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Can ultrasound of plantar plate have normal appearance with a positive drawer test?

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ABSTRACT

Objectives: The aims of this study were (1) to evaluate the reliability of ultrasound (US) examination in the identification and measurement of the metatarsophalangeal plantar plate (MTP-PP) in asymptomatic subjects and (2) to establish the correlation of US findings with those of physical examination and magnetic resonance imaging (MRI), once it is an important tool in the evaluation of the instability syndrome of the second and third rays.
Materials and Methods: US examinations of the second and third MTP-PPs were performed in eight asymptomatic volunteers, totaling 32 MTP joints, by three examiners with different levels of experience in musculoskeletal US. Plantar plate dimensions, integrity and echogenicity, the presence of ruptures, and confidence level in terms of structure identification were determined using conventional US. Vascular flow was assessed using power Doppler. US data were correlated with data from physical examination and MRI.
Results: MTP-PPs were ultrasonographically identified in 100% of cases, always showing homogeneous hyperechoic features and no detectable vascular flow on power Doppler, with 100% certainty in identification for all examiners. There was excellent US inter-observer agreement for longitudinal measures of second and third toe MTP-PPs and for transverse measures of the second toe MTP-PP. The MTP drawer test was positive for grade 1 MTP instability in 34.4% of joints with normal US results. Transverse MTP-PP measures were significantly higher in individuals with positive MTP drawer test. US measures and characteristics of MPT-PPs were positively correlated with those of MRI.
Conclusions: US is efficient in identifying and measuring MPT-PPs and may complement physical examination. A grade 1 positive MTP drawer test may be found in asymptomatic individuals with normal MPT-PPs, as assessed by imaging.

1. Introduction

Metatarsophalangeal plantar plates (MTP-PPs) are rectangular structures composed of three layers of fibrocartilagenous tissue that occupy the plantar surface of metatarsophalangeal (MTP) joints [1,2]. These plates are firmly adhered to the proximal phalanx by collagen fibers that do not penetrate the hyaline cartilage, and run directly into the bone [2] but are only loosely inserted into the lower portion of the metatarsal neck by synovial connections. Additionally, MTP-PPs are predominantly composed of type-I collagen, represent the larger structure of distal fixation of plantar aponeurosis, and are connected to transverse intermetatarsal ligaments and accessory collateral ligaments of MTP joints [3,4]. MTP-PP ruptures may be related to acute traumatic events or sub-acute repetitive traumas (degenerative lesions) [5,6].

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MTP-PP images studies are important to clarify diagnosis of metatarsalgia mainly in the evaluation of the second and third ray instability syndrome, but also in others less common clinical conditions and many pathological states which have no expression on X ray [7].

The use of ultrasound (US) to evaluate the PP is recommended in clinical practice [8], since several studies have demonstrated that this method is slightly superior to magnetic resonance imaging (MRI) in diagnosing MTP-PP ruptures [9,10]. The advantages of US evaluation include greater availability, lower cost, and the ability to provide multiplanar evaluation and dynamic studies. In addition, US is noninvasive and low risk. Disadvantages of US include long learning curves and dependence on an operator [11,12].

Using a standardized US technique, this study sought to describe US aspects of the MTP-PP in asymptomatic subjects not engaged in professional sports activities, to compare US measures of the MTP-PP of second and third toes with MRI findings, and to investigate correlations between US findings and physical examination, since there are no available data on these topics in the literature.

2. Material and methods

2.1. Study design and subjects

The study was approved by the Universidade Federal de São Paulo Research Ethics Committee. Eight asymptomatic volunteers (2 men and 6 women; age 25.88 ± 4.82 years) were recruited among university students, medical residents, and employees of a teaching hospital. All the individuals signed a written consent form. Exclusion criteria included history of trauma or of degenerative, infectious, rheumatic or microcrystalline diseases, foot pain or foot deformities, MTP instability of grade 2 or higher according to the MTP drawer test, or US evidence of MTP-PP rupture.

2.2. Clinical evaluation

Subjects were classified as sedentary when no regular physical activity was reported or active when regular sports practice was reported. There were no high-performance or professional athletes in this group.

Clinical evaluation started with an overall examination performed by an orthopedist (TSM). Lower limbs were examined for deformities or defective alignments. The presence of hallux valgus, hallux rigidus, hammer toes, claw toes, and dorsal and plantar callosities were determined by visual inspection. Mild lateral deviations of MTP joints were tolerated up to 6°, as long as joint congruity was maintained. Mobility and range of motion of hallux and lesser toes were evaluated by dynamic inspection. To check for the presence of Morton's neuroma the Mulder's test was performed by squeezing the transverse metatarsal arch. This test was considered positive when there were pain and snapping (painful clicking) during mediolateral compression of the forefoot. To assess the stability of MTP joints in the second and third toes, the MTP drawer test was performed by holding the MTP joint in a neutral position, and then applying vertical stress in a dorsal direction [13]. MTP drawer test results were classified as grade 0: stable, no subluxation of the proximal phalanx from metatarsal head; grade 1: subluxation of up to 50%; grade 2: subluxation greater than 50%; grade 3: dislocated toe but flexible deformity; grade 4: dislocated toe and fixed deformity [14] (Figs. 1 and 2).

2.3. Imaging evaluation

US examinations were performed by three examiners whose experience in musculoskeletal US varied from 20 years (EAF) to 1 year (FFT) to 1 month (CTC). Each of the three examiners performed a separate US evaluation on each subject, and had no access to the measurements taken by the other examiners, or to the results of subjects' physical examination and MRI.

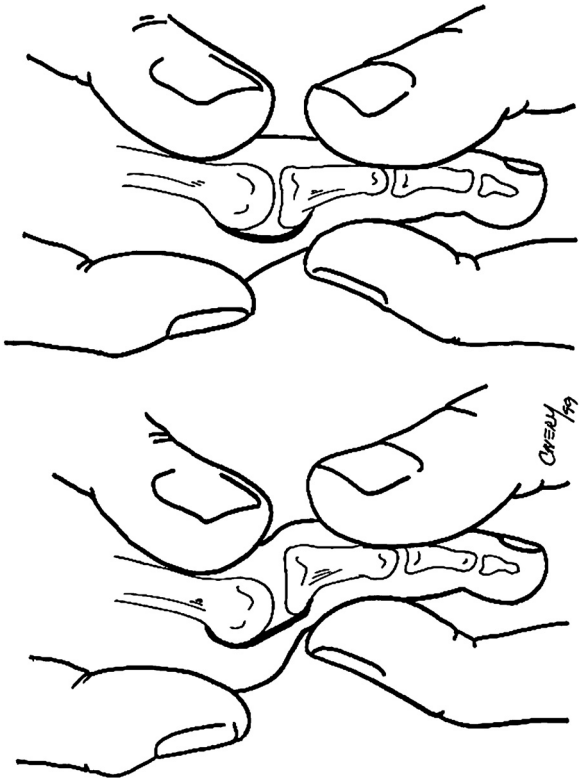

Fig. 1. The Hamilton-Thompson metatarsophalangeal "drawer" test. With the head and neck of the metatarsal bone fixed by one hand, the examiner attempts to dislocate the proximal phalanx dorsally with the other hand.

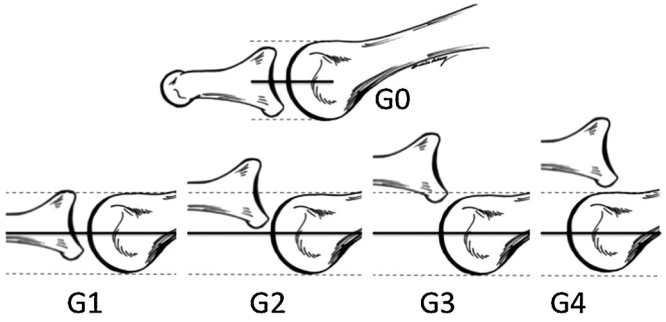

Fig. 2. Hamilton-Thompson metatarsophalangeal "drawer" test grading scheme. G0 indicates stable joint; G1, slight instability (<50% subluxable); G2, moderate instability (>50% subluxable); G3, gross instability (dislocatable joint); and G4, dislocated joint.

US imaging was performed using devices with a multi frequency 7–15 mHz linear transducer (Antares Sonoline, Siemens Medical Solutions, Malvern, PA, USA) and a multi frequency 6–12 mHz linear transducer (Accuvix V10 Samsung Medison, Seoul, Korea). Power Doppler US was used in the longitudinal and transverse planes to detect vascular flow, and exclude inflammatory signs. To enhance detection of vascular flow the smallest filter was used and the gain was set as high as possible without causing background artifacts.

US examination was performed with the subject in the supine position and lower limbs extended. MTP-PPs of second and third toes (32 MTP joints) were bilaterally assessed in the longitudinal axis, in the medial-lateral direction, and in the transverse axis, in the proximal-distal direction. The transducer was moved