bluntly dissected down to the joint capsule by a hemostat and the dorsal capsule is perforated by the tip of the hemostat.

### Closed Reduction of the Second MTP Joint and Release of the Dorsal Capsule

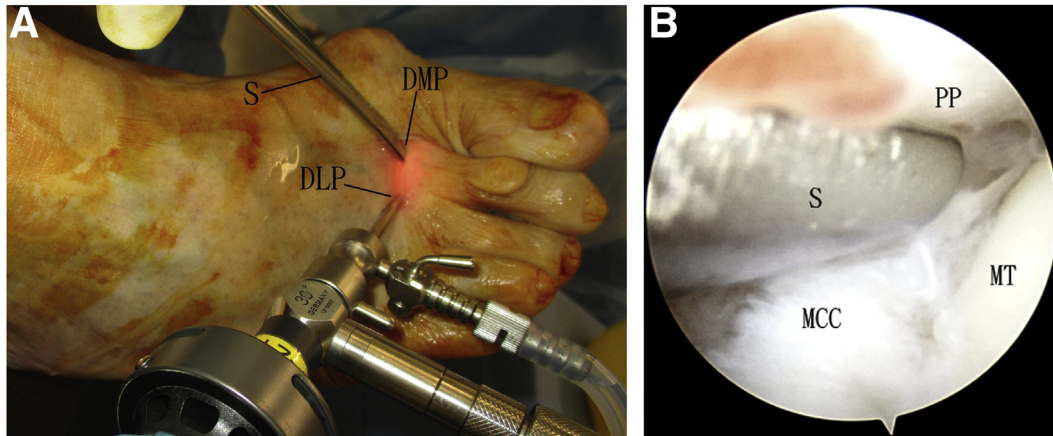
The second MTP joint is manually reduced and the dorsal joint capsule is stripped from the metatarsal neck by a small periosteal elevator via the portals (Fig 1). With the dorsolateral and dorsomedial portals interchangeable as the viewing and working portals, the MTP joint is examined arthroscopically for the integrity of the plantar plate, the status of the articular cartilage, and the presence of synovitis. Arthroscopic synovectomy is performed with an arthroscopic shaver (Smith & Nephew) if synovitis is present.

### Release of Medial Capsuloligamentous Complex

The dorsolateral portal is the viewing portal and the dorsomedial portal is the working portal. The medial capsuloligamentous complex (medial capsule and medial proper collateral ligament) is released down to



**Fig 1.** Plantar plate tenodesis and release of collateral ligaments for correction of claw toe deformity of the right second toe with dislocated second metatarsophalangeal (MTP) joint. The patient is placed in the supine position with the legs spread. The second MTP joint is manually reduced and the dorsal joint capsule is stripped from the metatarsal neck by a small periosteal elevator via the dorsolateral portal. (DLP, dorsolateral portal; PE, periosteal elevator.)



**Fig 2.** Plantar plate tenodesis and release of collateral ligaments for correction of claw toe deformity of the right second toe with dislocated second metatarsophalangeal joint. The patient is in supine position with the legs spread. The dorsolateral portal is the viewing portal and the dorsomedial portal is the working portal. The medial capsuloligamentous complex (medial capsule and medial proper collateral ligament) is released down to the plantar plate by means of SuperCut scissors. (A) Clinical photo; (B) arthroscopic photo. (DLP, dorsolateral portal; DMP, dorsomedial portal; MCC, medial capsuloligamentous complex; MT, metatarsal head; PP, proximal phalanx base; S, scissors.)

the plantar plate by means of SuperCut scissors (STILLE Surgical, Lombard, IL) (Fig 2).

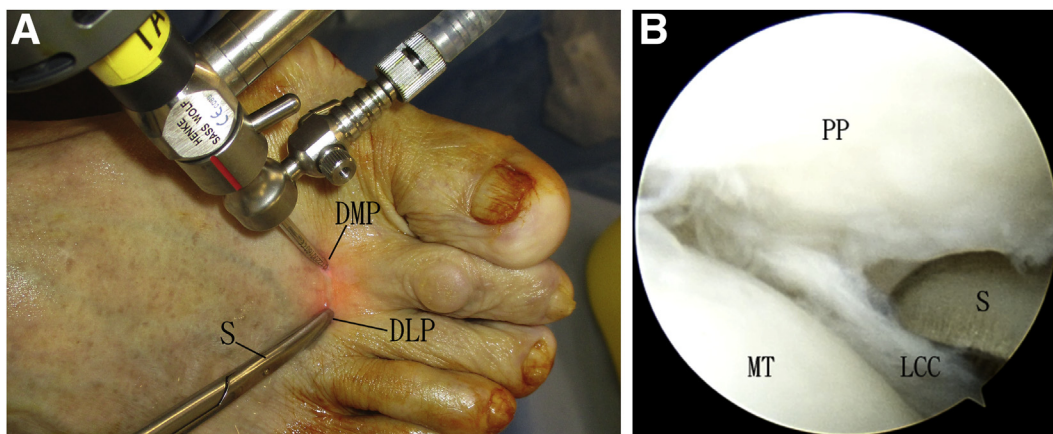
#### Release of Lateral Capsuloligamentous Complex

The dorsomedial portal is the viewing portal and the dorsolateral portal is the working portal. The lateral capsuloligamentous complex (lateral capsule and medial proper collateral ligament) is released down to the plantar plate by means of SuperCut scissors (Fig 3).

#### Anchoring the Plantar Plate

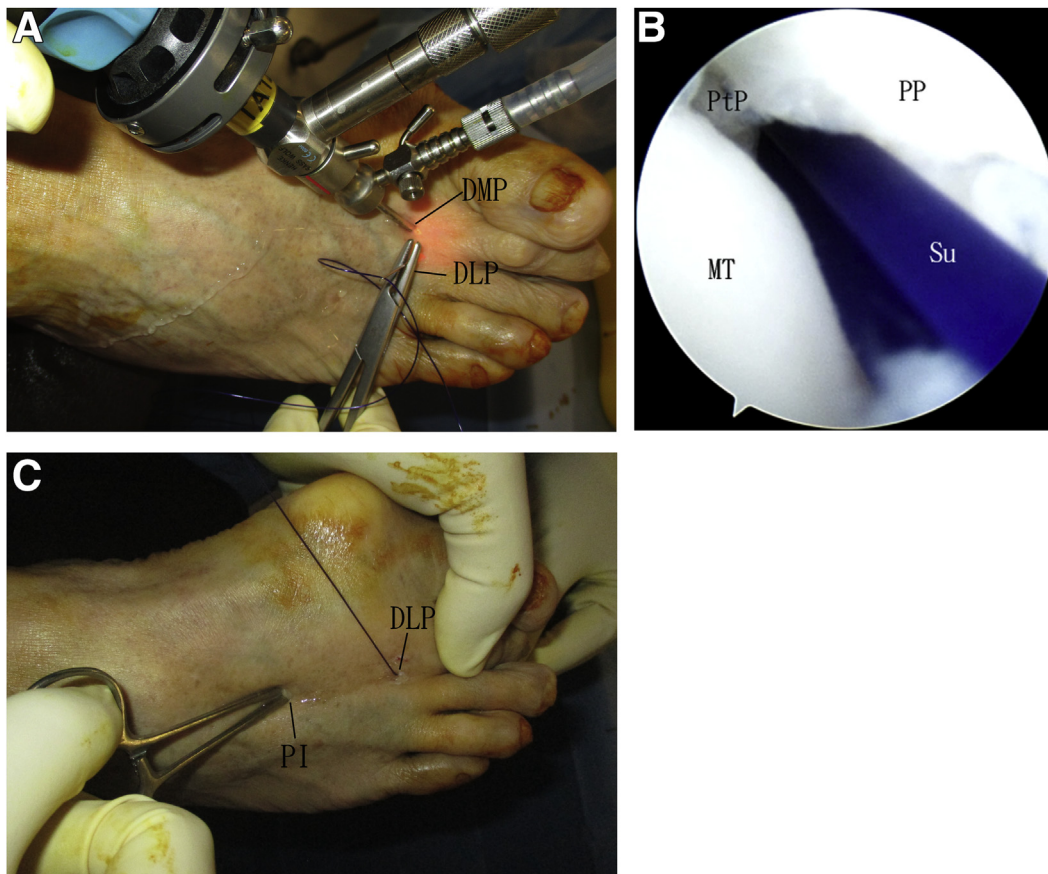
The dorsomedial portal is the viewing portal and the dorsolateral portal is the working portal. A straight-

eyed needle (FavorMed, Ningbo, China) loaded with a No. 1 polydioxanone suture (ETHICON; Johnson & Johnson, Cincinnati, OH) is passed through the dorsolateral portal and pierces the lateral part of the plantar plate. The needle and the suture pass through the plantar plate close to its phalangeal insertion, the fibrous flexor tendon sheath, and the plantar skin. A 1-cm proximal incision is made at the dorsal side of diaphysis of the second metatarsal. The suture is retrieved from the plantar surface of the flexor fibrous tendon sheath to the proximal incision by a curved hemostat along the lateral surface of the metatarsal. The suture is tensioned to facilitate catching of the suture by the hemostat (Fig 4). A plastic tube is inserted



**Fig 3.** Plantar plate tenodesis and release of collateral ligaments for correction of claw toe deformity of the right second toe with dislocated second metatarsophalangeal joint. The patient is in the supine position with the legs spread. The dorsomedial portal is the viewing portal and the dorsolateral portal is the working portal. The lateral capsuloligamentous complex (lateral capsule and medial proper collateral ligament) is released down to the plantar plate by means of SuperCut scissors. (A) Clinical photo; (B) arthroscopic photo. (DLP, dorsolateral portal; DMP, dorsomedial portal; LCC, lateral capsuloligamentous complex; MT, metatarsal head; PP, proximal phalanx base; S, scissors.)



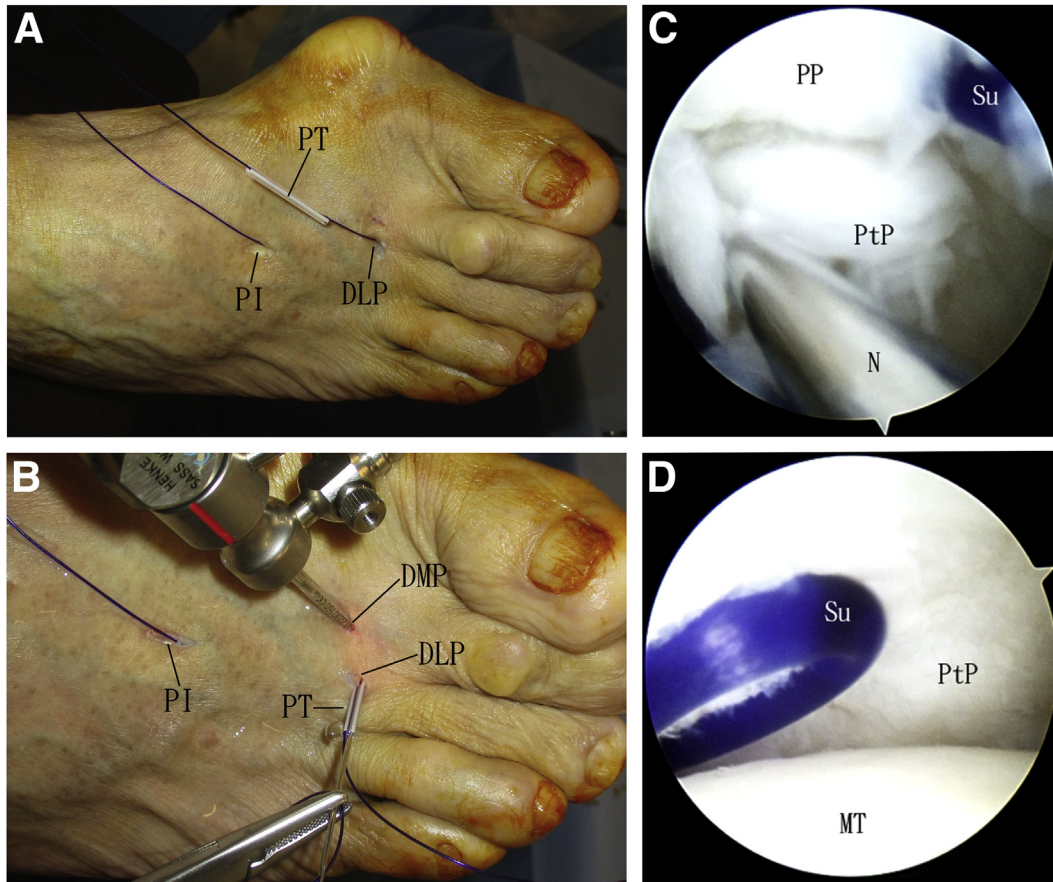


**Fig 4.** Plantar plate tenodesis and release of collateral ligaments for correction of claw toe deformity of the right second toe with dislocated second metatarsophalangeal joint. The patient is in the supine position with the legs spread. The dorsomedial portal is the viewing portal and the dorsolateral portal is the working portal. (A) A straight-eyed needle loaded with a No. 1 poly-dioxanone suture is passed through the dorsolateral portal and pierces the lateral part of the plantar plate. (B) The needle and the suture pass through the plantar plate close to its phalangeal insertion, the fibrous flexor tendon sheath and the plantar skin. (C) A 1-cm proximal incision is made at the dorsal side of diaphysis of the second metatarsal. The suture is retrieved from the plantar surface of the flexor fibrous tendon sheath to the proximal incision by a curved hemostat along the lateral surface of the metatarsal. The suture is tensioned to facilitate catching of the suture by the hemostat. (DLP, dorsolateral portal; DMP, dorso-medial portal; MT, metatarsal head; PI, proximal incision; PP, proximal phalanx base; PtP, plantar plate; S, scissors; Su, suture.)

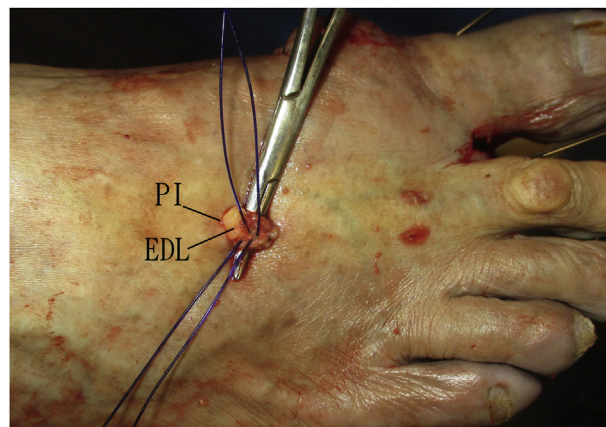
along the suture into the dorsolateral portal. The needle loaded with the other limb of the suture passes through this plastic tube to enter the second MTP joint. This can avoid the needle and the suture accidentally pierces through the surrounding soft tissue. The needle and suture pass through the plantar plate, fibrous flexor tendon sheath, and the plantar skin again. The plastic tube is removed and a suture loop is maintained at the dorsolateral portal to allow tensioning of the suture during retrieval of the suture limb back to the proximal incision. This helps the hemostat to catch the suture at the plantar surface of the fibrous flexor tendon sheath. The plantar plate is then anchored by the suture (Fig 5). The procedure is repeated with another No. 1 poly-dioxanone suture. The claw toe deformity can be corrected by pulling the sutures.

#### Correction of the Claw Toe Deformity

Keeping the second MTP joint in reduced position, the claw toe is slightly overcorrected by 20° plantarflexion of the MTP joint. The sutures are sewed under tension to the extensor digitorum longus (EDL) tendon to the second toe to complete the correction (Fig 6). If the EDL tendon distal to the sew point is still tight, distal EDL tenotomy can be performed at the portal incisions. Any concomitant hallux valgus deformity will be corrected under arthroscopic assistance (Fig 7, Video 1, Table 2).<sup>22,23</sup> Postoperatively, bulky dressing is applied to the operated foot for 2 weeks. The operated lesser toe is allowed free mobilization. The patient is advised to be non-weight-bearing for 2 weeks and then weight-bearing walking as tolerated with wooden-based sandals for another 4 weeks before resuming normal shoe wear.<sup>20</sup>

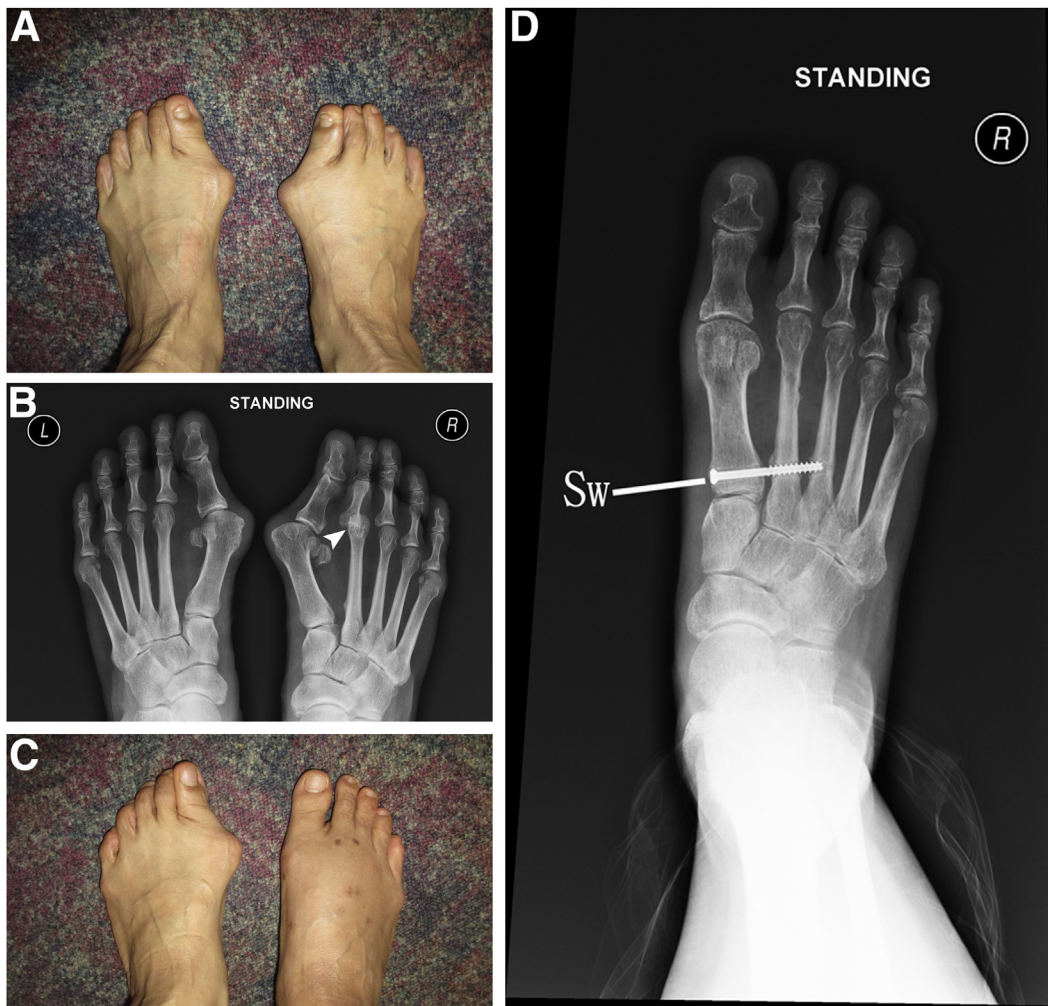


**Fig 5.** Plantar plate tenodesis and release of collateral ligaments for correction of claw toe deformity of the right second toe with dislocated second metatarsophalangeal joint. The patient is in the supine position with the legs spread. The dorsomedial portal is the viewing portal and the dorsolateral portal is the working portal. (A) A plastic tube is inserted along the suture into the dorsolateral portal. (B) The needle loaded with the other limb of the suture passes through this plastic tube to enter the second MTP joint. (C) The needle and suture pass through the plantar plate, fibrous flexor tendon sheath, and the plantar skin again. (D) The plastic tube is removed and a suture loop is maintained at the dorsolateral portal to allow tensioning of the suture during retrieval of the suture limb back to the proximal incision. This helps the hemostat to catch the suture at the plantar surface of the fibrous flexor tendon sheath. The plantar plate is then anchored by the suture. (DLP, dorsolateral portal; DMP, dorsomedial portal; MT, metatarsal head; PI, proximal incision; PP, proximal phalanx base; PT, plastic tube; PtP, plantar plate; Su, suture.)



**Fig 6.** Plantar plate tenodesis and release of collateral ligaments for correction of claw toe deformity of the right second toe with dislocated second metatarsophalangeal joint. The patient is in the supine position with the legs spread. The sutures are sewn under tension to the EDL tendon to the second toe to complete the correction. (EDL, extensor digitorum longus tendon; PI, proximal incision.)





**Fig 7.** Plantar plate tenodesis and release of collateral ligaments for correction of claw toe deformity of the right second toe with dislocated second metatarsophalangeal joint. The patient is in the supine position with the legs spread. In this illustrated case, the right hallux valgus and claw second toe was to be corrected (A). (B) Preoperative radiograph showed that the right second MTP joint was dislocated (arrowhead). (C) postoperative clinical photo shows the right hallux valgus and claw toe deformities were corrected. (D) Postoperative radiograph shows that the second MTP joint is reduced. (Sw, screw of endoscopic soft-tissue procedure for correction of hallux valgus deformity.)

## Discussion

In chronic claw toe deformity of the second toe, dislocation of second MTP joint is not uncommon. It is a difficult condition to be managed. Weil shortening

metatarsal osteotomy to reduce the joint is commonly performed to reduce the joint.<sup>13</sup> However, it may lead to transfer metatarsalgia, floating toe deformity, or stiff toe syndrome. Excisional arthroplasty may cause

**Table 2.** Pearls and Pitfalls of Correction of Plantar Plate Tenodesis and Release of Collateral Ligaments for Correction of Claw Toe Deformity of the Second Toe With Dislocated Second MTP Joint

Pearls	Pitfalls
<ol style="list-style-type: none"> <li>1. The medial and lateral capsuloligamentous complexes should be released down to the plantar plate.</li> <li>2. The use of plantar tube can prevent the needle piercing through the surrounding soft tissue before entering the MTP joint.</li> <li>3. Even without crossover toe deformity, the plantar plate sutures should be retrieved along the lateral surface of the metatarsal to the proximal incision.</li> </ol>	<ol style="list-style-type: none"> <li>1. If the articular cartilage is already degenerated, reduction of the MTP joint may accelerate the degenerative process.</li> <li>2. Release of the lumbrical in the absence of crossover toe deformity may lead to lateral deviation of the second toe.</li> </ol>

MTP, metatarsophalangeal.

**Table 3.** Advantages and Risks of Plantar Plate Tenodesis and Release of Collateral Ligaments for Correction of Claw Toe Deformity of the Second Toe With Dislocated Second MTP Joint

Advantages	Risks
1. Complete soft-tissue balance around the MTP joint	1. Injury to the articular cartilage.
2. Precise placement of the suture to the plantar plate under arthroscopic guidance	2. Injury to the interdigital nerve.
3. Minimal soft-tissue dissection	3. Injury to the digital arteries.
4. Avoidance of plantar wound	4. Recurred or residual deformity.
5. Tendons of the toes can be preserved	5. Postoperative toe stiffness.
6. Sophisticated instruments are not needed.	

MTP, metatarsophalangeal.

instability of the toe or transfer metatarsalgia. Reduction of the MTP joint without metatarsal osteotomy seems to be a logical approach unless there is an excessively long second metatarsal. However, adequate periarticular soft-tissue release including the dorsal capsule, collateral ligaments, and extensor tendon is needed to reduce the intra-articular pressure and minimize the risk of joint degeneration. In this technique, the medial and lateral collateral ligaments are released. As the plantar plate sutures are tied to the EDL tendon, the pull of EDL is redirected plantarward to stabilize the plantar plate and the fibrous flexor tendon sheath. The tension of the EDL distal to the sutures is relieved.<sup>21</sup> If the tension at the EDL tendon distal to the sew point is still high, distal EDL tenotomy can be performed and all the pulling force of EDL will be transmitted plantarily to stabilize the plantar plate.<sup>21</sup>

The advantages of this technique include complete soft-tissue balance around the MTP joint, precise placement of the suture to the plantar plate under arthroscopic guidance, minimal soft-tissue dissection, avoidance of plantar wound, tendons of the toes can be preserved, and sophisticated instruments are not needed. The potential risks of this technique include injury to the articular cartilage, injury to the interdigital nerve, injury to the digital arteries, recurred or residual deformity, and postoperative toe stiffness (Table 3). This procedure is technically demanding and should be reserved for more experienced foot and ankle arthroscopists.

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