Diabetic Foot Osteomyelitis: Diagnosis and Treatment

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Nude - Pierre Auguste Renoir (Philadelphia Art Museum)
Osteomyelitis in the diabetic foot

~20% of all patients presenting with an infected foot ulcer have an underlying bone infection

~2/3 of patients hospitalized for severe foot infection have osteomyelitis

Lipsky BA. Clin Infect Dis 1997;25:1318-26
CASE

- 53 year-old, ♂
- Diabetes duration: 11 years
- Ulcer on plantar surface left 2nd toe: 3 months ago
- Initial therapy given by another clinic: ampicillin/sulbactam (30 days)
- Healing following the treatment
- Reinfection 2 weeks ago, worsening of lesion despite second course of oral ampicillin/sulbactam
- Hospitalization in our clinic following outpatient visit
Physical examination

- Fever: 38.8°C
- Respiratory rate: 28/min.
- Pulse rate: 96/min.
- Necrotic and malodorous wound on the left foot
Compartments of foot
Tendon sheaths
Laboratory findings

- Leucocyte count: 18,230/mm (PMN 87%)
- Hemoglobin: 9.8 g/dL (range: 13.6-17.2 g/dL)
- CRP: 236 mg/dL (range: < 6 mg/dL)
- ESR: 98 mm/h
- Procalcitonin: 2.19 ng/dL (range: < 0.5 ng/dL)
- Fasting glucose: 253 mg/dL (range: 70-105 mg/dL)
- Creatinine: 1.25 mg/dL (range: 0.7-1.3 mg/dL)
Question 1

- Which grade does the case belong according to the PEDIS/IDSA classification?
  
  a. Grade 1 (uninfected)
  b. Grade 2 (mild infection)
  c. Grade 3 (moderate)
  d. Grade 4 (severe)
Findings to be considered in the classification

- Presence of infection?
- Presence of deep abscess or compartment syndrome?
- Presence of osteomyelitis?
- Presence of SIRS?
Physical examination

- Fever: 38.8°C
- Respiratory rate: 28/min.
- Pulse rate: 96/min.
- Necrotic and malodorous wound on the left foot
Laboratory findings

- Leucocyte count: 18 230/ mm (PMNL 86.6%)
- Hemoglobin: 9.8 g/dL (range: 13.6-17.2 g/dL)
- CRP: 236 mg/dL (range: < 6 mg/dL)
- ESR: 98 mm/h
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- Fasting glucose: 253 mg/dL (range: 70-105 mg/dL)
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Question 1

Which grade does the case belong to according to the PEDIS/IDSA classification?

a. Grade 1 (uninfected)
b. Grade 2 (mild infection)
c. Grade 3 (moderate)
d. Grade 4 (severe)
Question 2

Does this patient have osteomyelitis? If so, how can it be diagnosed?

a. Physical examination
b. Probing to bone
c. Plain radiography of the foot
d. Magnetic resonance imaging
e. Culture/histopathological examination of bone
Diagnosis of osteomyelitis

- Physical examination
- Probing to bone
- Laboratory examinations
  - Biochemical
  - Microbiological
  - Pathological examinations of bone tissue
- Plain radiography of the foot
- High resolution ultrasonography
- 3/4phase leucocyte labelled scintigraphy
- Magnetic resonance imaging

Ertuğrul MB. J Klimik 2009;22(Supp 1)
### History and Physical examination

<table>
<thead>
<tr>
<th>Variables</th>
<th>Osteomyelitis</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>N=78</td>
<td>n=48</td>
<td>n=30</td>
</tr>
<tr>
<td>Previous hospitalization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (51)</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>No (27)</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>N=76</td>
<td>n=46</td>
<td>n=30</td>
</tr>
<tr>
<td>Wound depth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>No</td>
<td>33</td>
<td>15</td>
</tr>
<tr>
<td>Grade 2</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Grade 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=75</td>
<td>n=48</td>
<td>n=27</td>
</tr>
<tr>
<td>Duration DFI (median, d [25% - 75%])</td>
<td>30 (20 - 63.8)</td>
<td>17.5 (10 - 32.59)</td>
</tr>
<tr>
<td>Wound size (cm²) median [25% - 75%])</td>
<td>7.5 (3.75 - 15)</td>
<td>3 (2 - 6.25)</td>
</tr>
</tbody>
</table>

Wound size ≥4.5cm² significantly associated with presence of osteomyelitis (p=0.041, OR=2.8)

Physical examination

Ertugrul MB. et al.. J Klimik 2004;17(1):3-12
### Diabetic foot osteomyelitis vs. Charcot osteoarthropathy

<table>
<thead>
<tr>
<th>Charcot osteoarthropathy</th>
<th>Osteomyelitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Tarsometatarsal joint involvement</td>
<td>• Distal metatarsal joint involvement</td>
</tr>
<tr>
<td>• Intact skin</td>
<td>• Ulcer/wound of skin</td>
</tr>
<tr>
<td>• Minimal changes in deep tissues</td>
<td>• Abscess formation in deep tissues</td>
</tr>
</tbody>
</table>

Diabetic foot osteomyelitis vs. Charcot osteoarthropathy

Ertuğrul BM, Lipsky BA, Savk O. Diabetic Foot & Ankle 2013;4:21855
Probing to bone
Probing to bone for diagnosing Diabetic Foot Osteomyelitis

<table>
<thead>
<tr>
<th>Reference</th>
<th>No. Patients (Ulcer type)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grayson et al</td>
<td>76 (I)</td>
<td>66</td>
<td>85</td>
<td>89</td>
<td>56</td>
<td>66</td>
</tr>
<tr>
<td>Shone et al</td>
<td>81 (A)</td>
<td>38</td>
<td>91</td>
<td>53</td>
<td>85</td>
<td>24</td>
</tr>
<tr>
<td>Lavery et al</td>
<td>247 (A)</td>
<td>87</td>
<td>91</td>
<td>57</td>
<td>98</td>
<td>12</td>
</tr>
<tr>
<td>Morales Lozano et al</td>
<td>132 (I)</td>
<td>94</td>
<td>98</td>
<td>95</td>
<td>91</td>
<td>80</td>
</tr>
<tr>
<td>Aragon-Sanchez et al</td>
<td>327 (I)</td>
<td>95</td>
<td>93</td>
<td>97</td>
<td>83</td>
<td>74</td>
</tr>
<tr>
<td>Mutluoglu et al</td>
<td>65 (I)</td>
<td>66</td>
<td>84</td>
<td>87</td>
<td>62</td>
<td>60</td>
</tr>
</tbody>
</table>

**A**=All diabetic foot ulcers; **I**=Infected ulcers only; **PPV**= positive predictive value; **NPV**= negative predictive value; **prevalence**= the percent of patients studied who had osteomyelitis

Ertugrul BM, Lipsky BA, Savk O. Diabetic Foot & Ankle 2013;4: 2185
Inflammatory Markers of DFO

Highly elevated ESR level (>70 mm/h) increases the likelihood of DFO

<table>
<thead>
<tr>
<th>ESR (mm/h)</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESR ≥65 + Wound size ≥2 cm</td>
<td>83</td>
<td>77</td>
<td>80</td>
<td>81</td>
</tr>
<tr>
<td>ESR ≥70 + Wound size ≥2 cm</td>
<td>79</td>
<td>82</td>
<td>83</td>
<td>78</td>
</tr>
</tbody>
</table>


# Imaging techniques in DFO

<table>
<thead>
<tr>
<th>Imaging technique</th>
<th>+ LR</th>
<th>− LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain radiograph</td>
<td>2.3</td>
<td>0.63</td>
</tr>
<tr>
<td>MRI</td>
<td>3.8</td>
<td>0.14</td>
</tr>
<tr>
<td>18F-FDG PET</td>
<td>5.6</td>
<td>0.4</td>
</tr>
<tr>
<td>$^{99m}$Tc / $^{111}$In labelled-leukocytes scans</td>
<td>4.73 / 2.31</td>
<td>0.12 / 0.38</td>
</tr>
<tr>
<td>$^{99m}$Tc or $^{67m}$Ga SPECT/CT</td>
<td>3.0</td>
<td>0.18</td>
</tr>
<tr>
<td>$^{99m}$Tc-UBI 29-41 scan</td>
<td>Max*</td>
<td>Min*</td>
</tr>
<tr>
<td>$^{99m}$T bone scan</td>
<td>1.11</td>
<td>0.71</td>
</tr>
</tbody>
</table>

+ LR = positive likelihood ratio; − LR = negative likelihood ratio

*specificity=100%, specificity=100%

Lipsky BA et al. Diagnosis and Management of Foot Infections in Persons with Diabetes: IWGDF Infection Guidance Revision 2015

*Permission of Dr. Selcuk Baktiroglu
### Plain radiographs

**Osteomyelitis**

- Periosteal reaction or elevation
- Loss of cortex with bony erosion
- Focal loss of trabecular pattern or marrow radiolucency
- New bone formation
- Bone sclerosis with or without erosion
- Sequestrum: devitalized bone
- Involucrum: layer of new bone growth
- Cloacae: opening in involucrum or cortex

Ertuğrul BM, Lipsky BA, Savk O. Diabetic Foot & Ankle 2013;4:21855
<table>
<thead>
<tr>
<th>Method</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbiological examination</td>
<td>92</td>
<td>60</td>
</tr>
<tr>
<td>Tc$^{99}$ radiolabelled leukocytes scintigraphy</td>
<td>91</td>
<td>67</td>
</tr>
<tr>
<td>Magnetic resonance imaging</td>
<td>78</td>
<td>60</td>
</tr>
</tbody>
</table>

Percutaneous bone biopsy

Divide specimen for:
✓ Microbiology
✓ Histopathology
Pathological examination

- Diagnostic criterion: Bone biopsy
  ✔ PMNL ≥10 / microscopic area


Ayşe Akman, The foot, 2008
Diagnosis of osteomyelitis

- For infected open wound do probe-to-bone test; (Strong; High)

- Markedly ↑ serum inflammatory markers, especially ESR, suggestive of osteomyelitis in suspected cases (Weak; Moderate)

- Histological & microbiological examinations of an aseptically obtained bone sample (Strong; Moderate)

- Avoid using results of soft tissue or sinus tract specimens for selecting antibiotic therapy for osteomyelitis (Strong; Moderate)

- Plain X-rays (Strong; Low)

- MR imaging (Strong; Moderate)

- SPECT/CT or 18 F- FDG PET scans (Weak; Moderate)

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Does our patient have osteomyelitis? If so, how can we diagnose?

a. Physical examination
b. Probing to bone
c. Direct radiography of the foot
d. Magnetic resonans imaging
e. Culture/histopathological examination of bone
Treatment of DFO

- Outpatient or Inpatient?
- Antibiotics
  - Local, oral, parenteral
  - Empirical or culture based
  - Duration of treatment
- Vascular intervention?
- Hyperbaric oxygen therapy?
- Surgery?
  - Necessary, or is antibiotic therapy sufficient
  - Amputation?
  - Which level?
Medical
- Patient is too medically unstable for surgery
- Poor postoperative mechanics of foot is likely
- No other surgical procedures on foot are needed
- Infection is confined to small, forefoot lesion
- No adequately skilled surgeon is available
- Surgery costs are prohibitive for the patient
- Patient has a strong preference to avoid surgery

Surgical
- Foot infection is associated with substantial bone necrosis
- Foot appears to be functionally nonsalvageable
- Patient is already nonambulatory
- Patient is at particularly high risk for antibiotic-related problems
- Infecting pathogen is resistant to available antibiotics
- Limb has uncorrectable ischemia (precluding systemic antibiotics)
- Patient has a strong preference for surgical treatment
Selection of Antibiotherapy

- Patient status
- Causative bacteria
- Proper antibiotic
<table>
<thead>
<tr>
<th>Site of Infection, by severity or extent</th>
<th>Route of administration</th>
<th>Duration of therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone or joint</td>
<td>Parenteral or oral</td>
<td>2-5 days</td>
</tr>
<tr>
<td>• No residual infected tissue (eg, postamputation)</td>
<td>Parenteral or oral</td>
<td>1-3 wk</td>
</tr>
<tr>
<td>• Residual infected soft tissue (but not bone)</td>
<td>Initial parenteral, than consider oral switch</td>
<td>4-6 wk</td>
</tr>
<tr>
<td>• Residual infected (but viable bone)</td>
<td>Initial parenteral, than consider oral switch</td>
<td>≥ 3 mo</td>
</tr>
<tr>
<td>• No surgery, or residual dead bone postoperatively</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


- Elongated antibiotic therapy is usually advisable in some selected patients who do not receive surgical treatment (*Strong; Moderate*).
- For diabetic foot osteomyelitis we recommend 6 weeks of antibiotic therapy for patients who do not undergo resection of infected bone and no more than a week of antibiotic therapy if all infected bone is resected (*Strong; Moderate*)

Lipsky BA et al. Diagnosis and Management of Foot Infections in Persons with Diabetes: IWGDF Infection Guidance Revision 2015
After operation
After 3 months

Follow-up in clinic
Thank you for your attention