

Resident Core Curriculum

Thoraco-abdominal: Body MR

General Goals: The specific goals include objectives required for every level of training with graduated levels of supervision and responsibility. All aspects of thoracoabdominal imaging are incorporated into the residency with a focus on MR imaging and diagnosis of the liver, pancreas, kidneys, adrenal glands, biliary system, female and male pelvis, mediastinum and brachial plexus. During every training rotation, the resident will read the required literature and study the teaching file in thoracoabdominal radiology. Over time, the resident will become progressively more knowledgeable about normal MR imaging anatomy, physiology of abdominal and pelvic organs, and the MR appearances of abdominal diseases. In addition, the resident will demonstrate a progressively increasingly understanding of disease entities, their clinical presentations, and current modes of treatment.

Resident Daily Work Responsibilities (OVERALL BENCHMARKS/OBJECTIVES for Self-Evaluation)

1. Residents assigned to thoracoabdominal imaging will be available for consultations by MRI technologists, clinicians, and other health care providers, except during conference times, when the attending faculty will cover.
2. Resident questions will be referred to the supervising faculty covering thoracoabdominal radiology.
3. Resident review of cases with the supervising faculty will be conducted as many times in the day as necessary to keep an efficient workflow.
4. All resident examinations will be dictated by the end of every working day.
5. Residents will check and sign his/her reports prior to final verification by supervising faculty.
6. Residents must be familiar with the operation of all MRI equipment.
7. Residents will learn the MRI techniques for performing high quality, state-of-the art diagnostic examinations throughout the body, but especially liver, pancreas, kidneys, adrenal glands, biliary system, female and male pelvis, mediastinum and brachial plexus. Examinations will be checked before the patient leaves the department if requested to do so by the supervising faculty.
9. Residents must become proficient at detecting abnormalities demonstrated by the MRI be able to generate meaningful differential diagnosis.
10. Residents will become knowledgeable about the use of different MRI contrast agents (including their indications, contraindications, dosages and side effects).
11. Residents will acquire an understanding of the proper preparation of patients for examinations and appropriate follow-up afterward. At the start of every working day, the resident will be familiar with the patient schedule and anticipate need for any procedures. The resident will check requisitions for the next working day to evaluate for appropriateness of the requested procedure or if additional exams/protocols need to be

performed. Absent clinical indication or seemingly inappropriate requests will be clarified and discussed with the referring physician.

12. Residents will do in-depth reading and study, along with a review of teaching file cases, to become knowledgeable about the normal anatomy and physiology of abdominal organs and the MRI appearances of diseases, and gain a general understanding of the disease entities, their clinical presentations, and certain modes of treatment.
13. Residents will serve as a secondary consultant to referring physicians regarding thoracoabdominal imaging. This will strengthen the confidence of the resident in the very important role every radiologist must perform throughout his/her career as a consultant to clinicians.
14. Residents will become prepared to pass the certifying examination of the American Board of Radiology.
15. Residents will teach and share knowledge to medical students, radiologic technologist students, and junior residents.
16. Residents will participate in the preparation and presentation of imaging studies at the weekly Body Club Conference.

Supervising Faculty Responsibilities:

1. Supervising faculty will be available at all times for any questions or consultations needed by the resident.
2. Supervising faculty will review all cases with the residents before the end of the day.
3. Supervising faculty will provide the resident with constructive feedback in any problem areas encountered during the rotation.
4. Supervising faculty will verify resident-generated reports in a timely manner and inform the resident of any major changes made.

Educational Goals and Objectives (Third Year Residents):

Patient Care:

- Adequately explain each examination to the patient in order to ensure that the patient feels comfortable and to provide patient care that is compassionate, appropriate, and effective
- Familiarity with the operation of MRI equipment
- Understand the indications for and contraindications to use of intravenous radiographic contrast material, and be able to monitor its administration
- Recognize and treat reactions to intravenous contrast material
- Understand the indications and contraindications to the different types of contrast material, dosages, side effects, and the differences and relative merits of contrast studies
- Understand the MRI physics and how this relates to the various pulse sequence techniques.
- Obtain consent when needed for the study and answer all questions the patient may have

- Develop a knowledge of the preparation for the imaging study
- Improve skills for performing MR imaging studies and tailor examinations to answer all questions being asked by the clinician; anticipate those questions that should have been asked but were not
- Demonstrate knowledge of indications for the examinations requested (when the reason for the examination is not clear, the resident will effectively communicate with the patient and referring physician until clarified)
- Familiarity with available medical records and how to access them for the purposes of patient care
- Protocol cases, in consultation with the attending, to assure that MR imaging study is appropriate and of sufficient quality to address the clinical concerns of the patient and referring physician
- Review all studies with the supervisor faculty attending
- Provide preliminary reports to all referring clinicians if needed before the final review of cases (when there is a significant discrepancy between the preliminary reading and final reading, the resident will notify the referring clinician immediately)
- Demonstrate the ability to recommend additional imaging studies as appropriate to better assess findings on MR imaging studies

Medical Knowledge:

- Recommend the appropriate study based on the clinical scenario
- Familiarity with the anatomy of the organs examined in every case
- Familiarity with imaging findings of common acute and chronic diseases evaluated with MRI
- Identify pathology in order to interpret routine MR imaging studies with accuracy appropriateness to the level of training when presenting to the attending
- Distinguish between normal and abnormal body anatomy as demonstrated on MR studies to level of training when presenting to the attending
- Detect abnormalities while the MR imaging studies are in progress, such as 1) disease recognition skills will continue to increase, and 2) begin to develop meaningful differential diagnoses for the pathology that is found
- Learn the basic physics of MR as well as various MRI pulse sequence techniques and (surface) coils so that differences in tissue contrast related to the various pulse sequence techniques is understood
- Observe and learn the techniques to achieve high-quality diagnostic examinations
- Become knowledgeable about the different contrast agents available and begin to recognize abnormalities that are demonstrated by MRI
- List the risk factors for allergic reaction to intravenous contrast media
- State the proper assessment and treatment for allergic reactions to contrast media
- Recognize the more common abnormalities encountered
- Develop a knowledge of the differential diagnoses of the more commonly encountered abnormalities
- Demonstrate the ability to recognize and describe common medical conditions depicted on MR imaging studies

- Understand the specific problems associated with MR body imaging such as cardiac and respiratory motion, and flow artifacts

Practice-Based Learning and Improvement:

- Identify, rectify and learn from personal errors
- Incorporate feedback into improved performance
- Demonstrate evidence of independent reading and learning through use of printed and electronic resources
- Follow up on abnormal or interesting cases through personal communication with the referring physician or patient medical records
- Research interesting cases as directed by faculty
- Competent in using PACS, voice recognition systems, and hospital and patient information systems in the daily accomplishment of the workload and instruct others in their use. Become proficient in dictating reports of significant findings in a concise and clear manner
- Demonstrate appropriate follow up of interesting cases

Interpersonal and Communication Skills:

- Appropriately obtain informed consent
- Produce concise reports that include all relevant information
- Communicate effectively with all members of the healthcare team (technologists, medical students, fellows, residents, allied health providers, support staff, and attending physicians/radiologists)
- Communicate effectively the results of studies to referring clinicians whenever needed (for emergent studies, this will be accomplished in a timely manner)
- Effectively convey the findings of examinations through accurate dictation of reports
- Communicate with the patient at all times during the examination to ensure that patient remains comfortable
- Interact with clinicians when reviewing cases involving MR imaging studies and show ability to provide preliminary readings, follow up with attending radiologists, formulate a plan of complex cases, and communicate any changes to referring clinicians

Professionalism:

- Demonstrate respect for patients and all members of the healthcare team (technologists, nurses, and other healthcare workers) and be able to discuss significant radiology findings
- Respect patient confidentiality at all times
- Present oneself as a professional in appearance and communication
- Demonstrate a responsible work ethic in regard to work assignments
- Explain the nature of the examination or findings in an examination to patients and their families when needed
- Explain the impact of the radiology findings on patient care, including what imaging studies may/may not be appropriate
- Observe ethical principles when recommending further work-up
- Promptness and availability at work are required of every resident

- Dress appropriately for work

Systems-Based Practice:

- Demonstrate knowledge of ACR practice guidelines and technical standards for MR imaging and thoracoabdominal body MR
- Demonstrate knowledge of ACR appropriateness criteria and cost-effective imaging evaluations
- Familiarity with departmental procedures, contrast safety, and sedation required in the performance of examinations
- Use appropriate language in communicating to clinicians through reports or consultations so proper management decisions can be made
- Thorough dictations will be made with indications, techniques, findings, and conclusions
- Dictate and correct reports in a timely fashion to avoid delay in patient disposition
- Make suggestions to improve methods and systems utilized in radiology whenever appropriate
- Able and willing to participate in clinical conferences in which imaging studies are used to guide patient care/evaluations and be able to demonstrate understanding of how imaging relates to the clinical care of the patient
- Show ability to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical entities

Monitoring and Assessment of Resident Performance

The resident's progress will be monitored by the faculty on the service. Toward the end of each rotation, the resident will receive an evaluation of performance from each attending. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director by the attending radiologist. Residents are evaluated monthly by faculty. Resident performance is also evaluated through direct observation, case logs, multi-source professional evaluations, structured case discussion, review of patient outcomes, and other performance evaluation methods as determined.

Educational Goals and Objectives (Fourth Year Residents):

The above objectives as well as the following:

Patient Care:

- Perfect diagnostic examination techniques and be very skilled and efficient in performing and interpreting all diagnostic and interventional procedures performed
- Demonstrate knowledge of indications for the examinations requested (when the reason for the examination is not clear, the resident will effectively communicate with the patient or referring physician until clarified)
- Familiarity with available medical records and how to access them for the purposes of patient care

- Protocol cases, in consultation with the attending, to assure that the MRI examination is appropriate and of sufficient quality to address the clinical concerns of the patient and referring physician
- Review all studies with the supervising faculty attending
- Provide preliminary reports to all referring clinicians if needed before the final review of cases (when there is a significant discrepancy between the preliminary reading and final reading, the resident will notify the referring clinician immediately)

Medical Knowledge:

- Develop a thorough knowledge of the differential diagnosis of abnormalities encountered on body MRI studies
- Develop a thorough knowledge of the differential diagnosis of body MRI abnormalities
- Relate the imaging findings to the clinical condition and its pathology
- Understand the clinical management of the conditions encountered
- Familiarity with the anatomy of the organs examined in every case
- Familiarity with imaging findings of common acute and chronic diseases evaluated with MRI
- Identify pathology in order to interpret MR imaging studies with accuracy appropriate to the level of training when presenting to the attending
- Distinguish between normal and abnormal body anatomy with excellent accuracy according to the level of training when presenting to the attending and demonstrate improvement compared to the prior rotation
- Proficient in detecting abnormalities on MR imaging studies while in progress
- Development of appropriate differential diagnostic lists will be well advanced
- Know the proper preparation of patients for diagnostic procedures and the appropriate follow-up afterwards
- Act as a consultant in thoracoabdominal radiology to the clinical services
- Obtain a broad understanding of diseases, their clinical features, MRI manifestations, and current modes of treatment
- Thorough knowledge of studies related to brachial plexus and breast as well as studies involving the chest, abdomen, heart, mediastinum, liver, kidneys, and pelvis

Practice-Based Learning and Improvement:

- Identify, rectify, and learn from personal errors
- Incorporate feedback into improve performance
- Demonstrate evidence of independent reading and learning through use of printed and electronic resources
- Follow up on abnormal or interesting cases through personal communication with the referring physician or patient medical records
- Competent in using PACS, voice recognition systems, and the patient information systems in the daily accomplishment of the workload and instruct others in their use

Interpersonal Skills:

- Appropriately communicate results to patients and clinicians whenever needed (for emergent studies, this will be done in a timely manner)
- Produce concise reports that include all relevant information and be able to effectively convey the findings of examinations through accurate dictation of reports
- Communicate effectively with all members of the healthcare team
- Assist with supervision and teaching of medical and radiology technologist students

Professionalism:

- Demonstrate respect for patients and all members of the healthcare team (technologists, nurses, and other healthcare workers)
- Respect patient confidentiality at all times
- Present oneself as a professional in appearance and communication
- Demonstrate a responsible work ethic in regard to work assignments
- Explain the nature of the examination of findings in an examination to patients and their families when needed
- Observe ethical principles when recommending further work-up for cases
- Promptness and availability at work are required of every resident
- Dress appropriately when reporting to work

Systems-Based Practice:

- Demonstrate knowledge of ACR practice guidelines and technical standards for MR imaging studies
- Demonstrate knowledge of ACR appropriateness criteria and cost effective imaging practices
- Complete final preparations to pass the certifying examination of the American Board of Radiology
- Familiarity with departmental procedures, contrast material safety, and sedation required in the performance of examinations
- Use appropriate language in communicating to clinicians through reports or consultations so proper management decisions can be made
- Produce thorough dictations with indications, techniques, findings, and conclusions
- Dictate and correct reports in a timely fashion to avoid delay in patient disposition
- Recognize the role that body MRI plays in the management of acute and chronic diseases
- Make suggestions to improve methods and systems utilized in radiology whenever appropriate

Monitoring and Assessment of Resident Performance

The resident's progress will be monitored by the faculty on the service. Toward the end of each rotation, the resident will receive an evaluation of performance from each attending. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director by the attending radiologist. Residents are evaluated monthly by faculty. Resident performance is also evaluated through direct observation, case logs, multi-source professional evaluations, structured case

discussion, review of patient outcomes, and other performance evaluation methods as determined.

Reading List for all Years

1. Introduction to MR Imaging
2. William E Brant and Eduard E. de Lange. *MRI: Essentials of Body MRI*. Oxford University Press, 2012.
3. Evin S Siegelman. *Body MRI*. Elsevier Health Sciences, 2004.
4. Richard C Semelka. *Abdominal-Pelvic MRI*, Wiley-Blackwell 2010

Other Requirements/Expectations

Body MRI Teaching File

An important element in the resident's development of interpretative skills will be the review of multiple cases from the body MR teaching file. It is our goal that the residents on this service actively review these cases during the working day when they are not involved with current examinations. These cases will be made available for independent review. In addition, whenever possible, the attendings will also review as many cases as possible with each resident on the service. The residents are encouraged to discuss the individual cases with the attending. The residents are also required to assist in preparing suitable cases for the MR teaching file.

Supplemental Reading and Lectures

It is well recognized that MR physics is rather difficult to comprehend. However, there is sufficient literature that teaches MR physics effectively, and a list of basic reading is attached. In addition, most of the books regarding clinical MR imaging usually contain chapters on MR physics. Furthermore, Drs. James Brookeman, and John Mugler give annual courses on MR physics. The physicists have agreed to also be available for additional teaching of the individual resident during his/her rotation in body MRI.

Core Knowledge Presentation Topics

Magnetic fields

Magnets, direction characteristics, field strength, field gradients, magnetic resonance process, resonant (Larmor) frequency, field strength, chemical shift

Tissue brightness and contrast

Determination by RF signal intensity, relation to tissue characteristics, photon density, magnetic relaxation rates (T1 and T2), flow, imaging methods

The acquisition process

The imaging cycle, cycle duration (TR), number of cycles, averaging, acquisition time

Tissue magnetization and image contrast

Vector representation, nuclear (proton) concentration, proton density image contrast, longitudinal magnetization, growth characteristics (relaxation/recovery), relaxation time (T1), T1 contrast, transverse magnetization, decay characteristics (relaxation), relaxation time (T2), T2 image contrast

Radiofrequency pulses and signals

Pulse characteristics, flip angle, spin echo, gradient-echo dephasing and rephasing, echo time (TE), multi-echo imaging, inversion recovery, fast imaging

Image types

Proton density weighted, T1-weighted, T2-weighted, flow imaging, flow related enhancement, flow related intensity reduction.

Image detail and noise

Voxel size, slice thickness, matrix size, field-of-view (FOV) noise

Spatial characteristics of magnetic resonance imaging

Gradients, coils, slice selection, slice orientation, slice profile, selected excitation, slice thickness, phase encoding, frequency encoding, image reconstruction, 3D imaging.

Motion reduction techniques

Cardiac triggering, pulse triggering, respiratory triggering, gradient moment nulling rephasing/dephasing, multi-averaging, presaturation pulses

MRI of the body

Mediastinum and lung, bile ducts, breast, liver, pancreas, pancreatic duct, spleen, retroperitoneum, adrenal glands, kidneys, female pelvis, obstetrics, male pelvis and bladder, rectum, scrotum and testes, brachial plexus, MRCP, and MRA.

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