Sonographic Evaluation of Morton's Neuroma Prior To and Following Laser Therapy

David Melville, Matthew Del Giudice, Darin Bocian, Lana Gimber, Elizabeth Krupinski, Mihra S. Taljanovic

University of Arizona College of Medicine
Department of Medical Imaging

Disclosures

None

Introduction

- Morton's Neuroma
  - Non-neoplastic enlargement of common plantar digital nerve due to perineural fibrosis, edema, vascular proliferation, & axonal degeneration (neuropathy)
  - Common cause of metatarsalgia, results from entrapment (transverse intermetatarsal ligament) or repetitive trauma
  - According to literature, occurs most commonly in 3rd followed by 2nd intermetatarsal (IM) spaces at the level of the metatarsal heads
  - May be multiple & bilateral
- Diagnosis
  - MRI and US principal imaging methods
  - Most helpful in cases of unclear clinical examination & concern for multiple lesions

Introduction – Treatment

- Lesions > 5 mm more likely to be symptomatic
- Lesions > 20 mm, consider alternative dx.
- First Line, Conservative Management:
  - Wide shoe with firm sole & metatarsal pad
  - Steroid Injection
- Second Line, Intervention:
  - Neurectomy (20-30% with recurrent sxs.)
  - Percutaneous osteotomy & ligament release
  - US-guided cryoneurolysis or alcohol injection
  - Laser therapy (allows non-invasive targeting of smaller lesions)

Introduction – Laser Therapy

High Intensity Laser Therapy (HILT) –

- Employs an ND:YAG laser causing minor & slow light absorption by chromophores, noninvasively delivers radiation to deep tissue
- Laser-tissue interactions: photochemical, photothermal & photomechanical/photoionizing
- No universally accepted theory explaining therapeutic effect, but suggested mechanisms include:
  - ↓ specific inflammatory markers, oxidative stress, muscle fatigue
  - Neural blockade (reduced axonal flow)

Introduction – Laser Therapy

High Intensity Laser Therapy (HILT) –

- Used in a variety of musculoskeletal disorders:
  - Adhesive capsulitis, subacromial impingement syndrome
  - Chronic low back pain, cervical myofascial pain syndrome
  - Knee osteoarthritis
  - Relief often short term (8-12 weeks), allowing completion of physical therapy regimen
- Local practice applications include painful plantar fibromatosis & Morton's neuroma

Introduction

- In our experience, US is effective in diagnosing Morton's neuroma
- However, the US appearance of Morton's neuroma following HILT is not established in the literature with respect to:
  - Size
  - Shape & Borders
  - Echogenicity
  - Vascularity

HILT for 2nd intermetarsal space Morton's neuroma

Purpose

- The purpose of the study was to:
  - Retrospectively assess for differences in sonographic appearances of Morton's neuromas prior to and following HILT

  - Correlate US findings with MRI when available

Materials and Methods

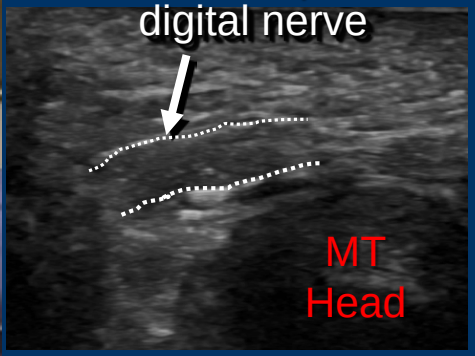
- IRB Approval
- Review of US case logs for examinations assessing for Morton's neuroma

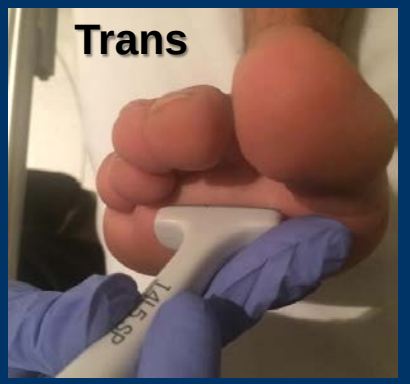
- Identified patients who underwent US for Morton's neuroma prior to HILT (n=42)

- Final study group: patients undergoing US evaluation & HILT (n=21)

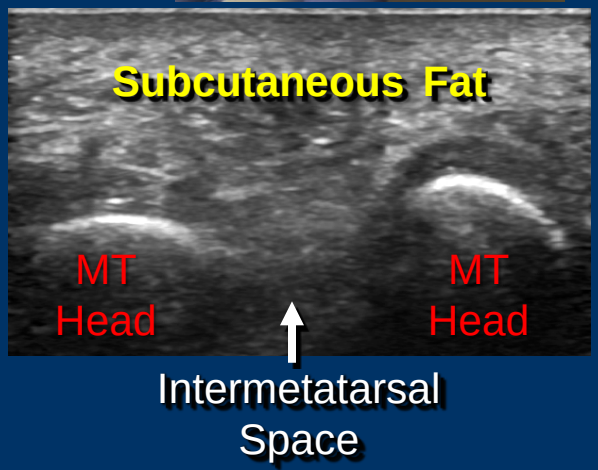
Technique

- Patient supine with plantar surface of foot exposed
- Transducer:
  - Sagittal – plantar digital nerve
  - Transverse – center between metatarsal (MT) heads
  - Small footprint probe helpful



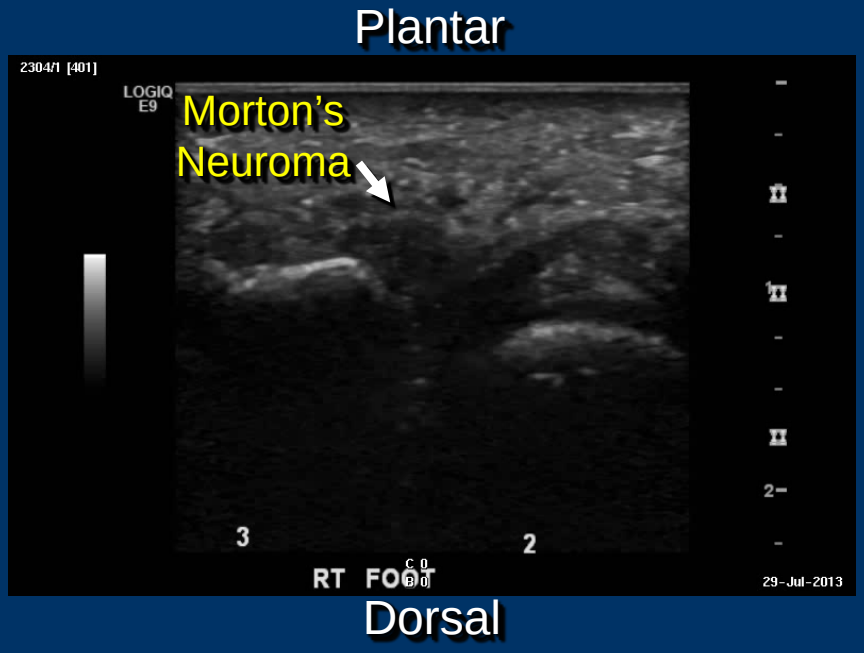


- Normal Intermetatarsal Space:
  - May be slightly hypoechoic relative to subcutaneous fat
  - No mass or focal bursal fluid



Technique

- Dynamic imaging – assess for compressibility, distinguish between bursa & mass
- Mulder's Sign
  - Application of opposed medial and lateral stress to compress metatarsal heads
  - Results in plantar displacement of Morton's neuroma with palpable click



Materials and Methods

- Retrospective review of US images of Morton's neuromas (n=31) prior to & following HILT
  - 2 musculoskeletal radiologists (consensus):
    - 3 & 17 years of experience
  - Variables assessed:
    - Presence of IM space soft tissue lesion
    - Lesion characteristics prior to and following therapy
      - IM space, size, shape, echogenicity, borders, Doppler signal
      - Presence of Mulder sign, pain with transducer pressure and associated IM bursa
    - Lesion visibility on US versus MRI (when available)

Results

- 42 patients underwent forefoot US over approximately 2 years

- 21 patients subsequently underwent HILT following US diagnosis of Morton's neuroma
  - 24 feet (Left = 13, Right = 11)
  - 31 total treated Morton's neuromas

Results

- Study Group:
  - 19% men (4/21), 81% women (17/21)
  - Age: 62.5 years (29-85)
  - 38% right foot (8/21), 48% left (10/21), 14% bilateral (3/21)

- Treated Lesions
  - Location: 2nd IM space, 77% (24/31); 3rd IM space, 23% (7/31)
  - Average pre-treatment size: 4.1 mm

Results – Pre-treatment

- US appearance of IM lesion:
  - Pain with transducer pressure: 97% (30/31)
  - Heterogeneously hypoechoic: 100%
  - Shape: fusiform, 97%; round, 3%
  - Borders: well-defined, 87%; ill-defined, 13%
  - Doppler: 0%
  - Positive Mulder sign: 3% (1/31)
  - Associated bursa: Yes, 10%; No, 90%

Results – Post-treatment

- US appearance of treated lesion:
  - Pain: None, 81%; Mild, 13%; Present, 6%
  - Visible: Yes, 94%; No, 6%
  - Size: Decreased, 55%; Same, 45%
  - Heterogeneously hypoechoic: 100%
  - Shape: fusiform, 74%; round, 26%
  - Borders: well-defined, 26%; ill-defined, 74%
  - Associated bursa or Mulder sign: 0%

Results – Statistical Analysis

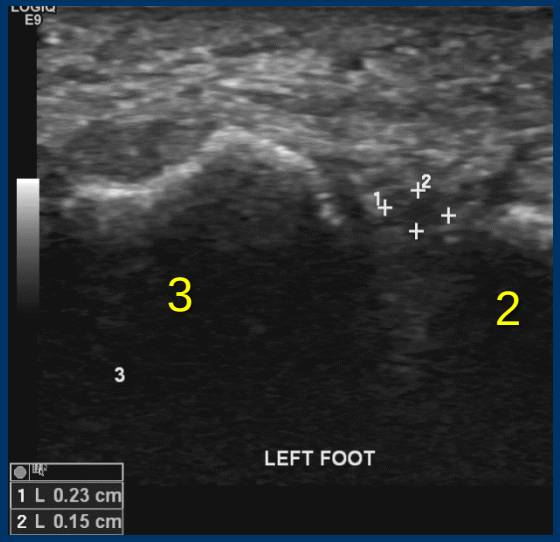
- Pain ($p < 0.0001$, $X^2 = 50.66$):
  - Pre-tx: present → Post-tx: absent/mild
- Borders ($p < 0.0001$, $X^2 = 24.089$):
  - Pre-tx: well-defined → Post-tx: ill-defined
- Bursa ($p < 0.05$, $X^2 = 5.16$)
  - Resolution following treatment
- Shape ($p < 0.05$, $X^2 = 4.30$)
  - Pre-tx: fusiform → Post-tx: round
- No significant change in size, echogenicity, echotexture or Mulder's sign

Results – US vs. MRI

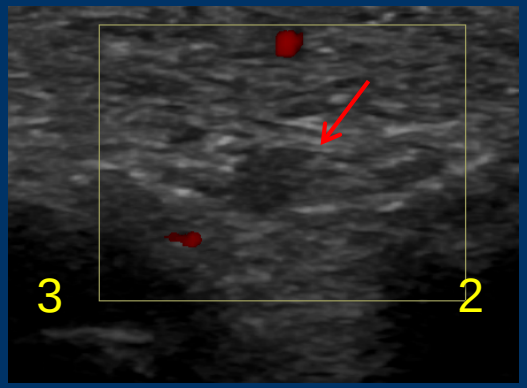
- Pre-treatment MRI = 17
  - Better visualized on US: 100%
- Post-treatment MRI = 3
  - Better visualized on US: 100%
- No lesions identified on MRI were undetected using US

Discussion

- Pre-Tx. US Appearance:
  - Majority similar to literature: well-defined, hypoechoic lesion measuring less than 5 mm in continuity with digital plantar nerve, resulting in fusiform appearance
  - Size of Morton's neuromas may have contributed to absence of Mulder sign
  - No Doppler signal, which is expected; however, some "acute" painful neuromas have been reported to show internal vascularity representing perineural inflammation



Small, well-defined, hypoechoic lesion in 2nd IM space

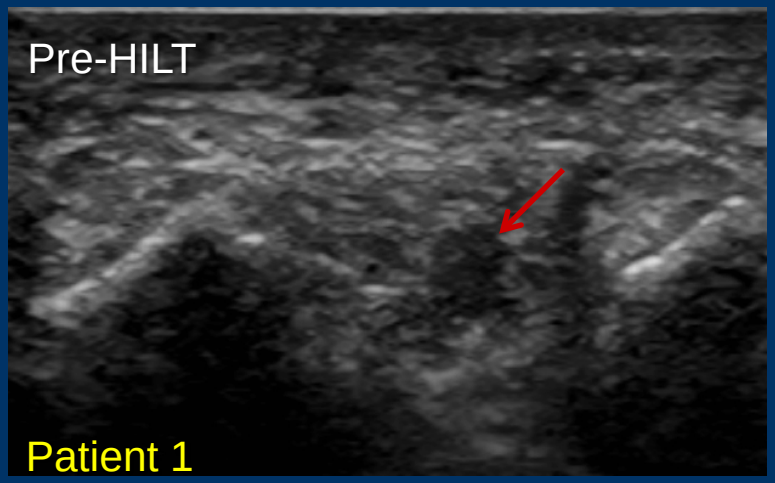


Morton's neuroma without internal Power Doppler Signal

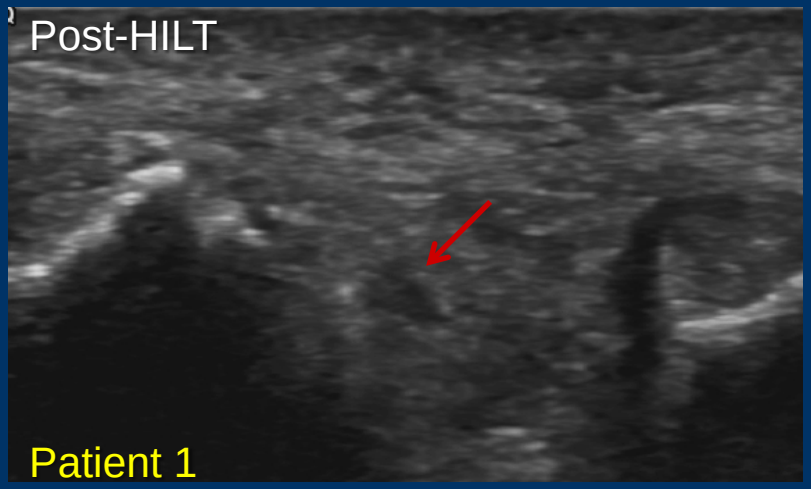
Discussion

- Morton's Neuroma following laser therapy:
  - Absent/improved pain & ill-defined borders, are most significant post-HILT findings
    - Indistinct borders may be partly related to change in adjacent intermetarsal fat
  - Resolution of IM bursa also seen following laser treatment, when uncommonly present
  - Aside from shape, laser therapy does not result in additional significant changes in size or other imaging appearances

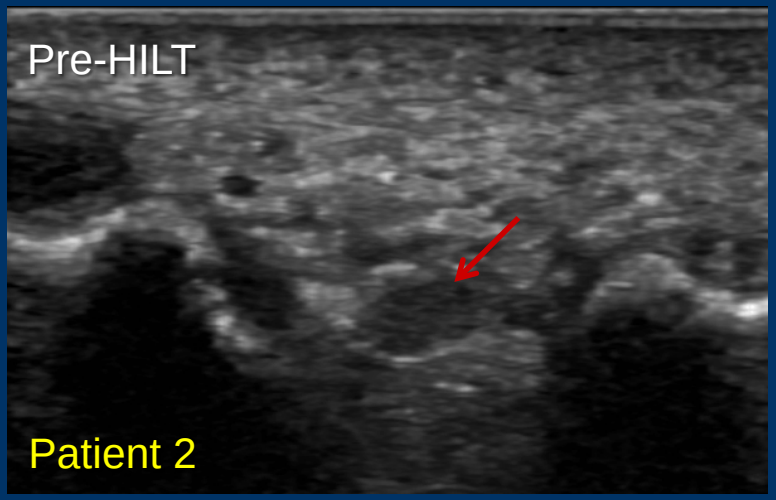
Treated Morton's Neuroma



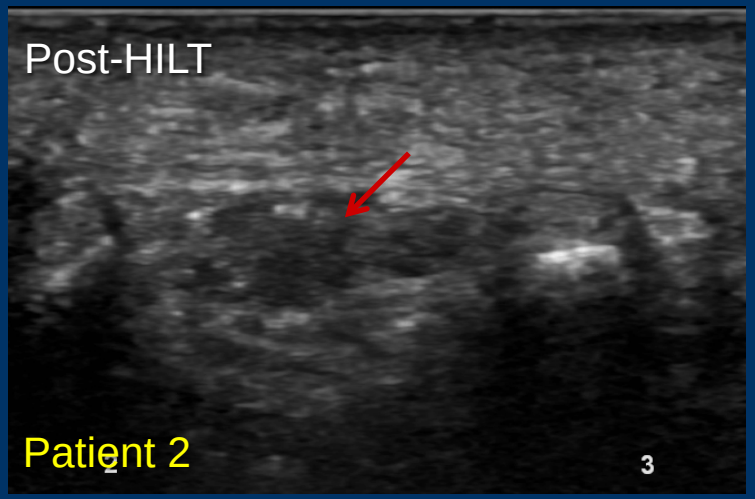
Round, hypoechoic IM lesion with well-defined borders



Round, hypoechoic IM lesion with less distinct borders & size decrease



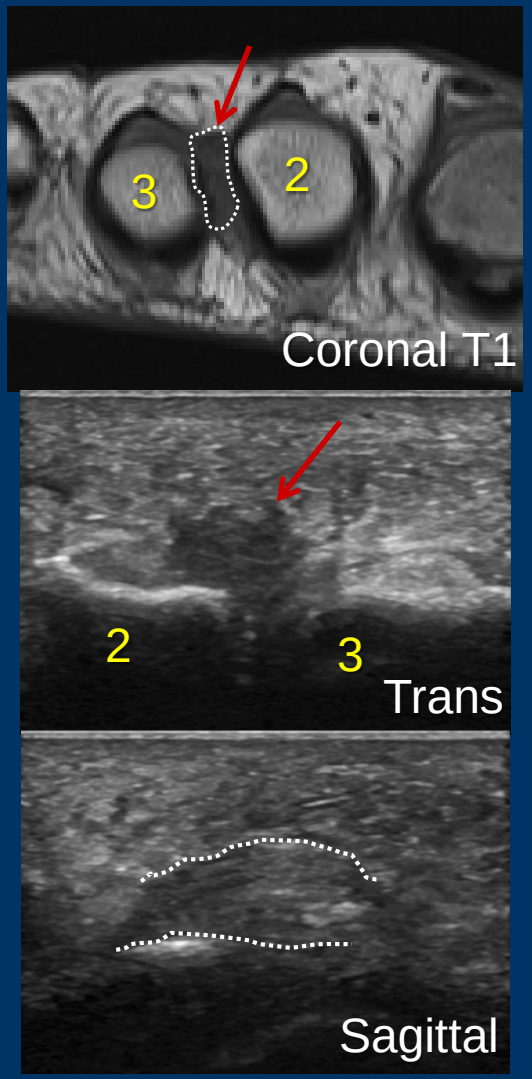
Round, hypoechoic IM lesion with well-defined borders



Round, hypoechoic IM lesion with stable size & lesion margins blended with IM fat

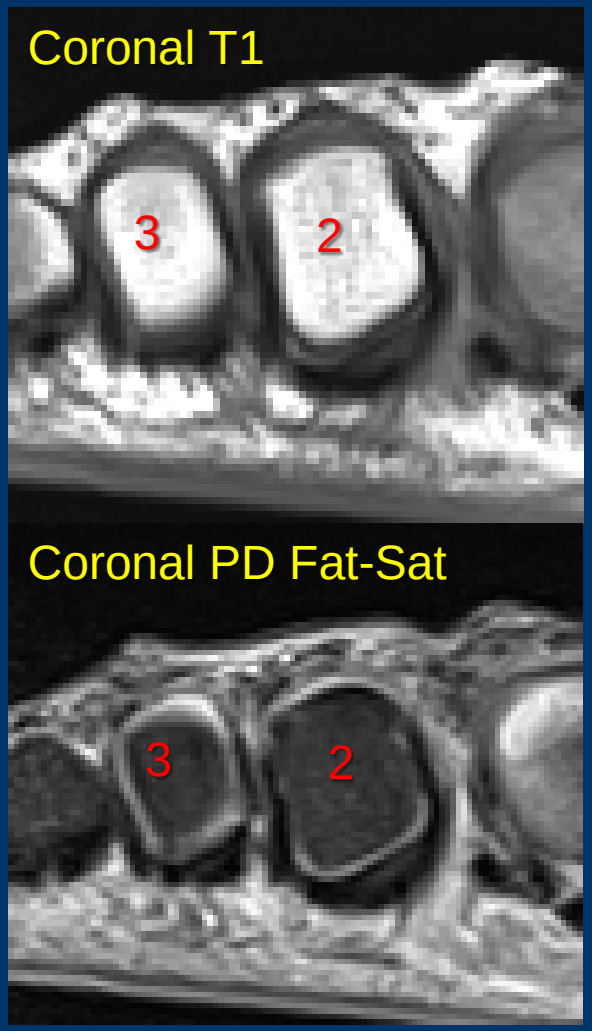
Discussion

- US compared to MRI:
  - Both techniques used for diagnosis
  - Consensus review determined that all Morton's neuromas were better visualized on US compared to MRI
  - Bignotti et al. (2015): US sensitivity & accuracy in diagnosing Morton's neuroma equal to MRI
  - Bencardino et al. (2000): MR diagnosis does not imply symptoms
  - US offers more cost-effective method for pre-treament diagnosis, as well as symptom confirmation



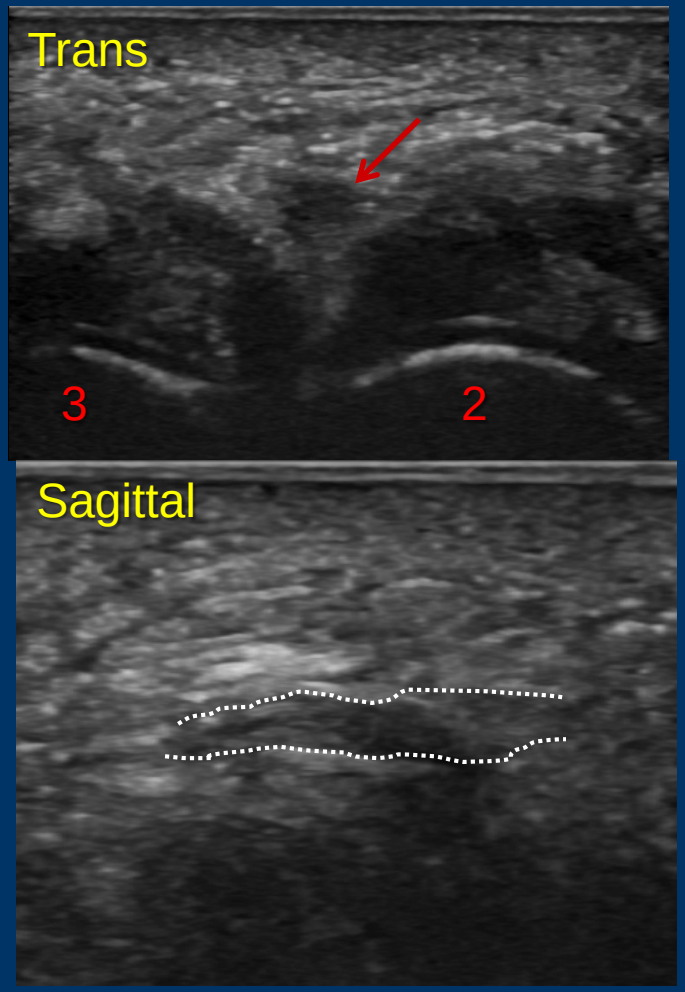
MRI Occult Morton's Neuroma

MRI



Pain at 2nd IM space without apparent Morton's neuroma

US



Subsequent US reveals MRI occult Morton's neuroma, measuring up to 3 mm

Discussion

- Morton's Neuroma Location:
  - Literature reports 3rd intermetarsal space most common location
  - Our study demonstrated significantly more 2nd intermetatarsal space Morton's neuroma than 3rd ($p < 0.0001$, $X^2 = 25.90$)
  - When multiple, not all identified neuromas were found to be symptomatic or require HILT

Limitations

- Retrospective review
- Limited number of cases (<50)
- No pathologic correlation
- Inter-observer/intra-observer US variability

Conclusions

- Majority of treated symptomatic lesions measured less than 5 mm in size
- US useful in the pre-treatment diagnosis of Morton's neuroma with better visualization of these smaller lesions compared to MRI
- Most significant imaging difference following HILT was ill-defined lesion borders
- Pain with transducer pressure was present in nearly all pre-HILT lesions with significant improvement following therapy stressing importance of clinical examination

Thank You

Key References

- Abreu et al. Peripheral tumor and tumor-like neurogenic lesions. European Journal of Radiology. 2013; 82: 38-50.
- Bencardino et al. Morton's Neuroma: is it always symptomatic. AJR. 2000; 175: 649-653.
- Bignotti et al. Ultrasound versus magnetic resonance imaging for Morton neuroma: systematic review and meta-analysis. European Radiology. 2015; 25: 2254-62.
- Friedman et al. Sonographically Guided Cryoneurolysis. JUM. 2012; 31: 2025-34.
- Hughes et al. Treatment of Morton's Neuroma with alcohol injection under sonographic guidance: follow-up of 101 cases. AJR; 188: 1535-1539.
- Kim et al. Short-term effects of high-intensity laser therapy on frozen shoulder: a prospective randomized control study. Manual Therapy. 2015; Epub ahead of print.
- Pastides et al. Morton's neuroma: a clinical versus radiological diagnosis. Foot & Ankle Surgery. 2012; 18: 22-24.
- Quinn et al. Sonography of Morton's Neuromas. AJR. 2000; 174: 1723-8.
- Zanetti et al. Morton Neuroma: Effect of MR imaging findings on diagnostic thinking and therapeutic decisions. Radiology; 213: 583-8.
- Zanetti et al. MR imaging of the forefoot: Morton Neuroma and differential diagnosis. Seminars in Musculoskeletal Radiology. 2005; 9(3): 175-86.

Contact

- Darin Alan Bocian, DPM, FACFAS
  - bociandpm@comcast.net
  - bociandpm.com