

A 45-year-old female presented with a three-month history of left forefoot pain. There was no history of trauma although the patient reported a rapid onset of pain whilst walking. The pain was localised to the plantar surface of the base of the left second digit. Since the initial onset of pain the patient had noticed a gradual deviation and retraction of the digit with dorsal pressure occurring between the proximal interphalangeal joint (PIPJ) and the toe box of her left shoe (Figure 1). The patients presenting complaint concerned both the irritation to the dorsal surface of the PIPJ as well as the continued pain in the base of the second toe.

A diagnosis of rupture of the plantar plate was made through the use of a vertical stress test, plantar palpation, toe position and medical history. With the disruption of the retaining mechanism to stabilise the proximal phalanx and an alteration in the alignment of the pull of the flexor tendons there is subsequent and progressive hammering of the digit. The patient failed to respond to conservative care including padding, strapping, orthoses and a cortisone injection. The patient progressed onto primary repair of the plantar plate with arthroplasties and long flexor-to-extensor transfer. A review of the literature has shown a recent improved understanding of the pathology and management of this injury. This case helps to highlight the recent literature and suitable conservative and surgical management.

Key words: Plantar plate rupture, plantar plate tear, hammer toe deformity

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Figure 2: MRI of plantar plate rupture. Sagittal T1-weighted MRI. The straight arrow indicates the plantar plate, the curved arrow indicates the ruptured plate. (Reproduced with permission from Yao et al.¹)



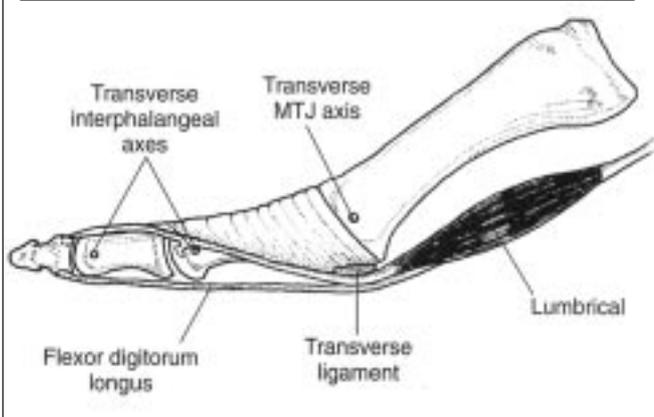
Figure 4: Vertical Stress Test. This test involves stabilising the proximal metatarsal and elevating the related digit dorsally. Translocation of the digit greater than two millimetres is felt to be suggestive of rupture.



ANATOMY

The plantar plate has a variety of roles in foot function. It is a fibrocartilaginous structure that aids in stabilising the digit along with collateral ligaments, intrinsic and extrinsic muscles. It acts as an attachment for the plantar fascia and has a role in the windlass mechanism. Its cartilaginous structure helps to reduce compressive loads on the metatarsal heads. Combined with other adjacent structures it also helps to guide the line of pull of various muscles attaching to the digits, specifically the lumbricals and flexor digitorum longus (Figure 3).⁷

Figure 3: Anatomical relationships of the intrinsic muscles to the transverse ligament. The transverse ligament blends with the plantar plate. Note should be made of the way the lumbrical muscle tendon slings under the transverse ligament which will be disturbed in the case of a plantar plate rupture.



DIAGNOSIS

Diagnosis of plantar plate tear is made through patient history, appearance of the affected area and a positive vertical stress test. Patients commonly present with chronic focal pain underlying the second metatarsophalangeal (MTP) joint. A history of trauma, commonly tripping, may have occurred. Complaints of a “lump” or “bruised feeling” underneath the

second MTP joint are common. There may be associated mild swelling plantarly and dorsally. Commonly patients may also notice a gradual hammering and/or transverse plane deformity of the second toe. A positive vertical stress test is similar to the anterior drawer test used to test the integrity of ankle ligaments. It involves stabilising the proximal metatarsal and elevating the related digit dorsally (Figure 4).⁸ Translocation of the digit greater than two millimetres is felt to be suggestive of rupture. MRI imaging or a plain film arthrogram may be used to visualise the area of rupture.¹ Advanced-imaging techniques need only be used when differential diagnosis is required. Differential diagnosis includes stress fracture, hammertoe deformity, degenerative joint disease, avascular necrosis, synovitis and neuroma.

AETIOLOGY

There are believed to be a number of contributing aetiologies to the development of plantar plate rupture. The condition is commonly associated with hallux valgus. Dorso-medial displacement of the first ray in the hallux valgus deformity leads to overloading of the longer second metatarsal which, due to its more rigid proximal Lisfranc articulation, is subject to significantly more strain at the distal metatarsal and MTP joint. The condition has also been associated with a long second metatarsal, short first metatarsal, inflammatory arthropathies, diabetes mellitus, degeneration with aging, biomechanical anomalies, and high-heeled footwear.⁶ Athletes are also prone to this condition as repetitive hyperextension of the MTP joint during sporting activities (particularly ballet) produces a pathological elongation of the plantar aponeurosis and capsule.⁹ In many cases there is a tear in the central portion of the plate, which is typically the thinnest point of the plantar plate and most exposed to stress from the juxtaposed head of the metatarsal.⁸ In cases of significant crossover (transverse deviation), one should suspect collateral ligament rupture.¹⁰

Figure 5: Cross-over taping can be used to plantarflex the affected digit and reduce tension on the ruptured plantar plate.

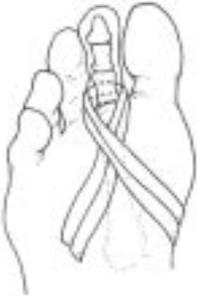


Figure 6: A plantar pad with suitable strapping can help both cushion and plantarflex the digits to improve plantar plate alignment.



Figure 7: An orthotic incorporating a sub first metatarsal balance and an EVA post to the sulcus of the digits helps to allow the first ray to drop below the level of the second metatarsal and effectively apply a dorsiflexory force to the second metatarsal. This allows better alignment of the affected digit and approximation of the tissues of the torn plantar plate.



may actually hasten the progression of the digital deformity. Allowing for plantarflexion of the metatarsal promotes the dorsiflexory action of the intrinsic muscles (interossei and lumbricals) hence worsening the hammering of the digit and further opening up the plantar plate rupture. There is little other conservative management recommended or discussed in the literature. Although physical therapies have been suggested in the management of metatarsalgia there is no specific recommendation for the use of these techniques in plantar plate tears. It is likely that some therapies developed for the strengthening of plantar intrinsic muscles may benefit individuals with progressive hammer deformities, although the efficacy of such management is not known to the authors.

Conservative treatment that fails to provide pain relief may be assisted with the use of cortisone into or around the painful MTP joint. Patients need to be informed of the risk of the cortisone further weakening connective tissue structures and the risk of sepsis (albeit a risk of < 0.0002%).^{11,2}

Failure to respond to conservative treatment may indicate a surgical approach. Surgical approaches recommended for plantar plate repair include osseus correction of the hammered digit combined with a variety of soft-tissue techniques, flexor-to-extensor transfer and/or simple primary repair of the plantar plate or collateral ligament tears.^{6,13} The surgical procedure chosen is based typically on the severity of the hammer deformity of the affected digit.

KEY-POINTS

Plantar plate injury is a common cause of second MTP joint pain in adults.⁶ Pain on direct palpation of the second MTP joint plantarly, progressive hammering of the second toe and a positive vertical stress test is indicative of plantar plate damage.⁶ The aims of conservative treatment are to attempt realignment of the affected digit and plantar plate, prevent or slow progressive deformity and cushion the uncomfortable MTP joint. The use of U-shaped pads to relieve pressure on the MTP joint could potentially worsen the alignment of the digit.

Patients who fail to respond to conservative treatment may be recommended surgical intervention, commonly involving osseus correction of the hammered digit, flexor-to-extensor transfer and/or primary repair of the plantar plate.

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TREATMENT

Treatment of plantar plate rupture can be approached conservatively or surgically. Conservative treatments include taping (Figure 5), padding and orthoses to realign the digit; the latter providing cushioning or pressure relief for the painful MTP joint. The authors provide illustrations of their own commonly used treatments (Figure 6 and 7). An orthotic with an EVA post-to-sulcus (web-spaces of toes) is used by both authors for the management of this condition. The addition of the EVA post-to-sulcus provides a moderately cushioning material that is also capable of providing a dorsiflexory force to the metatarsals while allowing plantarflexion of the digits. This effect improves apposition of the torn ligament tissues. Importantly, it should be noted that based on the biomechanical underpinnings of this condition, pads or orthoses that incorporate a U-shaped design to balance the metatarsal head,

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