Accuracy of Magnetic Resonance Imaging (MRI) and Dynamic Ultrasound for the Diagnosis of Plantar Plate Injuries: A Systematic Review and Meta-Analysis

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Background
- Plantar plate injuries are a common condition that can result in forefoot pain, joint subluxation, and worsening of hammertoe deformities. Diagnosis can be difficult when plantar plate injuries mimic other conditions (e.g., Morton’s neuroma, capsulitis) and may often present as generalized forefoot pain with ambiguous physical examination findings. Advanced imaging modalities are often utilized to confirm diagnosis of plantar plate pathology.
- Ultrasound and MRI have both been extensively studied in relation to the plantar plate and pathology in this region. Ultrasound is generally considered to be a low-cost, easy to perform examination. MRI is more costly and time consuming, but utilizes a standardized protocol which creates a more predictable, detailed image.
- Klein et al performed a direct comparison of MRI and US with intra-operative inspection being utilized as the gold standard of reference. Prospective comparison of 42 consecutive patients (51 feet) identified that US was the more sensitive exam while MRI was the more specific exam.
- A more recent case series directly compared high-resolution dynamic ultrasonography to MRI utilizing intra-operative exam as the gold standard of reference. The authors concluded that both modalities were acceptable for imaging plantar plate tears.

Purpose
- The purpose of this study was to examine the diagnostic accuracy of MRI and dynamic, musculoskeletal ultrasound in diagnosing plantar plate injuries using a systematic review and meta-analysis.

Methods
- Followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the Cochrane Handbook.
- Inclusion Criteria: any study that tested the diagnostic accuracy of MRI, ultrasound, and pathology in this region. Exclusion criteria: articles that did not include detailed data to create a full 2x2 table, or had patients that were less than 18 years old.
- The search strategy included the following MeSH terms: ‘plantar plate’, ‘metatarsalgia’, ‘hammertoe syndrome’, ‘metatarsophalangeal joint’, ‘ultrasonography’, ‘magnetic resonance imaging’ and ‘physical examination’. Several keywords were additionally utilized to ensure a comprehensive search was undertaken.
- The Dorsal Drawer test/Lachman’s test was included in the initial search but failed to yield enough studies with the data required for an analysis.
- A total of 16 studies were included in the meta-analysis.

Results

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Discussion
- Multiple studies have been conducted to see the accuracy of advanced imaging techniques (MRI and ultrasound) to confirm suspected plantar plate tears. However, there have been no definitive conclusions about which is superior in form of imaging.
- MRI was superior to ultrasound in diagnosing plantar plate injuries.
- Ultrasound was more sensitive than MRI, suggesting a negative ultrasound would likely exclude any plantar plate injury in the presence of an equivocal physical exam.
- MRI showed greater specificity than Ultrasound, suggesting that determining the presence of a plantar plate injury and the grade of the injury is best served with MRI.
- The study of MRI (apart from its accuracy) lies in its ability to evaluate associated collateral and suspensory ligaments in addition to the plantar plate structure.
- Based on the current literature, MRI performed better and is a more accurate test in diagnosing plantar plate tears than ultrasound.
- These findings may justify the added costs of MRI to ensure accurate diagnosis of plantar plate pathology.

Conclusion
- Based on our findings, a negative test result via point of care ultrasound (with its high sensitivity) will be helpful in ruling plantar plate pathology out. In contrast, MRI appears to be a slightly more accurate method of diagnosing plantar plate pathology overall and, due to its higher cost, might best be reserved for use only after equivocal ultrasound exams or when added insight into the integrity of the joint’s additional supporting structures (e.g., collateral and suspensory ligaments) is also needed.

References

Figure 1: PRISMA Flow Diagram

Figure 2: Final Forest Plots for Meta-Analysis of Included Studies

Figure 3: Summary Receiver Operating Curves: MRI versus Ultrasound