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

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Disclosures

None
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 sxss.)
  – Percutaneous osteotomy & ligament release
  – US-guided cryoneurolysis or alcohol injection
  – Laser therapy (allows non-invasive targeting of smaller lesions)
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
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
• 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: 2\textsuperscript{nd} IM space, 77% (24/31); 3\textsuperscript{rd} 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** \( (p < 0.0001, \chi^2 = 50.66) \):
  – Pre-tx: present → Post-tx: absent/mild

• **Borders** \( (p < 0.0001, \chi^2 = 24.089) \):
  – Pre-tx: well-defined → Post-tx: ill-defined

• **Bursa** \( (p < 0.05, \chi^2 = 5.16) \)
  – Resolution following treatment

• **Shape** \( (p < 0.05, \chi^2 = 4.30) \)
  – 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
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 intermetatarsal 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

- **Pre-HILT**
  - Patient 1
  - Round, hypoechoic IM lesion with well-defined borders

- **Post-HILT**
  - Patient 1
  - Round, hypoechoic IM lesion with less distinct borders & size decrease

- **Pre-HILT**
  - Patient 2
  - Round, hypoechoic IM lesion with well-defined borders

- **Post-HILT**
  - Patient 2
  - 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-treatment diagnosis, as well as symptom confirmation
MRI Occult Morton’s Neuroma

MRI

Coronal T1

Coronal PD Fat-Sat

Pain at 2\textsuperscript{nd} IM space without apparent Morton’s neuroma

US

Trans

Sagittal

Subsequent US reveals MRI occult Morton’s neuroma, measuring up to 3 mm
• **Morton’s Neuroma Location:**

  – Literature reports 3rd intermetatarsal 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
Key References

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