Q/ What’s the best test for underlying osteomyelitis in patients with diabetic foot ulcers?

Evidence-based answer

A/ Magnetic resonance imaging (MRI) has a higher sensitivity and specificity (90% and 79%) than plain radiography (54% and 68%) for diagnosing diabetic foot osteomyelitis. MRI performs somewhat better than any of several common tests—probe to bone (PTB), erythrocyte sedimentation rate (ESR) >70 mm/hr, C-reactive protein (CRP) >14 mg/L, procalcitonin >0.3 ng/mL, and ulcer size >2 cm²—although PTB has the highest specificity of any test and is commonly used together with MRI. No studies have directly compared MRI with a combination of these tests, which may assist in diagnosis (strength of recommendation [SOR]: B, meta-analysis of cohort trials and individual cohort and case control trial).

Experts recommend obtaining plain films when considering diabetic foot ulcers to evaluate for bony abnormalities, soft tissue gas, and foreign body; MRI should be considered in most situations when infection is suspected (SOR: B, evidence-based guidelines).

MRI has highest sensitivity, probe to bone test is most specific

A meta-analysis of 9 cohort trials (8 prospective, 1 retrospective) of 612 patients with diabetes and a foot ulcer examined the accuracy of diagnostic methods for osteomyelitis (TABLE14). MRI had the highest sensitivity (90%), followed by bone scan (81%). Bone scan was the least specific (28%), however. Plain film radiography had the lowest sensitivity (54%). A PTB test was highly specific (91%) but had moderate sensitivity (60%). (PTB involves inserting a sterile, blunt stainless steel probe into an ulcerated lesion. If the probe comes to a hard stop, considered to be bone, the test is positive.)

Combining ESR with ulcer size increases specificity

A prospective trial of 46 diabetic patients hospitalized with a foot infection examined the accuracy of a combination of clinical and laboratory diagnostic features in patients with diabetic foot osteomyelitis that had been diagnosed by MRI or histopathology.5 (Twenty-four patients had osteomyelitis, and 22 didn’t.)

ESR >70 mm/hr had a sensitivity of 83% and specificity of 77% (positive likelihood ratio [LR+] =3.6; negative likelihood ratio [LR−] =0.22). Ulcer size >2 cm² had a sensitivity of 88% and specificity of 77%
Combined, an ESR >70 mm/hr and ulcer size >2cm² had a slightly better specificity than either finding alone, 82%, but a lower sensitivity of 79% (LR+=4.4; LR−=0.26).

**Diagnosing osteomyelitis: How the tests stack up**

<table>
<thead>
<tr>
<th>Type of evidence</th>
<th>Number of patients</th>
<th>Diagnostic test</th>
<th>Gold standard comparison</th>
<th>Pooled results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meta-analysis of 9 cohort trials¹</td>
<td>Total N=612</td>
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<tr>
<td></td>
<td>4 trials; N=177</td>
<td>Plain film</td>
<td>Histopathology or bone culture</td>
<td>Sensitivity 54% Specificity 68% LR+=1.7 LR−=0.68</td>
</tr>
<tr>
<td></td>
<td>4 trials; N=135</td>
<td>MRI</td>
<td>Histopathology or bone culture</td>
<td>Sensitivity 90% Specificity 79% LR+=4.3 LR−=0.13</td>
</tr>
<tr>
<td></td>
<td>6 trials; N=185</td>
<td>Bone scan</td>
<td>Histopathology or bone culture</td>
<td>Sensitivity 81% Specificity 28% LR+=1.1 LR−=0.68</td>
</tr>
<tr>
<td></td>
<td>2 trials; N=288</td>
<td>PTB</td>
<td>Histopathology or bone culture</td>
<td>Sensitivity 60% Specificity 91% LR+=6.7 LR−=0.44</td>
</tr>
<tr>
<td>Meta-analysis² of 21 cohort trials²</td>
<td>Total N=1027</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>1 trial; N=35</td>
<td>Ulcer &gt;2 cm²</td>
<td>Bone biopsy</td>
<td>LR+=7.2 LR−=0.48</td>
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<tr>
<td></td>
<td>3 trials; N=75</td>
<td>PTB</td>
<td>Bone biopsy</td>
<td>LR+=6.4 LR−=0.39</td>
</tr>
<tr>
<td></td>
<td>4 trials; N=108</td>
<td>ESR &gt;70 mm/hr</td>
<td>Bone biopsy</td>
<td>LR+=11 LR−=0.34</td>
</tr>
<tr>
<td></td>
<td>16 trials; N= 567</td>
<td>Plain film</td>
<td>Bone biopsy</td>
<td>LR+=2.3 LR−=0.63</td>
</tr>
</tbody>
</table>

ESR, erythrocyte sedimentation rate; LR+, positive likelihood ratio; LR−, negative likelihood ratio; MRI, magnetic resonance imaging; PTB, probe to bone test.

* Numbers of trials and patients don’t add up because multiple diagnostic tests were used in some trials.

† 10 trials were graded as a level II or III (included a blind comparison to the gold standard) and the rest were of low quality because they lacked blinding.

**Serum markers accurately distinguish osteomyelitis from infection**

An individual prospective cohort trial of 61 adult patients with diabetes and a foot infection, published after the meta-analysis¹ described previously, examined the accuracy of serum markers (ESR, CRP, procalcitonin) for diagnosing osteomyelitis.⁶ A positive PTB test and imaging study (plain film, MRI, or nuclear scintigraphy) were used as the diagnostic gold standard.

Thirty-four patients had a soft tissue infection and 27 had osteomyelitis. All markers were higher in patients with osteomyelitis than in patients with a soft tissue infection (ESR =76mm/hr vs 66mm/hr; P<.001; CRP=25mg/L vs 8.7 mg/L; P<.001; procalcitonin=2.4 ng/mL vs 0.71 ng/mL; P<.001). The sensitivity and specificity for each marker at its optimum points were: ESR >67 mm/hr (sensitivity 84%; specificity 75%; LR+=3.4; LR−=0.21); CRP >14 mg/L (sensitivity 85%; specificity 83%; LR+=5; LR−=0.18); and procalcitonin >0.3 ng/mL (sensitivity 81%; specificity 71%; LR+=2.8; LR−=0.27).

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**Recommendations**

The Infectious Diseases Society of America (IDSA) recommends performing the PTB test on any diabetic foot infection with an open wound (level of evidence: strong moderate). It also recommends performing plain radiography on all patients presenting with a new infection to evaluate for bony abnormalities, soft tissue gas, and foreign bodies (level of evidence: strong moderate).

The IDSA, the American College of Radiology diagnostic imaging expert panel, and the National Institute for Health and Clinical Excellence recommend using MRI in most clinical scenarios when osteomyelitis is suspected (level of evidence: strong moderate).

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**References**