55 Second metatarsophalangeal joint instability (crossover toe)

55.1 Introduction

A common complaint among patients presenting to an orthopaedic foot and ankle practice is pain in the second metatarsophalangeal (MTP) joint. Inflammation at this joint can result in instability, ultimately leading to 2nd MTP joint instability (crossover toe), where the second toe crosses either under or over the hallux (Figure 1).

Figure 1. A severe crossover toe deformity

This deformity can be isolated or associated with hallux valgus, hallux rigidus, hammertoe deformity or neuroma of the second intermetatarsal space.²⁻¹³

Coughlin coined the term "crossover toe" in 1986 during a presentation at the 16th annual AOFAS meeting in New Orleans.² Subsequent papers by Coughlin further characterized the deformity and outlined its treatment.³⁻⁶,¹³
55.2 Anatomy/Function

The plantar plate and the collateral ligaments stabilize the 2nd MTP joint. The plantar plate is the most important of these stabilizing structures. It originates on the metatarsal head via a thin synovial attachment, just proximal to the articular surface, and inserts on the base of the proximal phalanx. It also serves as an attachment for a number of important structures, including the distal fibers of the plantar fascia, collateral ligaments, transverse metatarsal ligaments, interosseus tendons, and the fibrous sheath of the flexor tendons.\textsuperscript{14}

The collateral ligaments are positioned medially and laterally to the 2nd MTP joint. They are composed of two major structures: the phalangeal collateral ligament, which inserts onto the base of the proximal phalanx, and the accessory collateral ligament, which inserts onto the plantar plate.\textsuperscript{14} Their function is to resist varus/valgus stress at the 2nd MTP joint.

55.3 Biomechanics

As chronic inflammation or trauma occurs, the stabilizing structures of the 2nd MTP joint become attenuated. The lateral collateral ligament likely fails first, leading to medial deviation of the second toe.\textsuperscript{3} As this occurs, the plantar plate and its flexor tendon attachments displace medially.\textsuperscript{10} This results in an eccentric force across the joint, causing further medial displacement. Once the flexors and plantar plate are displaced medially, they no longer oppose the pull of the extensor tendons.

The second structure to fail is likely the plantar plate. The tendency with weight-bearing is to displace the proximal phalanx dorsally. The plantar plate and the intrinsic flexors (interossei and lumbriciles) resist this force and pull the proximal phalanx back into a neutral position at the MTP joint. Chronic or acute hyperextension forces on the proximal phalanx cause stretching and/or attenuation of the plate, resulting in instability.

The end result of collateral ligament and plantar plate attenuation is a dorsomedial subluxation of the proximal phalanx on the metatarsal head.

55.4 Clinical Presentation

Crossover second toe presents as pain and inflammation of the 2nd MTP joint. Patients often complain of a feeling that they are walking on a marble in the ball of their foot which likely represents swelling of the joint capsule and surrounding soft tissues and a prominent metatarsal head and overlying callus. In its earliest stage, there is no deformity noted; however, swelling of the digit is common. As the disease progresses the second toe crosses either under or, more often, over the hallux.

Anterior to posterior radiographs reveal only joint distension with a widened joint space early on in the disease. In later stages, radiographs will demonstrate medial deviation of the second toe (Figure 2).
The deformity is often associated with hallux valgus, hallux rigidus, a hammertoe, or a neuroma. It has a peak incidence in women older than 50 years.\textsuperscript{13}

### 55.5 Pathogenesis

Acute trauma to the first MTP joint as a result of forced hyperextension with axial loading has been reported as a cause of crossover toe.\textsuperscript{13,15,17} The plantar plate ruptures and becomes interposed in the 2nd MTP joint.

More commonly, the patient has an idiopathic onset likely secondary to chronic inflammation. The cause of this inflammation is unknown; however, authors have proposed that overloading of the 2nd MTP joint can result form a long 2nd metatarsal, hypermobility of the first ray, pes planus, or genetic predisposition.\textsuperscript{13} Other proposed etiologies are impingement of the 3rd metatarsal onto the 2nd metatarsal head and hallux valgus, with impingement of the hallux into the 2nd toe contributing to joint instability.

Anatomic studies have revealed attenuated or even ruptured collateral ligaments.\textsuperscript{11} The plantar plate has also been described as deformed, attenuated, and displaced dorsomedially.\textsuperscript{10}

### 55.6 Classification (Staging)

Haddad was the first to suggest a staging system.\textsuperscript{12}

- Stage 1 - Synovitis and mild medial deviation at metatarsal joint
- Stage 2 - Dorsomedial deviation (subluxation) at the metatarsal joint
- Stage 3 - Overlapping of the Hallux
- Stage 4 - Complete dislocation at the metatarsal joint

Coughlin improved on this initial attempt and proposed a staging system based on physical exam and radiographic and clinical findings.

### 55.7 Physical Examination
Observation initially reveals swelling with no other deformities. As the disease progresses, medial deviation of the 2nd toe toward the hallux occurs. Palpation will result in tenderness at the 2nd MTP joint. Instability can be elicited by gripping the 2nd toe with one hand and the 2nd metatarsal head with the other and performing a “drawer test” similar to what one might do when testing for instability in the knee. Comparison to the normal foot can be helpful. It is also common to elicit pain in the 2nd intermetatarsal space if there is an associated neuroma.\(^8\)

### 55.8 Imaging

Radiographs may be normal in the early stages of the disease. The second MTP joint may appear distended. In later stages there is dorsal and medial subluxation of the second MTP joint. Figure 3 depicts the progression of a crossover toe over a 5 year period.

![Figure 3.](image)

### 55.9 Conservative Treatment

Conservative management should be attempted for Stages 1, 2, and 3 crossover toe deformities. Once the toe becomes dislocated (Stage 4), non-operative treatment is likely to fail.

- **Taping** - The goal of taping is to position the toe into a neutral position and provide stability, thus decreasing symptoms (Figure 4). As inflammation decreases healing can occur. Stability may be achieved with scar tissue formation, however, this can require several months. Prolonged taping does not correct the deformity.
• **Metatarsal pad** - Placement of a metatarsal pad just proximal to a symptomatic metatarsal head can alleviate plantar discomfort by redistribution of weight on the plantar surface of the foot (Figure 5).

• **Anti-inflammatories** - The use of non-steroidal anti-inflammatory drugs (NSAIDs) can decrease discomfort from inflammation at a symptomatic MTP joint.

• **Orthotics** - Stiffening the area under the metatarsal head with a carbon fiber footplate can relief the dorsiflexion stress across the 2nd MTP joint (Figure 6). A rocker bottom sole may help relieve dorsiflexion. Providing a recess for an intractable keratosis or thickened metatarsal fat pad can also help.\(^{18}\)
Operative treatment is reserved for patients in whom non-operative treatment has failed. Surgical management depends on the severity of the deformity. In general, mild deformities can be treated by soft tissue procedures; severe deformities may require the addition of a shortening osteotomy. In general, a smooth k-wire should be used to stabilize the 2nd MTP joint after realignment has been obtained. It should not be used to correct the deformity because once it is removed, the deformity will likely recur.

Soft tissue procedures should start with dorsal and medial capsular release with lateral capsular reefing. If this is not successful, then a flexor or extensor tendon transfer can be attempted as described by Haddad.\textsuperscript{12} Outcomes with flexor to extensor transfers have been mixed, however, with a significant potential for patient dissatisfaction.\textsuperscript{16}

If realignment cannot be obtained with soft tissue procedures, then a shortening osteotomy of the second metatarsal can be used. The distal oblique metatarsal osteotomy, otherwise known as the Weil osteotomy, is one option.\textsuperscript{7} This osteotomy can be used in conjunction with the above soft tissue procedures to regain adequate alignment.

One of the biggest factors in obtaining a good outcome after 2nd MTP joint realignment is the postoperative care. Patients in our clinic begin self-guided exercises of the lesser toes 3 weeks after surgery and continue for 3 months. These exercises included active resistive and passive toe flexion and extension.

### 55.11 Controversy

The cause of crossover toe has been debated. Morton\textsuperscript{14} believed that a long 2nd metatarsal was prone to develop metatarsalgia. However, the method of measuring length of the 2nd metatarsal results in different incidences of metatarsal length.\textsuperscript{13}
Surgical treatments are debated in the literature. The use of various soft tissue and bony procedures alone and in combination have been reported.

55.12 References