

Ultrasound Evaluation of the Forefoot

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Disclosures

- Consultant: Bioclinica
- Book Royalties: Elsevier
- Not relevant to this lecture

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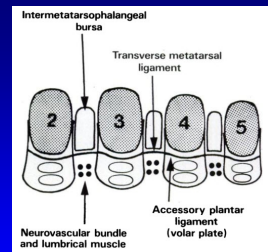
Outline

- Interdigital neuroma
- Plantar plate
- Fracture
- Infection and Inflammation
- Tumors and Tumor-like Abnormalities

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Anatomy

- At level of metatarsal heads:
 - Transverse metatarsal ligament
 - Attaches to plantar plates
 - Intermetatarsal bursa: dorsal
 - Neurovascular bundle: plantar



Zanetti M et al. Radiology 2014; 203:516

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Interdigital Neuroma

- Common plantar digital nerve entrapment
- Edema, fibrosis, necrosis
- 3rd intermetatarsal space > 2nd
- Sharp, burning pain to toes
- Females: pliable foot, high-heeled, narrow-toed shoes
- Asymptomatic neuromas in up to 33%
- Neuromas < 5 mm mediolateral: often asymptomatic



Zanetti M et al. Radiology 1997; 203:516

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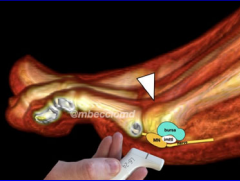
Neuromas: eponyms

- Medial to first metatarsal: Joplin
- 1st webspace: Heuter
- 2nd webspace: Hauser
- 3rd webspace: **Morton**
- 4th webspace: Iselin

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Interdigital Neuroma

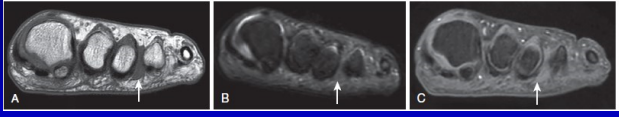
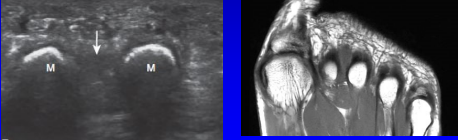
- Pathophysiology:
 - Neuroma forms where common plantar digital nerve passes distal around transverse metatarsal ligament at distal metatarsal heads
 - Note: intermetatarsal bursa is more dorsal and more proximal at level of transverse metatarsal ligament



From: youtube @mbecciomd

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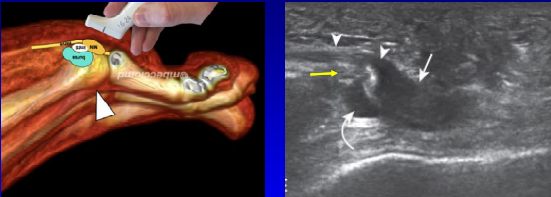
Interdigital Neuroma

Note: location of neuroma located plantar extending beyond metatarsal heads

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Interdigital Neuroma




Note: neuroma is at distal edge of transverse metatarsal ligament
 White arrow: neuroma
 Arrowheads: common plantar digital nerve
 Curved arrow: intermetatarsal bursa
 Yellow arrow: transverse metatarsal ligament

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Ultrasound Evaluation

- #1: plantar, short axis
 - With dorsal compression
- #2: plantar, long axis
 - With dorsal compression
- #3: Mulder maneuver
 - With side-to-side compression

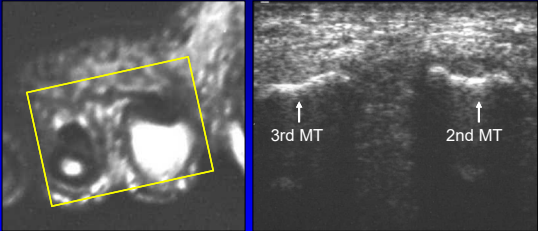


*Neuroma of 5 mm or larger: 100% sensitivity, 83% specificity

Redd et al. Radiology 1989; 171:415
 Quinn et al. AJR 2000; 174:1723

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Interdigital Space: normal

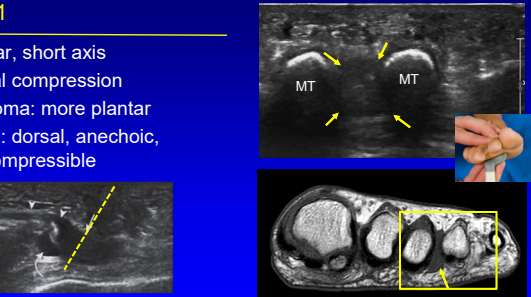


Short Axis to Metatarsals

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Step #1

- Plantar, short axis
- Dorsal compression
- Neuroma: more plantar
- Bursa: dorsal, anechoic, compressible

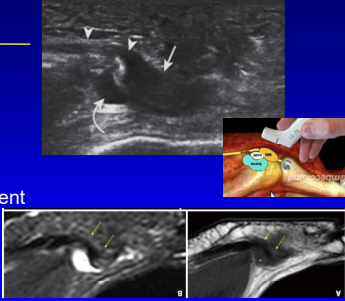


Note: coronal-oblique plane moving distal to metatarsal heads

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Step #2

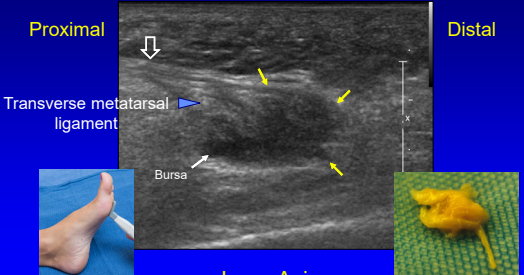
- Plantar, long axis
 - Follow MT head curvature
- Dorsal compression
 - Move finger distal, proximal
 - See neuroma sliding over transverse metatarsal ligament
- Neuroma: plantar, distal
- Bursa: curved arrow
 - Dorsal, proximal
 - Anechoic, compressible



MRI flipped upside down to simulate US

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Neuroma: nerve continuity (white open arrow)



Proximal Distal

Transverse metatarsal ligament

Bursa

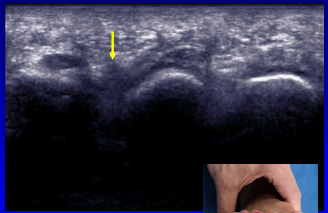

Long Axis

Courtesy of Mark Murphey, MD

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Step #3: Mulder's maneuver

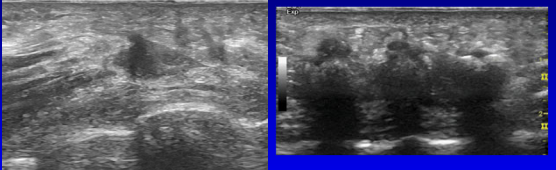
- Transducer: plantar, short axis
- Squeeze foot side-to-side
- Neuroma moves plantar
 - Palpable click, elicits symptoms
 - Important to document
 - Improved accuracy, measurements
- Make sure to perform distal to intermetatarsal ligament
- Bursa: remains dorsal

Torriani M et al. AJR 2003; 180:1121

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Dynamic: Interdigital Neuroma + Bursa

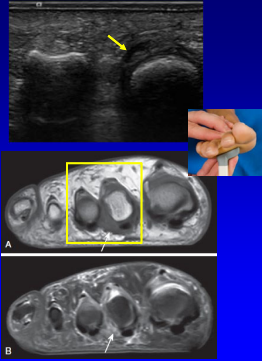


Dorsal Mulder's Maneuver

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Differential Diagnosis

- Pericapsular fibrosis
- Associated with capsule injury
- Hypoechoic
- Eccentric
- Not truly intermetatarsal
- Negative Mulder's maneuver



Umans H et al. Skeletal Radiol 2014

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Outline

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Plantar Plate Injury

- US: hypoechoic defect
- At proximal phalanx
- Partial tear: articular surface
- Full-thickness tear: complete detachment
- May be asymptomatic finding in 47% (MTP 2 – 4)

*From: Gregg JM et al. AJR 2006; 186:984
Gregg JM et al. Eur Radiol 2006; 16:2661*

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Plantar Plate Injury and Pericapsular Fibrosis

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Outline

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Fracture

- Stress fracture:
 - Insufficiency: normal stress, abnormal bone
 - Fatigue: abnormal stress, normal bone
- Acute fracture
- Point tenderness
- Ultrasound:
 - Periostitis and soft tissue hypoechoogenicity
 - Cortical step-off deformity
 - Irregular callus

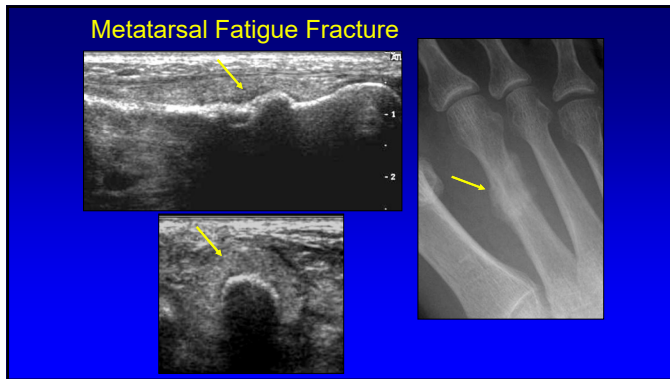
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Metatarsal Fatigue Fracture

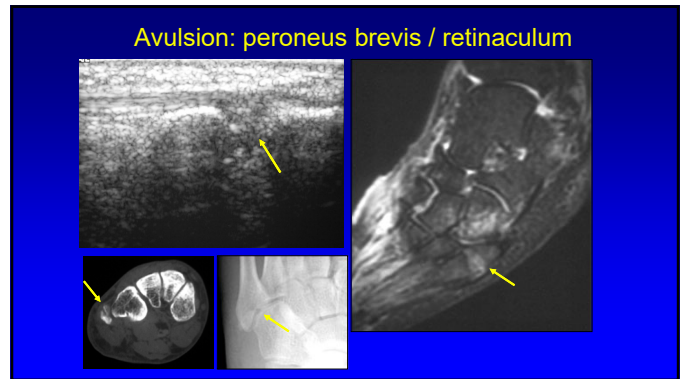
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Metatarsal Fatigue Fracture

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Syllabus

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Infection: predicted by route

- Direct spread:
 - Ulceration (diabetic), penetrating injury
 - Osteomyelitis, tenosynovitis
- Hematogenous spread:
 - Septic joint, osteomyelitis
 - Children, intravenous drug users

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Cellulitis: acute

- Thickened and hyperechoic subcutaneous fat
- Skin erythema

J Ultrasound Med 2000; 19:743

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Cellulitis: chronic

- Anechoic channels
- Distended lymphatics
- May appear similar to simple edema
- Not defined like an abscess
- Lower leg: look for popliteal cyst rupture

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Abscess: forefoot

Sagittal T1w

Coronal post-gado

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Septic Joint

- Anechoic or hypoechoic distention of joint recesses
- May be hyperechoic if complicated
 - Possible synovitis
- US or color Doppler cannot distinguish between septic and aseptic effusion*

*Strouse et al. Radiology 1998; 206:731

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5th Metatarsal Phalangeal Joint: septic

Sagittal

Coronal

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Osteomyelitis: 5th metatarsal

Coronal

Sagittal T1w

Coronal

Sagittal T2w

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Rheumatoid Arthritis

- 5th metatarsal head
 - Most common site for involvement in foot
- Supplement dorsal evaluation with lateral and plantar view

Sagittal: dorsal

Transverse

Sagittal: plantar lateral

Inanc N et al. US Bio Med 2016; 42:865

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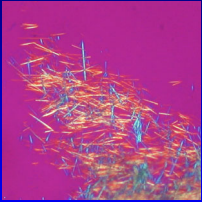
Gout:

- Monosodium urate crystals:
 - Negative birefringence
- Stages:
 - Asymptomatic hyperuricemia
 - Acute gouty arthritis
 - Interval asymptomatic phase
 - Chronic tophaceous gout

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Gout

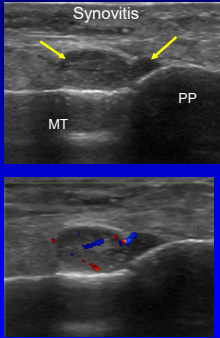
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Gout

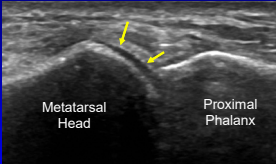
- Joint effusion / synovial hypertrophy
- Double contour sign:
 - Monosodium urate crystal icing on cartilage
- Tophi:
 - Hyperechoic with hypoechoic rim
- Erosions:
 - Adjacent to tophi
 - Medial 1st metatarsal head



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Gout

- Double contour sign:
 - Hyperechoic foci on surface of hyaline cartilage
 - Does not demonstrate anisotropy
 - Unlike normal cartilage interface
 - Disappears with serum urate < 6 ml/dl

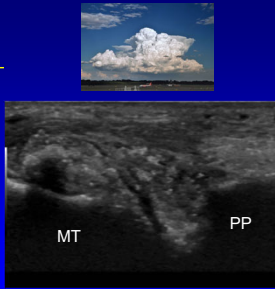


Thiele RG, Rheumatol Int 2010; 30:495

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Tophi

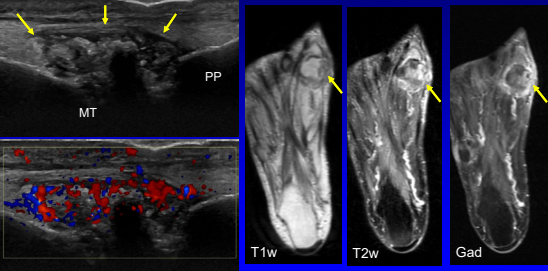
- Hyperechoic heterogeneous with hypoechoic rim
- Tiny internal speckles*
- “wet clump of sugar” appearance
- Variable shadowing: even without calcification



Fernandes et al. Skeletal Radiol 2011; 40:309

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Gout: tophus



1st Metatarsophalangeal Joint

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- **Tumors and Tumor-like Abnormalities**

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Ganglion Cyst

- Multilocular
- Hypochoic
- Non-compressible
- Joint or tendon sheath communication

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Plantar Fibromatosis

- Benign fibrous proliferation
- Multiple: 33%, bilateral: 20 – 50%
- Hypochoic mass or masses
- Plantar aponeurosis
- Variable vascularity
- "Comb" sign

Cohen BE et al. J Ultrasound Med 2018; 2725
Griffith JF et al. AJR 2002; 179:1167

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Plantar Fibroma

Coronal T1w

Coronal

Sagittal

Coronal T2w

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Plantar Fibromatosis

Sagittal

Coronal

Coronal

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Plantar Fibromatosis

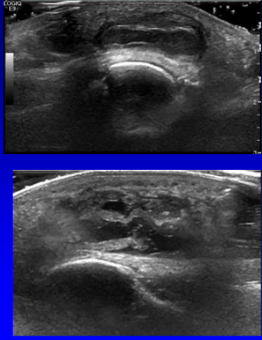
Sagittal

Sagittal T2w

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Adventitious Bursa

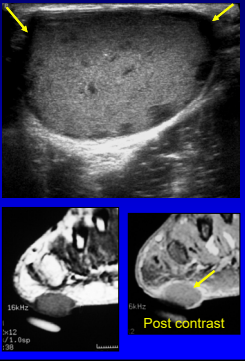
- Heterogenous
- Predominantly hypoechoic
- Variable surrounding hyperemia
- Plantar to distal metatarsals or at heel
- **Compressible**



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Epidermal Inclusion Cyst

- Etiology: implantation of epithelium, congenital, squamous metaplasia, hair follicle obstruction
- US findings:
 - Low level echoes and hypoechoic halo
 - Through transmission
 - **Hypoechoic clefts**
 - Periscope sign: extension to skin

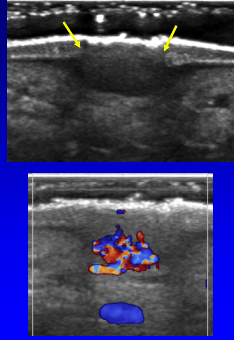


Kim et al. Skeletal Radiol 2011; 40:1415

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Plantar Wart


- Fusiform, hypoechoic
- Epidermis and dermis
- Inward growth: subcutaneous
- Focal intense dermal arterial flow in 77%




Wortsman X JUM 2009; 28:787

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Thank you!



NYC Ann Arbor San Diego

Syllabus → 

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