The Plantar Soft Tissues

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Objectives

1) Review normal plantar anatomy of the foot

2) Describe optimal technique for MR Imaging of the foot

3) Review the most common abnormalities affecting the plantar soft tissues

4) Infection
Anatomy - calcaneus
Supporting structures - longitudinal arch

- Plantar fascia
- Long and short plantar ligaments
- Spring ligament
- Tibialis posterior tendon
- Peroneus longus tendon
Anatomy - plantar fascia
Plantar fascia
Anatomy – plantar ligaments
MRI Technique

- Extremity surface coil
- Small FOV (12 cm)
- Slight plantar flexion
- T1 sequence in 1 plane
- Fluid sensitive sequence in all 3 planes
Plantar fasciitis

- Inflammation of the plantar fascia and perifascial structures
- Undersurface heel pain with weight bearing
- Etiology
  - Mechanical: pes cavus, pronated foot
  - Degenerative: heel pad atrophy, increase in foot pronation
  - Systemic: RA, seronegatives
Plantar fasciitis

Heel Spur
**Plantar fasciitis**

- **MR Imaging**

<table>
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<tr>
<th>T1 weighted</th>
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<tbody>
<tr>
<td>Thickened plantar aponeurosis</td>
<td>Edema in PA, calcaneus, and surrounding soft tissues</td>
<td>Enhancement usually present</td>
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</table>
Plantar fasciitis

- 53 y.o. man with heel pain
Plantar fasciitis

- 40 y.o. man with heel pain
Plantar fasciitis
Plantar fasciitis

- **Treatment**
- **Conservative:** Most often successful (rest, stretching & strengthening, orthotics, anti-inflammatories)

- Local corticosteroid injections, ESWT

- **Surgery:** plantar fascial release, open or endoscopic
  - 50-80% of the plantar fascia transected medially
  - successful in 70-80% of pts.
Plantar fascia rupture

- Rare c/w plantar fasciitis
- Occur following corticosteroid injections
- Spontaneous much less common, usually athletes involved in running or jumping
- “snap” followed by intense localized pain
- Partial or complete
Plantar fascia rupture

- **MR Imaging**

- Gap in plantar fascia with edema/fraying of the torn ends

- Edema in adjacent plantar musculature

- Partial rupture may be difficult to distinguish from fasciitis on imaging. Clinical history helpful.
Plantar fascia rupture

Pitfall: prior plantar fascial release
Partial plantar fascia rupture

- 22 y.o. professional basketball player
Plantar fascia rupture
Plantar fascia rupture

- **Treatment**
- **Conservative:** rest, boot brace followed by stiff sole athletic shoe, physical therapy

- **Surgery:** plantar fascia release with resection of scar tissue, calcaneal osteotomy, lengthening of the lateral column of the foot
Plantar fibromatosis

- Originally described by Georg Ledderhose in 1897. “Ledderhose’s disease”

- **Non-neoplastic process** – fibrous proliferation and replacement of portions of the PA with abnormal fibrous tissue

- Typically involve the medial and central portions

- Solitary or multiple / unilateral or bilateral

- Possible association with Dupuytren’s contractures and Peyronie’s disease
Plantar fibromatosis

- Usually asymptomatic and discovered by palpation
- All ages, men > women
Plantar fibromatosis

**MR Imaging**

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<tr>
<td>low signal</td>
<td>low – intermediate (possible regions of high signal)</td>
<td>variable – ranges from none to marked 50% avid</td>
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<tr>
<td>usually &lt; 3 cm</td>
<td></td>
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Plantar fibromatosis

- 18 y.o. man with plantar mass
Plantar fibromatosis

- 27 y.o. man with swelling on sole of foot
Plantar fibromatosis

- 27 y.o. man with palpable foot nodules
Plantar fibromatosis

PDfs
Plantar fibromatosis
Plantar fibromatosis

- 56 y.o. man with tender mass in arch of foot for 6 mo.
Plantar fibromatosis
Plantar fibromatosis
Plantar fibromatosis
Plantar fibromatosis
Plantar fibromatosis
Plantar fibromatosis
Plantar fibromatosis

- 45 y.o. woman with pain and focal pea-sized bump on bottom of foot
Plantar fibromatosis

- **Treatment**
- **Conservative**: orthopedic footwear

- **Surgery**: local excision
  - high rate of post-surgical recurrence
  - adjunctive XRT sometimes used to prevent local recurrence
Is this a plantar fibroma?
Plantar fascia xanthoma

- Usually bilateral and symmetric

- Dorsum of hands > Achilles > Plantar fascia

- Focal aponeurotic enlargement with heterogeneous signal intensity
Halifax, Nova Scotia, Canada
Morton’s neuroma

- Originally described by Thomas Morton in 1876

- **Non-neoplastic lesion** - Perineural fibrosis involving and entrapping a plantar digital nerve

- May be common in asymptomatic patients

- Clinically manifests as forefoot pain, exacerbated with walking

- 80% women, commonly young & middle-aged
Morton’s neuroma

- Typically 3rd IMT space
- May be associated with IMT bursal fluid
Morton’s neuroma

- **MR Imaging**

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<td>variable, usually low may not be visible</td>
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*best sequence

* Prone imaging may be more sensitive
Morton’s neuroma

- 59 y.o. woman with plantar foot pain
Morton’s neuroma
Morton’s neuroma

- Forefoot pain
Morton’s neuroma

- Small amount of bursal fluid in the first 3 IMT spaces is present in 67% of individuals

- Larger amount (> 3 mm) is suggestive of an associated Morton’s neuroma
Morton’s neuroma
Morton’s neuroma

- **Treatment**
- **Conservative**: footwear modification, neuroma pads
- Steroid injection, ultrasound therapy
- **Surgery**: release of the IMT ligament for decompression, surgical resection of the neuroma with the involved nerve segment
Heel pad abnormalities

- Heel pain may arise from the fat pad itself
- Composed of columns of adipose tissue separated by fibrous septae. Serves as shock absorbing layer.
- Abnormalities:
  - rheumatoid nodules
  - heel pad inflammation
  - gout
  - peripheral nerve sheath tumours
Rheumatoid nodules

- Affect 20-30% of patients with RA, rarely affect seronegative pts.

- Occur in areas subjected to repetitive minor trauma – areas overlying osseous prominences

- May be painful

- May break down and get infected
Rheumatoid nodules

- **MR Imaging**

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<td>Isointense to muscle</td>
<td>Intermediate to high signal</td>
<td>Variable - homogeneous, heterogeneous, peripheral</td>
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Rheumatoid nodules

- 70 y.o. man with longstanding RA
Rheumatoid nodules

- 45 y.o. woman with RA and heel swelling
Heel pad inflammation

- Affects young pts as a result of sports injuries, obese elderly pts, truck drivers with stiff clutch pedals

- MRI: Edematous changes in the fat pad

- **Treatment** - conservative
Schwannoma

T1

T1 post
Hemangioma

• RARE in the plantar soft tissues, usually cavernous

• Can arise from many different tissues
  - skin, subcutaneous tissue, muscle, synovium
Hemangioma

- **MR Imaging**

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<td>low to intermediate variable amounts of high signal fat</td>
<td>high signal septations due to vascular channels or fibrous septae</td>
<td>marked</td>
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<td>50% have phleboliths</td>
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- 50% have phleboliths
- Fluid sensitive
- Post Gad marked
Hemangioma

- 6 y.o. boy with severe pain in the lateral aspect of his foot, exacerbated by wearing shoes.
Hemangioma

- 33 y.o. female with foot mass
Hemangioma

• **Treatment**

• Surgical resection, embolization, laser, XRT

• Biopsy usually non-diagnostic and can result in excess bleeding
Malignancies of the Plantar Soft Tissues

- RARE but they do occur

- Sarcomas – synovial sarcoma, dermatofibrosarcoma

- Synovial sarcomas
  - can remain quiescent for long periods of time
  - can be relatively small
  - can have well-defined margins and homogeneous appearance
Synovial sarcoma

- 29 y.o. woman with a 10 year hx of foot pain and treatment of plantar fasciitis without relief
TRIVIA

• What native of Halifax was nominated for Best Actress at the 2008 Oscars?

Ellen Page
“Juno”
• Plantar ligament abnormalities
• 29 y.o. man with chronic ankle pain X 4 y
Anatomy Review
Spring ligament tears

- Typically a chronic degenerative process that occurs with TPT insufficiency

- The larger superomedial component is the greater contributor to hindfoot stability

- MR findings
  - abN calibre of the spring ligament
  - increased signal on fluid sensitive sequences
  - full thickness gap or wavy appearance
  - abN TPT

- Tear of the spring ligament warrants surgical repair
Spring ligament tear
Take Home Points

• When performing MRI of the foot, use a small FOV centered over the region of interest with a skin marker.

• Reactive non-tumoral lesions are the most common abnormalities.

• Malignant tumours are very rare but they do occur - Synovial sarcomas can remain quiescent for long periods of time and can have a non-aggressive appearance.

• Evaluate the plantar ligaments.
References


- Disorders of the Plantar Aponeurosis – A Spectrum of MR Imaging Findings. DJ Theodorou, SJ Theodorou, S Farooki, Y Kakitsubata, D Resnick. AJR 2001; 176:97-104


