

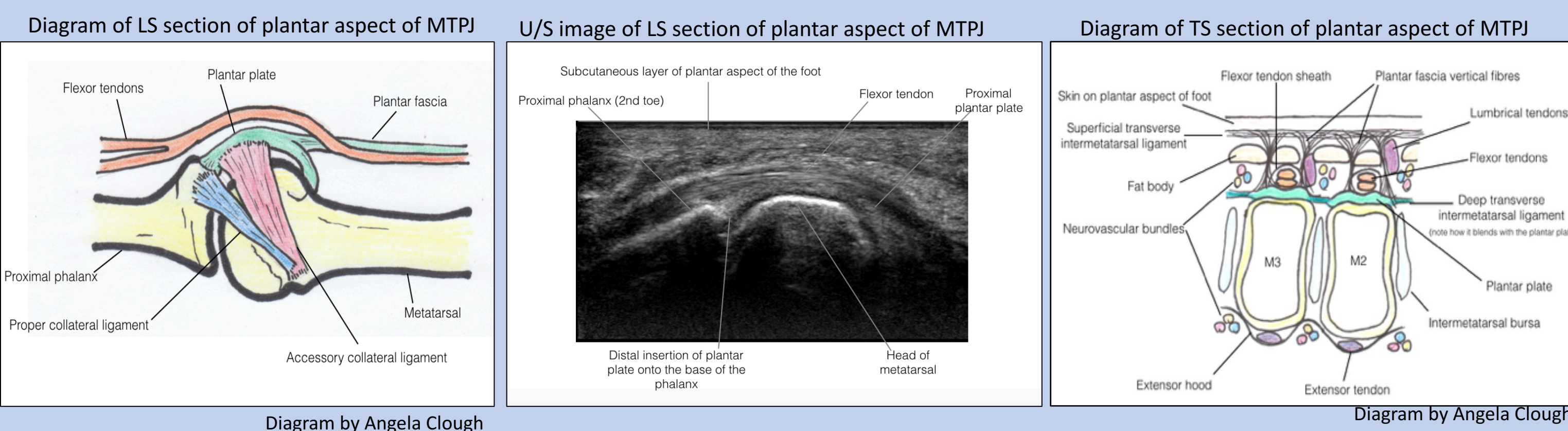
3 Ultrasound assessment of a common cause of forefoot pain: Plantar plate tear of the 2nd-5th metatarsophalangeal joint

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Introduction

Plantar plate tears (PPTs) are a common but sometimes overlooked cause of forefoot pain, as shown in a 2014 study which identified that 40% of patients with metatarsalgia had detectable PPTs (1). Ultrasound has a valuable role in diagnosing PPTs and is most effective when combined with simple clinical tests at the time of the examination, as demonstrated in this case study.

The plantar plate is a fibrocartilaginous structure which stabilizes the plantar aspect of the metatarsophalangeal joint (MTPJ). It prevents dorsi-extension of the toe and is part of a complex of support structures for the MTPJ as seen in the LS and TS sections below



The plantar plate is susceptible to partial or complete tears due to chronic overload, age or trauma. Tears typically present with burning, throbbing or tingling and are commonly misdiagnosed as a Morton's neuroma, stress fracture or arthropathy. The second MTPJ is most commonly affected as it has the longest metatarsal bone (2).

The incidence of metatarsalgia relating to symptomatic PPTs may be explained by associated pathology such as capsular inflammation which can occur secondary to a tear, as described in an early study in 1994 by Yao *et al* (3). A more recent MRI study in 2014 (1) looking at adjacent interspace lesions in patients with PPTs, found that a significant number of symptomatic second toe PPTs had coexisting non-neuromatous second interspace lesions. The most common pathology identified was peri-capsular fibrosis followed by inter-metatarsal bursitis and ganglions, and interestingly, no concomitant second interspace Morton's neuromas were detected.

Treatments of PPTs include the use of strapping and/or orthotics to stabilise and off-load the joint, and non-steroidal anti-inflammatory medication when inflammation is present (4). Steroid injection is not recommended as this can further weaken or rupture the plantar plate, and this makes differentiation between plantar plate tears and a Morton's neuroma particularly important as this is a common treatment for the latter (4).

The plantar plate does not readily repair itself as it is made of type 1 collagen, and where conservative treatment has been exhausted, surgery may be required to achieve satisfactory MTPJ alignment, stability and pain reduction (1).

Case study

A 66 year old female with metatarsalgia in the region of the left 2nd toe was referred by an MSK podiatrist for ultrasound assessment of the pain. A steroid injection was also requested to be performed at the time of the scan if a Morton's neuroma was detected.

A brief clinical examination of the affected toe was performed before the scan. The patient was first observed with the foot uncovered, in the standing position, to assess for medial toe drift. Clinical tests for a PPT were then undertaken to assess for any reduced plantar purchase and/or a positive metatarsophalangeal 'drawer test' (See clinical tests below). The foot was also assessed for a Mulder click by using sonopalpation and simultaneously squeezing the forefoot.

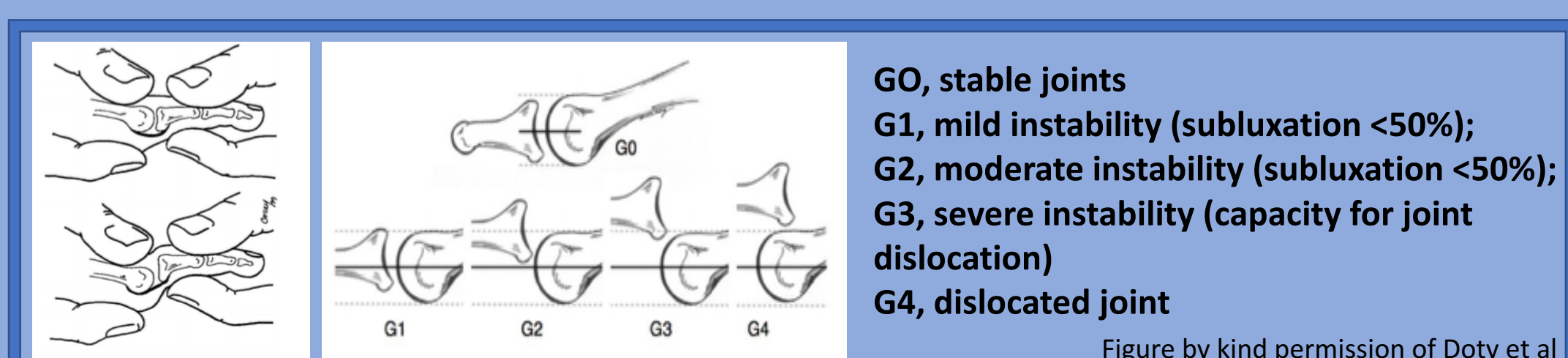
The left forefoot was then scanned on a Philips iu22 machine using a 17MHz linear transducer with a musculoskeletal preset. Longitudinal and transverse assessment was made of the 2nd MTPJ, the plantar plate and the adjoining toe interspaces. Colour Doppler was then applied to assess for abnormal vascularity within the joint and/or interspaces.

Clinical test for plantar plate tears

There are two recognized clinical tests for PPTs, the metatarsophalangeal 'drawer test' and the 'paper pull out test'.

Metatarsophalangeal 'drawer test'

Devised by Thompson and Hamilton (5), the 'drawer test' of the MTPJ is designed to test joint stability, and according to Doty *et al* (2014) (6) has 80.6% sensitivity and 99.8% specificity for PPT. The toe has vertical stress applied in a dorsal direction and the amount of subluxation and pain produced by the test can be graded 1-4 (see figure below).



Paper pull-out test

This second test measures plantar flexion strength and was first described by Bouché and Heit (7).

A strip of paper (1 x 6cm) is placed beneath the tip of the affected toe and the patient is asked to perform plantar flexion of the forefoot, and to press down on the paper with the toe. (See photograph). The test is positive when the digit is unable to grip the paper and the strip can be pulled out without ripping. Findings from this test have been combined with the 'Drawer test' to provide clinical staging (6).

Another sign of a plantar plate tear is medial toe drift which presents because the tear occurs most commonly on the lateral edge, allowing the flexor tendon to pull the toe medially. This is best observed with the patient standing at the start of the ultrasound examination (as demonstrated in the case study findings).



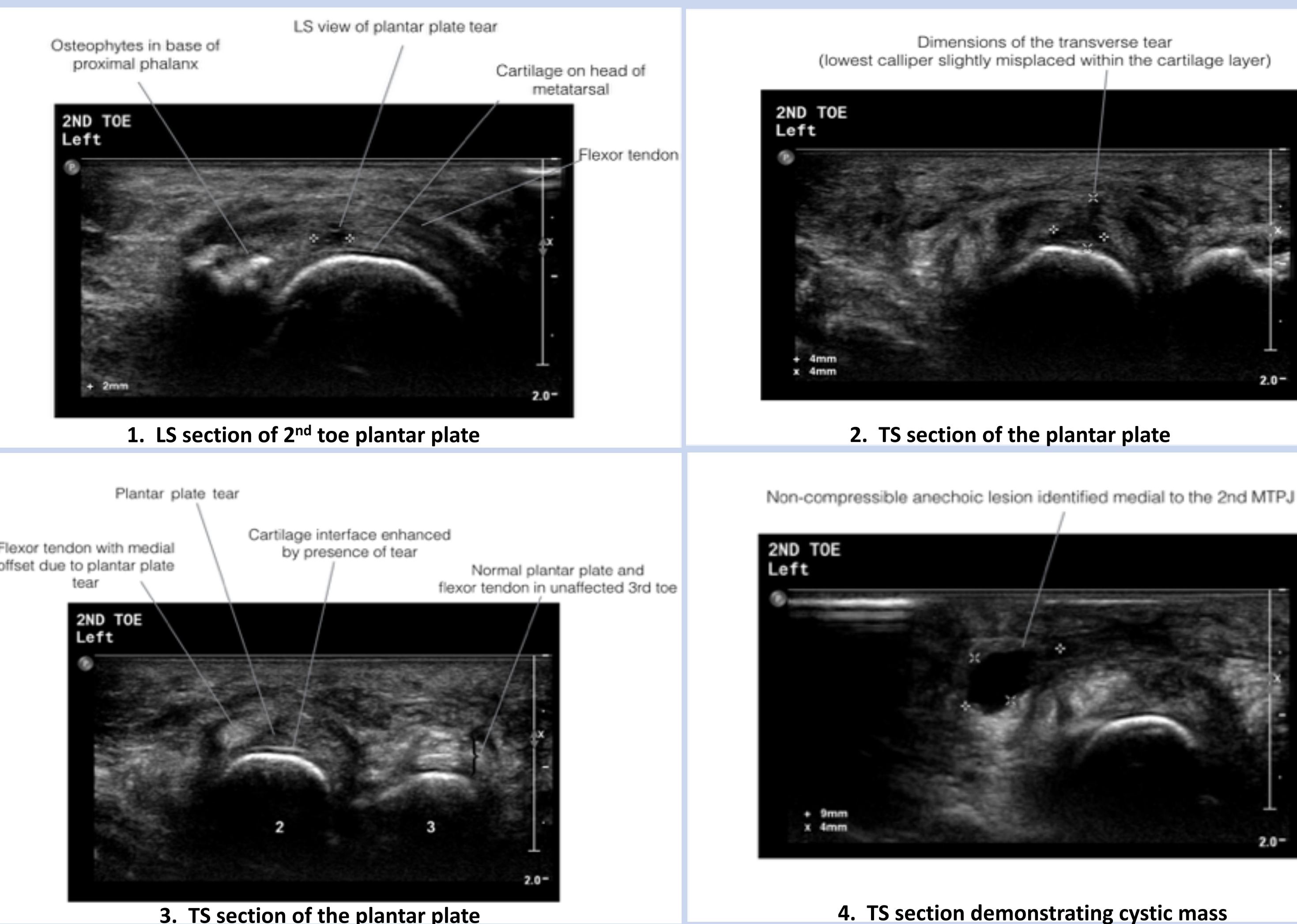
Clinical and scan findings

A physical examination of the foot identified swelling of the 2nd MTPJ as well as medial toe drift, which the patient confirmed was a recent development. The paper pull out test and drawer test were both positive. No Mulder click was identified.

Photos of patient's foot demonstrating medial drift of the 2nd toe



The scan confirmed the presence of a partial, laterally located plantar plate tear. Osteophytes within the MTPJ and a probable MTPJ ganglion were also identified. There was no Morton's neuroma in evidence. No abnormal vascularity was noted within the joint, or in the toe interspaces either side of the 2nd toe.



Follow up

A steroid injection was not performed due to the presence of a tear.

The referring podiatrist opted initially for conservative treatment using strapping and orthotics, and follow up after one month indicated an improvement in symptoms.

Discussion

There is nothing in the literature to suggest guidelines or a definite consensus on imaging of suspected PPTs; that said there is a general trend towards MRI as the preferred non-invasive imaging modality (10). The first studies to evaluate PPTs with ultrasound were conducted by Gregg *et al* in 2006 (8, 11) and showed slightly better detection rates compared with MRI. Later studies indicated that although ultrasound had excellent sensitivity, the specificity is lower than MRI, and it gives less accurate localization (12, 13). MRI is also better at detecting soft tissue pathology around the joint such as co-lateral ligament tears (14). Ultrasound is however better at detecting interspace lesions such as ganglions, neuromas (15) and inter-metatarsal bursitis (16).

These studies indicate that ultrasound is more sensitive than MRI in detecting plantar plate tears and this, together with its low-cost and flexibility, suggest that ultrasound is suitable as the first line test. As they also show that ultrasound has a poorer specificity than MRI, this might suggest that ultrasound alone may not suffice for surgical planning, and in some cases follow-up MRI imaging may be required.

Clinical assessment is commonplace in forefoot imaging (9) and the specific tests for MTPJ stability described here are especially useful in assisting detection of a PPT in combination with ultrasound, as in this case study. However it should be noted that the plantar plate presents challenges for both MRI and ultrasound scanning as it is a small curved structure which can be difficult to access with an MRI coil, and susceptible to anisotropy with ultrasound (8). In addition, some tears are not easily visualised on ultrasound as hypoechoic areas, as there can be an infill of loose connective tissue as repair commences (8).

In conclusion PPTs commonly occur and as illustrated by this case study can be successfully identified by simple clinical tests and ultrasound. Concomitant interspace lesions can also be characterized. The ability to accurately differentiate between a tear and Morton's neuroma is particularly advantageous as it indicates the correct treatment option and avoids the inappropriate administration of a steroid injection when the pathology is a tear.

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