Three-year degree course in Medical Radiology Techniques for Imaging and Radiotherapy

INTEGRATED TEACHING: DIAGNOSTIC IMAGING TECHNIQUES II

SSD: MED/36, MED/50

CFU: 12 RESPONSIBLE TEACHER: PROF. FEDERICO SANTARELLI

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MODULE: Diagnostic Imaging and Radiotherapy

SSD: MED/36

Number of credits: 6 Teacher name:

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MODULE: Medical Sciences and Techniques II

SSD: MED/50

Number of credits: 6

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PREREQUISITES

Minimum basic knowledge of human anatomy, general and atomic physics is required. Knowledge of physical principles and radiological anatomy, basic physics of electromagnetic fields. Satisfactory completion of the first year of the course is required, with required credits in core subjects such as anatomy, physiology, biochemistry and physics, as well as a good knowledge of radiological diagnostic procedures and related technologies

LEARNING OBJECTIVES

The course aims to provide students with the physiological, pathophysiological, clinical and diagnostic applications of the imaging technique to use and optimize specific skills to correctly use radiological

equipment. The teaching of these applications is fundamental for the development of specific professional skills. The course aims to provide students with the specific skills to correctly use advanced radiological equipment. Teaching, integrated with the study of Magnetic Resonance and Computerized Tomography study techniques, is fundamental for the development of specific professional skills. The training objectives for the second year student of the degree course in medical radiology techniques, in the integrated course med /50 of medical and technical sciences, are of extreme importance to guarantee complete and advanced training in the field of medical radiology. During this second year, the student must pursue a series of goals that foster greater specialization and expertise in the field.

First of all, it is essential that the student develops an in-depth knowledge of advanced radiological methodologies and technologies. This includes learning about different radiological imaging modalities, such as computed tomography (CT), as well as understanding the indications, limitations, and potential complications associated with this branch of diagnostic imaging. Comprehension of the phenomenon from the Resonance Magnetic Nuclear ; Knowledge of the components of an MRI scanner (resistive , permanent, superconductive); understanding of the generation mechanisms of the signal (classification of the RF pulses), training of the MR image (meaning " sequence " of gradient pulses) and of the meaning of the main ones scanning parameters (echo time , repetition time , flip angle , bandwidth , acquisition matrix , length of the train of echoes , etc.); f groups of scans conventional (Spin- Echo , Rapid Acquisition with Relaxation Enchancement Spin- Echo , Gradient- Recalled Echo); meaning of " weighting " of the images (T1, T2, Proton Density , T2* , Flow , velocity and acceleration , water mobility , susceptibility , perfusion) . The course aims to provide students with the specific skills to correctly use radiological equipment. Teaching, integrated with the study of radiographic techniques of angiography and interventional radiology, is fundamental for the development of specific professional skills.

EXPECTED LEARNING OUTCOMES

Knowledge and understanding _ _

- At the end of this teaching the student will have to know:
- Know the applications physiological and physio-pathological clinical and diagnostic from the imaging technique _
- Knowing how to collaborate in achieving and optimizing Magnetic Resonance Imaging exams
- Know the setup and use of Magnetic Resonance Imaging sequences in order to be able to correctly apply the knowledge acquired in different anatomical and pathological fields
- The expected learning outcomes for the student in the integrated course of computed tomography in the second semester of the second year of the degree course in medical radiology techniques include:
- In-depth knowledge of the physical principles and technological bases of computed tomography (CT).

- Expertise in using CT acquisition systems, including selecting the correct parameters to obtain high quality images.
- Ability to perform and optimize CT scanning procedures based on different diagnostic indications.
- Ability to recognize CT images, including the correct identification of anatomical structures and possible pathological alterations.
- Knowledge of the main study protocols, in the different anatomical and pathological areas.
- Expertise in CT image management, including the ability to process, store and retrieve images effectively.
- Ability to collaborate with radiologists in analyzing CT images and providing relevant information for a correct diagnosis.
- Awareness of patient safety precautions during CT examinations, including radiation dose minimization and management of adverse reactions in a multidisciplinary team.
- Ability to adapt and work effectively in a clinical work environment, collaborating with other healthcare professionals.
- Commitment to continuous learning and professional development to stay abreast of technological developments and new applications in CT.
- These learning outcomes aim to train highly competent medical radiology technicians in the field of computed tomography, capable of providing high-quality diagnostic support and contributing significantly to patient care.
- General understanding of the fundamental principles of MR image formation and contrast. Ability to correctly distinguish the different weights in the image starting from the image itself and/or the reported parameters.

Ability to apply knowledge and understanding

At the end of the teaching the student will be able to :

Use consciously the resonance equipment _ Magnetic

Use the equipment consciously

Perform the exams independently

Use the knowledge acquired for the independent study of aspects relating to the specific field to which the student will dedicate himself in the context of his professional activity;

Know and apply the basic principles of the different angiographic practices for complete autonomy and correct practical execution.

Communication skills

At the end of the teaching the student will have to know :

Use specific scientific terminology appropriately.

be able to apply your knowledge and understanding in a way that demonstrates a professional approach to work and possess adequate skills both to devise and support arguments and to solve problems in your field of study

He/she must be able to collaborate in a team to be able to carry out radiological practices in the field of technical expertise, be supportive and know how to involve patients during the carrying out of the radiological study.

Autonomy of judgement

At the end of the course the student must know:

carry out general assessments relating to the topics covered.

Know the main criteria of correctness for a careful evaluation of all the radiological practices covered during teaching.

PLAN

Diagnostic Imaging and Radiotherapy

- Protocols and setup of the MRI exam Magnetic
- MRI Neuro
- RM Neck
- Musculoskeletal MRI
- Abdominal MRI
- MRI Pelvis
- Angio -MRI
- RM-Breast
- Study techniques in diagnostic imaging
- Principle of justification and optimization of the radiological examination
- Physical principles of equipment
- Radiation protection
- Telemedicine
- Study techniques in the angiography room
- Interventional room
- Physical principles of equipment

- Radiation protection

Medical sciences and techniques II

- Brief history of the phenomenon of magnetic resonance imaging and magnetic resonance imaging.
- The phenomenon of magnetic resonance imaging
- Larmor 's concept of frequency . Particularities of 1H Hydrogen. -T1 and T2
- MR imaging semiotics.
- The MRI scanner
- Resistive and permanent (low field)
- auberconductive (high and very high field)
- superconductive MgB2 (high and very high field)
- Radio Frequency Coils
- Gradient coils
- Receive coils (quadrature coil and phased array coil concepts)
- The RM image
- Imaging gradients
- The space k and the Fourier transform
- Pulse sequences (excitation, encoding, refocusing and inversion)
- MRI sequences
- Gradient-Recalled Echo
- Spin- Echo
- Echo -Planar Imaging
- Rapid Acquisition with Relaxation Enchancement (RARE, Turbo Spin-Echo and Fast
- Spin- Echo)
- Some variations
- Scan parameters and contrast generation - Typical examples
- operating principles of CT
- CT image formation
- evolutions of CT
- software for retro reconstructions in CT
- MRI and CT techniques and methods for functional and morphological studies

Program for 20 hours of computerized tomography (CT) teaching:

1. Introduction to CT (1 hour)

- History and fundamental principles of CT;
- Advantages and limitations of CT compared to other imaging modalities.

2. Physical bases and technologies of CT (2 hours)

- Physical principles of CT image formation;
- Components of the CT acquisition system and their functions;
- Types of CT scanners and differences between them.

3. Technical protocols and acquisition parameters (3 hours)

- Technical protocols in different anatomical and pathological areas;
- Selection of appropriate acquisition parameters to obtain high quality images;
- Radiation dose considerations and dose reduction strategies;

4. Viewing CT images and clinical cases with the associated technical part (3 hours)

- Radiological anatomy in CT images;
- Identification of anatomical structures and possible pathological alterations;
- Systematic approach to the visualization of CT images, their transformation into multiplanar images , MIP and Volume Rendering.

5. Laboratory (TOPIC): Use of the CT acquisition simulator (3 hours)

- Introduction to the CT acquisition simulator and planning software;
- Practical exercises on selecting acquisition parameters and planning scans;
- Simulations of CT acquisition and reconstruction of the images obtained.

6. Clinical applications of CT (2 hours)

- Main diagnostic indications for CT in the various internationally renowned acquisition protocols;
- Role of CT in the diagnosis and evaluation of pathologies.

7. Patient safety and management of adverse reactions (1 hour)

- Radiological precautions and radiation dose reduction.
- Management of adverse reactions to contrast agents and CT procedures.

8. Review and evaluation (2 hours)

- Review of key concepts and skills acquired during the course;
- Evaluation of knowledge through practical exercises and/or quizzes.

This 20-hour computed tomography (CT) teaching program offers a combination of theoretical lectures, practical laboratory sessions and the use of a CT acquisition simulator. This allows students to gain in-depth knowledge of CT principles, technologies and applications, as well as develop practical skills in planning scans and interpreting CT images.

TEACHING METHOD

The teaching is structured in 20 hours of frontal teaching , divided into 4-hour lessons .
Attendance is mandatory . _ The IMAGING DIAGNOSTICS TECHNIQUES II module is organized into lectures (20 hours) and theoretical and practical exercises. The lessons take place by projecting illustrative images (Power-Point) and through the use of paper material provided by the teacher.
The teacher will adopt a variety of teaching tools to ensure a complete and engaging learning experience. Presentations organized in PowerPoint files will be used, containing explanatory slides, illustrations and images that will allow an in-depth understanding of the different dynamics of the methodology covered. Furthermore, films and animations will be used to integrate and visualize the processes described in class, offering visual and practical support to students. For the computed tomography techniques module, interactive lessons will be offered in which students will be able to actively participate, carrying out exercises both individually and in groups. This approach will encourage practical and collaborative learning, allowing students to put the knowledge acquired into practice and to deal with the different facets of the subject.

In order to evaluate student progress, module-specific ongoing tests may be envisaged. These tests will allow both students and the teacher to evaluate the level of understanding and application of the knowledge acquired during the course.
Please remember that class attendance is mandatory to ensure complete learning and active participation in the proposed exercises and activities.

LEARNING EVALUATION METHODS

The teaching module is integrated with other disciplines still relating to radiological sciences. The student can take the Applied Medical Technical Sciences test in a single session or in different sessions of the current academic year.
The test consists of a compulsory written test and an optional oral test. The written and oral tests are aimed at evaluating both the theoretical knowledge and the student's ability to solve problems. The exam will be divided into two parts: a written test on Computed Tomography Techniques and an oral test. The written test will consist of a series of multiple choice questions, with only one correct answer, regarding the topics covered during the lessons. The student will have to answer 30 questions on the subject covered (with a score of 1 for each correct answer).

To be able to access the CT Techniques oral test, the student must have achieved at least a grade of 18/30 in the written test. The oral test will be structured as a sort of public exam speaking , and will have the aim of preparing the student to face similar situations that could arise in his future degree thesis. During this test, the student will have to present and discuss topics covered in the program in a clear and convincing way in front of the teacher. His ability to effectively communicate the knowledge acquired and to respond appropriately to the questions and insights requested by the teacher will be assessed.

In this way, the exam will not only evaluate the student's theoretical knowledge, but will also provide him with the opportunity to develop communication and presentation skills that will be invaluable for his academic and professional career.

The final evaluation will be the result of a weighted average between the outcome of the written and oral test.

The exam will be overall evaluated according to the following criteria:

Not suitable: significant deficiencies and/or inaccuracies in knowledge and understanding of the topics; limited analysis and synthesis skills, frequent generalizations.

18-20: just sufficient knowledge and understanding of the topics with possible imperfections; Sufficient analytical, synthesis and independent judgment skills.

21-23: knowledge and understanding of routine topics; correct analysis and synthesis skills with coherent logical argumentation.

24-26: reasonable knowledge and understanding of the topics; good analytical and synthesis skills with rigorously expressed arguments.

27-29: complete knowledge and understanding of the topics; remarkable analytical and synthesis skills. Good independent judgement.

30-30L: excellent level of knowledge and understanding of the topics. Remarkable analytical and synthesis skills and independent judgement. Arguments expressed in an original way.

SUPPORT ACTIVITIES

Not foreseen

RECOMMENDED TEXTS AND BIBLIOGRAPHY

Prof. Argirò

Elements of magnetic resonance imaging (MRI) - From the proton to the sequences for the main diagnostic applications of Coriasco - Rampado - Bradac - Boris • 2014

Prof. Capotondi/Santarelli/Magi

Diagnostic Radiology Physics: A Handbook for Teachers and Students. DR Dance, S. Christofides , ADA Maidment, ID McLean, KH Ng. Technical Editors

Prof. De Almeida

1. “Computed Tomography for Technologists: A Comprehensive Text” by Lois E. Romans. Publisher: Wolters Kluwer Health, The Point.

2. Slides provided by the professor.

3. https://uwgect.wiscweb.wisc.edu/protocol-manuals/

Prof. Fierro

Handouts of lessons _

MA Bernstein, KF King, XJ Zhou, Handbook of MRI pulse sequences (2004, Elsevier Academic Press)

ZP Liang, PC Lauterbur, Principles of Magnetic Resonance Imaging (2000, IEEE Press Series on Biomedical Engineering)

EM Haake , RW Brown, MR Thompson, R. Venkatesan, Magnetic Resonance Imaging – Physical Principles and Sequence Design (1999, Wiley- Liss) – difficult

P. Mansfield, PG Morris, NMR Imaging in Biomedicine (1982, Academic Press) – very difficult

Talbot J., Westbrook C., MRI in Practice MRI Question (Internet site) MRI Master (Internet site)MRI-Tip (Internet site)