

MUSCULOSKELETAL RADIOLOGY:
Curriculum, Goals and Objectives, Recommended Reading, Conferences

Goals and Objectives: Musculoskeletal

It is anticipated that the resident will have four rotations of 4 weeks duration. When a resident has additional time in MSK, either at their request or at the recommendation of the staff, the goals and objectives of Rotation IV will apply, but may be tailored to the education needs and goals of the resident in consultation with the MSK Staff.

Rotation I

Knowledge Based Objectives: At the end of the rotation the resident should be able to:

1. Discuss basic bone physiology.
2. Describe the radiographic manifestations that allow for distinction between different forms of arthritis.
3. Describe the radiographic signs that are used to characterize a tumor of bone.
4. Describe the stages of fracture healing.
5. State the indications for Computed Tomography, plain tomography, MRI and bone scans.
6. Describe the imaging protocols for MR of the knee and the shoulder and describe the usefulness of each sequence.

Technical Skills: At the end of the rotation the resident should be able to:

1. Identify, with a high level of accuracy, most types of bone fractures.
2. Recognize the commonly used radiographic projections in musculoskeletal radiology.
3. Identify normal musculoskeletal structures and some of the normal variants.
4. Perform hip and shoulder therapeutic injections.
5. Consistently dictate reports that are clear and accurate.

Decision-Making/Value Judgment Skills: At the end of the rotation the resident should be able to:

1. Given musculoskeletal radiographs that are not diagnostic without further study, state whether the patient should have additional exams in CT, MR, plain film, or nuclear imaging.
2. Given a radiograph of a healing bone fracture, determine the stage of bone healing and identify complications, if present.

General Competencies:

At the end of the rotation the resident should be able to:

Patient Care

Residents must be able to provide patient care that is compassionate, appropriate, and effective for the diagnosis and treatment of health problems.

- Communicate effectively
- Demonstrate caring and respectful behaviors when interacting with patients and their families.
- Gather essential and accurate medical and radiologic history pertinent to the procedure for which the patient is scheduled or for the examination that the patient has had.
- Communicate with the technologists about additional views/sequences/parameters needed to demonstrate pathology.
- Learn to perform hip and shoulder basic therapeutic procedures.
- Work with health care professionals, including those from other disciplines, to provide patient-focused care.

Assessment

- Global ratings by faculty
- 360 degree review from Technologists
- Evidence of accomplishments in the learning portfolio

Medical Knowledge

Residents must demonstrate knowledge about established and evolving biomedical, clinical, and cognate sciences and the application of this knowledge to patient care.

During this rotation, residents are expected to:

- Learn the normal musculoskeletal plain film anatomy
- Begin to learn normal musculoskeletal MR anatomy
- Begin to learn to interpret plain radiographs, CTs, MRIs, of the musculoskeletal system
- Learn the radiographic manifestations of common disease entities seen in the above studies

- Evaluate orthopedic follow-up imaging and discuss the imaging findings of post-operative orthopedic hardware complications.
- Demonstrate knowledge of levels of ionizing radiation related to specific imaging modalities and procedures and employ measures to minimize radiation dose to patient.
- Be knowledgeable of the indications and uses of contrast media in MSK imaging.
- Know how to obtain consent for contrast by demonstrating knowledge of:
 1. when to use contrast and the different types
 2. how to manage the spectrum of contrast reactions should they occur
 3. how to appropriately administer the contrast agent
- Attend Rheumatology and be prepared to discuss recent cases, as well as using the information from conference to tailor patient exams.

Assessment

- Global ratings by faculty
- ACR in-training examination
- Evidence of accomplishments in the learning portfolio

Practice-Based Learning and Improvement

Residents must be able to investigate and evaluate their patient care practices, appraise and assimilate scientific evidence, and improve their patient care practices. Residents are expected to:

- Apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on the diagnostic effectiveness of plain films, CT, MRI, fluoroscopic procedures and ultrasound and their role in the clinical care of the patient
- Use information technology to manage information, access on-line medical information, and support their own education
- Facilitate the learning of students and other health care professionals (medical students, residents from other disciplines, and college students will periodically rotate through MSK)
- Locate, appraise, and assimilate evidence from scientific studies
- Maintain a personal procedure log
- Demonstrate knowledge and use of medical informatics in patient care and education

Assessment

- Global ratings by faculty
- 360 degree assessment by Core supervising technologist
- Evidence of accomplishments in the learning portfolio

Interpersonal and Communication Skills

Residents must be able to demonstrate interpersonal and communication skills that result in effective information exchange with technologists, referring physicians, and other medical personnel. Residents are expected to:

- Work professionally and effectively with other health care professionals, including technologists, secretaries, schedulers, nurses, students, residents, and physicians
- Interact effectively and sensitively with patients, and with family members of patients, by greeting them appropriately, introducing themselves and their role, explaining the procedure to be performed, allowing them an opportunity to ask questions, obtaining informed consent when indicated, and discussing results as indicated
- Communicate findings effectively with the referring clinicians
- Communicate and document the communication of critical findings with the appropriate medical personnel in a timely fashion

Assessment

- Global ratings by faculty
- 360 degree evaluation
- Evidence of accomplishments in the learning portfolio

Professionalism

Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient and professional population. Residents are expected to:

- Demonstrate respect, compassion, and integrity
- Display appropriate grooming and dress habits
- Maintain an appropriate professional demeanor and bearing
- Demonstrate a commitment to excellence and on-going educational and professional development
- Demonstrate a commitment to ethical principles pertaining to provision or withholding of clinical care, confidentiality of patient information, and business practices
- Demonstrate sensitivity and responsiveness to patients' culture, age, gender, and disabilities

Assessment

- Global ratings by faculty
- Attendance at rheumatology conferences with logs as necessary
- Evidence of accomplishments in the learning portfolio

Systems-Based Practice

Residents must demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value. Residents are expected to:

- Understand how their professional practice affects other health care professionals, the health care organization and the larger society, and how these elements affect their own practice
- Assist referring clinicians in providing cost-effective health care
- Practice cost-effective health care and resource allocation that does not compromise quality of care
- Be prepared to evaluate the request for imaging as regards cost, effectiveness, and appropriateness, and to facilitate performance of an alternative study if indicated
- Know the charge for routine examinations including MR of the knee, x-ray of the spine, total body bone scan, and CT of the pelvis
- Begin to become familiar with ACR Appropriateness Criteria as it applies to MSK radiology

Assessment

- Global ratings by faculty
- Evidence of accomplishments in the learning portfolio

Rotation II:

Knowledge-Based Objectives: At the end of the rotation the resident should be able to:

1. Describe patterns of internal derangement of the joints and associated findings on MR, CT and arthrography. This would include primarily the knee and shoulder and, to a lesser extent, the elbow, ankle, and wrist (e.g., a TFC tear of the wrist). A deeper knowledge of internal derangement of the elbow, ankle, and wrist will be expected on Rotation III.
2. Name and differentiate between various forms of arthritis. Be able to discuss each type of arthritis in terms of typical radiographic signs. Use Brower's book as a guide.
3. State the radiographic features that differentiate aggressive and nonaggressive bone tumors.
4. Name and describe clinical/pathological/radiological features of congenital and acquired bone pathologies.
5. Identify common complications of arthroplasty.

Technical Skills: By the end of the rotation the resident should be able to:

1. Given an appropriate radiograph, identify the following categories of bone pathology:
 - a. inflammatory process
 - b. bone tumors
 - c. congenital and acquired diseases
 - d. metabolic diseases
2. Given a radiograph demonstrating bone pathology listed in #1 above and pertinent clinical/pathological information, identify common pathologies in each category.
3. Demonstrate increasing skill in quality and quantity of dictation of musculoskeletal images.
4. Aspirate a hip, knee, or shoulder without assistance.

Decision-Making/Value Judgment Skills: At the end of the rotation the resident should be able to:

1. Given a patient with a musculoskeletal pathology, review radiographs and clinical history, then make a decision about the appropriateness of nuclear, CT, and/or MR imaging.

General Competencies:

At the end of the rotation the resident should be able to:

Patient Care

Residents must be able to provide patient care that is compassionate, appropriate, and effective for the diagnosis and treatment of health problems. Residents are expected to:

- Communicate effectively and demonstrate caring and respectful behaviors when interacting with patients and their families.
- Gather essential and accurate medical and radiologic history pertinent to the procedure for which the patient is scheduled or for the examination that the patient has had.
- Learn to perform MSK procedures done under fluoroscopic guidance.
- Work with health care professionals, including those from other disciplines, to provide patient-focused care.
- Recognize the indications, contraindications, risks, benefits and alternatives of the various MSK studies and procedures.
- Know the indications for and uses of intravenous iodinated contrast material and gadolinium.
- Be able to properly manage a contrast reaction.

Assessment

- Global ratings by faculty
- 360 degree review including Supervising Technologists
- Evidence of accomplishments in the learning portfolio

Medical Knowledge

Residents must demonstrate knowledge about established and evolving biomedical, clinical, and cognate sciences and the application of this knowledge to patient care. During this rotation, residents are expected to:

- Learn the normal musculoskeletal plain film, MR, and ultrasound anatomy
- Learn to interpret plain radiographs, CTs, MRIs, and ultrasound of the musculoskeletal system
- Learn to interpret MSK fluoroscopic studies
- Learn the radiographic manifestations of common disease entities seen in the above studies
- Be able to protocol MSK CT examinations. Be familiar with routine MRI protocols for imaging of the most frequently imaged joints
- Apply knowledge of basic MRI (principles, artifacts and their correction, and parameter manipulation) to the practice of MRI by observing studies being performed.
- Attend Rheumatology conferences and be prepared to discuss recent cases, as well as using the information from conference to tailor patient exams.

Assessment

- Global ratings by faculty
- ACR in-training examination
- Evidence of accomplishments in the learning portfolio

Practice-Based Learning and Improvement

Residents must be able to investigate and evaluate their patient care practices, appraise and assimilate scientific evidence, and improve their patient care practices. Residents are expected to:

- Apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on the diagnostic effectiveness of plain films, CT, MRI, fluoroscopic procedures and ultrasound and their role in the clinical care of the patient
- Use information technology to manage information, access on-line medical information, and support their own education
- Facilitate the learning of students and other health care professionals (medical students, residents from other disciplines, and college students will periodically rotate through MSK)
- Locate, appraise, and assimilate evidence from scientific studies

- Maintain a personal procedure log
- Demonstrate knowledge and use of medical informatics in patient care and education

Assessment

- Global ratings by faculty
- 360 degree evaluation
- ACR in-service exam
- Evidence of accomplishments in the learning portfolio

Interpersonal and Communication Skills

Residents must be able to demonstrate interpersonal and communication skills that result in effective information exchange with technologists, referring physicians, and other medical personnel. Residents are expected to:

- Work professionally and effectively with other health care professionals, including technologists, secretaries, schedulers, nurses, students, residents, and physicians
- Interact effectively and sensitively with patients, and with family members of patients, by greeting them appropriately, introducing yourself and your role, explaining the procedure to be performed, allowing them an opportunity to ask questions, obtaining informed consent when indicated, and discussing results as indicated
- Communicate findings effectively with the referring clinicians
- Communicate and document the communication of critical findings with the appropriate medical personnel in a timely fashion
- Learn the ACR standards and guidelines for communication (acr.org). Provide direct communication to the referring physician when there is an urgent or unexpected finding and document this communication in the radiology report.

Assessment

- Global ratings by faculty
- 360 degree evaluation
- Evidence of accomplishments in the learning portfolio

Professionalism

Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient and professional population. Residents are expected to:

- Demonstrate respect, compassion, and integrity
- Display appropriate grooming and dress habits
- Maintain an appropriate professional demeanor and bearing

- Demonstrate a commitment to excellence and on-going educational and professional development
- Demonstrate a commitment to ethical principles pertaining to provision or withholding of clinical care, confidentiality of patient information, and business practices
- Demonstrate sensitivity and responsiveness to patients' culture, age, gender, and disabilities

Assessment

- Global ratings by faculty
- Attendance at rheumatology conferences with logs as necessary
- Place evidence of your accomplishments in your department portfolio

Systems-Based Practice

Residents must demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value. Residents are expected to:

- Understand how their professional practice affects other health care professionals, the health care organization and the larger society, and how these elements affect their own practice
- Assist referring clinicians in providing cost-effective health care
- Practice cost-effective health care and resource allocation that does not compromise quality of care
- Be prepared to evaluate the request for imaging as regards cost, effectiveness, and appropriateness, and to facilitate performance of an alternative study if indicated
- Know the charge for routine examinations including MR of the knee, x-ray of the spine, total body bone scan, and CT of the pelvis
- Become familiar with the ACR Appropriateness Criteria

Assessment

- Global ratings by faculty
- ACR in-training exam
- Evidence of accomplishments in the learning portfolio

Rotation III:

Knowledge-Based Objectives: At the end of the rotation the resident should be able to:

1. Describe patterns of internal derangement of the joints and associated findings on MR, CT and arthrography. At this stage this would include the wrist, elbow, and ankle in addition to the knee and shoulder.
2. Name and describe clinical/pathological/radiological features of metabolic bone diseases.

3. Describe the radiographic features of inflammatory bone/joint diseases.
4. Identify common fractures and discuss reduction and routine fixation.

Technical Skills: By the end of the rotation the resident should be able to:

1. Protocol routine MR examinations including:
 - knee
 - shoulder
 - ankle
 - wrist
 - tumor and infection
2. Demonstrate increasing skill in quality and quantity of dictation of musculoskeletal images.
3. Create MPR and 3D reconstructions of CT data sets with special attention to CT of the fractured pelvis and acetabulum.
4. Aspirate a hip, knee, or shoulder without assistance. (This skill should ideally have been acquired by the end of Rotation II and should be maintained throughout Rotation III.)

Decision-Making/Value Judgment Skills: At the end of the rotation the resident should be able to:

Given imaging studies of a patient, discuss the findings and clinical significance clearly and concisely, offer an opinion regarding diagnosis, and suggest appropriate additional imaging if needed.

General Competencies:

At the end of the rotation the resident should be able to:

Patient Care

Residents must be able to provide patient care that is compassionate, appropriate, and effective for the diagnosis and treatment of health problems. Residents are expected to:

- Communicate effectively and demonstrate caring and respectful behaviors when interacting with patients and their families.
- Gather essential and accurate medical and radiologic history pertinent to the procedure for which the patient is scheduled or for the examination that the patient has had.
- Learn to perform MSK fluoroscopic procedures.

- Take Responsibility for all MSK procedures include preprocedural patient management. This includes review of the patient's history, pre-procedure laboratory values, and imaging studies.
- Obtain informed consent following a discussion with the patient and/or family or representative about the risks, benefits and alternatives of the procedure.
- Write a brief pre-procedure note in the patient record.
- Following the procedure and prior to discharge, evaluate all outpatients and document appropriately in the patient record.
- Identify any complication, discuss it with the MSK attending and document it in the patient record.
- Work with health care professionals, including those from other disciplines, to provide patient-focused care.

Assessment

- Global ratings by faculty
- 360 degree review with Core Supervising Technologists' input
- Evidence of accomplishments in the learning portfolio

Medical Knowledge

Residents must demonstrate knowledge about established and evolving biomedical, clinical, and cognate sciences and the application of this knowledge to patient care. During this rotation, residents are expected to:

- Learn the normal musculoskeletal plain film, MR, and ultrasound anatomy
- Learn to interpret plain radiographs, CTs, MRIs, and ultrasound of the musculoskeletal system
- Learn to interpret MSK fluoroscopic studies
- Learn the radiographic manifestations of common disease entities seen in the above studies
- Act as the primary consultant for radiographic and CT evaluation of MSK pathology and for planning of MSK imaging to solve a particular problem.
- Attend Rheumatology conferences and be prepared to discuss recent cases, as well as using the information from conference to tailor patient exams.

Assessment

- Global ratings by faculty
- ACR in-training examination
- ABR exam
- Evidence of accomplishments in the learning portfolio

Practice-Based Learning and Improvement

Residents must be able to investigate and evaluate their patient care practices, appraise and assimilate scientific evidence, and improve their patient care practices. Residents are expected to:

- Apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on the diagnostic effectiveness of plain films, CT, MRI, fluoroscopic procedures and ultrasound and their role in the clinical care of the patient
- Use information technology to manage information, access on-line medical information, and support their own education
- Facilitate the learning of students and other health care professionals (medical students, residents from other disciplines, and college students will periodically rotate through MSK)
- Locate, appraise, and assimilate evidence from scientific studies
- Maintain a personal procedure log
- Demonstrate knowledge and use of medical informatics in patient care and education
- Participate in the education of medical students rotating through the department

Assessment

- Global ratings by faculty
- ABR exam
- ACR in-training exam
- Evidence of accomplishments in the learning portfolio

Interpersonal and Communication Skills

Residents must be able to demonstrate interpersonal and communication skills that result in effective information exchange with technologists, referring physicians, and other medical personnel. Residents are expected to:

- Work professionally and effectively with other health care professionals, including technologists, secretaries, schedulers, nurses, students, residents, and physicians
- Interact effectively and sensitively with patients, and with family members of patients, by greeting them appropriately, introducing yourself and your role, explaining the procedure to be performed, allowing them an opportunity to ask questions, obtaining informed consent when indicated, and discussing results as indicated
- Communicate findings effectively with the referring clinicians
- Communicate and document the communication of critical findings with the appropriate medical personnel in a timely fashion

Assessment

- Global ratings by faculty
- 360 degree evaluation

- ABR exam
- Evidence of accomplishments in the learning portfolio

Professionalism

Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient and professional population. Residents are expected to:

- Demonstrate respect, compassion, and integrity
- Display appropriate grooming and dress habits
- Maintain an appropriate professional demeanor and bearing
- Demonstrate a commitment to excellence and on-going educational and professional development
- Demonstrate a commitment to ethical principles pertaining to provision or withholding of clinical care, confidentiality of patient information, and business practices
- Demonstrate sensitivity and responsiveness to patients' culture, age, gender, and disabilities
- Serve as a role model for 1st and 2nd year radiology residents, medical students, and residents in other specialties.

Assessment

- Global ratings by faculty
- 360 degree evaluation
- Attendance at rheumatology conferences with logs as necessary
- Place evidence of your accomplishments in your department portfolio

Systems-Based Practice

Residents must demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value. Residents are expected to:

- Understand how their professional practice affects other health care professionals, the health care organization and the larger society, and how these elements affect their own practice
- Assist referring clinicians in providing cost-effective health care
- Practice cost-effective health care and resource allocation that does not compromise quality of care
- Be prepared to evaluate the request for imaging as regards cost, effectiveness, and appropriateness, and to facilitate performance of an alternative study if indicated
- Know the charge for routine examinations including MR of the knee, x-ray of the spine, total body bone scan, and CT of the pelvis
- Be familiar with the ACR Appropriateness Criteria (<http://www.acr.org>)

Assessment

- Global ratings by faculty
- 360 degree assessment
- Evidence of accomplishments in the learning portfolio

Rotation IV:

Knowledge-Based Objectives: At the end of the rotation the resident should be able to:

1. Describe patterns of internal derangement of the joints and associated findings on MR, CT, and arthrography.
2. Identify, name, and differentiate between various forms of arthritis.
3. Identify, name, and describe clinical/pathological/radiological features of congenital and acquired bone pathologies.
4. Identify, name, and describe clinical/pathological/radiological features of metabolic bone diseases.

Technical Skills: By the end of the rotation the resident should be able to:

1. Demonstrate increasing skill in quality and quantity of dictation of musculoskeletal images.

Decision-Making/Value Judgment Skills:

1. Given imaging studies of a patient, discuss the findings and clinical significance clearly and concisely, offer an opinion regarding diagnosis, and suggest appropriate additional imaging if needed.

General Competencies:

At the end of the rotation the resident should be able to:

Patient Care

Residents must be able to provide patient care that is compassionate, appropriate, and effective for the diagnosis and treatment of health problems. Residents are expected to:

- Communicate effectively and demonstrate caring and respectful behaviors when interacting with patients and their families.
- Gather essential and accurate medical and radiologic history pertinent to the procedure for which the patient is scheduled or for the examination that the patient has had.

- Confirm that the MSK imaging study requested is appropriate. If necessary, suggest alternative studies to the referring physician.
- Learn to perform MSK fluoroscopic procedures, as well as other procedures routinely done under fluoroscopic guidance.
- Take Responsibility for all MSK procedures include preprocedural patient management. This includes review of the patient's history, pre-procedure laboratory values, and imaging studies.
- Obtain informed consent following a discussion with the patient and/or family or representative about the risks, benefits and alternatives of the procedure.
- Write a brief pre-procedure note in the patient record.
- Following the procedure and prior to discharge, evaluate all outpatients and document appropriately in the patient record.
- Identify any complication, discuss it with the MSK attending and document it in the patient record.
- Work with health care professionals, including those from other disciplines, to provide patient-focused care.

Assessment

- Global ratings by faculty
- 360 degree review with Core Supervising Technologists' input
- Evidence of accomplishments in the learning portfolio

Medical Knowledge

Residents must demonstrate knowledge about established and evolving biomedical, clinical, and cognate sciences and the application of this knowledge to patient care. During this rotation, residents are expected to:

- Learn the normal musculoskeletal plain film, MR, and ultrasound anatomy
- learn to interpret plain radiographs, CTs, MRIs, and ultrasound of the musculoskeletal system
- Learn to interpret MSK fluoroscopic studies
- Learn the radiographic manifestations of common disease entities seen in the above studies
- Be able to protocol and supervise routine and advanced imaging studies.
- Attend Rheumatology conferences and be prepared to discuss recent cases, as well as using the information from conference to tailor patient exams.
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Assessment

- Global ratings by faculty
- • ACR in-training examination
- Computer-based ABR examination
- Evidence of accomplishments in the learning portfolio

Practice-Based Learning and Improvement

Residents must be able to investigate and evaluate their patient care practices, appraise and assimilate scientific evidence, and improve their patient care practices. Residents are expected to:

- Apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on the diagnostic effectiveness of plain films, CT, MRI, fluoroscopic procedures and ultrasound and their role in the clinical care of the patient
 - Use information technology to manage information, access on-line medical information, and support their own education
 - Facilitate the learning of students and other health care professionals (medical students, residents from other disciplines, and college students will periodically rotate through MSK)
 - Locate, appraise, and assimilate evidence from scientific studies
 - Maintain a personal procedure log
 - Demonstrate knowledge and use of medical informatics in patient care and education
- Participate in the education of medical students rotating through the department.

Assessment

- Global ratings by faculty
- ACR in-training exam

- Evidence of accomplishments in the learning portfolio

Interpersonal and Communication Skills

Residents must be able to demonstrate interpersonal and communication skills that result in effective information exchange with technologists, referring physicians, and other medical personnel. Residents are expected to:

- Work professionally and effectively with other health care professionals, including technologists, secretaries, schedulers, nurses, students, residents, and physicians
- Interact effectively and sensitively with patients, and with family members of patients, by greeting them appropriately, introducing yourself and your role, explaining the procedure to be performed, allowing them an opportunity to ask questions, obtaining informed consent when indicated, and discussing results as indicated
- Communicate findings effectively with the referring clinicians
- Communicate and document the communication of critical findings with the appropriate medical personnel in a timely fashion

- Obtain informed consent, including a discussion of the risks, benefits and alternatives of a particular MSK imaging study or procedure.
- Create a clear and informative radiology report that is concise but contains all pertinent information.

Assessment

- Global ratings by faculty
- 360 degree evaluation
- ACR In-service examination
- ABR computer-based exam
- Evidence of accomplishments in the learning portfolio

Professionalism

Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient and professional population. Residents are expected to:

- Demonstrate respect, compassion, and integrity
- Display appropriate grooming and dress habits
- maintain an appropriate professional demeanor and bearing
- Demonstrate a commitment to excellence and on-going educational and professional development
- Demonstrate a commitment to ethical principles pertaining to provision or withholding of clinical care, confidentiality of patient information, and business practices
- Demonstrate sensitivity and responsiveness to patients' culture, age, gender, and disabilities
- Serve as a role model for 1st, 2nd, and 3rd year radiology residents, medical students, and residents in other specialties.
- Demonstrate excellence by performing responsibilities at the highest level and continue active learning throughout one's career.

Assessment

- Global ratings by faculty
- 360 degree evaluation
- Attendance at rheumatology conferences with logs as necessary
- Evidence of accomplishments in the learning portfolio

Systems-Based Practice

Residents must demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value. Residents are expected to:

- Understand how their professional practice affects other health care professionals, the health care organization and the larger society, and how these elements affect their own practice
- Assist referring clinicians in providing cost-effective health care
- Practice cost-effective health care and resource allocation that does not compromise quality of care
- Be prepared to evaluate the request for imaging as regards cost, effectiveness, and appropriateness, and to facilitate performance of an alternative study if indicated
- Know the charge for routine examinations including MR of the knee, x-ray of the spine, total body bone scan, and CT of the pelvis
- Be familiar with Musculoskeletal radiology Appropriateness Criteria

Assessment

- Global ratings by faculty
- 360 degree assessment
- Place evidence of your accomplishments in your department portfolio
- Systems Based Practice Skills
- Demonstrate knowledge of basic management principles such as record keeping and medical records

Recommended Reading:

Recommended and required reading for first year residents:

Required:

1. All first year residents are expected to complete the web based tutorial on “Skeletal Trauma” from the University of Virginia (<http://www.med-ed.virginia.edu/courses/rad/ext/index.html>) during the first six months of residency.
2. The chapters on musculoskeletal radiology in any general Radiology textbook. Either Brandt and Helms, “Fundamentals of Diagnostic Radiology” or Paul & Juhl's “Essentials of Radiologic Imaging” would be fine. An on-line version of Paul and Juhl is available for free on the library website.
3. Resnick, Donald and Kransdorf, Mark. **Bone and Joint Imaging**. 3rd ed. (this is the single volume smaller version) copy in resident library collection, selected chapters
 - a. Chapter 15. Rheumatoid Arthritis and the Seronegative Spondyloarthropathies: Radiographic and Pathologic Concepts
 - b. Chapter 29. Degenerative Diseases of Extraspinal Locations
 - c. Chapter 30. Degenerative Diseases of the Spine
4. Rogers, **Radiology of Skeletal Trauma**, (the green book)
 - a. Chapter 4: Description and Detection of Fractures. pp 45-108.

- b. Other sections as appropriate.
5. Review papers on topics of interest are available at the Radiology website. During the first rotation, the papers reviewing shoulder and hip arthroplasty are strongly recommended as are the papers on inflammatory and degenerative arthritis.

Recommended textbooks for residents in the more advanced rotations

(in addition to the suggested texts from the beginning rotation)

1. Bone and Joint Imaging. Donald Resnick, and Mark Kransdorf. 3rd Edition Elsevier/Saunders; 2004.
2. Diagnosis of Bone and Joint Disorders. Donald Resnick. 4th Edition. WB Saunders; 2002.
3. Musculoskeletal MRI. Phoebe A. Kaplan, Robert Dussault, Clyde A. Helms, Mark Anderson. 1st Edition. WB Saunders; 2001.
4. Musculoskeletal Imaging Companion. Thomas Berquist. 1st Edition. Lippincott, Williams, and Wilkins; 2002.
5. Diagnostic Imaging: Orthopaedics. David Stoller, Phillip Tirman, and Miriam Bredella. WB Saunders; 2003.
6. Differential Diagnosis of Tumors and Tumor-Like Lesions of Bones and Joints. Adam Greenspan and Wolfgang Remagen. 1st Edition. Lippincott, Williams, and Wilkins; 1998.
7. Imaging of Soft Tissue Tumors. Mark J. Kransdorf and Mark D. Murphey. Lippincott Williams & Wilkins; 2 edition (May 1, 2006)

Curriculum

The following curriculum guide comprises a list of subjects which are important to a thorough understanding of disorders that affect the musculoskeletal system. This list provides the practicing radiologists with the fundamentals needed to be valuable consultants to orthopedic surgeons, rheumatologists, and other referring physicians. It also serves as a “study” for diagnostic radiology residents.

Knowledge-Based Objectives:

1. Aspects of Basic Science Related to Bone
 - a. Histogenesis of developing bone
 - i. Intramembranous ossification
 - ii. Endochondral ossification
 - iii. Remodeling
 - b. Bone anatomy
 - i. Cellular constituents
 1. Osteoblasts
 2. Osteoclasts
 - ii. Noncellular constituents
 1. Organic matrix
 2. Inorganic matrix
 - c. Bone physiology
 - i. Mineralization of bone
 - ii. Calcium homeostasis
 - iii. Bone resorption
 - iv. Bone formation
 - v. Humoral regulation
 1. Parathyroid hormone
 2. Calcitonin
 3. Vitamin D
 4. Other humoral factors
 - d. Regional anatomy to include bony, marrow, cartilage, ligamentous, musculotendinous, neural, vascular, lymphatic, and fatty constituents.
2. Techniques Relevant to Musculoskeletal Radiology
 - a. Radiography
 - i. Routine views
 - ii. Specialized views
 - b. Computed tomography
 - c. Magnetic resonance imaging
 - d. Fluoroscopy
 - e. Conventional tomography
 - f. Ultrasonography

- g. Densitometry
- h. Leg length or axis determination
- i. Bone age determination
- j. Interventional procedures

- i. General considerations

Evaluation of patients for interventional procedures requires a knowledge of appropriate indications and contraindications, objectives, alternatives, and possible complications. Coordination with the referring physician is essential to ensure appropriate patient selection and, for biopsy, appropriate approach.

- ii. Arthrography, major joints

1. Shoulder
2. Hip (including prosthesis evaluation)
3. Wrist (radiocarpal joint)
4. Wrist (midcarpal joint, distal radioulnar joint)
5. Spinal facet
6. Sacroiliac
7. Knee
8. Elbow
9. Ankle

- iii. Percutaneous biopsy

1. Presumed metastases
2. Presumed primary tumors

3. Normal Features and Variants

- a. Sequence of ossification at joints (e.g., elbow)
- b. Physiologic radiolucencies
- c. Bone island (enostosis)
- d. Vascular channels
 - i. Nutrient canal in phalanx or long bone cortex
 - ii. Vertebral body
 - iii. Scapula
 - iv. Iliac bone
- e. Normal sulci
 - i. Preauricular sulcus (paraglenoid fossa)
 - ii. Rhomboid fossa
- f. Supracondylar process
- g. Dorsal defect of patella
- h. Epiphyseal ossification from multiple centers (e.g., bipartite patella)
- i. Irregular epiphyseal ossification (e.g., Meyer dysplasia)
- j. Periosteal reaction of infancy
- k. Physiologic bowing
- l. Transverse (growth) line
- m. Vacuum joint

4. Congenital and Developmental Abnormalities of the Spine

- a. Os odontoideum
- b. Klippel-Feil
- c. Sprengel deformity
- d. VATER association
- e. Vertebral anomaly (e.g., butterfly vertebra, hemivertebra)
- f. Spinal dysraphism, meningomyelocele
- g. Diastematomyelia
- h. Caudal regression syndrome including sacral agenesis
- i. Schmorl node
- j. Scheuermann disease
- k. Limbus vertebra
- l. Scoliosis

5. Congenital Anomalies and Dysplasias (Basic)

- a. Developmental dysplasia of the hip
- b. Proximal femoral focal deficiency
- c. Blount disease
- d. Discoid meniscus
- e. Foot deformity
 - i. Tarsal coalition
 - ii. Talipes equinovarus (clubfoot)
 - iii. Pes planus
 - iv. Pes cavus
 - v. Metatarsus adductus varus
 - vi. Vertical talus
 - vii. Rocker-bottom foot
- f. Congenital pseudarthrosis
- g. Madelung deformity
- h. Pectus excavatum
- i. Pectus carinatum
- j. Asphyxiating thoracic dysplasia (Jeune)
- k. Thanatophoric dwarfism
- l. Achondroplasia
- m. Chondrodysplasia punctata (stippled epiphyses)
- n. Chondroectodermal dysplasia (Ellis-van Creveld)
- o. Cleidocranial dysplasia (dysostosis)
- p. Spondyloepiphyseal dysplasia
- q. Multiple epiphyseal dysplasia
- r. Dysplasia epiphyseal hemimelica
- s. Osteogenesis imperfecta
- t. Osteopetrosis
- u. Pyknodysostosis
- v. Osteopoikilosis
- w. Melorheostosis
- x. Osteopathia striata
- y. Diaphyseal dysplasia

- i. Engelmann
- ii. Van Buchem
- z. Metaphyseal dysplasia (Pyle)
- aa. Pachydermoperiostosis
- bb. Nail-patella syndrome
- cc. Holt-Oram
- dd. Macrodystrophia lipomatosa
- ee. Fibrodysplasia (myositis) ossificans progressive mucopolysaccharidosis (general findings)
- ff. Neurofibromatosis
- gg. Tuberous sclerosis
- hh. Trisomy 21 (Down syndrome)
- ii. Marfan syndrome
- jj. Ehlers-Danlos syndrome
- kk. Turner syndrome

6. Congenital Anomalies and Dysplasias (Advanced)

- a. Achondrogenesis
- b. Hypochondroplasia
- c. Pseudoachondroplastic dysplasia
- d. Diastrophic dwarfism
- e. Metatrophic dwarfism
- f. Mesomelic dwarfism
- g. Spondylometaphyseal dysplasia
- h. Metaphyseal chondrodysplasia (dysostosis)
- i. Dyschondrosteosis
- j. Idiopathic osteolysis (Hajdu-Cheney)
- k. Tarsal-carpal osteolysis
- l. Arthrogryposis multiplex congenital (amyotonia congenital)
- m. Amniotic band syndrome
- n. Mucopolysaccharidosis (MPS) types
 - i. Hunter syndrome (MPS II)
 - ii. Hurler syndrome (MPS I-H)
 - iii. Maroteaux-Lamy syndrome (MPS VI)
 - iv. Morquio syndrome (MPS IV)
 - v. Sanfilippo syndrome (MPS III)

7. Infection

- a. Basic concepts
 - i. Routes of spread
 - 1. Hematogenous
 - 2. Spread from a contiguous source
 - 3. Direct implantation
 - ii. Sites of localization
 - 1. Infants
 - 2. Children

3. Adults
4. Intravenous drug users
- b. Osteomyelitis
 - i. Terminology
 1. Sequestrum
 2. Involucrum
 3. Cloaca
 4. Brodie abscess
 5. Sclerosing osteomyelitis of Garre
 - ii. Organisms
 1. Bacterial
 2. Tuberculous
 3. Fungal
 4. Syphilis
 5. Rubella
 6. Leprosy
 7. Lyme disease
 8. Bacillary angiomatosis
 9. Parasitic infection
 10. Hydatid disease
 11. Cysticercosis
 - iii. Miscellaneous
 1. Sarcoidosis
 2. Osteitis pubis
 3. Pyomyositis
 4. Gas gangrene
 5. Ainhum
 6. Necrotizing fasciitis
 7. Chronic multifocal osteomyelitis
8. Tumors and Tumor-Like Lesions (Basic)
 - a. Natural history
 - b. Staging criteria
 - c. Bone lesions
 - i. Cartilaginous
 1. Enchondroma
 - a. Ollier disease
 - b. Maffucci syndrome
 2. Chondromyxoid fibroma
 3. Chondroblastoma
 4. Osteochondroma
 - a. Hereditary multiple exostoses
 5. Juxtacortical (periosteal) chondroma
 6. Chondrosarcoma
 - a. Primary
 - b. Secondary
 - c. Clear cell

d. Dedifferentiated

ii. Osseous

1. Osteoma
2. Osteoid osteoma
3. Osteoblastoma
4. Osteosarcoma
5. Parosteal
6. Periosteal
7. Telangiectatic

iii. Fibrous and fibrohistiocytic

1. Fibroxanthoma (nonossifying fibroma)
2. Fibrous dysplasia
3. McCune-Albright syndrome
4. Fibrosarcoma
5. Malignant fibrous histiocytoma

iv. Vascular

1. Hemangioma
2. Angiosarcoma

v. Miscellaneous

1. Simple (unicameral) bone cyst
2. Langerhans cell histiocytosis (histiocytosis X)
3. Giant cell tumor
4. Aneurysmal bone cyst
5. Adamantinoma
6. Ewing sarcoma
7. Chordoma
8. Multiple myeloma/plasmacytoma
9. Leukemia
10. Lymphoma
 - a. Hodgkin
 - b. Non-Hodgkin
11. Metastasis

d. Soft tissue lesions

i. Adipose tissue

1. Lipoma
2. Intramuscular
3. Intermuscular
4. Liposarcoma

ii. Vascular and lymphatic

1. Hemangioma
2. Lymphangioma
3. Angiosarcoma/lymphangiosarcoma

iii. Fibrous and fibrohistiocytic

1. Fibromatoses
2. Palmar (Dupuytren contracture)
3. Plantar

4. Intraabdominal (Gardner syndrome)
 5. Extraabdominal (aggressive)
 6. Fibrosarcoma
 7. Malignant fibrous histiocytoma
 - iv. Muscle
 1. Leiomyosarcoma
 2. Rhabdomyosarcoma
 - v. Peripheral nerve
 1. Neurofibroma
 2. Schwannoma
 3. Malignant peripheral nerve sheath tumor
 4. Morton neuroma
 - vi. Synovial
 1. Localized giant cell tumor of tendon sheath (nodular tenosynovitis)
 2. Ganglion
 3. Synovial sarcoma
 - vii. Bone and cartilage forming
 1. Myositis ossificans
 2. Extraskeletal osteosarcoma
 3. Extraskeletal chondrosarcoma
9. Tumors and Tumor-Like Lesions (Advanced)
- a. Bone lesions
 - i. Cartilaginous
 1. Mesenchymal chondrosarcoma
 - ii. Osseous
 1. High grade surface osteosarcoma
 - iii. Fibrous and fibrohistiocytic
 1. Benign fibrous histiocytoma
 2. Osteofibrous dysplasia (ossifying fibroma of long bone)
 3. Desmoplastic fibroma
 - iv. Vascular
 1. Hemangiomatosis (angiomatosis)
 2. Gorham disease
 3. Glomus tumor
 4. Hemangiopericytoma
 5. Lymphangioma
 6. Hemophilic pseudotumor
 - v. Miscellaneous
 1. Lipoma
 2. Adamantinoma
 3. Primitive neuroectodermal tumor
 4. Intraosseous ganglion
 5. Epidermoid inclusion cyst
 - b. Soft tissue lesions
 - i. Adipose tissue

1. Fibrolipomatous hamartoma of nerve
2. Lipomatosis
3. Parosteal lipoma
4. Liposarcoma (types)
- c. Well differentiated (atypical lipoma)
- d. Myxoid
- e. Round cell
- f. Pleomorphic
- g. Dedifferentiated
 - i. Vascular and lymphatic
 1. Glomus tumor
 2. Hemangiopericytoma
 3. Hemangioendothelioma
 4. Kaposi sarcoma
 5. Lymphangiomatosis
 - ii. Fibrous and fibrohistiocytic
 1. Elastofibroma
 2. Infantile fibromatosis
 3. Juvenile aponeurotic fibroma (calcifying juvenile fibroma)
 4. Fibrous hamartoma of infancy
 5. Myofibromatosis
 6. Fibromatosis coli
 7. Dermatofibrosarcoma protuberans
 - iii. Muscle
 1. Leiomyoma
 2. Rhabdomyoma
 - iv. Peripheral nerve
 1. Plexiform neurofibroma
 2. Granular cell tumor
 3. Clear cell sarcoma
 4. Extraskelatal Ewing sarcoma
 - a. Primitive neuroectodermal tumor
 - b. Askin tumor
 - v. Bone and cartilage forming
 1. Fibro-osseous pseudotumor of the digit
 - vi. Miscellaneous
 1. Myxoma
 2. Alveolar soft part sarcoma
 3. Epithelioid sarcoma
 4. Malignant mesenchymoma
 5. Lymphoma
 6. Metastasis

10. Trauma

- a. General principles
 - i. Biomechanics of fractures

1. Relationship of force and deformation
2. Mechanisms of direct and indirect loading
3. Relevant anatomy and terminology
- ii. Biomechanics of soft tissue injuries
- iii. Open fractures
 1. Mechanism
 2. Classification
 3. Implications for treatment
- iv. Gunshot wounds
- v. Stress injuries
 1. Mechanisms
 2. Pathophysiology
 3. Epidemiology
 4. Imaging diagnosis
 5. Implications for treatment
- vi. Thermal trauma
 1. Burns
 2. Cold injury
 3. Traumatic myonecrosis
- b. Trauma in adults
 - i. Hand
 1. Volar plate fracture
 2. Gamekeeper thumb
 3. Bennett fracture
 4. Carpometacarpal dislocation
 - ii. Wrist
 1. Scaphoid fracture
 2. Perilunate injuries
 3. Chronic carpal instability
 - a. Dorsal intercalated segment instability
 - b. Volar intercalated segment instability
 - c. Scapholunate advanced collapse
 4. Distal radioulnar joint injury
 5. Carpal tunnel syndrome
 - iii. Forearm and elbow
 1. Galeazzi fracture/dislocation
 2. Monteggia fracture/dislocation
 - iv. Shoulder
 1. Rotator cuff tear
 2. Labral injury
 3. Adhesive capsulitis
 - v. Clavicle and acromioclavicular joint
 1. Post-traumatic osteolysis
 - vi. Thoracic cage
 - vii. Spine
 1. Spondylolysis

- 2. Spondylolisthesis
- viii. Pelvis and hip
 - 1. Acetabular fracture
 - 2. Hip dislocation
 - 3. Femoral neck fracture
- ix. Knee
 - 1. Meniscal injury
 - 2. Ligament injury
 - 3. Extensor mechanism injury
 - 4. Articular cartilage injury
 - 5. Segond fracture
 - 6. Tibial plateau fracture
- x. Ankle
 - 1. Mechanisms of injury
 - 2. Ligament injury
 - 3. Foot
 - a. Calcaneal fracture
 - b. Lisfranc fracture/dislocation
- c. Trauma in children
 - i. Biomechanics of immature skeleton
 - ii. Growth plate injuries
 - iii. Hand, wrist, and forearm
 - 1. Torus fracture
 - 2. Greenstick fracture
 - 3. Plastic bowing
 - iv. Elbow
 - 1. Radial head dislocation
 - 2. Supracondylar fracture
 - 3. Entrapped epicondyle
 - v. Shoulder
 - vi. Spine
 - vii. Hip
 - 1. Slipped capital femoral epiphysis
 - viii. Knee
 - 1. Osteochondritis dissecans
 - 2. Cortical desmoid
 - ix. Tibia, ankle, and foot
 - 1. Toddler fracture
 - 2. Triplane fracture
 - x. Battered child
 - 1. Reporting statutes
 - 2. Metaphyseal corner fracture
- d. Fracture healing
 - i. Pathophysiology
 - ii. Biomechanics
 - iii. Time course

- iv. Treatment
 - 1. Casting
 - 2. Hardware
- v. Complications
 - 1. Malunion
 - 2. Nonunion
 - 3. Premature physal closure
- e. Post-surgical imaging
 - i. Indications
 - ii. Principles of treatment
 - iii. Complications
 - iv. Joint replacement
 - v. Bone grafting
 - vi. Spinal stabilization
 - vii. Limb salvage procedures

11. Metabolic, Systemic, and Hematologic Disorders (Basic)

- a. Osteoporosis
 - i. Disuse
 - ii. Related to aging (postmenopausal, senile)
 - iii. Idiopathic juvenile
 - iv. Transient
 - v. Reflex sympathetic dystrophy
- b. Osteomalacia
 - i. Dietary
 - ii. Gastrointestinal malabsorption
 - 1. Liver disease
 - 2. Anticonvulsant therapy
 - iii. Tumor induced
 - iv. Renal osteodystrophy
 - v. Vitamin D dependent rickets
 - vi. Milk-alkali syndrome
- c. Parathyroid disorder
 - i. Primary hyperparathyroidism
 - 1. Subperiosteal resorption
 - 2. Brown tumor
 - ii. Secondary hyperparathyroidism
- d. Pituitary disorder
 - i. Gigantism
 - ii. Acromegaly
 - iii. Intoxication, poisoning
 - iv. Heavy metal (lead)
 - v. Fluorine
 - vi. Hypervitaminosis A
 - vii. Hypervitaminosis D
- e. Complication of drug use

- i. Prostaglandin (periostitis)
- f. Osteonecrosis
 - i. Causes
 - ii. Bone infarction
 - iii. Legg-Calve-Perthes disease
 - iv. Freiberg infraction
 - v. Kienbock diseases
 - vi. Kohler disease
 - vii. Spontaneous osteonecrosis of the knee
- g. Hematologic disorder
 - i. Sickle cell disease or variant
 - ii. Thalassemia or variant
 - iii. Iron deficiency anemia
 - iv. Hemophilia
 - v. Idiopathic myelofibrosis
 - vi. Extramedullary hematopoiesis
 - vii. Fatty marrow reconversion
- h. Miscellaneous
 - i. Hemochromatosis
 - ii. Alkaptonuria
 - iii. Amyloidosis
 - iv. Paget disease
 - v. Calcification/ossification secondary to venous stasis
 - vi. Calcification/ossification secondary to paraplegia
 - vii. Hypertrophic osteoarthropathy
 - 1. Primary (pachydermoperiostosis)
 - 2. Secondary (pulmonary, etc.)
 - viii. Infantile cortical hyperostosis (Caffey disease)
 - ix. Metabolic, Systemic, and Hematologic Disorders (Advanced)
- i. Parathyroid disorder
 - i. Hypoparathyroidism
 - ii. Pseudohypoparathyroidism
 - iii. Pseudopseudohypoparathyroidism
- j. Thyroid disorder
 - i. Cretinism, hypothyroidism
 - ii. Hyperthyroidism
 - iii. Thyroid acropachy
- k. Hematologic disorder
 - i. Erythroblastosis
 - ii. Fanconi syndrome
 - iii. Spherocytosis
 - iv. Thrombocytopenia/absent radius syndrome
 - v. Polycythemia vera
 - vi. Aplastic anemia
 - vii. Drug-induced myelosuppression
 - viii. Radiation induced marrow changes

- I. Miscellaneous
 - i. Scurvy
 - ii. Hypophosphatasia
 - iii. Cushing syndrome
 - iv. Mastocytosis
 - v. Wilson disease
 - vi. Cerebral palsy
 - vii. Muscular dystrophy
- 12. Joint Disorders
 - a. Normal anatomy
 - i. Types of joints
 - 1. Fibrous
 - 2. Cartilaginous
 - 3. Synovial
 - ii. Intervertebral discs
 - iii. Entheses
 - b. General features that should be evaluated for each specific disorder
 - i. Distribution of involvement
 - ii. Soft tissue changes
 - iii. Joint space width
 - iv. Bone density
 - v. Osteophytes
 - vi. Subchondral lesions
 - vii. Osseous erosions
 - viii Proliferative new bone
 - ix. Joint deformity
 - x. Calcification
 - c. Specific diseases
 - i. Osteoarthritis
 - 1. Primary
 - 2. Secondary
 - 3. Erosive (inflammatory)
 - ii. Inflammatory joint diseases
 - 1. Rheumatoid arthritis
 - 2. Psoriatic arthritis
 - 3. Reiter syndrome
 - 4. Ankylosing spondylitis
 - 5. Enteropathic spondyloarthropathy
 - 6. Juvenile chronic arthritis
 - iii. Septic arthritis
 - 2. Bacterial
 - 3. Tuberculous
 - iv. Connective tissue disease
 - 1. Systemic lupus erythematosus
 - 2. Scleroderma

3. Dermatomyositis and polymyositis
- v. Crystal-associated arthropathies
1. Gout
 2. Calcium pyrophosphate dehydrate crystal deposition disease
 3. Calcium hydroxyapatite deposition disease
- vi. Neuropathic osteoarthropathy
1. Diabetes mellitus
 2. Syringomyelia
- vii. Miscellaneous
1. Jaccoud arthropathy
 2. Arthropathy associated with acquired immune deficiency syndrome
 3. Hemophilic arthropathy
 4. Pigmented villonodular synovitis
 5. Synovial chondromatosis
 6. Lipoma arborescens
 7. Osteitis condensans ilii
 8. Degenerative disc disease
 9. Diffuse idiopathic skeletal hyperostosis
 10. Tumoral calcinosis

