Diagnosis of bone pathology is a complex process involving the use of multiple imaging modalities with varying capabilities and judicious use of the available resources is required to answer the clinical question accurately, while ensuring that radiation exposure is as low as reasonably possible. The different scenarios frequently encountered in imaging bone pathology have been broadly divided into trauma, tumours and infections.

**Trauma and Fractures**

In trauma, cross sectional imaging can be used to complement plain films or as the primary imaging, especially in regions with complex anatomy or superposition of multiple structures such as in the pelvis, wrist and spine. Historically, bone scintigraphy has been described as a sensitive test for the investigation of bone trauma especially to assess the chronicity. In the late 1980s, magnetic resonance imaging (MRI) revolutionised imaging and the late 1990s saw the advent of ultrasound for the evaluation of soft tissue injuries.

The choice of modality is largely dependent on clinical question, local policy and the age and disability of the patient. For example, in occult fractures of the scaphoid, computed tomography (CT) and MRI can be used depending on the local policy, whereas an MRI scan is the preferred modality in suspected fractures of the hip with non-specific plain radiograph appearances.

When patients who have had trauma continue to have localised pain in the presence of a normal plain radiograph, MRI or bone scintigraphy can be used to look for bone bruising, which is assumed to be due to trabecular disruption without cortical discontinuity. On MRI, bone bruising manifests as increased marrow signal on T2 weighted images, while on scintigraphy it manifests as increased perfusion and blood pool associated with increased tracer accumulation on delayed bone images.

**Stress fracture**

Stress fractures are an important subset of fractures that pose diagnostic challenges and cross sectional imaging is routinely employed for diagnosis of these injuries. Stress fractures can be broadly classified into fatigue fractures and insufficiency fractures. Fatigue fractures are those caused in normal bones due to repetitive strain and insufficiency fractures are those caused in abnormal bones due to repetitive strain (figure 1) and insufficiency fractures are those caused in abnormal bones (figure 2).

Several grading systems have been proposed for grading of stress fractures to guide treatment. Milgrom et al described stress fractures in military recruits and Zwas et al'
published a four point grading system according to lesion dimension, bone extension and tracer accumulation. With the advent of MRI a new grading system has been suggested to guide treatment (table 1).

**Tumours**

Skeletal tumours are a large, diverse group of conditions with a wide range of behaviour, varied spectrum of imaging appearances and wide variety of histological appearances. Distinction between benign and malignant lesions is important to prevent undertreatment of aggressive lesions and overtreatment of tumour-like conditions, the consequences of which can be disastrous, and the diagnosis of benignity and malignancy can sometimes hang on imaging characteristics. Imaging is also vital in determining choice of treatment, biopsy of tumour for histological diagnosis and planning of treatment in case of radiotherapy and surgery. Imaging also helps to determine surgical approach. Since a large number of lesions are curable if detected early, accuracy of diagnosis is vital.

Plain radiography is the mainstay of imaging and while it is able to distinguish between very aggressive and obviously benign lesions, there are a range of appearances in between that can cause diagnostic dilemmas. Used in conjunction with a good clinical history and examination they can guide further imaging for local staging and assessment of distant metastases.

CT and MRI scans are used for local staging as they demonstrate bony and soft tissue anatomy clearly. These can also demonstrate involvement of adjacent neurovascular bundles and regional lymph nodes, thus helping in surgical planning. CT scans of bone tumours help to look for features like cortical breach and periosteal reaction. MRI would help to assess the medullary cavity and soft tissue component. Another feature to frequently consider is distant metastases, which would influence the operability of the tumour and choice of treatment.

Bone scintigraphy, while sensitive for detection of lesions, lacks specificity. However, it is an excellent test to assess multiple bone involvement and distant metastasis (figure 3). Even though the likelihood of metastatic spread is usually proportional to the grade of tumour, some benign lesions such as giant cell tumours and chondroblastomas have the potential for metastatic spread.

PET scans can be used to assess the biologic activity to determine the grade of a tumour in situations where a biopsy would be difficult, for example in tumours that are close to neurovascular structures. PET scans can also be used to diagnose occult distant metastases.

Another use of cross sectional imaging in bone tumours is for the assessment of response to therapy and as a prognostic indicator, especially in multiple myeloma. PETCT and MRI are used for this, according to local protocol and availability. In one study, use of MRI and PET CT in combination and with concordant findings was shown to have specificity and positive predictive value of 100%. Used on their own, whole-body MRI performed better than PET in the assessment of disease activity demonstrating higher sensitivity (68% vs 59%) and specificity (83% vs 75%) respectively.

**Infection and inflammation**

Diagnosis of infections in the skeletal system is challenging due to non-specific signs and indolent nature of infections. Parameters like C-reactive protein, erythrocyte sedimentation rate and white blood cell count lack specificity. CT and MRI scans are routinely used for imaging suspected osteomyelitis and septic arthritis. MRI is more sensitive in diagnosis of bone marrow involvement.

An important area in bone and joint infections is detection of infection around prosthesis. Distinction between aseptic loosening of prosthesis and peri-prosthetic infection is crucial, as the treatment varies between simple revision and multi-stage revision combined with long-term antibiotic therapy. Since periprosthetic infection is usually chronic, CT findings are non-specific and MRI is impaired by artefact from metal prosthesis. Ultrasoundography can be used to diagnose effusion and guide aspiration to make histological and tissue diagnosis.

Radionuclide imaging which reflects physiological rather than anatomical change is valuable in making the diagnosis. Bone scintigraphy has high sensitivity but low specificity. Accuracy of scintigraphy with 99m Tc labelled monoclonal antibodies is 81% and that of combined labelled leucocyte and Tc-99m sulphur colloid scan is as high as 90%.

Recently, some studies with FDG PET scans have shown higher sensitivity in diagnosing chronic infections compared to the combination of bone scintigraphy and white cell labelled scan. The advantages of PET scans are high target to background ratio, high resolution and no impairment by metal implants. Disadvantages are limited availability, high cost and possible lower sensitivity in diabetic patients.

Enthesopathy

Enthesopathy is inflammation at the site of tendon, ligament or articular capsule insertion to the bone. This usually manifests on plain radiographs as periosteal reaction and can be caused by mechanical macro or micro trauma or as a local manifestation of a systemic inflammatory process such as rheumatoid arthritis, gout or seronegative spondyloarthropathy.

On MRI scans, enthesopathy is characterised by increased signal on T2 weighted images. Bone scintigraphy can help distinguish between active and inactive enthesopathy. Plantar fasciitis is a form of enthesopathy in the heel, which can be caused by overuse or obesity. Ultrasound scans are regularly used to look for thickening of the fascia to help in the diagnosis of plantar fasciitis.

Diabetic foot

Diagnosis of osteomyelitis underlying a diabetic foot ulcer is challenging due to multiple reasons. Results of laboratory tests like ESR and CRP are non-specific and plain radiographs are of limited use, unless the osteomyelitis is well established. Bone scan and indium labelled leucocyte scans have low to moderate accuracy. MRI is probably the most accurate test in this setting, with one meta-analysis showing a pooled sensitivity of 90% and specificity of 79%. The sen-

![Figure 3](https://example.com/figure3.jpg) Bone scan demonstrating Ewing’s sarcoma in right ischium with rib metastases.
Sensitivity and specificity for bone scan were 81% and 28% and for indium labelled scan were 74% and 68% respectively. Osteomyelitis on MRI is indicated by low signal on T1 and high signal on T2 weighted and STIR images.

**Conclusion**
With modern advances in imaging, a wide variety of techniques are available for the diagnosis of different musculoskeletal pathologies. Judicious use of appropriate imaging will help in accurate diagnosis and early, appropriate management of patients. When faced with difficult to diagnose conditions, alternate imaging modalities should be considered.

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**References**