Diagnostic Imaging Pathways - Stress Fracture (Suspected)

Population Covered By The Guidance

This pathway provides guidance on the imaging of adult patients with suspected stress fractures.

Date reviewed: August 2013
Date of next review: 2017/2018
Published: August 2013

Quick User Guide

Move the mouse cursor over the PINK text boxes inside the flow chart to bring up a pop up box with salient points. Clicking on the PINK text box will bring up the full text. The relative radiation level (RRL) of each imaging investigation is displayed in the pop up box.

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>RRL</th>
<th>EFFECTIVE DOSE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="None" /></td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td><img src="image" alt="Minimal" /></td>
<td>Minimal</td>
<td>&lt; 1 millisieverts</td>
</tr>
<tr>
<td><img src="image" alt="Low" /></td>
<td>Low</td>
<td>1-5 mSv</td>
</tr>
<tr>
<td><img src="image" alt="Medium" /></td>
<td>Medium</td>
<td>5-10 mSv</td>
</tr>
<tr>
<td><img src="image" alt="High" /></td>
<td>High</td>
<td>&gt;10 mSv</td>
</tr>
</tbody>
</table>

Pathway Diagram
Image Gallery

Note: These images open in a new page
Suspected Stress Fracture

1a Image 1a (Plain Radiography): Normal x-ray in 18 yo male with medial tibial pain.

1b Image 1b (Bone Scan): Delayed phase of bone scan showing focal uptake in the posteromedial cortex typical of a stress fracture (arrow).

Teaching Points

- Plain radiographs are the initial imaging modality of choice, but are limited due to their inability to detect bony changes early in the development of a stress fracture.
- Early radiographs are often normal. Consider repeat plain radiography at 10-14 days.
- MRI is the most sensitive and specific investigation to diagnose a stress fracture when radiographs are normal or equivocal and can best evaluate for other differential diagnoses.
- Scintigraphy has high sensitivity for stress fracture but poorer specificity, and is associated with ionising radiation exposure. It is an alternative when MRI is contraindicated or unavailable.
- CT can be helpful as an alternative to MRI to demonstrate bony changes but is less sensitive.

Plain Radiographs

- Initial imaging modality of choice for detection of suspected stress fractures.
- Highly specific (~96%) but poorly sensitive (~56%), limiting accuracy (~67%).
  - When plain radiographs demonstrate changes consistent with stress fracture, such as linear cortical radiolucency or localised periosteal reaction 5-7, no further imaging is indicated.
  - Early radiographs are often normal or nonspecific. The lag time between manifestation of initial symptoms and detection of radiographic findings ranges from 1 week to several months.
  - Radiographs may be negative initially in 60-90% of patients and remain negative in 40-60% of stress fractures.
- If the plain radiographs are normal or non-diagnostic, options include:
  - Treat the patient for a presumed fracture and repeat radiography in 2-3 weeks. The American College of Radiology Expert Panel suggest repeat radiography in 10-14 days.
  - If definitive diagnosis is needed, further investigate with MRI (preferred over bone scan due to higher specificity and absence of ionising radiation).

Magnetic Resonance Imaging

- Comparable sensitivity and superior specificity to that of bone scan for detection of bone abnormalities.
- Aids in differentiating pathologic fractures from stress and insufficiency fractures 21 and superior soft tissue visualisation aids in differential diagnosis of pain.
- Multiple classification systems for stress fractures have been developed to evaluate stress.
fractures and a ‘gold standard’ is yet to be developed. Two four-stage grading scales using MRI have been published:
- Arendt and Griffiths’ scale has been used for the femur, tibia, fibular, navicular, calcaneus and forefoot and has prognostic implications regarding time of healing.
- Fredericson and colleagues’ scale was developed using tibia data, and found presence of a fracture or cortical abnormality opposed to oedema alone predicted a longer symptomatic period in runners. These findings were not replicated in a more heterogeneous study population.

### Three-Phase Bone Scintigraphy

- A radiotracer (e.g., 99-Technetium-MDP) is injected into a vein after which a series of images are taken immediately (dynamic phase, demonstrating perfusion to a lesion), shortly after the injection (blood pool phase) and again 3-4 hours later (demonstrating relative bone turnover associated with a lesion).
- High sensitivity (~100%) for stress fractures. 80% of all fractures show some scan abnormality 24 hours post-injury and 95% at 72 hours. Classical findings include focally intense and fusiform cortical uptake.
- The addition of SPECT to planar scintigraphy improves accuracy.
- Less specific than MRI. False positives can occur in osteoid osteoma, osteomyelitis, or metastatic disease.
- Not as useful in follow-up care as uptake can persist for months after clinical healing.
- Due to the radiation exposure and poorer specificity, the role of bone scintigraphy should be reserved to exclude a radiographically occult fracture in patients unable to undergo MRI or after an inconclusive MRI examination.

### Computed Tomography

- Less sensitive than bone scintigraphy or MRI in the detection of stress fractures, but may better define an abnormality discovered with another modality and have played a role in the diagnosis of longitudinal fractures.
- CT may occasionally depict osteopaenia, the earliest finding of a cortical stress injury, in symptomatic patients with normal MRI findings.
- May be useful in follow-up evaluation of healing in radiographically-occult fractures.

### Ultrasound

- While less accurate than MRI, use of ultrasound to evaluate stress fractures in the metatarsal bones has been evaluated with a reported 83% sensitivity and 76% specificity, compared to MRI as the gold standard.
- Performance has been poor in more common sites of stress fracture.
- Further studies are needed to determine the role of ultrasound in the evaluation of stress fracture.

### References

Date of literature search: April 2013


18. Deutsch AL, Mink JH, Waxman AD. **Occult fractures of the proximal femur - MR imaging.**


<table>
<thead>
<tr>
<th>Consent to Procedure or Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation Risks of X-rays and Scans</td>
</tr>
<tr>
<td>Stress Fracture (Suspected)</td>
</tr>
<tr>
<td>Bone Scan</td>
</tr>
<tr>
<td>Computed Tomography (CT)</td>
</tr>
<tr>
<td>Magnetic Resonance Imaging (MRI)</td>
</tr>
<tr>
<td>Plain Radiography (X-ray)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Computed Tomography (CT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Resonance Imaging (MRI)</td>
</tr>
<tr>
<td>Plain Radiography/X-rays</td>
</tr>
<tr>
<td>Radiation Risk of Medical Imaging During Pregnancy</td>
</tr>
<tr>
<td>Radiation Risk of Medical Imaging for Adults and Children</td>
</tr>
<tr>
<td>Nuclear Medicine Bone Scan</td>
</tr>
<tr>
<td>Nuclear Medicine</td>
</tr>
<tr>
<td>SPECT-CT Scan</td>
</tr>
</tbody>
</table>

**Copyright**

© Copyright 2015, Department of Health Western Australia. All Rights Reserved. This web site and its content has been prepared by The Department of Health, Western Australia. The information contained on this web site is protected by copyright.

**Legal Notice**

Please remember that this leaflet is intended as general information only. It is not definitive and The Department of Health, Western Australia can not accept any legal liability arising from its use. The information is kept as up to date and accurate as possible, but please be warned that it is always subject to change.

**File Formats**

Some documents for download on this website are in a Portable Document Format (PDF). To read these files you might need to download Adobe Acrobat Reader.