

# Plantar plate rupture

Matthew C Dilnot, *B Pod (Hons)*  
Thomas C Michaud, *DC*

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

Australasian Journal of Podiatric Medicine  
2003; Vol 37, No.2 : 43-46

**Correspondence:** Matthew C Dilnot, PO Box 7600 Middle  
Camberwell, VIC 3124  
Ph: +61 (3) 9830 2211 Email: equus@equusmedical.com

## INTRODUCTION

Plantar plate ruptures have recently received far greater recognition in the literature, due partly to improved imaging techniques.<sup>1,2,3,4</sup> The advent of MRI has led to easy visualisation of the plantar plate and has elucidated tears as a common cause of pain and progressive digital deformity (Figure 2). A fallen transverse arch has possibly been a common misrepresentation of this condition throughout the last century.<sup>5</sup> The condition is now recognised through a variety of names including predislocation syndrome, floating toe syndrome, monoarticular nontraumatic synovitis, subluxation and crossover-toe deformity although the authors feel plantar plate rupture is apt.<sup>6</sup>

**Figure 1: Early stage plantar plate rupture. Patient presents with a history of no trauma, pain plantar to the second MTPJ and progressive dorsiflexion and medial deviation of the second digit (widening of second interspace).**



**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.<sup>1</sup>)**



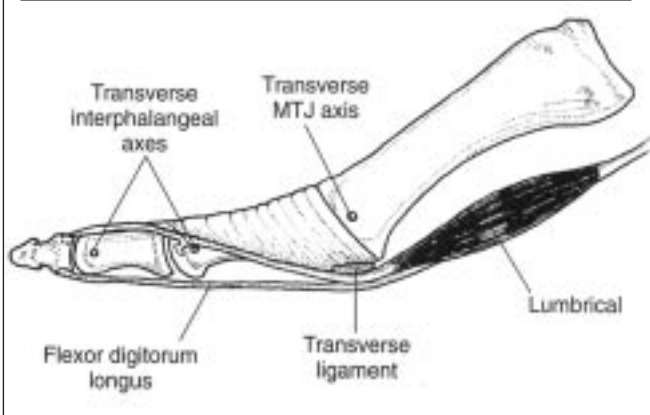
**Figure 4: Vertical Stress Test. This test involves stabilising the proximal metatarsal and elevating the related digit dorsally. Translocation of the digit greater than two millimetres is felt to be suggestive of rupture.**



**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).<sup>7</sup>

**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**

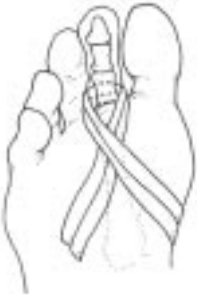
Diagnosis of plantar plate tear is made through patient history, appearance of the affected area and a positive vertical stress test. Patients commonly present with chronic focal pain underlying the second metatarsophalangeal (MTP) joint. A history of trauma, commonly tripping, may have occurred. Complaints 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).<sup>8</sup> 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.<sup>1</sup> 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.<sup>6</sup> 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.<sup>9</sup> 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.<sup>8</sup> In cases of significant crossover (transverse deviation), one should suspect collateral ligament rupture.<sup>10</sup>

**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%).<sup>11,2</sup>

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.<sup>6,13</sup> 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.<sup>6</sup> 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.<sup>6</sup> 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.

**REFERENCES**

1. Yao L, Do HM, Cracchiolo A, Farahani K. Plantar plate of the foot: findings on conventional arthrography and MR imaging. *American Journal of Roentgenology* 1994; 163(3):641-644.
2. Yao L, Cracchiolo A, Farahani K, Seeger LL. Magnetic resonance imaging of plantar plate rupture. *Foot & Ankle International* 1996; 17(1):33-36.
3. Umans HR, Elsinger E. The plantar plate of the lesser metatarsophalangeal joints: potential for injury and role of MR imaging. *Magnetic Resonance Imaging Clinics of North America* 2001; 9(3):659-669, xii.
4. Ashman CJ, Klecker RJ, Yu JS. Forefoot pain involving the metatarsal region: differential diagnosis with MR imaging. *Radiographics* 2001; 21(6):1425-1440.
5. Morton DJ. Structural factors in static foot disorders of the foot. *American Journal of Surgery* 1930; 9(2):315-328.

**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,

# Why do more Podiatrists choose us to help them get ready to work in the UK?

*Because with over ten years experience of helping 15000 people prepare to work in the UK – we know what you need!*

## Advice From Home

As an Australasian you need a company based here as the difficult part of your organisation happens before you leave home. We give you advice and instructions prepared here, by us, specifically for Australian and New Zealand Podiatrists like you.

## Our UK Experience

BMG Associates are a part of one of the leading recruitment specialists for Podiatrists in the UK. This means you receive our personalised service both here at home and when you arrive in the UK.

## Visas

We will advise you on which visa or work permit best suits your needs, then help you apply for that visa to avoid rejection or delay.

## Professional Registration

We will guide you through the registration process, check over your forms and liaise with the UK registration board on your behalf.

## Eight Essential Documents

Before leaving you will also need to collect the eight essential documents that all UK employers will expect to see. We can help you source these documents to make sure you have everything you need before you leave home.

## Free Checklist

So call Simon Price in Australia on Freecall 1800 677 948, or Kim Robertson in New Zealand on Freephone 0800 803 854, to receive your free Working in Great Britain checklist and find out everything that we know about working in the UK.

## BMG Associates

PO Box 76  
Brunswick East, Vic 3057  
PO Box 56-157  
Dominion Road, Auckland 1030



6. Yu GV, Judge MS, Hudson JR, Seidelmann FE. Predislocation syndrome. Progressive subluxation/dislocation of the lesser metatarsophalangeal joint. *Journal of the American Podiatric Medical Association* 2002; 92(4):182-199.
7. Stainsby GD. Pathological anatomy and dynamic effect of the displaced plantar plate and the importance of the integrity of the plantar plate-deep transverse metatarsal ligament tie-bar. *Annals of the Royal College of Surgeons of England* 1997; 79(1):58-68.
8. Thompson FM, Hamilton WG. Problems of the second metatarsophalangeal joint. *Orthopedics* 1987; 10(1):83-89.
9. Coughlin MJ. Second metatarsophalangeal joint instability in the athlete. *Foot and Ankle* 1993; 14:309-319.
10. Deland JT, Sung I. The medial crossover toe: a cadaveric dissection. *Foot and Ankle* 2000; 21:375-378.
11. Noyes FR, Grood ES, Nussbaum NS, Cooper SM. Effect of intra-articular corticosteroids on ligament properties: a biomechanical and histological study in rhesus knees. *Clinical Orthopaedics and Related Research* 1977; 123:197-209.
12. Esterhai JL, Gelb I. Adult septic arthritis. *The Orthopedic Clinics of North America* 1991; 22(3):503-514.
13. For LA, Collins KB, Christensen JC. Stabilization of the subluxed second metatarsophalangeal joint: flexor tendon transfer versus primary repair of the plantar plate. *Journal of Foot and Ankle Surgery* 1998; 37(3):217-222.

[www.bmgassociates.com.au](http://www.bmgassociates.com.au)