Απεικονιστική διερεύνηση διαβητικού ποδιού

Γ. Αρσος, Γ΄ Εργ. Πυρηνικής Ιατρικής ΑΠΘ - ΓΝ "Παπαγεωργίου"
Amputations 2010

73,000 non-traumatic lower-limb amputations

60% of all non-traumatic lower-limb amputations: adults ≥ 20 years with DM

**Fast Facts on Diabetes**

- 29.1 million people or 9.3% of the U.S. population have diabetes.
  - **Diagnosed**: 21.0 million people
  - **Undiagnosed**: 8.1 million people

(27.8% of people with diabetes are undiagnosed).

**Estimated Diabetes Costs in the United States, 2012**

- **Total (Direct and Indirect)**: $245 billion
  - **Direct Medical Costs**: $176 billion
    - After adjusting for population age and sex differences, average medical expenditures among people with diagnosed diabetes were 2.3 times higher than people without diabetes.
  - **Indirect Costs**: $69 billion
    - (disability, work loss, premature death).

All ages, 2012
Complications of DM

no diabetic brain
no diabetic eye
no diabetic ear
no diabetic heart
no diabetic kidney
no diabetic penis

...but, THE diabetic foot!
"The foot of diabetic patients with:

- ulceration
- infection
- and/or destruction of the deep tissues

associated with:

- neurological abnormalities
- and various degrees of peripheral vascular disease in the lower limb"

WHO & International Working Group on the Diabetic Foot, 1999
“Every 30 seconds a lower limb is lost somewhere in the world as a consequence of diabetes.”

See Review page 1719
● ≈ 60-70% of DM patients: mild - severe diabetic neuropathy

● Rate of amputation for people with DM: X10 than for people without DM (NHS: X15)

● After an amputation: chance of another amputation within 3-5 yrs ≥ 50%
Relative five-year mortality (%)

Armstrong DG et al, Int Wound J 2007
Diabetic neuropathy

Charcot arthropathy → ULCER

Soft tissue infection

OSTEOMYELITIS

AMPUTATION

DM

angiopathy

difficult diagnosis

medical treatment
the diagnostic dilemas

DFU, diabetic foot ulcer; STI, soft tissue infection; OM, osteomyelitis; aCA, acute Charcot Arthropathy

DFU, diabetic foot ulcer; STI, soft tissue infection; OM, osteomyelitis; aCA, acute Charcot Arthropathy

treatment - duration
<table>
<thead>
<tr>
<th>Severity / Extent</th>
<th>Route</th>
<th>Setting</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOFT TISSUE ONLY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>Topical- P.O.</td>
<td>Outp</td>
<td>1-2 w</td>
</tr>
<tr>
<td>Moderate</td>
<td>I.V. → P.O.</td>
<td>Outp (Inp)</td>
<td>1-3 w</td>
</tr>
<tr>
<td>Severe</td>
<td>I.V. → P.O.</td>
<td>Inp → Outp</td>
<td>2-4 w</td>
</tr>
<tr>
<td><strong>BONE or JOINT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No residual infected tissue</td>
<td>I.V. → P.O.</td>
<td>Inp → Outp</td>
<td>2-5 d</td>
</tr>
<tr>
<td>Residual infected soft tissue (not bone)</td>
<td>I.V. / P.O.</td>
<td>Inp → Outp</td>
<td>1-3 w</td>
</tr>
<tr>
<td>Residual infected (but viable) bone</td>
<td>I.V. → P.O.</td>
<td>Inp → Outp</td>
<td>4-6 wk</td>
</tr>
<tr>
<td>No surgery / residual dead bone postop.</td>
<td>I.V. → P.O.</td>
<td>Inp → Outp</td>
<td>≥3 mo</td>
</tr>
</tbody>
</table>

*Lipsky AB et al, ISDA Guidelines 2012*
Ulcer-OM relationships in the DF

- in > 90% of OM cases: a pre-existing ulcer is the gate of infection
- pre-existing ulcer in 85% of DF amputations

Treating Foot Infections in Diabetic Patients: A Randomized, Multicenter, Open-Label Trial of Linezolid versus Ampicillin-Sulbactam/Amoxicillin-Clavulanate

- Ulcer: 4
- Soft Tissue Infection: 3
- Osteomyelitis: 1

<table>
<thead>
<tr>
<th>Condition</th>
<th>Linezolid</th>
<th>Ampic/Clav</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inf Ulc</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>STI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OM</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

Lipsky BA, Clin Inf Dis 2004
“General inspection

A careful inspection of the feet in a well-lit room should always be carried out after the patient has removed shoes and socks.”…

Boulton AJM et al, Diabetes Care 2008
Invited Review

Challenges in diagnosing infection in the diabetic foot

Table 1 Summary of potentially useful clinical findings in diagnosing diabetic foot infection

A. History
1. Long duration ( > 4 weeks) of foot wound
2. Previous infection at the same or a nearby site
3. Presence of new pain in the wound (especially in a previously insensate foot)
4. Presence of immunosuppressive condition (beyond that related to diabetes)

B. Physical examination
1. Large wound ( > 2 cm²)
2. Deep wound ( > 3 mm)
3. Classic signs of inflammation (tenderness, pain, redness, warmth, induration)
4. Secondary signs of infection (foul odour, friable or discoloured granulation tissue, rim undermining, purulent or non-purulent secretions)

clinical judgment (..η δε κρίσις χαλεπή..)

OM = 68.3%

41 foot ulcers (13 inflammed)

28 OM+

9 C+  19 (68%) C-

C, clinical suspicion

Unsuspected osteomyelitis in diabetic foot ulcers: Diagnosis and monitoring by leukocyte scanning with indium In-111 oxyquinoline

Newman LG et al, JAMA 1991
Probing to bone in infected pedal ulcers. A clinical sign of underlying osteomyelitis in diabetic patients

Grayson ML et al, JAMA 1995
Probe-to-Bone Test for Diagnosing Diabetic Foot Osteomyelitis
Lavery LA et al., *Diabetes Care* 2007

247 pts with foot wound / 151 pts with 199 foot infections

30 pts with OM  12% of those with a foot wound
20% of those with a foot infection

<table>
<thead>
<tr>
<th>Statistic</th>
<th>All wounds value (n = 247)</th>
<th>Infected wounds value (n = 150)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.87 (0.71–0.96)</td>
<td>0.87 (0.69–0.96)</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.91 (0.89–0.92)</td>
<td>0.87 (0.79–0.92)</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>0.57 (0.46–0.62)</td>
<td>0.62 (0.46–0.76)</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>0.98 (0.96–0.99)</td>
<td>0.92 (0.91–0.99)</td>
</tr>
<tr>
<td>Positive likelihood ratio</td>
<td>9.40 (6.05–14.61)</td>
<td>6.50 (4.03–10.48)</td>
</tr>
<tr>
<td>Negative likelihood ratio</td>
<td>6.81 (2.73–16.97)</td>
<td>6.50 (2.60–16.23)</td>
</tr>
</tbody>
</table>

OM = 10.9%
The Performance of Serum Inflammatory Markers for the Diagnosis and Follow-up of Patients With Osteomyelitis


OM = 44.3%

<table>
<thead>
<tr>
<th>Markers</th>
<th>Cutoff</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP</td>
<td>&gt;14 mg/L</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>ESR</td>
<td>&gt;67 mm/h</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>WBC</td>
<td>&gt;14 × 10⁹/L</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>PCT</td>
<td>&gt;0.30 ng/mL</td>
<td>0.8</td>
<td>0.7</td>
</tr>
</tbody>
</table>

bone biopsy: sensitivity 88-100% (7 studies)*

- histology
- culture
- sensitivity?
- no significant sequelae
  - 15g trocar
  - not contiguous to ulcer
- sampling error
- bone biopsy expertise
- significant peripheral vascular disease?

*Diagnosing pedal osteomyelitis: testing choices and their consequences
Mushlin AI et al., J Gen Int 1994
Needle Puncture and Transcutaneous Bone Biopsy Cultures Are Inconsistent in Patients with Diabetes and Suspected Osteomyelitis of the Foot.

Senneville E et al., *Clin Infect Dis* 2009
......room for imaging

RADIOLOGY

- Ro
- US
- CT
- MRI

NUCLEAR MEDICINE

- Bone scan: 99mTc-MDP
- Ga-67-citrate
- Tc-99m-IgG
- Tc-99m-ciprofloxacin
- In-111-WBC
- Tc-99m-HMPAO-WBC
- Tc-99m-Ab-WBC
- F-18-FDG (PET)

HYBRID TECHNIQUES: PET/CT, SPECT/CT
3 very good reasons for plain Rx in diabetic foot!
Early OM
- focal lucency
- loss of trabecular pattern
- cortical destruction

Late abnormalities
- periosteal reaction
- sclerosis
- new bone formation

Se ~ 60%  Sp ~ 80%
changes visible with demineralization of > 30–50% / 2–4 weeks
suboptimal for detecting soft tissue infection
dif. infection from co-existing neuro-osteoarthropathy ??

serial radiographs /2 weeks
changes characteristic of osteomyelitis over time

likelihood of OM very high or low
sufficient to confirm the clinical suspicion
Diagnosing diabetic foot osteomyelitis: is the combination of probe-to-bone test and plain radiography sufficient for high-risk inpatients?

J. Aragón-Sánchez, Benjamin A. Lipsky*† and J. L. Lázaro-Martínez‡


OM = 72.4%

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
<th>Negative predictive value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe-to-bone test</td>
<td>0.95 (0.89–0.96)</td>
<td>0.93 (0.86–0.97)</td>
<td>0.97 (0.95–0.99)</td>
<td>0.83 (0.72–0.94)</td>
</tr>
<tr>
<td>Plain X-ray</td>
<td>0.82 (0.77–0.87)</td>
<td>0.93 (0.86–0.97)</td>
<td>0.97 (0.95–0.99)</td>
<td>0.65 (0.47–0.83)</td>
</tr>
<tr>
<td>Combined*</td>
<td>0.97 (0.95–0.99)</td>
<td>0.92 (0.84–0.96)</td>
<td>0.97 (0.95–0.99)</td>
<td>0.93 (0.88–0.98)</td>
</tr>
</tbody>
</table>
### MRI findings

<table>
<thead>
<tr>
<th></th>
<th>MRI findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bone marrow signal change</td>
</tr>
<tr>
<td>2</td>
<td>Bone marrow oedema pattern</td>
</tr>
<tr>
<td>3</td>
<td>Distribution</td>
</tr>
<tr>
<td>4</td>
<td>Typical location</td>
</tr>
<tr>
<td>5</td>
<td>Deformity</td>
</tr>
<tr>
<td>6</td>
<td>Soft tissue changes</td>
</tr>
</tbody>
</table>

**MRI of the diabetic foot:**

differentiation of infection from neuropathic change
<table>
<thead>
<tr>
<th></th>
<th>OM</th>
<th>CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM signal change</td>
<td>↓$T_1$, ↑$T_2$, STIR, Contr+</td>
<td>Acute $\approx$ OM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chronic $-$, ↓$T_1$, $T_2$</td>
</tr>
<tr>
<td>BM oedema pattern</td>
<td>Single bone</td>
<td>Periarticular</td>
</tr>
<tr>
<td></td>
<td>Diffuse</td>
<td>Subchondral</td>
</tr>
<tr>
<td>Distribution</td>
<td>Focal</td>
<td>Several bones</td>
</tr>
<tr>
<td>Typical location</td>
<td>– Toes</td>
<td>Midfoot</td>
</tr>
<tr>
<td></td>
<td>– Metatarsal heads</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Calcaneous</td>
<td></td>
</tr>
<tr>
<td>Deformity</td>
<td>NO (+NAP?)</td>
<td>YES (+bone debris)</td>
</tr>
<tr>
<td>ST changes</td>
<td>– Ulcer</td>
<td>Skin intact</td>
</tr>
<tr>
<td></td>
<td>– Abcess</td>
<td>Oedematous</td>
</tr>
<tr>
<td></td>
<td>– Sinus tract</td>
<td></td>
</tr>
</tbody>
</table>
MRI findings
MRI: osteomyelitis vs bone marrow edema

13 DM patients
15 MR examinations before surgery

MR - histologic correlations in 57 bones
T2-weighted, STIR

18 bones with increased signal: edema of the marrow, not OM

Se = 90%, Sp = 71%

● “Marrow edema cannot be reliably distinguished from osteomyelitis with MR imaging…….”

Osteomyelitis of the diabetic foot: MR imaging-pathologic correlations
Craig JG et al. Radiology 1997
Main radionuclide imaging

A) 3-phase bone scan : $^{99m}$Tc-MDP
Sensitive, not specific (+ in uninfected Charcot !)

B) Radionuclide labelled WBC scan

Labelled WBCs migrate to sites of infection (chemotaxy)
Not in sites of increased bone metabolism!
Specificity > bone scan

1) $^{111}$In-WBC
2) $^{99m}$Tc-HMPAO-WBC
3) $^{99m}$Tc-Antibodies-WBC
   - improved spatial resolution
   - lower radiation dose
   - complete in a single day
99mTc Phosphate

polyphosphate
Subramanian and McAfee, 1971

pyrophosphate

diphosphonate
normal 12 year boy
Making the diagnosis of osteomyelitis. The role of prevalence

Σ. Γεώργα Διαφορική διάγνωση της οστεομυελίτιδας στους άκρους πόδες διαβητικών ασθενών με ραδιοϊσοτοπικές μεθόδους. Διδ. Διατριβή, Θεσσαλονίκη 2007

- **Bone scan**
- **Bone + WBC scan**

![Bar chart showing sensitivity and specificity](chart.png)

- **Sensitivity**
- **Specificity**
ACR Appropriateness Criteria  2008 : inappropriate!

Clinical Condition: Suspected Osteomyelitis of the Foot in Patients with Diabetes Mellitus

Variant 4: Neuropathy without ulcer.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray foot</td>
<td>9</td>
<td>Initial study. Radiographs and MRI are complementary. Both are indicated.</td>
<td>Min</td>
</tr>
<tr>
<td>MRI foot with contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary. Both are indicated. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>None</td>
</tr>
<tr>
<td>MRI foot without contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary. Both are indicated.</td>
<td>None</td>
</tr>
<tr>
<td>CT foot without contrast</td>
<td>5</td>
<td>For neuropathy or if MRI contraindicated.</td>
<td>Min</td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan foot</td>
<td>5</td>
<td>Useful for pre-radiographic findings of neuropathy. Also if MRI contraindicated.</td>
<td>Med</td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan and In-111 WBC scan foot</td>
<td>2</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>In-111 WBC scan and Tc-99m sulfur colloid marrow scan foot</td>
<td>1</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan and In-111 WBC scan and Tc-99m sulfur colloid marrow scan foot</td>
<td>1</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>US foot</td>
<td>1</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>FDG-PET foot</td>
<td>1</td>
<td></td>
<td>High</td>
</tr>
</tbody>
</table>

Rating Scale: 1=Least appropriate, 9=Most appropriate

*Relative Radiation Level
### ACR Appropriateness Criteria 2012: learning... but still inappropriate

**Clinical Condition:** Suspected Osteomyelitis of the Foot in Patients with Diabetes Mellitus

**Variant 2:** Soft-tissue swelling with neuropathic arthropathy without ulcer.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray foot</td>
<td>9</td>
<td>Initial study. Radiographs and MRI are complementary, and both are indicated. The results of initial x-ray examination do not preclude the necessity for additional studies.</td>
<td>☹</td>
</tr>
<tr>
<td>MRI foot without and with contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary, and both are indicated. MRI is useful preoperatively to identify the extent of involvement and to map devitalized areas. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>☒</td>
</tr>
<tr>
<td>MRI foot without contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary, and both are indicated.</td>
<td>☒</td>
</tr>
<tr>
<td>CT foot without contrast</td>
<td>5</td>
<td>For neuropathy or if MRI contraindicated.</td>
<td>☺</td>
</tr>
<tr>
<td>Labeled leukocyte scan foot (In-111 or Tc-99m)</td>
<td>3</td>
<td>May be appropriate in certain circumstances such as if MRI is contraindicated or unavailable.</td>
<td>☑️</td>
</tr>
<tr>
<td>Labeled leukocyte scan foot (In-111 or Tc-99m) and Tc-99m sulfur colloid marrow scan foot</td>
<td>3</td>
<td>May be appropriate in selected clinical circumstances.</td>
<td>☑️</td>
</tr>
<tr>
<td>CT foot without and with contrast</td>
<td>1</td>
<td></td>
<td>☃</td>
</tr>
<tr>
<td>CT foot with contrast</td>
<td>1</td>
<td></td>
<td>☃</td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan foot</td>
<td>1</td>
<td></td>
<td>☃</td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan labeled leukocyte scan (In-111 or Tc-99m) foot</td>
<td>1</td>
<td></td>
<td>☆</td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan and labeled leukocyte scan (In-111 or Tc-99m) and Tc-99m sulfur colloid marrow scan foot</td>
<td>1</td>
<td></td>
<td>☆</td>
</tr>
<tr>
<td>US foot</td>
<td>1</td>
<td></td>
<td>☊</td>
</tr>
<tr>
<td>FDG-PET/CT foot</td>
<td>1</td>
<td></td>
<td>☑️</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

---

**5, four yrs ago**

---

*Relative Radiation Level*
Υπόνοια οστεομελείτιδας (OM)

απλή ακτινογραφία άκρου ποδός

OM +

απλή ακτινογραφία άκρου ποδός

OM - / ?

Μέσο & οπτικότητα

τριτημόριο

άκρου ποδός

Σπίνθηρογράφημα
με επικαιροποιημένα
με ⁹⁹mTc-HMPAO
λευκά αιμοσφαιρία

OM -

OM +

Σπίνθηρογράφημα
οστών
με ⁹⁹mTc-MDP

Σπίνθηρογράφημα
με επικαιροποιημένα
με ⁹⁹mTc-HMPAO
λευκά αιμοσφαιρία

Σπίνθηρογράφημα
με επικαιροποιημένα
με ⁹⁹mTc-κολλοιδίας

Σχήμα 14.2.1 Αλγόριθμος απεικονιστής διερεύνησης οστεομελείτιδας.
Infected right foot plantar ulcer without OM

- 66-yr-old woman with NIDDM
- bilateral Charcot joints
- presented with a right midfoot deep plantar ulcer (Wagner 2)

Focal intense leucocyte uptake limited to the ulcer, incongruent with BS uptake

99mTc-MDP bone scan

99mTc-HMPAO-LS

Σ. Γεώργιο, Εργ. Πυρηνικής Ιατρικής ΑΠΘ, ΓΝΘ Ιπποκράτειο
Σ. Γεώργα, Εργ. Πυρηνικής Ιατρικής ΑΠΘ, ΠΝΘ Ιπποκράτειο
clinical presentation of Charcot arthropathy

- warmth
- redness
- swelling
- pedal ulcer in 50%

also present in osteomyelitis

pain often absent

joint instability
foot deformity

Osteomyelitis may be clinically indistinguishable from an acute Charcot joint and both may occur simultaneously
• 69-yr-old woman
• 20-yr history of DM type 2

Presentation: warm & swollen right foot, no pain

Rö: findings indicative of Charcot arthropathy
no findings of Osteomyelitis

MRI:
bone marrow edema, compatible with Osteomyelitis

Σ. Γεώργα, Εργ. Πυρηνικής Ιατρικής ΑΠΘ, ΓΝΘ Ιπποκράτειο
99mTc-MDP three-phase bone scan

**Diagnosis:**
Acute Charcot arthropathy, without OM

**Outcome:**
Resolution of signs and symptoms after 4-months off-loading of the foot, without antibiotic treatment

Σ. Γεώργα, Εργ. Ψυχικής Ιατρικής ΑΠΘ, ΓΝΘ Ιπποκράτειο
Hybridic imaging
- SPECT / CT
- PET / CT

Image fusion
- software
- integrated
FDG tumor model

Normal cell

Glucose 6-phosphatase

FDG6P  →  FDG

G6P  →  G

Hexokinase

FDG  →  G

Glycolysis

Tumour cell (inflammatory cells)

Glucose 6-phosphatase

FDG6P  →  FDG

G6P  →  G

Hexokinase

FDG  →  G

Glycolysis
Keidar Z et al. The Diabetic Foot: Initial Experience with 18F-FDG PET/CT
J Nucl Med 2005
Keidar Z et al. The Diabetic Foot: Initial Experience with 18F-FDG PET/CT
J Nucl Med 2005
Diagnostic Performance of FDG-PET, MRI, and Plain Film Radiography (PFR) for the Diagnosis of Osteomyelitis in the Diabetic Foot

Asad Nawaz, Drew A. Torigian, Evan S. Siegelman, Sandip Basu, Timothy Chryssikos, Abass Alavi

<table>
<thead>
<tr>
<th>Patients characteristics</th>
<th>Number of patients (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of patients</td>
<td>110</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>Range, 29–85</td>
<td></td>
</tr>
<tr>
<td>Mean, 59.3</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
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<td>Female</td>
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<td>Diagnosis of osteomyelitis</td>
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<td>Number of patients confirmed by bone culture and histology</td>
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<tr>
<td>Number of patients confirmed by clinical evaluation</td>
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RESEARCH ARTICLE

Diagnostic Performance of FDG-PET, MRI, and Plain Film Radiography (PFR) for the Diagnosis of Osteomyelitis in the Diabetic Foot

Asad Nawaz, Drew A. Torigian, Evan S. Siegelman, Sandip Basu, Timothy Chryssikos, Abass Alavi

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
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<td>PFR</td>
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<td>MRI</td>
<td>91</td>
<td>78</td>
<td>56</td>
<td>97</td>
<td>81</td>
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</tbody>
</table>
DFI imaging recommendations

Ro: All with DFI

MRI: Abcess, OM uncertain

Radionuclide imaging: Alternative to MRI

DFI, Diabetic foot infection

Lipsky BA et al, Clin Inf Dis 2012
This pathway focuses on the algorithm used to diagnose infection or osteomyelitis under a diabetic foot ulcer. Other important considerations when evaluating a diabetic foot is whether there is neuroarthropathy and/or peripheral vascular disease present. Click here for peripheral vascular disease pathway.

Data reviewed: August 2019
Please note that this pathway is subject to review and revision.

**DIABETIC FOOT ULCER**

- Pain radiography

  - Radiographic changes compatible with osteomyelitis?
    - Yes
      - Diabetic bone biopsy
      - Treat as osteomyelitis
    - No
      - Bone or view of positive probe in bone?
        - Yes
          - High clinical suspicion osteomyelitis?
            - No
              - MRI contraindicated or unavailable
              - Nuclear medicine scan
                - No
                  - Repeat radiograph in 2 weeks
                  - Consider Charcot neuropathy
                - Yes
                  - MRI
                    - Suggestive of osteomyelitis?
                      - Yes
                        - Presumed osteomyelitis
                      - No
                        - MRI
                          - Treat as osteomyelitis
        - No
          - Consider bone biopsy
        - Yes
          - Consider bone biopsy
          - Treat as osteomyelitis

*Consider Charcot neuropathy as a differential or consistent diagnosis if peripheral neuropathy is present.*
**Personal point of view**

| Ro | • initial imaging / serial  
|    | • all with DFI  
| MRI | • forefoot  
|    | • wide soft tissue infection  
|    | • possible surgical intervention  
| Nuclear imaging | • specific infection imaging  
|    | - $^{99m}$Tc-HMPAO-WBC (not Ab-labelled!)  
|    | - hybrid imaging (SPECT/CT)  
|    | • mid-hidefoot : dif. aCA vs OM, > MRI  
|    | • response : unique  
|    | • bone scan : of limited value  
|    | • 18F-FDG PET/CT : expensive  
|    | • MRI alternative : on contraindications  

Local expertise : indispensable
Ευχαριστώ για την προσοχή σας