Introduction

Why a Clinical Practice Guideline?

The practice of radiology has changed remarkably over the years. New inventions have changed the patient management by providing early diagnosis.

Who has developed this guideline?

This guide line has been developed by Members of the Committee on Guidelines of the Sri Lanka College of Radiologists. The Committee had representations of specialists from other fields.

For whom is this guideline intended?

Objectives

Provide evidence based recommendation to clinicians and radiologists to decide on the best sequence of radiological imaging, in order to arrive at a correct diagnosis, at an early stage, in the management of a patient with a musculoskeletal disorder, to reduce morbidity and mortality.

How are the guidelines structured?

Two different levels of institutions are identified in these guide lines for easy application.
All institutions like Base hospitals, Provincial hospitals, General Hospitals and the teaching hospitals with specialist services available are considered and recommendation given in a different color.

1. Radiological Investigations of Musculoskeletal System

1.1 Introduction:

Imaging of chronic pain, tumors, infections, and osteoporosis is a broad subject and is due to various etiologies. Pain may be due to bone, soft tissue and articular pathologies or could be due to referred pain. Few common disorders have been dealt here. Clinical data is mandatory in selecting most appropriate imaging technique. Establishment of the correct diagnosis is much more than an academic exercise since it determines the appropriate therapy. Multiple imaging modalities are available for this purpose. Initial exam is almost always X ray. This gives clue to the diagnosis. Further information can be gained by doing additional examinations. MRI is sensitive for detection of many abnormalities involving the soft tissues and bones. Availability and cost play a major role in selecting these imaging methods.

1.2 Chronic pain/ Pathology

1.2.1 Hip Joint

Initial exam is X ray pelvis AP to include both hip joints/ Hip Joint LAT

Grade (X)

Symptoms may be due to numerous etiologies including trauma, neoplasm & arthropathy.
Plain X ray helps to detect most common causes like OA and also less common causes like pigmented villonodularsynovitis (PVNS)

A. Osteoarthritis (OA)

It is best evaluated with X rays. When X ray shows the changes of OA, no more study is needed. OA hip is commonly bilateral and involves superior joint space initially.

X ray findings are;

- Marginal sclerosis,
- Subchondral cysts
- Osteophytes
- Joint space narrowing.

B. In suspected osteochrondramatosis

The X ray - may show uniform size calcified or ossified bodies in the joint.
MRI - provides greater details of the disease with thickened synovium and nodules in the joint. It is useful if diagnosis is doubtful. (Y)
Confirmation is done by synovial biopsy.

C. In Pigmented Villonodularsynovitis (PVNS)

X ray shows erosions with preservation of joint space. **Grade (X)**
Hemosiderin laden synoviam is well demonstrated by MRI. **Grade (Y)**

D. When X ray is nondiagnostic

i. But pain persists & then suspected bone/soft tissue problem,
MRI is indicated as it is highly sensitive for structures around hip and soft tissue .After reviewing MRI, contrast can be given. .If MRI is not available CT can be done.

ii. But suspected Osteonecrosis (ON) –
X ray shows increased joint space; flatten femoral head, fissures and sclerosis.
Grade (X)
MRI is the next examination of choice as it has shown a high accuracy.
Grade (Y)

iii. But suspected osteoid osteoma –
X ray shows an area of sclerosis
CT is indicated because CT helps to identify the nidus in the sclerotic bone.

iv. But suspected labral tear ,
MRI with intraarticular CM is indicated. High resolution MRI obviates the need of intraarticular injection. **Grade (Y)**

Indirect arthrography is an alternative to direct MRarthrography and conventional arthrography in investigating of intraarticular disorders as it is noninvasive and faster.

Joint aspirations can be performed under US guidance for diagnostic or therapeutic purposes whenever it is necessary.

1.2.2 Knee Joint

Initial study for chronic knee problem is X-ray AP/LAT. **Grade (X)**
In AP view - Patella is centrally located.
Lateral view - The quadriceps and patella tendons are best seen.
Axial view – This is mandatory to show patellofemoral joint. **Grade (X)**

A. In Patella dislocation
X ray may show subtle osteochondral fragment in the patella.

B. In Osgood schalatter,s disease –
X ray may show fragmented tibial tubercle
This can be confirmed by US in doubtful cases.
Grade (Y)

C. Patella tendinosis -
This can be assessed by US. **Grade (Y)**

D. In chondromalacia patellae -
MRI better assess the articular cartilage.
Grade(Y)

E. Nonlocalized knee pain with normal X-ray or with evidence of effusion
Next exam should be MRI as it provides more specific information. Apart from joint effusion, It detects communicating synovial cysts, proliferative changes of synovial membrane, osteophytes, bone marrow edema, fractures and any other lesion. **Grade (Y)**

F. When X-ray shows changes of OA

- Weight bearing PA X ray standing view better assess the cartilage loss,
  Standing X ray with knee flexed shows medial and lateral joint compartment cartilaginous loss than supine X-ray.

- In advanced OA joint narrowing in plain X ray indicates cartilage loss. Then no further work up is needed.

- In early stages of OA plain X ray may not be sensitive.
  When x ray is normal but clinically suspecting OA, MRI is done for assessment of cartilage as it is important in the management. **Grade (X)**

G. In Inflammatory arthritis

No further work up is necessary. X ray can be done only to check secondary OA changes.

H. In osteochondritis dessicans

X-ray may show lucent ring surrounding a bony fragment.

X ray tunnel view is indicated here. In doubtful cases MRI is done as it is sensitive in detecting marrow changes and in deciding the stability of the fragment .MRI is useful to assess the status of the articular cartilage better. **Grade (Y)**

I. When X ray shows changes of internal derangement

MRI is indicated to assess the cartilage, menisci, ligaments, subchondral bone, and marrow and to detect effusions, and cysts. **Grade (Y)**

MRI is useful in meniscal/ligament tears,, transient osteoporosis , stress fractures, synovial proliferation, degenerative bone marrow edema and osteonecrosis. **Grade (Y)**

1.2.3 Ankle Joint

Best initial study is X-ray AP & LAT views. (X)
Mortise view (ankle AP with 15 degrees rotation) is done to get unobscured view of the talar dome.

A. Suspected osteochondral injury -

X ray may show cystic changes beneath the fragment.
If sclerosis is more diffuse, frank avascular necrosis is considered.

MRI is better in detecting these lesions. MRI changes are visible even when plain X-ray is normal. **Grade (Y)**
CT if MRI is not available.

B. In suspected OA -

X ray findings are,

- Joint space narrowing,
- Marginal osteophytes,
- Subchondral sclerosis
- Cysts.

C. In suspected osteoid osteoma -

X ray - shows a patch of sclerosis.
Grade (X)

CT is valuable in confirming it.
Grade (Y)

D. When X-ray is negative –

i. But suspected tendinopathy –

Sensitivity of MRI to fluid allows making a specific diagnosis of tendonitis or tears.

Grade (Y)

US scan helps to show the changes in the tendon.

ii. But suspected instability -

MRI is indicated. **Grade (Y)**

If screening is not available stress views have a value. Stress views are done with varus and vulgus position and foot in neutral and planter flexed position.

MRI is more accurate and also helpful in assessing ligaments and synchondrosis, injuries, and other mimicking conditions like tenosinivitis or osteochondral lesions.

iii. Pain of no cause

If imaging is necessary MRI is indicated as it gives global information.

Steroid injection to peroneal tendon has helped to confirm that the pain is due to tendon pathology.

iv. Suspected impingement –

MRI is better. MRI arthrography is Better than CT arthrography.

Grade (Y)

MRArthrography is found to be used in assessing anterolateral and anteromedial impingement.

US shows the high degree accuracy in sencitivity (100%) and specifity (88%) for tendon pathology and helpful to use in dynamic imaging for conditions like subluxation of peroneal tendon .It also helps to identify the cause for impingement.

1.2.4 Foot

Initial evaluation is always begin with plain X ray, AP and Lat. **Grade (X)**
Internal and external rotation views are supplementary views and are done to answer specific question, for example, external oblique is used for evaluation of calcaneonavicular coalition.

CT or MRI may be useful if further evaluation is necessary.
Axial view through the calcanium is useful in assessing calcaneal lesions.
Real time US is useful to evaluate achillis tendons because of low cost and ability to study tendon motion in real time. Extent of involvement is accurately assessed by MRI.

A. Accessory navicular
This may form synchondrosis on the navicular bone and chronic traction is the cause of pain. X ray will show the changes as sclerosis, separation, and cystic changes at the junction.
If pain is over accessory bone with no response to conservative treatment MRI is done to show the underline bone changes.

B. X ray is nondiagnostic but pain over tarsonavicular
MRI is indicated.

C. Subtalar coalition
A well penetrated axial view is indicated to demonstrate the posterior and middle subtalar joint.
Tarsl coalition is a congenital abnormality resulting from fibrous, cartilage or osseous union. It is frequently overlooked on standard foot radiograph.

But it can be suspected by secondary signs,

- Talar beaking
- Flattening
- Broadning of lateral talar process
- Positive C sign
- Narrowing of the posterior talocalcanial joint

D. In suspected Reiter's in a young male,
X ray oblique view is done to show the periosteal reaction along the metatarsals. **Grade (X)**

E. In suspected Freiberg's disease
The X-ray changes are characteristic showing increase density of metatarsal head, flattening, collapse, cystic changes and widening of the joint.

F. In suspected reflex sympatheticdystrophy (RSD)
X ray shows localized osteopenia distal to ankle joint.
Three phase radionuclide scan shows the characteristic delayed bone scan pattern .Here the sensitivity is 100% and specificity is 80%.
MRI shows marrow edema even with normal

X-ray.
Power Doppler US shows increase flow in the affected region.

G. Suspected Planter fascitis

X ray may show planter facial thickening and spur formation at the inferior calcaneal margin. These finding may not be specific.
Bone scintigraphy and MRI - is useful in arrive at the diagnosis.
US has been useful in differentiating normal planter fascia from planter fascitis.
Planter fascitis is a common cause for heel pain and could be due to poliarthritis, obesity; flat feet.

H. In Freiberg's disease

The X-ray changes are characteristic showing flattening of metartarsal head.
Initial X ray can be negative in stress fractures but the changes can be seen in delayed X-ray.
MRI is the next study of choice.
In osteonecrosis, X-ray may not show changes in early stages. After sometime sclerosis may appear and later stages OA changes will be superadded.

I. In tarsal tunnel syndrome

This is a compression neuropathy of posterior tibial nerve.
MRI or US is useful when exclusion of mass is indicated.

Arthritis can be evaluated with plain x rays. MRI has a place in detecting early Rhematoid arthritis.
Tendon dysfunction is best evaluated with US and MRI. **Grade (Y)**

1.2.5 Shoulder Joint

Initial study is X-ray Shoulder AP. **Grade (X)**
In OA X ray AP shows osteophytosis, sclerosis, and joint space narrowing. Similar changes can be visible in the acromioclaviccular joint.
When X-ray AP is nondiagnostic but clinically suspected OA X-ray axial view can be done.
Undiagnosed Hill Sachs lesion is best seen in the X ray done with internal rotation of the arm.
Erect comparative view of both shoulders with weights held in both hands is done for suspected acromioclavicular joint subluxation/dislocation.
Suspected SLAP lesion can be first evaluated with US Scan.
In recurrent dislocation X ray AP is done with internal rotation. Next study is MRI.

Clinical condition	X ray axial	MRI scan	US scan	CT scan	MRI Arthro graphy	CT Arthro graphy
Suspected Impinge ment	2nd Ix	4th Ix	3rd Ix	-	5th Ix	-
Suspected Instability	-	2nd Ix	-	-	3rd Ix	4th Ix
Suspected Rotator cuff tear	-	3rd Ix	2nd Ix	-	4th Ix	-

1.2.6 Elbow Joint

Initial study – X-ray/ LAT. **Grade (X)**

Chronic elbow pain may be due to osseous or soft tissue abnormality. X-ray may reveal calcification around the joint, osteochondral lesion, and osteochondritis dissecans and osteocartilaginous body. When the aetiology is uncertain other imaging modalities are considered. MRI is advocated in suspected osteochondral fracture or osteocartilaginous intra-articular body. Direct intra-articular MR arthrography is preferred to routine MRI for diagnosis of intraarticular loose bodie.

MRI gives diagnostic information in collateral ligament injury. X ray may show the calcifications in the collateral ligament.Avulsion of the ligament at insertion site is best evaluated with MRI. In suspected epicondylitis MRI has a place Ultrasound is an alternative to MRI. abnormality of nerve and soft tissue masses around the elbow.

Ultrasound has a role in diagnosing complete and partial tears of distal biceps tendon, flexor and extensor tendon and ligaments. Bursitis can be diagnosed by MRI or ultrasound. MRI is also helpful in evaluating nerve entrapment syndrome. When X-ray is nondiagnostic but suspected nerve entrapment / mass next exam is MRI.Anatomic variations of cubital tunnel retinaculum may contribute to ulnar neuropathy.

Axial T1 Weighted images depicts the size and shape of the nerve and axial T2 Weighted or STIR images may show increased signal in the presence of neuritis. A snapping of the medial head of the triceps can cause recurrent dislocation of the ulnar nerve. US is useful for confirmation of snapping ticeps and for evaluating the ulnar nerve.

Some of the clinical scenarios have been dealt here as follows.

1.2.7 Wrist Joint

X-ray AP, Lat and Oblique views are helpful in imaging of painful wrist to exclude arthritis, complications of injury, infection, bone or soft tissue tumors. Additional views are done in specific conditions. eg. PA Oblique and or PA in ulnar deviation for scaphoid #. **Grade (X)**

Tears of triangular fibro cartilage (TFC) & interosseeous ligaments are diagnosed on arthrography with injection into radiocarpal, midcarpal and distal radial ulnar joint. MRI gives global information about soft tissue and bone. It may be diagnostic in TFC, ligament tears, occult fractures, or avascular necrosis. Direct and indirect MRI arthrograms are useful in ligamental abnormalities and specially for scapholunate abnormalities. **Grade (Y)**

Investigation of some of the clinical conditions after initial X-ay have been shown as follows.

Xray non diagnostic	MRI	CT scan	US Scan	Isotope scan	Arthro -gram	Comment
but pain persists	2nd Ix	-	-	-	-	MRI gives global informatio n.
Suspected arthritis	-	-	-	-	-	Most of the time imaging is not necessary.
but suspected TFC tear	2nd Ix	-	-	-	2nd Ix	Choice of Ix depends on the availabilit y
but suspected Keinbock' s	2nd Ix	sos	-	-	-	CT if MRI is not available
but suspected Occult #	2nd Ix	sos	-	3rd Ix	-	Bone scan may be helpful.M RI detects occult #

in suspected carpal tunnel syndrome MRI be individually assessed. Masses like ganglia are well shown.

1.2.8 Cervical or Lumbar Spine

Initial study is cervical or lumbar spine AP & LAT. **Grade (X)**

Two important categories for causes of chronic pain in the spine are post traumatic and degenerative. Other less comman causes are inflammatory and neoplastic conditions. Presence of chronic pain may be closely related to personality trait, neuroticism, and the presence of previous injury.

Diagnosis of spondylosis is made if osteophytes, disc narrowing and facet diseases present in the X ray .Oblique X rays are decided if root pain is present. MRI gives anatomic details and is the second most important study whenever there are neurological signs.

Clinical problem	MRI	Comment
X ray shows spondilosis, no neurological signs	-	No further study is needed
X ray shows spondilosis and present with neurological signs	2nd Ix	Myelogram or CT myelogram if no access to MRI
X ray is negative. but neurological signs & symptoms present	2nd Ix	Myelogram or CT myelogram if no access to MRI
X ray shows old trauma and now presents with neurological signs & symptoms	2nd Ix	Myelogram or CT myelogram if no access to MRI
X ray shows bone or disc destruction	2nd Ix	Myelogram or CT myelogram if no access to MRI

1.3 Bone and Joint Infection

X ray is useful to show

- Soft tissue swelling,
- Periosteal reaction,
- Destructive foci, involucrum,
- Cloaca and sequestra.

Appearance of these features depends on the time of the infection. Bony changes are seen in the X-ray after two weeks.
US scan is valuable in demonstrating joint effusion and subperiosteal abscess .It is used for guided aspirations. US is very much useful in early stages of the infection.

Grade (Y)

MRI scan accurately demonstrates the changes specially in the spine. **Grade (Y)**
CT scan is valuable in demonstrating sequestra.
Isotope scan finding are nonspecific but useful when there are no localizing signs. Gallium 67 and In 111 labelled white cells may be useful in confirming infection in the bone.

Grade (Z)

1.4 Tumors and masses

1.4.1 Bone Tumors

Initial study is plain X-ray of the area of interest.
Radiograph provides lesion location, matrix mineralization, cortical involvement and periosteal reaction.
CT is better for characterization of matrix mineralization, cortical involvement and periosteal reaction.
MRI gives improved anatomic details, define the nature of the lesion and is sensitive & superior for staging of bone tumors. It is useful to detect invasion of muscle, neurovascular bundle, adjacent fat planes, marrow, intracortical extension, necrosis and hemorrhage. MR spectroscopy has a potential to differentiate benign from malignant lesion.

Grade (Z)

Bone scan is useful in patients with symptoms related to bone or joint with normal X-ray. U/S &CT guided biopsy can be done only after discussion with referring surgeon.

	Isotpe scan	MRI	US scan/ Angio	CT scan	Comment
X ray nondiagnostic but persistant symptoms	-	3rd Ix	-	2nd Ix	MRI provide global information
X ray findings are definitely benign	-	-	-	-	No Ix needed. eg; nonosifying fibroma, fibrous dysplasia etc. But CT or US guided Bx is done for confirmation.
suspected osteoid osteoma	3rd Ix	4th Ix	-	2nd Ix	CT better than MRI.CT identifies nidus and sometimes calcification in the nidus. Bone scan is sensitive but nonspecific
Suspected malignancy on X ray	-	2nd Ix	-	3rd Ix	CT is useful for evaluation of calcification, cortical breech, # & also when MRI is not available.

1.4.2 Soft Tissue Tumors & Masses

Initial study is the X-ray of the area of interest.

X-ray is important as it provides valuable insight to the additional studies. Eg; pleboliths in haemangiomas, Fat density in lipomas etc.
U/S is useful in differentiating cystic from solid lesions. Duplex scan helps to evaluate the vascularity of the mass or its proximity to the vessles. **Grade (Y)**
CT is helpful in evaluation of calcification in soft tissue lesions, suspected myositis ossificans and lipoma. CT also has a place in abdominal/ chest wall lesions where motion artifact is a problem with MRI.
MRI is the technique of choice because of its improved soft tissue contrast and multiple image plane capabilities. Vascular or neurovascular involvement is easily defined. Ability to differentiate benign & malignant lesion by MRI is controversial. But spectroscopy & diffusion weighted images are helpful in differentiating benign from malignant lesions. **Grade (Z)**
Radionuclide scan is not helpful but PET scanning is helpful for follow up of treated lesions.

Grade (Z)

Angiography is done to evaluate vascularity of the lesion and if embolization is indicated before surgery. It is also done in suspected AV malformations and haemangiomas.
U/S &CT is used for guided biopsies.

	Isotope scan	MRI	US scan	CT scan	CT scan contrast	Comment
Xray is non diagnostic	-	3rd Ix	2nd Ix	-	4th Ix	MRI with & without contrast is the most useful CT if MRI contraindicate.
Calcified soft tissue mass in the X ray	-	3rd Ix	2nd Ix	3rd Ix	sos	CT – NC if myositis - ossificans is suspected. Otherwise MRI.
Superficial or near joint mass with or without X ray changes	-	2nd Ix	3rd Ix	-	4th Ix	U/S good substitute for MRI
Abdominal or Chest wall mass	sos	4th Ix	2nd Ix	-	3rd Ix	X-ray important for selecting additional studies
Suspected muscle tear	-	2nd Ix	1st Ix	-	-	

1.4.3 Metastatic Bone Disease

Bone survey (X ray pelvis, spine, CXR) is indicated in an asymptomatic patient with incidental finding of a lytic lesion on X-ray.

When patient gives H/O Ca breast

Present Clinical condition	X-ray	CT	MRI	Isotope Scan	Comment
With back & hip pain	1st Ix	-	-	2nd Ix	Other studies if only indicated
Follow up scan- Single hot lesion in the spine	1st Ix	-	2nd Ix	-	MRI if X ray is negative. CT if MRI is not available.
With 3 hot areas in spine. No back pain	1st Ix	-	2nd Ix	-	MRI if X ray is negative. CT spine if biopsy is needed.
Single hot spot in sternum	1st Ix	2nd Ix	-	-	CT sternum for diagnosis & if biopsy needed.
Known bone metastasis came with path # of femur	-	-	-	1st Ix	Bone scan is to look for other sites

Patient with prostatic carcinorma,

Clinical condition	Isotope Scan	Comments
Prostate nodule on PR, proven well/moderately diff. Ca PSA<20mg and asymptomatic.	-	No imaging necessary
Prostate nodule on physical exam. Proven poorly diff. Ca , asymptomatic.	1st Ix	

Significant proportion of prostatic carcinoma which are poorly differentiated (anaplastic) may not affect PSA. Therefore imaging should not be decided purely by PSA value.

4. Other tumors

Clinical condition	CT-Myelo /US/ Myelo	MRI	Isotope Scan	Comments
1cm lung nodule. Non-small cell ca. for staging & resection.	-	-	1st Ix	To exclude bone metastasis
Multiple myeloma with acute back pain with normal x-ray spine.	3rd Ix	2nd Ix	-	1st Ix is X-ray lumbar spine AP & lat. MRI if neurological symptoms .
Osteosarcoma long bone for staging. Chest CT normal. looking for bone metastasis .	-	-	1st Ix	Asymptomatic metastatic deposits (chance 16%) affects management. But with other 1ry tumors less likely
Osteosarcoma 6 month follow up to rule out bone metastasis.	-	-	1st Ix	can get bone metastasis before lung
Elderly female known 1ry with acute vertebral collapse	3rd Ix	2nd Ix	1st Ix	MRI is helpful to detect spinal cord involvement but - unable to differentiate trauma/osteopenic # from pathological
pregnant with known 1ry now suspected of met metastasis	-	2nd Ix	-	MRI whole body fast STIR is done if available.

Radionucleide bone scan remains the 1ry imaging method in detecting metastasis. It is sensitive but not specific. Now MRI is replacing bone scan for detecting metastatic bone especially in vertebral column.

Cold areas on bone scan can be seen with highly aggressive tumors, multiple myeloma and histioseytisos X. Radiographic surveys are recommended for these patients. Diffuse bony metastasis may show intense uptake (super scan) which mimic negative examination.

In Ca breast, bone scan is useful in stage 2-4 disease. CT is recommended if neddle biopsy is warranted. Cancers which rarely metastasize to bone – eg: cervical, endometrial, bladder & GIT tumors, baseline scan is obtained only in advanced disease.

In suspected Osteosarcoma, whole bone CT is indicated to detect skip lesions and CT chest is done to detect metastasis.

1.5 Osteoporosis

Bone mineral density (BMD) is an underused technique which is beneficial as are mammography, blood pressure and cholesterol testing.

Premenapausal woman, female with H/O fragility fracture and Postmenapausal women without drugs with risks should be investigated.

Dual absorptiometry(DXA) lumbar spine and DXA Proximal femur are the areas of choice for measurement of mineral density.

BMD is used to predict fracture risk. This is important in dicision making process in certain clinical conditions such as estrogen deficiency, vertebral abnormalities, primary hyperparathyroidism, and steroid therapy. In hormone replacement therapy, it determines whether pharmacological intervention is indicated.. Site of the measurement should be the clinician's choice. Total body calcium measurement by DXA has low precision error, low radiation dose, and its capacity to measure multiple sites. Advantage of Quantitative computer tomography (QCT) is that it is widely available and it provides true volumetric measurement but the disadvantages are its high radiation dose, low precision accuracy and speed. Trabacular bone is more metabolicaly active. There is strong association between vertebral fracture and QCT measurement.It is better than DXA in sever scoliosis, hypertropic arthropathy, obese and thin patients.

Peripheral BMD including radiographic absorptiometry (RA) and peripheralDXA and QCT (pDXA and pQCT) are used as screening techniques. Periphereal quantitative US (QUS) was adopted as primary care due to low cost, ease of use and lack of radiation.

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