

Radiographic evaluation and determination of predisposing factors to Plantar Plate tear in the second metatarsal phalangeal joint.

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STATEMENT OF PURPOSE

The plantar plate (PP) of the second metatarsal phalangeal joint (2nd MPJ) is most commonly affected leading to attenuation or rupture. Few authors have described any radiographic findings of underlying biomechanical or anatomical causes that predispose patients to a PP tear. The purpose of this study is to determine a structural etiology common amongst patients with known PP tears using plain radiographs to measure overall ray length of rays one, two and three; metatarsal length of metatarsals one, two and three; and metatarsal protrusion distance.

INTRODUCTION

Plantar plate (PP) pathology, or tearing of the ligament that stretches from the metatarsal head to the toe, is a common condition that has historically been misdiagnosed clinically (8). Common misdiagnoses include neuroma, hammertoes, capsulitis, and tendonitis. If left untreated, this condition can cause a crossover toe deformity (2). The pathology and etiology has been classically attributed to a variety of biomechanical or anatomical stressors that lead to attenuation or tearing of the plantar plate most commonly associated with the second digit (9). We clinically can evaluate this pathology with ease in 95% of patients presenting with symptoms of PP pathology if the digit is dorsally dislocated/subluxed in the sagittal plane and deviated in the transverse plane as well, however there is not much literature surrounding protocols for early-stage detection (8). Thompson and Hamilton described the drawer test (Lachman test) to determine early presentation of second metatarsal phalangeal instability or PP pathology (3). The purpose of this study is to determine a structural etiology common amongst patients with known PP tears using plain radiographs to measure overall ray length; metatarsal length; sagittal plane deviation of the first metatarsal; hypermobility of the first ray; and metatarsal protrusion distance. No notable publications currently exist that can speak to the radiographic evidence which may predispose patients to a plantar plate rupture based on biomechanics or anatomy. Classically, plantar plate pathology is attributed to an abnormal metatarsal protrusion distance of greater than two millimeters,

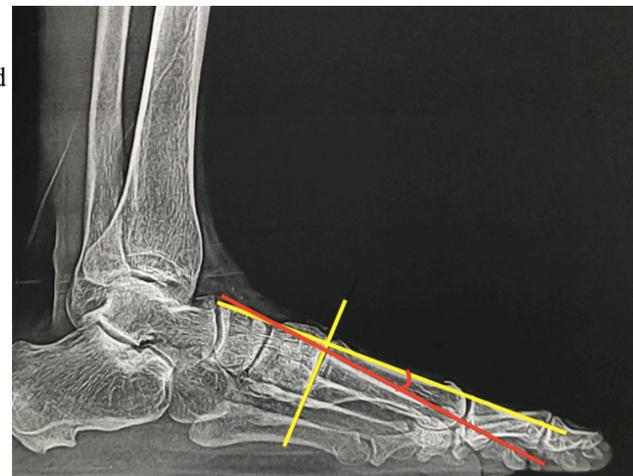
hypermobility of the first ray, Morton's foot, metatarsus primus elevatus or an elongated second metatarsal, rheumatoid arthritis and trauma (2,9). Extrinsic pressure and chronic extension of the digit has also been described by Coughlin as an etiology of plantar plate attenuation and tear seen in older women, especially those who have regularly worn high heels (2,3).

MATERIAL AND METHODS

Fifteen patients, twelve female and three male, with PP tears were selected for a retrospective analysis. Medical charts were reviewed as well as AP and lateral weight-bearing radiographs of all fifteen patients, which included nine right feet and six left feet. The inclusion criteria included a clinical diagnosis of PP tear with a positive Lachman test, second digit hammertoe and AP and lateral weight-bearing radiographs taken in a clinical setting. The exclusion criterion was no history of ulceration, infection or trauma. The patient population was an average age of 60.93 years of age, youngest being 42 years of age and the oldest being 76 years of age.

Patient history included commonly associated deformities with PP pathology. Seven of the fifteen patients in our study had concomitant hallux rigidus deformity of the first metatarsophalangeal joint, in which required first MPJ arthrodesis while three of the fifteen required associated joint-preserving bunionectomy procedures. Three of the fifteen patients had nerve entrapment syndromes, which were addressed intra-operatively with nerve decompressions. Weil osteotomies were done in all patients to decompress the second metatarsal phalangeal joint and fixated with screws to maintain parabola of the metatarsals, all surgeries were done by one of three principle authors.

Charts were reviewed and radiographic measurements were obtained by the supporting author. Measurements included metatarsal length of the first and second metatarsals from base to head, ray length, which included metatarsal length and length of entire digit, of the first and



second rays, and metatarsal protrusion distance of the second metatarsal compared to the first all on AP radiographs. Lateral radiographs were used to determine the met primus elevatus angle using technique described by Craig Camasta to assess for intrinsic or extrinsic etiology (1).

RESULTS

All patients were evaluated upon initial presentation with pain, which was localized to the second metatarsal phalangeal joint, and presented with a positive lachman test clinically. Radiographic measurement on the AP images of the average length discrepancy between first and second metatarsals was seen to be 0.926 cm while the average length discrepancy between the first and second rays was seen to be 0.466 cm. Metatarsal protrusion distance of the second metatarsal compared to the first metatarsal was noted on average to be 0.733 mm with only six of the fifteen patients proving to have a second metatarsal that is greater than 2 mm compared to the first metatarsal, which is only 40% of the population. The relationship on lateral images of the first and second metatarsal in the sagittal plane was used to determine first metatarsal elevatus. We used the technique described by Camasta, who identified that in order to confirm a true metatarsus primus elevatus the angular deviation between the first and second metatarsals must be observed in lateral images (3). Using this technique, we found that ten of the fifteen patients had an element of met primus elevatus, whether it was related to an intrinsic (structural) or extrinsic (positional) etiology as described by Camasta (1).

DISCUSSION AND CONCLUSION

Plantar plate tears have classically been mis-diagnosed in the clinical setting, leading to advancement of the pathology without proper intervention. This study was meant to identify radiographic evidence that biomechanical or anatomical variations predispose patients to plantar plate tears, and use that evidence to slow the progression of what Duvries and Coughlin relate is the most common dislocation of the forefoot that are related to plantar plate pathology (2,5).

This study proved that a long second metatarsal compared to first metatarsal was seen in all of the patients with an average of 16% longer or an average of 0.926 cm in length.

Also observed in a comparison between the first and second rays was a second ray an average of 5% longer, or on average 0.466 cm longer. Hypermobility of the first ray is often seen in conjunction with lesser metatarsal phalangeal joint instability (8), which was observed in nine of the fifteen, or 60%, of the patients showing hypermobility at the first tarsometatarsal joint. Those nine patients also presented with a dorsiflexed first ray on lateral standing xrays. Camasta describes the etiology of metatarsus primus elevatus as falling into one of two categories: intrinsic (structural) or extrinsic (Positional) (1). Intrinsic etiology of a dorsiflexed first metatarsal is described as being related to a violation of the normal architecture of the bone, while extrinsic etiology is described as being present when the normal architecture is preserved and there is a divergence between the first and second metatarsals.

While MRI and Arthrograms may be the standard of care for diagnosing plantar plate disruptions (7,13), early detection of predisposing anatomic or biomechanical factors leading to an atraumatic plantar plate tear will lead to a decrease in the use of expensive imaging modalities. Early manifestations of PP tears can be predicted by using radiographic analysis to detect the pathological process. Thus allowing the use of a more conservative modality if required.

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