

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 contra-indications, 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:**

PC1:Reporting; **PC2:**Clinical Consulting; **PC3:**Image Interpretation; **PC4:**Competence in procedures

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

Medical Knowledge

MK1:Diagnostic Knowledge; **MK2:**Physics; **MK3:**Protocol selection and contrast agent selecting/dosing; **MK3:**Imaging technology and Image acquisition

- Selecting appropriate protocol
- Makes core observations
- Formulate differential diagnoses
- Recognize critical findings
- Differentiate normal from abnormal

Systems-based Practice

SBP1: Patient Safety; **SBP2:** Quality Improvement; **SBP3:** System navigation for patient-centered care; **SBP4:** Physician role in health care systems; **SBP5:** Contrast agent safety; **SBP6:** Radiation Safety; **SBP7:** Magnetic resonance (MR) safety; **SBP8:** Informatics

- Describes departmental QI initiatives and the departmental QA system
- Generates accurate reports with appropriate elements for coding

Practice-based Learning and Improvement

PBLI1: Evidence-based and informed practice; **PBLI2:** Reflective practice and commitment to professional growth

- Recognizes and manages contrast reactions
- Describes the mechanism of radiation injury and the ALARA concept
- Recognizes personal limitations and seeks help when appropriate
- Responds appropriately to constructive criticism

Professionalism

P1: Professional behavior and ethical principles; **P2:** Accountability/Conscientiousness; **P3:** Self-awareness and help seeking

- Fulfills work related responsibilities
- Maintains patient confidentiality
- Recognizes the importance and priority of patient care and advocates for patient interests

Interpersonal and Communication skills

ICS1: Patient and family-centered communication; **ICS2:** Interpersonal and team communication, **ICS3:** Communication within health care systems

- Communicates information about imaging and examination results in routine, uncomplicated cases
- Communicates urgent and unexpected findings according to department policy

Educational Goals and Objectives (Second Year Residents):

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 demonstrate professional behaviors described under Year 1, and the following:

Patient Care:

PC1:Reporting; **PC2:**Clinical Consulting; **PC3:**Image Interpretation; **PC4:**Competence in procedures

- Recommend appropriate imaging of common conditions independently

- Competently perform basic procedures under indirect supervision
- Recognize and manage complications of basic procedures

Medical Knowledge

MK1:Diagnostic Knowledge; **MK2:**Physics; **MK3:**Protocol selection and contrast agent selecting/dosing; **MK3:**Imaging technology and Image acquisition

- Selects appropriate protocols and contrast agent/dose for intermediate imaging
- Describes management options
- Makes secondary observations
- Narrows differential diagnosis

Systems-based Practice

SBP1: Patient Safety; **SBP2:** Quality Improvement; **SBP3:** System navigation for patient-centered care; **SBP4:** Physician role in health care systems; **SBP5:** Contrast agent safety; **SBP6:** Radiation Safety; **SBP7:** Magnetic resonance (MR) safety; **SBP8:** Informatics Incorporating QI into clinical practice

- Participates in the QA department process
- States relative cost of common procedures

Practice-based Learning and Improvement

PBLI1: Evidence-based and informed practice; **PBLI2:** Reflective practice and commitment to professional growth

- 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

P1: Professional behavior and ethical principles; **P2:** Accountability/Conscientiousness; **P3:** Self-awareness and help seeking

- Becomes an effective health care team member

Interpersonal and Communication skills

ICS1: Patient and family-centered communication; **ICS2:** Interpersonal and team communication, **ICS3:** Communication within health care systems

- 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
- 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

Educational Goals and Objectives (Third & Fourth Year Residents):

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:

PC1:Reporting; **PC2:**Clinical Consulting; **PC3:**Image Interpretation; **PC4:**Competence in procedures

- Recommend appropriate imaging of uncommon conditions independently
- Integrate current research and literature with guidelines to recommend management
- Recognize and manage complications of MSK procedures
- Competently perform shoulder, knee and hip injections

Medical Knowledge

MK1:Diagnostic Knowledge; **MK2:**Physics; **MK3:**Protocol selection and contrast agent selecting/dosing; **MK3:**Imaging technology and Image acquisition

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

Systems-based Practice

SBP1: Patient Safety; **SBP2:** Quality Improvement; **SBP3:** System navigation for patient-centered care; **SBP4:** Physician role in health care systems; **SBP5:** Contrast agent safety; **SBP6:** Radiation Safety; **SBP7:** Magnetic resonance (MR) safety; **SBP8:** Informatics

- Identify and complete a systems based practice project
- 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: Evidence-based and informed practice; **PBLI2:** Reflective practice and commitment to professional growth

- 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

P1: Professional behavior and ethical principles; **P2:** Accountability/Conscientiousness; **P3:** Self-awareness and help seeking

- Serve as a role model for professional behavior

Interpersonal and Communication skills

ICS1: Patient and family-centered communication; **ICS2:** Interpersonal and team communication, **ICS3:** Communication within health care systems

- Communicate without supervision in challenging circumstances
- Communicate appropriately under stressful situations
- 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:

Resnick: Bone and Joint Imaging, 2nd edition. Donald Resnick. W. B. Saunders.

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

Helms: Fundamentals of Skeletal Radiology. Clyde Helms, W.B. Saunders.

Brower: Arthritis in Black and White. Ann Brower. W. B. Saunders

Helms and Major: Musculoskeletal MRI, 2nd edition. Clyde Helms, Nancy Major, Mark Anderson, Phoebe Kaplan, Robert Dussault. W.B. Saunders

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
4. Case logs: E-mail the list of procedures completed during the rotation to Dr. Fox

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

1. Netter FH, Atlas of Human Anatomy, CB_GEIGY
2. Kang HS, Resnick D, MRI of the Extremities an Anatomic Atlas, Saunders.
3. Möller TB, Reif E, MRI Atlas of the Musculoskeletal System, Blackwell Scientific Pub., 1993.

Arthrography

1. Peterson JJ, Imaged-Guided MSK Intervention.

DEXA

1. Lenchik L, Rochmis P, Sartoris DJ. Optimized reporting of dual x-ray absorptiometry (DXA) scans. AJR 1998; 171:1509-1520.

Emergency Radiology

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

General MSK:

1. Resnick & Niwayama, Diagnosis of Bone and Joint Disorders 2nd ed., Saunders, Vols. 1-6.

Orthopaedic Hardware

1. Berquist TH, Imaging Atlas of Orthopedic Appliances and Prostheses, Raven Press, 1995.

Pediatrics

1. Ozonoff, Pediatric Orthopedic Radiology, W. B. Saunders and Co.
2. Taybi, Radiology of Syndromes, Year Book Medical Publishers.

Trauma

1. Rogers LF, Radiology of Skeletal Trauma, Vol. I & II, Churchill Livingstone.

Tumor:

1. Kransdorf M, Murphey M