Clinical/Diagnostic Problem	Investigation	Recommendation (Grade)	Dose	Comment
D01. Osteomyelitis	XR	Indicated [C]	☢	XR is indicated for initial imaging.
	MRI	Indicated [C]	0	MRI is an excellent imaging modality to assess osteomyelitis and associated soft tissue abnormalities, especially in the spine.
	NM	Indicated [C]	☢☢ – ☢☢☢	Bone scan (Two- or three-phase skeletal scintigraphy) is useful after a normal or equivocal x-ray if osteomyelitis is suspected as a normal bone scan makes osteomyelitis very unlikely. If osteomyelitis is suspected but there are no localizing signs or symptoms, skeletal scintigraphy is useful; however, findings are not specific.
		Specialized investigation [C]		Tc-99-HMPAO and In-111-labelled white cell scans are an alternative to MRI. Gallium-67 Citrate imaging is useful for vertebral osteomyelitis and chronic infections. In-111-labelled white cells are useful for infections in bones or joints. Combined leukocyte and marrow imaging is currently the technique of choice for peri-prosthetic infection (see also painful prosthesis D22). The use of those specialized techniques is usually reserved for cases with abnormal bone scans.
	CT	Specialized investigation [C]	☢☢	CT is useful to guide soft tissue and bone biopsy and is the best imaging modality to evaluate for sequestra in chronic osteomyelitis.
	US	Specialized investigation [C]	0	US may be helpful to assess for a subperiosteal abscess in acute osteomyelitis.
D02. Primary bone tumour	XR	Indicated [B]	☢	XR should be performed when there is bone pain that is not resolving, and it may be the only imaging required for some benign bone lesions.
	MRI	Specialized investigation [B]	0	If the XR appearances are suggestive of a malignant bone tumour, referral to a specialist centre should not be delayed. MRI is the best imaging modality for local staging.
	NM	Indicated [B]	☢☢	If the XR appearances are suggestive of a primary bone tumour, obtaining skeletal scintigraphy should not delay referral to a specialist centre. NM is primarily used for evaluating the skeleton for additional sites of involvement; the bone scan may overestimate the local tumour extent. In most circumstances, a normal bone scan excludes malignancy. The role of FDG-PET remains to be clarified and may have a role for identification of distant metastasis (bone and non-bone). PET/CT fusion images may be helpful for targeting areas with more cellular metabolic activity (although biopsy should be carried out in specialized bone tumour centres where histological expertise and knowledge of surgical approach is available).

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Clinical/Diagnostic Problem	Investigation	Recommendation (Grade)	Dose	Comment
D02. Primary bone tumour *(continued)*	CT	Specialized investigation [B]	☢☢	CT may be useful in some tumours, such as osteoid osteoma, and can demonstrate intratumoral calcification and ossification better than MRI, but it should only be ordered by a specialist or after consultation with a radiologist.
D03. Known primary tumour, skeletal metastases	NM	Indicated [B]	☢☢	Bone scintigraphy is useful for assessing the presence and extent of skeletal metastases in patients with known primary cancers both at initial presentation and in follow-up. Its sensitivity and specificity is increased by using SPECT (and SPECT-CT whenever available). It is more sensitive for osteoblastic metastases and relatively insensitive in assessing the extent of multiple myeloma and purely osteolytic metastases. It is moderately specific and may require correlation with other imaging modalities. Bone scintigraphy may also be used to assess response to treatment, although the flare phenomena may suggest progression if bone scans are performed too soon after the initiation of systemic therapy (< 3 months).
	MRI	Indicated [B]	0	MRI is useful to assess and characterize skeletal metastases, particularly in the axial skeleton. It may underestimate peripheral lesions that are not included in the field of view but whole-body examinations using diffusion-weighted sequences are becoming more widespread. Its sensitivity is lower for small osteoblastic metastases.
	XR skeletal survey	Not indicated [B]	☢☢	XRs are only useful for the assessment of focal symptomatic sites or for correlation with a NM examination.
D04. Soft tissue mass or tumour	MRI	Indicated [B]	0	MRI is the best imaging modality for evaluating soft tissue masses and in some cases may provide a specific diagnosis.
	US	Indicated [C]	0	US is useful for distinguishing between solid and cystic masses. It can be used to determine appropriate evolution of a presumed hematomas or follow other probably benign lesions. Percutaneous biopsy under US guidance can be carried out in specialized bone tumour centres where histological expertise and knowledge of surgical approach is available.
	XR	Indicated in specific circumstances [B]	☢	XR can identify calcified (and sometimes fatty) tumor matrix and underlying osseous abnormalities. CT may also be useful in this regard.

Clinical/Diagnostic Problem	Investigation	Recommendation (Grade)	Dose	Comment
D05. Bone pain **(For children see L28 – L29)**	XR	Indicated [C]	☢	XR is an important first step in evaluation of focal bone pain.
	NM	Indicated [C]	☢☢	Indicated if pain persists with normal XR or equivocal and abnormal XR. Bone scans are commonly positive in patients with persistent bone pain and may be helpful in directing more specific studies.
	MRI	Specialized investigation [C]	0	MRI is an appropriate imaging modality if pain persists and XR and NM are normal. MRI may also provide further information when XR and/or NM findings are abnormal.
	CT	Specialized investigation [C]	☢☢	CT can assist in further characterization of bony abnormalities identified on XR, NM/MRI. It may be useful in planning bone biopsy.
D06. Myeloma	XR skeletal survey	Indicated [C]	☢ – ☢☢	XR indicated for initial staging and planning for possible radiation therapy. Follow up of abnormalities can be limited to specific sites.
	MRI	Specialized investigation [B]	0	Screening examination of the of the axial skeleton (spine, pelvis, proximal femora) is very sensitive, and particularly useful in patients with diffuse osteopenia or known non-secretory myeloma. It may be used for evaluation of a focal mass or follow up of disease extent.
	NM	Not indicated [B]	☢☢	NM has a limited senstivity and may not detect all sites of involvement.
D07. Metabolic bone disease	XR	Indicated [C]	☢☢	XR is the best imaging modality for identifying the characteristic features of some metabolic bone diseases such as hyperparathyroidism and osteomalacia. It may also identify new vertebral compression fractures in patients with osteoporosis. Correlation with NM may be required.
	DEXA	Indicated [A]	☢	DEXA is the standard technique to determine bone density. Quantitative CT can also accurately measure bone density.
	NM	Indicated [C]	☢ – ☢☢	NM can help determine some causes of hypercalcemia (e.g. hyperparathyroidism, certain metastases), and of raised alkaline phosphatase (e.g. Paget's disease, some metastases). Bone scans can also differentiate new from old vertebral fractures.

Clinical/Diagnostic Problem	Investigation	Recommendation (Grade)	Dose	Comment
D08. Osteomalacia with pain **(See also D07)**	XR	Indicated [B]	☢	XR is the best initial imaging modality to establish a cause of local pain or to assess an equivocal lesion identified on NM.
	NM	Specialized investigation [C]	☢ – ☢☢	NM may demonstrate abnormal increased activity and associated complications (e.g. pseudo-fractures).
	MRI	Specialized investigation [C]	☢☢	MRI may be used to establish the cause of local bone pain not shown on XR or to assess equivocal XR findings. May also be used in evaluation of complications, dating of fractures and identification of occult fractures if X Rays negative.
D09. Osteoporotic vertebral collapse with pain **(See also D07)**	XR thoracic and lumbar spine	Indicated [B]	☢ – ☢☢	Indicated to demonstrate compression fractures, but cannot always distinguish acute from old fractures without previous imaging for comparison.
	NM	Specialized investigation [C]	☢ – ☢☢	NM or MRI are more useful in distinguishing between recent and old fractures and can help exclude pathological fractures.
	MRI	Specialized investigation [C]	0	MRI is the best imaging modality for distinguishing between acute and chronic osteoporotic collapse, which is important for pre-vertebroplasty or kyphoplasty assessment. It is also the best modality for distinguishing between osteoporotic and malignant vertebral collapse.
D10. Arthropathy: presentation	XR affected joint	Indicated [C]	☢	XR may be helpful to determine the type of arthritis, although visible bony changes are often a relatively late feature.
	XR hands / feet	Indicated [C]	☢	In patients with suspected rheumatoid arthritis, XR of the feet may show erosions in asymptomatic as well as symptomatic feet, even when symptomatic hands appear normal.
	XR multiple joints	Indicated only in specific circumstances [C]	☢☢	Only symptomatic joints should be x-rayed unless otherwise indicated by other clinical investigations.
	MRI	Specialized investigation [C]	0	MRI can show acute synovitis, articular cartilage damage, early erosions and bone marrow edema better than XR.
	US	Specialized investigation [C]	☢☢	US can show acute synovitis and erosions in superficial joints. It requires a trained-operator.
	NM	Specialized investigation [C]	0	NM can show acute synovitis and its distribution.

Clinical/Diagnostic Problem	Investigation	Recommendation (Grade)	Dose	Comment
D11. Arthropathy: follow-up	XR	Indicated [C]	☢	XR is the investigation of choice.
	MRI	Indicated only in specific circumstances [C]	0	MRI may be used by a specialist to assist management decisions.
	US	Indicated only in specific circumstances [C]	0	US may be used by a specialist to assist management decisions.
D12. Painful shoulder, impingement syndrome and rotator cuff tear	XR	Indicated	☢	XR may demonstrate acromioclavicular osteoarthrosis and acromial enthesophytes, subacromial space narrowing, tendon calcification, and glenohumeral osteoarthrosis.
	US	Specialized investigation [C]	0	Provides dynamic assessment of shoulder impingement and demonstrates rotator cuff tears or tendinopathy. It requires a trained-operator.
	MRI	Specialized investigation [C]	0	MRI allows precise assessment of the extent of rotator cuff tears, and it also shows bursal inflammatory changes and other associated abnormalities.
D13. Shoulder instability	XR	Indicated	☢	Assess glenohumeral congruence and demonstrates bony abnormalities (Bankart and Hill-Sachs fractures).
	MR arthrography	Indicated only in specific circumstances [C]	0	Glenoid labrum, glenohumeral ligaments, cartilage and synovial cavity are well-delineated.
	CT arthrography	Indicated only in specific circumstances [C]	☢☢	Glenoid labrum, glenohumeral ligaments, cartilage and synovial cavity are well-delineated.
D14. Sacroiliac pain	XR	Indicated [B]	☢	XR is usually the first initial imaging modality for the assessment of sacroiliitis in patients with seronegative arthropathy.
	MRI	Specialized investigation [C]	0	MRI is the imaging modality of choice when strong suspicion of early sacroiliitis exists and the XR is normal.
	CT	Specialized investigation [C]	☢☢ – ☢☢☢	MRI is more sensitive than CT for early sacroiliitis, but CT may suffice if MRI is not readily available. CT may demonstrate early erosions when XR is normal.
	NM	Specialized investigation [C]	☢☢	MRI is preferred over NM for early sacroiliitis, but NM may suffice if MRI is not readily available.

Clinical/Diagnostic Problem	Investigation	Recommendation (Grade)	Dose	Comment
D15. Non-traumatic hip pain **(For trauma see J26)** **(For children see L25 – L26)**	XR	Indicated [C]	☢	XR is indicated as the initial imaging modality for persistent pain.
	MRI	Specialized investigation [C]	0	MRI is the best modality for further evaluation of persistent hip pain if the XR is normal. MRI arthrography is indicated for suspected labral tears.
	NM (Tc-99m MDP bone scintigraphy)	Indicated only in specific circumstances [B]	☢☢	MRI is preferred over NM since NM is less specific, but NM may suffice if MRI is not readily available. May be a screening tool before MRI., especially in older patients (osteoporotic fractures). It should be noted that SPECT (or SPECT-CT whenever available) should be used. Bone scans may show pathology that may cause referred pain.
D16. Suspected avascular necrosis	XR	Indicated [B]	☢	XR is indicated as the initial imaging modality, but it only becomes abnormal in established disease and may be negative within the first 6-9 months.
	MRI	Indicated [B]	0	MRI is the most sensitive imaging modality for the detection of early avascular necrosis and will show the extent of necrosis. MRI is useful to detect occult avascular necrosis in the contralateral hip. It may be required for surgical planning.
	NM (Tc-99m bone scintigraphy with SPECT)	Specialized investigation [B]	☢☢	NM can be used if MRI is not readily available.
	CT	Specialized investigation [B]	☢☢	CT is not as sensitive but may be used if MRI is not readily available.
D17. Non-traumatic knee pain **(For trauma see J21)**	XR	Indicated only in specific circumstances [C]	☢	Symptoms frequently arise from soft tissues which will not show on XR, and osteoarthritic changes are common. XR is indicated in the following circumstances: sudden or onset or exacerbation of pain; pain persisting more than 6 weeks in children and young adults; suspected intra-articular bodies (XR will only identify radio-opaque intra-articular bodies); and for pre-operative evaluation for knee replacement surgery.
	MRI	Indicated only in specific circumstances [B]	0	MRI is the best imaging modality for the assessment of internal knee derangement (eg. meniscal tears, intra-articular bodies).
	US	Indicated only in specific circumstances [C]	0	MRI is generally preferred over US because it evaluates the entire knee and it is not operator-dependent; however US may suffice if MRI is not readily available. US is indicated if the patient has anterior knee pain with suspected tendon pathology and/or bursitis.

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Clinical/Diagnostic Problem	Investigation	Recommendation (Grade)	Dose	Comment
D17. *(continued)*	NM	Indicated only in specific circumstances [C]	☢☢	NM can be useful in identifying referred pain, stress fractures and other bone lesions.
D18. Chronic foot pain **(For trauma see J23)**	XR	Indicated only in specific circumstances [C]	☢	Most patients should be managed on the basis of clinical findings without need for imaging. The cause of pain is rarely detectable on XR however XR is the first-line investigation for the imaging work-up of chronic foot pain. Pre-operative and post-operative evaluation of hallux valgus is best performed with weight-bearing AP and lateral XR of the feet.
	MRI	Specialized investigation [C]	0	If XR is unremarkable/equivocal and suspect tarsal coalition, plantar fasciitis, tarsal tunnel syndrome, painful accessory navicular, Morton's neuroma, or inflammatory arthropathy.
	US	Specialized investigation [C]	0	If proper expertise is available, US can be used in place of MRI to investigate tendinopathy, plantar fasciitis, tarsal tunnel syndrome, suspected inflammatory arthropathy, or Morton's neuroma.
	NM (Tc-99m bone scintigraphy)	Specialized investigation [C]	☢☢☢	If suspect reflex sympathetic dystrophy, synovitis, stress or insufficiency fractures, or enthesopathy, and XR is negative/equivocal.
	CT	Specialized investigation [C]	☢☢	If suspect tarsal coalition and XR is unremarkable/equivocal.
D19. Painful prosthesis	XR	Indicated [B]	☢	XR is indicated as the initial imaging to detect established loosening.
	NM	Indicated [B]	☢☢ – ☢☢☢	NM is valuable for the investigation of late complications. Imaging should be discussed with a NM specialist to determine the most appropriate procedure.
	Image-guided aspiration	Specialized investigation [B]	☢☢	Image guided aspiration is particularly helpful if there is concern about infection.
	US	Specialized investigation [C]	0	US is indicated if a peri-prosthetic abscess or superficial infection is suspected.
	MRI	Specialized investigation [C]	0	MRI is indicated if there is concern about peri-prosthetic soft tissue abnormalities.