Angiology of the Plantar Plate: A Novel Technique for Imaging of the Plantar Plate Microvasculature

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Disclosures

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Our disclosures are in the Final AOFAS Mobile App.
Background

• Lesser toe plantar plate attenuation or disruption is being increasingly implicated in a variety of very common clinical complaints including metatarsal-phalangeal (MTP) joint subluxation, hammertoe, crossover toe, etc\textsuperscript{1}.

• Many surgical techniques and devices have been recently developed to facilitate surgical repair of the plantar plate\textsuperscript{2-5}.

• The microvascular anatomy, and therefore the healing potential in large part, has not been well defined.

• Micro-CT and nano-CT technology is being increasingly applied to biomedical research, yet this technology has been largely confined to the study of bone, not soft tissue.
Purpose

The purpose of this study was to analyze the microvasculature of the lesser toe plantar plate by employing a new technique involving microvascular perfusion and nano-CT imaging.
Methods

• A barium sulfate-formalin solution was injected into the anterior and posterior tibial arteries of human cadaver legs amputated below the knee.
• After allowing the perfused specimens to setup for 24 hours, specimens were amputated at the level of the proximal metatarsals, and the skin and superficial soft tissues were sharply dissected away.
• Specimens were then allowed to soak for 3 weeks in phosphomolybdic acid (PMA) for soft tissue counterstaining with regular PMA changes.
• The lesser toe MTP joints were then scanned in a GE Nanotom S nanoCT scanner at a resolution of 14µm.
Results

• Preliminary results demonstrate the presence of a microvascular network at the attachments of the plantar plate on both the metatarsal and proximal phalanx.

• The mid-substance of the plantar plate appears to be completely avascular.
Figure 1: Sagittal cross section of MTP joint with barium perfused microvasculature (red). The plantar plate (*) demonstrates a microvascular network at the proximal (single arrow) and distal attachments (double arrows) and a relatively avascular area at the mid-substance. Flexor tendon represented deep to the plantar plate (**).
Figure 2: Sagittal cross section of MTP joint (metatarsal head removed in this specimen) with 3D representation of barium perfused microvasculature (red). The plantar plate (*) is seen overlying the flexor tendon (**). A microvascular network is again demonstrated at the proximal and distal attachments (arrows) and a relatively avascular area at the mid-substance.
Discussion

• There is a very narrow zone of transition between the well vascularized proximal and distal attachments and the avascular central region.

• The avascular mid-portion of the plantar plate may play an important role in the underlying patho-anatomy and pathophysiology of this area.

• We believe our findings likely have significant clinical implications for the reparative potential of this region, and therefore the surgical procedures currently described to accomplish anatomic plantar plate repair.

• Nano-CT is viable tool for analysis of human soft tissue micro-vasculature.
References


