Resident Core Curriculum  
Musculoskeletal Radiology

Introduction
There are three key elements for learning musculoskeletal (MSK) radiology. 1.) Daily exposure to high volume of imaging examination and procedures which the resident is directly responsible for (with close supervision). 2.) Attendance and participation in MSK imaging conferences. 3.) Reading assigned “level appropriate” material on MSK radiology covering core MSK topic over the course of the MSK rotation.

Daily Work

1. The residents are an essential part of the MSK imaging service. They are not observers. They are directly responsible for, and an integral part of, all activities relating to MSK imaging and are expected to act accordingly.
2. The residents will interpret radiographs as well as cross-sectional imaging studies during each of their rotations, in a ratio proportional to their level of experience.
3. There are primary and secondary MSK topics for the resident to focus on during each rotation. Focus areas for CT and MR interpretation are defined for each rotation as well.
4. It is expected that the resident will not be absent for more than 25% of the rotation without prior approval from the division director or unless there are extenuating circumstances.
5. Resident conferences will be given by the MSK faculty and fellows as a part of the departmental early morning and noon conference schedule. These sessions will be divided between didactic lectures, covering a "core curriculum" of topics, and case conferences in which a variety of cases will be presented. These conferences will help prepare the resident to function as a consultant to ordering clinicians.
6. To become competent in interpreting MSK imaging studies and performing basic image-guided MSK procedures.

Educational Goals and Objectives (First Year Residents):

University Hospital: MSK reading room

Primary Focus: Radiography and Trauma CT

Radiography
- Skeletal anatomy
- Fractures: recognition, description
- Osseous and soft tissue infection
- A focal osseous lesion
- Arthritis (Basic)

CT/MRI
- Spine trauma (CT)
- Pelvic/extremity fractures (CT)
Cognitive Objectives

At the end of the first MSK rotation, a radiology resident should be able to:

1. Dictate a succinct, precise, typographically free and coherent radiology report
2. Describe pertinent normal MSK anatomy on a radiograph
3. Establish a diagnosis and provide an appropriate description of a fracture involving either the peripheral or axial skeleton
4. Discuss the imaging findings of septic arthritis, osteomyelitis, metastatic diseases, and basic arthritis
5. Discuss the most common modalities used in MSK imaging, the indications and contraindications, and complications of the following:
   1. Radiographs & fluoroscopy
   2. MSK scintigraphy
   3. DEXA
   4. CT
   5. MRI

Affective Objectives

At the end of the 1st MSK rotation, a radiology resident should be able to:

1. Project a professional image
2. Demonstrate empathy and respect towards patients, referring clinicians, radiology personnel, and colleagues
3. Function as a consultant to clinicians for radiographic evaluation of MSK trauma and orthopedic follow-up.
4. Participate actively in the MSK division’s academic program (e.g. teaching medical students on the rotation)
5. Interpret over 50 radiographs/day
6. An evaluation will be given halfway through the rotation. The resident should use this evaluation to improve performance when necessary.

Milestones

Patient Care and Technical Skills
PCTS1: Consultant

- Uses established evidence based guidelines such as ACR appropriateness criteria
- Appropriately use the electronic health record to obtain relevant clinical information

Medical Knowledge
MK1: Protocol Selection and Optimization of Images
- Selecting appropriate protocol

MK2: Interpretation of examinations
• Makes core observations
• Formulate differential diagnoses
• Recognize critical findings
• Differentiate normal from abnormal

Systems Based Practice
SBP1: Quality Improvement (QI)
• Describes departmental QI initiatives and the departmental QA system

SBP2: Health Care Economics
• Generates accurate reports with appropriate elements for coding

Practice Base Learning and Improvement
PBLI1: Patient Safety: Contrast Agents; Radiations Safety; MR Safety; Sedation
• Recognizes and manages contrast reactions
• Describes the mechanism of radiation injury and the ALARA concept

PBLI2: Self-Direct Learning
• Recognizes personal limitations and seeks help when appropriate
• Responds appropriately to constructive criticism

Professionalism
PROF1: Professional Values and Ethics
• Fulfills work related responsibilities
• Maintains patient confidentiality
• Recognizes the importance and priority of patient care and advocates for patient interests

Interpersonal Communication Skills
ICS2: Effective Communication with Members of the Health Care Team
• Communicates information about imaging and examination results in routine, uncomplicated cases
• Communicates urgent and unexpected findings according to department policy

ROTATION 2 (Second Year)
Fontaine: MSK Reading Room (545 Building)
Primary Focus: Radiography; Introduction to MRI and procedures

Radiography
Arthritis (Advanced)
Hardware: normal appearance and complications
Metastases

MRI
Spine, knee, shoulder

Procedures
Fluoro-guided injections: shoulder, hip, knee

Other

- Work with CT/MRI techs for 1 half day
- Work with radiology tech for 1 half day
- Work in procedures for at least 2 half days

Cognitive Objectives
At the end of the 2nd MSK rotation, a radiology resident should be able to:
Discuss the imaging findings and, if indicated, provide an appropriate differential diagnosis for:

1. Articular diseases
2. Orthopaedic hardware: normal appearances
3. Orthopaedic hardware: complications
4. MRI spine, knee and shoulder
5. Discuss MRI safety issues

Affective Objectives
At the end of the second MSK rotation, a radiology resident should be able to:

1. Consolidate the objectives of the first rotation
2. Function as a consultant for MSK imaging studies and for recommending appropriate additional imaging examinations
3. Protocol MRI knee, spine; CT spine
4. Produce clear concise reports not requiring substantial edits
5. Interpret over 60 radiographs and 3 cross sectional exams/day

Milestones
Continues to demonstrates professional behaviors described under Year 1, and the following:

Patient Care and Technical Skills
PCTS1: Consultant
- Recommend appropriate imaging of common conditions independently

PCTS2: Competence in Procedures
- Competently perform basic procedures under indirect supervision
- Recognize and manage complications of basic procedures

Medical Knowledge
MK1: Protocol Selection and Optimization of Images
- Selects appropriate protocols and contrast agent/dose for intermediate imaging
- Describes management options

MK2: Interpretation of Examinations
- Makes secondary observations
- Narrows differential diagnosis

Systems Based Practice
SBP1: Quality Improvement (QI)
- Incorporating QI into clinical practice
- Participates in the QA department process

SBP2: Health Care Economics
- States relative cost of common procedures

Practice Base Learning and Improvement
PBLI1: Patient Safety: Contrast Agents; Radiation Safety; MR Safety; Sedation
- Re-demonstrates recognition and management of contrast reactions
- Accesses resources to determine exam specific average radiation dose info
- Accesses resources to determine safety of implanted devices and retained metal

Professionalism
PROF1: Professional Values and Ethics
- Becomes an effective health care team member

Interpersonal Communication
ICS1: Effective Communication with Patients, Families, and Caregivers
- Communicates under direct supervision in challenging circumstances
- Communicates under direct supervision difficult information such as errors, complications, adverse events, and bad news
- Obtains informed consent

ICS2: Effective Communication with Members of the Health Care Team
- Efficiently generates clear and concise reports that do not require substantive faculty member correction on routine cases
- Adhere to transfer of care policies
- Communicates findings and recommendations clearly and concisely

ROTATION 3 (Third Year)

Fontaine: MSK Reading Room (545 Building)

Primary Focus: MSK MRI; radiographs; additional procedures

Radiography
All including primary bone tumors, metabolic and congenital

MRI
Spine, knee, shoulder plus: pelvis/hips, wrist, ankle, bone/soft tissue tumors

Procedures
Fluoro-guided injections: shoulder, hip, knee, ankle
MSK Biopsy
Cognitive Objectives

At the end of the 3rd MSK rotation, a radiology resident should be able to:

1. Protocol all MRI and CT studies based on the clinical information
2. Interpret with competence MR imaging studies of the spine, knee, shoulder, pelvis/hips, bone/soft tissue lesions
3. Provide an appropriate differential diagnosis for a solitary bone lesion
4. Recognize the imaging findings in common metabolic bone diseases and congenital conditions
5. Perform fluoro-guided injections of the shoulder, hip and knee

Affective Objectives

At the end of the 3rd MSK rotation, a radiology resident should be able to:

1. Act as a consultant on all types of MSK imaging studies
2. Participate actively in the teaching of junior residents, other residents, interns, and medical students
3. Interpret over 70 radiographs and 5 cross sectional exams/day

Milestones

Patient Care and Technical Skills

PCTS1: Consultant
- Recommend appropriate imaging of uncommon conditions independently
- Integrate current research and literature with guidelines to recommend management

PCTS2: Competence in Procedures
- Recognize and manage complications of MSK procedures
- Competently perform shoulder, knee and hip injections

Medical Knowledge

MK1: Protocol Selection and Optimization of Images
- Select appropriate protocols and contrast agent/dose for advanced imaging
- Demonstrate knowledge of physical principles to optimize imaging quality
- Independently modify protocols as determined by clinical circumstances

MK2: Interpretation of Examinations
- Provide accurate, focused, and efficient interpretations
- Prioritize differential diagnoses and recommends management
- Make subtle observations
- Suggest a single diagnosis when appropriate

System-based Practice

SPB1: Quality Improvement (QI)
• Identify and complete a systems based practice project

**SPB2: Health Care Economics**

• Integrate current research and literature with guidelines, taking into consideration cost effectiveness and risk benefit analysis, to recommend imaging

**Practice-based Learning and Improvement**

**PBLI1: Patient Safety; Contrast agents; Radiation Safety; MR safety; Sedation**

• Communicate the relative risk of exam specific radiation exposure to patients and practitioners. Apply principles of image Gently and Wisely
• Select appropriate sedation agent and dose of conscious sedation
• Demonstrate recognition and management of contrast reactions

**Professionalism**

**PROF1: Professional Values and Ethics**

• Serve as a role model for professional behavior

**Interpersonal Communication**

**ICS1: Communication with Patients, Families, and Caregivers**

• Communicate without supervision in challenging circumstances
• Communicate appropriately under stressful situations

**ICS2: Effective Communication with Members of the Health Care Team**

• Efficiently generate clear and concise reports that do not require substantive faculty member correction on all cases
• Is an effective team leader promoting patient welfare and autonomy

**RESOURCES**

**Teachers**

• Dr. Mark Anderson is responsible for the organization and supervision of the MSK Radiology Rotation.
• The teaching of MSK radiology is done by Drs. Bennett Alford, Mark Anderson, Michael Fox, Cree Gaskin, Nicholas Nacey, Jennifer Pierce and the MSK imaging fellows. Pediatric MSK radiology will be taught by both the pediatric and MSK radiologists. CT and MRI of the spine will be taught by both neuro- and MSK radiologists.

**Bibliography**

The sections listed refer to the following texts:


**Greenspan:** Orthopedic Radiology, A Practical Approach. Adam Greenspan. Lippincott


Required Reading:

**Rotation 1**

- **General** Helms (entire text – it’s small!)
- **Trauma** Resnick 789-905
  Greenspan Chapters 2-8
- **Infection** Resnick 713-719
- **Arthritis** Resnick 519-541 (“Target” approach)
  Greenspan

**Rotation 2**

- **Arthritis** Brower (entire text)
- **Hardware** Selected readings
- **MR** Helms & Major - Ch.13,14

**Rotation 3**

- **Tumors** Resnick 1109-1264
  Helms – review “Don’t touch” lesions
- **Metabolic** Resnick 541-589 and 602-623
- **Osteonecrosis** Resnick 1067-1109
- **MR** Helms & Major - chapters 7, 10, 15
  Internal Derangement Resnick 905-995
LEARNING TECHNIQUES

Daily Work

Daily work starts no later than 8:00 AM and finishes not earlier than 5:00 PM.

- Interpretation/dictation of MSK examinations
- Reports: Edit and sign reports by the end of the day.
- The staff radiologist and/or fellow are available at all times for consultation.

Procedures

- Residents (Rotations 2-3) will participate in fluoroscopy-guided procedures at Fontaine under direct supervision of the MSK faculty member or MSK fellow covering the section.

Consultation

- Throughout the day, the resident should greet within 30 seconds and actively assist any referring physician or radiology colleague who enters the reading room for a consultation. The MSK faculty or fellow covering the service will provide back-up if necessary.

Conferences

- In addition to attending the ongoing resident conferences in the radiology department, the residents rotating on MSK imaging are expected to participate in certain MSK conferences that are held during their time on the service. They are also welcome and encouraged to attend any of these conferences during the year.

ROTATION PROGRAM

Daily Work

- When rotating on the MSK service, you are responsible for covering and being present in the MSK reading room from 8 AM to 5 PM daily, with the exception of 11:45 to 1:15 PM for lunch and conference. Any absence for other reasons between 8 AM and 5 PM is to be cleared with the attending covering your service that day.

RESIDENT'S EVALUATION

1. After each rotation, the resident will be evaluated in consensus by the MSK faculty members. The evaluation is based on many parameters including the specific rotation objectives listed above.
2. Rad Primer, 360 evaluations, Discussions in case conferences
3. Mid-rotation evaluation, Exam, Teaching files, Faculty evaluations
ADDENDUM I: Musculoskeletal Pathology Outline

Following completion of 12 weeks of musculoskeletal radiology, residents should be able to discuss:

1. Traumatic osteoarticular lesions of the axial and peripheral skeleton.
   - Classification of fracture type
   - Radiographic findings of a fracture
   - Physiopathology and radiologic correlation of fracture healing
   - Radiographic findings according to anatomic site

2. Articular Disease
   - Classification of articular disease
   - Radiographic findings of articular lesions
   - Physiopathology and radiologic correlation of articular disease:
     - Infections
     - Inflammatory/immune
     - Degenerative
     - Neuropathic
     - Metabolic and endocrine
     - Synovial tumors

3. Benign and malignant bone tumors
   - Classification of bone tumors
   - Radiographic findings of benign and malignant features of bone tumors
     - Characteristics (age, site, location, radiographic findings) of benign and malignant bone tumors

4. Infectious lesions
   - Classification of infections
   - Radiographic and cross-sectional imaging findings of infectious lesions
   - Physiopathology and radiographic correlation of infectious diseases

5. Metabolic and endocrine diseases
   - Classification of osteopenia
   - Radiographic findings of the three forms of diffuse osteopenia
     - Osteoporosis
     - Osteomalacia
     - Hyperparathyroidism
   - Physiopathology and radiographic correlation of diffuse and localized osteopenia
     - Physiopathology and radiographic correlation of endocrine disorders affecting bone
   - Physiopathology and radiographic correlation of hypo and hypervitaminoses
     - Vitamin A
     - Vitamin D
6. Miscellaneous disease entities
   - Paget's disease
   - Reticulo-endothelioses (histiocytosis \(x\)/Langerhans cell histiocytosis)
   - Storage Disease (Gaucher's disease)
   - Ischemic Disease (Osteonecrosis, osteochondrosis)
   - Anemias
   - Marrow disease
     Radiographic findings of these entities
     Physiopathology and radiographic correlation of these entities
     Complications and radiographic findings of these entities

7. Soft tissue lesions
   - Classifications of soft tissue lesions
   - Radiographic findings of soft tissue lesions
   - Physiopathology and radiographic correlations of soft tissue lesions

8. Congenital Syndromes
   - Radiographic findings of:
     - Congenital dislocation of the hip
     - Flat foot and club foot
     - Osteochondrodysplasia
       - Failure of growth of tubular bones and spine
         - achondroplasia
         - spondylo-epiphyseal dysplasia
     - Failure of growth and development of cartilage and fibrous tissue
       - dysplasia epiphysialis hemimelica
       - multiple exostoses
       - enchondromatosis
       - fibrous dysplasia
     - Anomaly in density and modeling
       - osteogenesis imperfecta
       - juvenile osteoporosis
       - osteopetrosis
       - osteopoikilosis
       - melorheostosis
       - diaphyseal dysplasia
     - Dysostosis
       - Klippel Feil
       - Sprengel deformity
   - Marfan syndrome
   - Neurofibromatosis
   - Chromosomal anomalies
     - Turner
     - Trisomy-21
ADDITIONAL REFERENCES

Anatomy


Arthrography

1. Peterson JJ, Imaged-Guided MSK Intervention.

DEXA


Emergency Radiology

1. Harris, The Radiology of Emergency Medicine, Williams & Wilkins.

General MSK:


Orthopaedic Hardware


Pediatrics

1. Ozonoff, Pediatric Orthopedic Radiology, W. B. Saunders and Co.

Trauma


Tumor:

1. Kransdorf M, Murphey M

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