A GUIDE TO MUSCULOSKELETAL IMAGING FOR MSIV STUDENTS

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BACKGROUND INFORMATION

Although background information is useful, the imaging studies are first interpreted without the clinical history to provide an objective analysis of the imaging findings. The clinical information is then reviewed and correlated with the imaging findings.

Age and Sex of Patient
Prior Surgery? Radiation Therapy? Chemotherapy?
Systemic Disease?
Prior Medications?
Trauma?
Symptomatology
Physical Findings

TERMINOLOGY FOR PRIMARY MODALITIES USED FOR IMAGING MUSCULOSKELETAL DISEASE

Radiography	**Density** normal, increased, decreased
Scintigraphy (Bone Scans)	**Radiotracer uptake** normal, decreased, increased
Sonography (US)	**Echogenicity** anechoic, hypoechoic, hyperechoic
Computed Tomography (CT) without contrast	**Attenuation** normal, low, high
Magnetic Resonance Imaging (MRI) without contrast agent	**Signal Intensity** •hypointense-low signal intensity •hyperintense-high signal intensity •isointense -isointensity
Magnetic Resonance Imaging (MRI) with contrast agent (gadolinium chelates)	**Enhancement** none, homogeneous, heterogeneous

THE ABCDE'S OF MUSCULOSKELETAL IMAGING

Alignment, **A**symmetry
Bone Density
Cartilage, **C**haracteristics, **C**ontour,
Distribution
Erosions, **E**xtent
Soft Tissues

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ALIGNMENT

•Are the bones in alignment, if not, why not?

Joint deformities? Subluxations? Dislocations?
Bone deformities?

ASYMMETRY

Are the bones and soft tissues the same thickness in both extremities?

Example:

In the paralyzed patient, the cortex as seen on the *radiographs.* may be thinned and the bones may appear gracile. In addition, when paralyzed, the muscles may atrophy and show fatty infiltration on radiographs, CT and MRI.

BONE DENSITY

Is the bone density normal, increased or decreased on the *radiographs?*

Decreased bone density

Decreased bone density (generalized)

Examples:

•Systemic disease: e.g. hypothyroidism, Cushing's syndrome
•Effect of systemic steroid therapy
•Malignant bone tumor: diffuse infiltration with multiple myeloma

Decreased bone density (focal area[s]

Examples

•Infection: osteomyelitis
•Primary malignant bone tumor that does not form bone or cartilage; e.g. Ewing sarcoma (child), fibrosarcoma (adult)
•Metastases: lung, kidney, multiple myeloma (men/women), breast (women), neuroblastoma (children)

Increased bone density

Increased bone density (generalized)

Examples

•Fluorosis
•Metastases (breast-women, prostate-men)
•Renal osteodystrophy,
•Sickle cell disease

Increased bone density (focal area[s]

Examples

•Metastases: breast (women); prostate (men)
•Malignant bone tumor: Hodgkin's disease, osteosarcoma
•Benign bone lesion: osteoma, bone island

Increased and decreased bone density in the same region

Examples

•Lymphoma
•Metastases: breast
•Active exacerbation of chronic osteomyelitis

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CARTILAGE

Cartilage is best evaluated on *MR images* (osteochondral defects, chondromalacia) Although cartilage is not visible on *radiographs,* joint space narrowing signifies cartilaginous loss. The adjacent bone should also be carefully evaluated on the *radiographs.*

Examples:

Osteoarthritis: subchondral sclerosis, osteophytes

Rheumatoid arthritis: periarticular osteoporosis and erosions

CHARACTERISTICS

Besides describing the margination, contour, deformities, types of matrix, and periosteal reaction, the radiologist uses terminology to describe to describe the different tissues for each modality-see terminology.

CONTOUR

Fractures

An abrupt change in contour of the cortex on *radiographs* may be the only manifestation of a subtle fracture. *CT* with reconstruction in different planes can help define extent of the fracture. (When a fracture is not seen on the radiograph, bone scan may show a stress fracture. When bone scan is equivocal, MRI may show both the linear fracture and accompanying bone marrow edema).

Tumors

Margination/contour of a tumor on radiographs can give information about its aggressiveness and tumor type

Geographic: non-aggressive tumor

Moth-eaten/permeative: more aggressive tumor

Lobulated suggests a chondroid tumor particularly when associated with chondroid matrix.

Dysplasias

Abnormal contours/deformities may be present.

DISTRIBUTION

What is the distribution of the abnormality? Generalized? Focal?

Examples

Arthritis

What joints are involved?

In the hands and wrists, osteoarthritis most commonly affects DIP and 1st MCP joints; rheumatoid arthritis more commonly affects PIP/MCP joints and wrist.

Fractures

Which bones are fractured? Are the epiphyses involved?

•In infants/children, multiple fractures in specific locations suggests child abuse.

•The configuration/location of the fracture may suggest the mechanism of injury.

Tumors:

Where is the tumor located?

The location may be important for diagnosis and prognosis. Certain tumors are more common in certain locations. Periosteal and juxtacortical tumors have better prognoses than medullary or soft tissue malignancies.

DISTRIBUTION (cont'd)

•Along the length of the bone (epiphysis, physis, metaphysis, diaphysis)?
Diaphysis: lymphoma, Ewing sarcoma, metastasis
Metaphysis: osteosarcoma, giant cell tumor
Epiphysis: chondroblastoma

•Along the width of the bone and/or in the soft tissue (medullary, cortical, periosteal/ subperiosteal, or soft tissues)?
Osteoid osteoma is a benign bone tumor that may cause marked local pain and is most frequently located in the *cortex*.

EROSIONS

Radiographs can detect erosions and are used to follow their progression.
CT can demonstrate small erosions not seen on the radiographs (e.g. sacroiliitis).
Contrast-enhanced MRI shows enhancementwhen the erosions are active (e.g. sacroiliitis).

EXTENT

How extensive is the disease process?
This is important particularly for bone and soft tissue tumors and for infection.
MRI can be used as a guide for the surgical resection.

Tumors
Does the bone tumor invade the soft tissues?
Does the soft tissue tumor invade bone?
Does the soft tissue tumor invade adjacent neurovascular structures?
Does the soft tissue tumor extend into more than one compartment?
Infection
Does the infect
on involve bone? muscle? subcutaneous tissue? tendons?

Bone scans (scintigraphy) show the extent of bone metastases

***CT guidance* can be used for performing biopsies of bone and soft tissue tumors and for osteomyelitis. Both CT and sonographic guidance are used for abscess drainage.**

SOFT TISSUES

***MR imaging* is the best modality for staging soft tissue sarcomas (see Extent) and for evaluating other soft tissue lesions whether secondary to trauma, infection, or inflammation**.

Trauma

Examples
A patient sprains his ankle. *MR imaging* shows ruptured anterior talofibular ligament and soft tissue edema.
A patient twists his knee while playing football and has an anterior drawer sign on clinical examination. *MR imaging* shows not only the suspected anterior cruciate ligament tear but also a meniscal tear, a joint effusion, and contusions of the bone contusion of the lateral femoral condyle and posterior lateral tibial plateau.

SOFT TISSUES (cont'd)

Infection

Example

A patient has tenderness and swelling of his foot and a fever.
MR imaging shows a cellulitis but excludes osteomyelitis.

Tumor

Example:

Soft tissue tumors as discussed above.

Although radiographs usually do not show good soft tissue contrast, one must carefully examine the soft tissues on *all radiographs*. A defect in the soft tissue may be an ulceration in a diabetic patient or a laceration in a patient who has trauma. Extensive air in the soft tissues after a puncture wound may represent gangrene that requires immediate treatment.

US has limited although useful roles for evaluating soft tissue disease. When US demonstrates that a palpable mass is a fluid-filled structure such as a cyst (e.g. popliteal cyst), then no further study is needed. If sonography shows a mass of uncertain etiology, MRI must be done for further evaluation. US can be used to evaluate a single tendon (e.g. Achilles tendon) or a group of tendons (rotator cuff).