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RADIOLOGICAL METHODS AND BASES OF RADIOLOGICAL SEMIOTICS

COLLECTION METHODICAL RECOMMENDATIONS

on radiology for students of the international
medical faculty 3 course

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The manual presents methodological works for the practical training of third-year students of the medical international faculty in the field of radiology.

CONTENTS

INTRODUCTION

Medical Imaging is the health profession concerned with the direct administration of radiation, primarily x-rays, in disease diagnosis and injury assessment. Medical imaging studies have been a cornerstone in medical diagnosis for decades; however, technological advances and the addition of new imaging modalities now place medical imaging among the most dynamic, expanding and high demand fields in clinical medicine.

Medical Imaging clinical practice includes: general radiography such as orthopedics, pediatrics and mammography, vascular imaging, cardiac catheterization studies, computerized tomography, and magnetic resonance imaging. Medical imaging professionals are employed in medical centers, community and private hospitals, clinics, and physicians' offices

Radiological methods play the leading role in the diagnosis of most diseases. That’s why all physicians should be able to chose optimal radiological method and use the information obtained to make diagnosis.

Detection and interpretation of radiological semiotics of different organs and systems pathologies is the basis of radiology.

According to state standards of higher medical education student should be able (**objectives of the module**):

1. To choose the optimal radiological method for visualization of different organs and systems: lungs and mediastinum, heart and vessels, digestive tract, hepatobilliary system, urinary system, genital system, bones and joints, central nervous system; thyroid gland.

2. To interpret general radiological semiotics: X-Ray (including CT), radionuclide, ultrasound, MRI.

AIMS AND TASKS OF THE DISCIPLINE

The aims of the diagnostic radiology are forming complex of knowledge, abilities and skill of students.

The tasks of the diagnostic radiology are selection of radiology method for investigation different organs and systems; recognize and difference abnormal radiological signs from normal radiological signs.

PROGRAM OF THE DISCIPLINE

Module 1. The principles and methods of radiology.

Substantial module 1 Radiology.

Topic 1. History of medical radiology. Structure of radiological department. Methods of visualization in radiology.

History of medical radiology. Types of radiological departments. Particular qualities of radiological departments and radio treatment department. Structure of x-ray room. Principles of protection (time, distance, shielding, quantity).

Radiation measurement and doses. The limits of exposure to radiation. “Working level” and “working level month”. Radiobiology and radiation risks. Preventive treatment of ionizing radiation. Mass health examination of personnel on atomic productions and population, contacting with ionizing radiation sources National register of persons which carried influence of radiation as a result of failure on CHAES.

The basic principle and source of ultrasound, x-ray examination, MRI, radioisotope scan. Advantages and disadvantages of methods of visualization in radiology imaging. Indications and contraindications of methods of visualization in radiology imaging. Medical devises for methods of visualization in radiology.

Substantial module 2 Methods of visualization in radiology.

Topic 2. The physical basis of diagnostic imaging. Imaging techniques. Methods of x-ray examination. CT scan, ultrasound, MRI, radioisotope scan.

Methods of x-ray examination: x-ray film, fluoroscopy, tomography, CT scan. Advantages and disadvantages methods of x-ray examination. Indications and contraindications methods of x-ray examination.

Technical aspects. Technique selection. Typical x-ray projections. Luminal contrast studies. Types of contrast materials. Patient preparation. Basic interpretation of x-ray film.

Methods of CT scan examination. Advantages and disadvantages methods of CT scan examination.

Methods of ultrasound examination. The physical basis of ultrasound. Advantages and disadvantages methods of ultrasound examination. Indications and contraindications methods of ultrasound examination. Doppler examination. Techniques and normal anatomy. Ultrasonic findings.

Radioisotope imaging. . The physical basis of radioisotope examination Advantages and disadvantages of radioisotope examination. Indications and contraindications of radioisotope examination. Techniques and normal anatomy. The gamma camera. Principles of positron emission tomography. Hybrid systems: SPECT-CT and PET-CT. Quantification and image processing. Image interpretation. Nonimaging applications. Radiopharmaceuticals.

Magnet resonance imaging. The physical basis of MRI diagnostic imaging. Advantages and disadvantages of MRI examination. Indications and contraindications MRI examination. Contrast substances.

Substantial module 3 Radiology of the chest

Topic 3. Methods visualization of the chest.

Methods visualization of the chest: x-ray film, conventional radiography, roentgenoscopy, photoroentgenography, computed tomography of the chest, nuclear medicine perfusion imaging of the chest, positron emission tomography/computed tomography imaging of the chest, magnetic resonance imaging of the chest, ultrasonography of the chest. Major indications for: x-ray film, conventional radiography, roentgenoscopy, photoroentgenography, nuclear medicine perfusion imaging of the chest, positron emission tomography/computed

tomography imaging of the chest, magnetic resonance imaging of the chest, ultrasonography of the chest, CT of the chest. Perfusion scintigraphy. Ventilation scintigraphy. Suggested imaging procedures for various chest problems. Circumstances in which a chest X-ray is not indicated. Limitations of the plain chest film. Physiological considerations of the lung.

Normal anatomy of the chest and variants: ribs, **bony structures, soft tissues,** lobes, segments, lung pattern, **hila** fissures, mediastinum, diaphragm, heart. Congenital anomalies of the chest. The chest film of the elderly person.

Radiological features of lung diseases. Types of bronchoobstruction. Interpretation of the abnormal film. Causes of miliary shadowing. Linear and band shadows. Causes of diffuse bilateral reticulonodular shadowing. The single pulmonary nodule. Multiple pulmonary nodules. Cavitating lesions and cysts. Fluid levels on a chest radiograph. Calcification on the chest radiograph. Signs of loss of volume. Causes of hilar enlargement. Causes of a small hilum. Causes of unilateral hypertranslucency. Causes of an opaque hemithorax.

Topic 4. Radiological features of lung diseases (inflammation, tuberculosis, tumors).

Pulmonary infection in adults. Lobar pneumonias. Emphysema. Chronic bronchitis. Lung abscess. **Hydatid disease. Primary tuberculosis. Post-primary tuberculosis.** Miliary tuberculosis. Pleural effusion. Bronchial obstruction. Primary malignant neoplasms. Secondary malignant neoplasm. Radiological imaging at urgent pathologies of respiratory system. Algorithm of clinical imaging of respiratory system.

Topic 5. Complex clinical imaging of the cardiovascular system (radiological anatomy and physiology, radiological features of its pathologies). Algorithm of clinical imaging of cardiovascular system.

Methods visualization of the cardiovascular system: Conventional radiographs, echocardiography, **Doppler echocardiography,** radionuclide imaging (nuclear medicine), computed tomography, magnetic resonance imaging, angiography, **coronary computed tomography angiography,** spin-echo imaging,

single photon emission computed tomography (SPECT), positron emission tomography (PET), imaging ventricular function.

Classification methods visualization of the cardiovascular system: initial, additional, invasive, non invasive. Indications and contraindications methods visualization of the cardiovascular system. **Contrast agents** and radiopharmaceuticals. **Limitations** methods visualization of the cardiovascular system. Interventional methods visualization of the cardiovascular system. Normal anatomy of the heart and great vessels. The imaging of the elderly person.

Topic 6. Algorithm of clinical imaging of cardiovascular system. Heart size and shape. Left atrial enlargement. Right atrial enlargement. Left ventricular enlargement. Right ventricular enlargement. Pulmonary arterial hypertension. Pericardial effusion. Aortic stenosis. Aortic regurgitation. Mitral stenosis. Mitral regurgitation. Aortic lesions.

Substantial module 4 Complex clinical imaging of the GIT.

Topic 7. Gastrointestinal imaging**.** Normal anatomy and function of the oesophagus, stomach, small intestine, large intestine.

Algorithm of clinical imaging of the GIT. Indications and contraindications methods visualization of the GIT. Methods visualization of the salivary glands: plain films, sialography, ultrasound, CT scan, MRI. Salivary gland lesions (radiological features).

Methods visualization of the GIT: plain radiography, barium studies, double contrast technique, barium follow - through, barium enema, extrinsic impressions, endoscopy, computed tomography, endoscopic ultrasound, radionuclide radiology including positron emission tomography, magnetic resonance imaging. **Contrast agents** and radiopharmaceuticals Technique of examination. Advances in gastric imaging. The normal swallow, peristalsis, gas patterns, organ shapes and sizes, gastric emptying, abdominal calcification Abnormal motility. Patient preparation.

Topic 8. Abnormal imaging of the GIT.

Evaluation of gas patterns. Abdominal calcifications. Differential diagnosis of abdominal calcifications. Strictures and dilatation.

Initial study to order for various clinical problems of the GIT.

Radiological features: esophageal diverticula, achalasia, foreign bodies of the esophagus, malignant tumors of the esophagus, gastritis and gastric ulcer disease, duodenal ulcers, malignant tumors of the stomach, ulcerative colitis, Crohn's disease, polyps, colon carcinoma, perforation, volvulus, small-bowel obstruction,

Topic 9. The liver. The biliary system. Imaging techniques.

Algorithm of clinical imaging of the biliary system. Indications and contraindications methods visualization of the biliary system. Liver imaging techniques: plain radiography, ultrasound, computed tomography, magnetic resonance imaging, liver scintigraphy, angiography.

Interventional radiology: percutaneous treatment of liver metastases, vascular interventional techniques, hepatic arterial embolization, hepatic arterial infusion techniques, portal vein embolization, transjugular portosystemic stent shunt, hepatic venous intervention.

Methods visualization of the biliary system: computed tomography (CT), cholangiography, magnetic resonance cholangiopancreatography, endoscopic retrograde cholangiopancreatography, percutaneous transhepatic cholangiography, intraoperative cholangiography, T-tube cholangiography, hepatobiliary scintigraphy. Role of radiology in investigation of jaundice Interventional techniques: percutaneous cholecystostomy, percutaneous transhepatic biliary catheterization, malignant disease, benign disease, biopsy techniques.

Liver anatomy. Diffuse liver changes. Focal liver lesions. Malignant focal liver lesions. Biliary anatomy. Gallbladder anatomical variants. Gallbladder stones. Milk of calcium bile. Acute calculous cholecystitis. Gallbladder perforation. Porcelain gallbladder. Postoperative strictures. Carcinoma of gallbladder.

Module 2. Scope of diagnostic imaging.
Substantial module 5 Radiology of the urinary tract.

Topic11. Radiology of the urinary tract. Radiologic findings of the urinary tract pathology. Imaging techniques of the urinary tract: abdominal radiography, computed tomography, ultrasonography, magnetic resonance imaging, nuclear medicine, retrograde pyelography, antegrade pyelography, cystography, urethrography, angiography. Normal anatomy of the urinary tract. **Contrast agents** and radiopharmaceuticals. . Patient preparation.

Topic12. Algorithm of clinical imaging of the urinary tract. Indications and contraindications. Radiologic findings of the urinary tract pathology: congenital abnormalities, renal cysts, renal stone disease, hematuria, pyelonephritis and renal infections, renal trauma, renal tumors, obstruction of the renal collecting system, dilatation of a ureter, trauma of urinary bladder, tumors of the bladder

Topic13. Gynaecological imaging. Radiology of the brest. Radiologic findings of the gynaecological system pathology and of the breast pathology.

Imaging techniques of the gynaecological system: ultrasound, Doppler ultrasound, plain radiograph, hysterosalpingography, MRI, percutaneous aspiration and drainage, angiography. Causes of pelvic calcification visible on a plain abdominal x-ray. The role of CT in the evaluation of gynaecological diseases.

Ovulation disorders and ovarian morphology. Screening for ovarium cancer

Radiologic findings of the gynaecological system pathology: ovarian tumours, congenital uterine abnormalities, endometrial carcinoma.

Technique and normal anatomy of the brest: film-screen and digital radiography (radiomammography), ultrasonography, magnetic resonance imaging, ductography, image-, guided needle aspiration and biopsy, image-guided needle localization, biopsy specimen radiography. Patient Preparation

Exercises: a) the symptomatic patient

1. the palpable mass

2. lumpiness, nipple discharge, and pain

b) the asymptomatic patient

1. the first mammogram

2. architectural distortion and asymmetric density

3. the follow-up mammogram

Limitations of the mammography. Standard projections. Additional projections. Breast compression. Indications for mammography. Normal structures of the brest: parenchyma, connective tissue, fat, lymph nodes, veins, arteries, skin. Brest pathology: cysts**, f**ibroadenoma and related conditions, classification of invasive breast cancer, The differential diagnosis of malignancy. Benign microcalcifications. Malignant microcalcifications.

Substantial module 6 Radiology of the skeletal system.

Topic14. Complex clinical imaging of the skeletal system. Imaging techniques of the skeletal system: radiography, skeletal scintigraphy, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound (US), arthrography. Algorithm of clinical imaging of the skeletal system. Indications and contraindications. Normal structures of the bones and joints. Typical x-ray projections. Basic interpretation of x-ray film. The bone x- film of the elderly person.

Radiological features of the: osteonecrosis, osteoporosis, periosteal reaction.

Topic15. Complex clinical imaging of the skeletal system pathology. General principles of diagnosis. Skeletal trauma. Evaluation of fracture. Displacement of fractured fragments. Mechanism of fracture healing. Complication of bone healing.

Osteomyelitis (causes, features, complication). Special forms of osteomyelitis. Causes of periosteal new bone. Formation.

Radiological features of the: spinal degenerative disease, ankylosing spondylitis, septic arthritis, Paget’s disease, giant cell tumors, aneurismal bone cyst.

Classification of bone tumors. Metastatic tumor involvement of bone. Radiological features of the: osteoid osteoma, osteosarcoma, Ewing’s sarcoma.

Substantial module 7 Skull and brain: methods of examination and anatomy. Complex clinical imaging of the thyroid gland.

Topic16. Complex clinical imaging of the thyroid gland.

Ultrasound of the thyroid gland: benign cyst, thyroid malignancy, metastatic disease. Radionuclide imaging of the thyroid gland (techniques, agent, indications, preparation, normal appearances). Anatomical consideration. Thyrotoxicosis, thyroid nodules, ectopic thyroid, thyroid cancer.

Topic17. Skull and brain: methods of examination and anatomy.

Methods of examination: plain radiography, cross-sectional imaging techniques, magnetic resonance imaging, magnetic resonance diffusion imaging, functional magnetic resonance imaging, computed tomography angiography, magnetic resonance angiography. Advanced magnetic resonance imaging (i**ndications, contraindications, complications). Intravenous contrast medium.**

Radiological features of the: congenital anomalies, craniocerebral trauma, intracranial hemorrhage, aneurysm, and infarction. **Radiological investigations in intracranial tumors.**

Topic18. Methods examination of the urgent conditions. Radiological features of the urgent pathologies.

Methods of examination: plain radiography, ultrasound, computed tomography (CT), magnetic resonance imaging, nuclear medicine, positron emission tomography. Radiological features of the: myocardial infarction, pulmonary oedema, pulmonary embolism, pericardial effusion, hydrothorax, pneumothorax, foreign bodies of the bronchus, foreign bodies of the GIT, intestine obstruction, perforation, abdominal trauma. Algorithm of clinical imaging of the urgent pathologies.

Topic19. Algorithm of clinical imaging of the different organs and systems.

Algorithm of clinical imaging of the: chest, abdomen, urinary system, gynecological system, breast, skeletal system, thyroid gland, **skull and brain,** urgent conditions.

THE STUDENTS HAVE TO KNOW:

1.1. Kinds and properties of ionizing radiation.

1.2. Radiobiology and radiation risks

1.3. Principles of protection.

1.4 Preventive treatment of ionizing radiation

1.5 The physical basis of diagnostic imaging.

1.6 Methods of visualization in radiology imaging and principles of diagnostic images.

1.7 Basic interpretation of x-ray film and CT scan

1.8 Normal radiological anatomy of different organs and systems

1.9 Initial method of visualization for different organs and systems

1.10 Advantages of methods of visualization in radiology imaging

1.11 History of medical radiology

1.12 Structure of radiological department

1.13 Rigging and work of the specialized medical establishments is for the grant of help persons which carried influence ionizing radiation.

1.14 Radiation measurement and doses of ionizing radiation: units of measurement, estimation of radioactivity and dose of radiation

1.15 Advantages and disadvantages of methods of visualization in radiology imaging

1.16 Indications and contraindications of methods of visualization in radiology imaging

1.17 Methods of visualization in radiology imaging: x-ray film, fluoroscopy, tomography, fluorography, CT scan

1.18 The basic principle of ultrasound

1.19 Normal ultrasonographic anatomy of different organs and systems

1.20 The basic principle of: radioisotope scan, emission computer tomography, positron emission computer tomography

1.21 The basic principle of MRI. Contrast substances

1.22 Complex clinical imaging of the respiratory system.

1.23 Normal radiological anatomy and physiology of the respiratory system

1.24 Basic interpretation of chest x-ray film

1.25 Characteristic of pathological shadow: position, quantity, shape, size, structure, intensive, outlines

1.26 Types of brochoobstruction

1.27 Algorithm of clinical imaging of respiratory system.

1.28 Radiological features of respiratory system pathology.

1.29 The basic radiological syndromes of respiratory system pathology

1.30 MRI features of respiratory system pathology.

1.31 Radioisotope features of respiratory system pathology.

1.32 Ultrasonographic features of respiratory system pathology

1.33 Algorithm of clinical imaging of respiratory system pathology

1.34 Complex clinical imaging of the cardio vascular system

1.35 Classification of methods of visualization for cardio vascular system (invasive,

noninvasive)

1.36 Normal radiological anatomy and physiology of the cardio vascular system

1.37 Radiological features of the cardio vascular system pathology

1.38 The shape of heart (in normal and pathology)

1.39 Algorithm of clinical imaging of the cardio vascular system

1.40 Complex clinical imaging of the gastrointestinal tract

1.41 Normal radiological anatomy and physiology of the gastrointestinal tract

1.42 Radiological features of the gastrointestinal tract pathology

1.43 Algorithm of clinical imaging of perforation

1.44 Algorithm of clinical imaging of oesophagus carcinoma, stomach carcinoma and colon carcinoma

1.45 Complex liver and bile-excreting ways, normal radiological anatomy and physiology.

1.46 Radiological features of biliary system pathology

1.47 Complex clinical imaging of the urinary system

1.48 Contrast media

1.49 Radiological features of the urinary system pathology

1.50 Algorithm of clinical imaging of the urinary system

1.51 Complex methods of visualization of the women's imaging (roentgenography,

ultrasonography, radioisotope scan, MRI, CT scan)

1.52 Normal radiological anatomy and physiology of the mammary gland and genitourinary system

1.53 Radiological features of the mammary gland and genitourinary system pathology

1.54 Complex clinical imaging of musculoskeletal system.

1.55 Radioanatomy of bones and joints

1.56 Symptoms and syndromes of musculoskeletal system pathology: inflammation, tumors, traumatic injuries.

1.57 Complex clinical imaging of the thyroid gland: Ultrasound, CT scan, MRI, radioisotope scan

1.58 Normal radiological anatomy and physiology of the thyroid gland. Radiological features of thyroid gland's pathology

1.59 Complex clinical imaging of the central nervous system

1.60 Normal radiological anatomy and physiology of the central nervous system.

1.61 Radiological features of central nervous system: head trauma, suspected intracranial hemorrhage, transient ischemic attack, intracranial aneurysm, primary brain tumors and metastases.

1.62 Radiological imaging at urgent pathologies

1.63 Radiological features of urgent pathologies

THE STUDENTS TO ABLE TO

2.1 measure protection principles of ionizing radiation

2.2 use preventive treatment of ionizing radiation

2.3 analyze and describe X - ray film, tomogram

2.4 analyze ultrasonogram

2.5 analyze of radioisotope imaging

2.6 analyze of MR imaging

2.7 determine normal radiological anatomy different organs

2.8 choose the initial method of visualization for different organs and systems

2.9 measure advantages of methods of visualization for different organs and systems

2.10 create algorithm of clinical imaging for different organs and systems

2.11 enumerate radiological features of gastrointestinal pathology

2.12 enumerate radiological features of biliary pathology

2.13 enumerate radiological features of cardiovascular pathology

2.14 enumerate radiological features of respiratory system pathology

2.15 enumerate radiological features of urinary system pathology

2.16 enumerate radiological features of mammary gland and genitourinary system pathology

2.17 enumerate radiological features of central nervous system pathology

2.18 enumerate radiological features of thyroid gland pathology

2.19 enumerate radiological features of musculoskeletal system pathology.

TOPIC 1.
HISTORY OF MEDICAL RADIOLOGY. STRUCTURE OF RADIOLOGICAL DEPARTMENT

Importance of the subject

The discovery of x rays by Roentgen in 1895, started a new era in medical diagnosis. In the recent half century, diagnostic radiology has undergone dramatic changes and developments. Conventional angiography, nuclear medicine, ultrasonography, and computed tomography (CT) were developed between 1950 and 1970. Magnetic resonance (MR) imaging, interventional radiology, and positron emission tomography (PET) were developed later. Conventional radiology, including contrast-enhanced radiography and CT, uses ionizing radiation created from x-ray equipment. Nuclear medicine uses ionizing radiation that is emitted from injected or ingested radioactive pharmaceuticals in various parts of the body. Nowadays radiological methods play a leading role in diagnosing most diseases. Non-ionizing radiations are widely used alongside ionizing ones. They are ultrasound and radiofrequency waves in magnetic resonance imaging.

Radiologic subspecialties have been developed based on organ systems, modalities, and specific fields. Organ-oriented subspecialties of radiology include musculoskeletal, breast, neurologic, abdominal, thoracic, cardiac, gastrointestinal, and genitourinary imaging. Modality-oriented subspecialties comprise nuclear medicine, interventional, ultrasonography, and MR imaging. Specific field subspecialties include pediatric and women's imaging. Functional and metabolic imaging methods are now being used clinically, with genetic and molecular marker imaging expected in the future.

Aims and tasks of the discipline

To learn history of medical radiology.

To learn the types of radiological departments.

To learn the principles of protection (time, distance, shielding, quantity).

The students have to know:

1. History of medical radiology.
2. Types of radiological departments.
3. Particular qualities of radiological departments and radio treatment department.
4. Structure of x-ray room.
5. Principles of protection (time, distance, shielding, quantity).
6. Radiation measurement and doses.
7. The limits of exposure to radiation. “Working level” and “working level month”.
8. Radiobiology and radiation risks.
9. Preventive treatment of ionizing radiation.
10. Mass health examination of personnel on atomic productions and population, contacting with ionizing radiation sources National register of persons, which carried influence of radiation as a result of failure on CHAES.
11. Use of radiation (ionization and non-ionization) in medicine practice: the physical characteristics, the source of radiation, the capacity for penetrate, the biological effects.
12. Local and general radiation.
13. The types of individual dosimeters.

The students to able to

- to be able to choose the optimum method of protection of medical personnel and patients during diagnostic and treatment procedures, which are connected with use of ionizing radiations.
- to be able to use preventive treatment of ionizing radiation
- to be able to explain the maximal tolerance dose for medical personnel and patients;

Summary of Procedures

At the beginning of the practice to check student’s level of training to the practice the homework will be analysed. Then each of the students will understand and will explain the maximal tolerance dose for medical personnel and patients; will

tractate the different factors of protection of medical personnel and patients from ionizing radiations and to evaluate their reliability

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI tests
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

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3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

4. Grainger and Allison's. - A textbook of medical imaging. Section three. 2008

5. David Sutton.- Radiology and imaging. Seventh edition 2003.

TOPIC 2.
METHODS OF VISUALIZATION IN RADIOLOGY.

Importance of the subject

Radiodiagnosis forms an integral part of clinical medicine. It provides a window through the clinical can look into a disease more meaningfully. Every doctor is expected to read and interpret a radiological investigation in the light of his or her patient's clinical findings. He or she must also realize the indications and limitations of this procedure. Advice for any radiological investigation should therefore be selective and specific. With addition of newer imaging techniques like CT scan, ultrasound and radionuclide scanning, radiology has become more fascinating. More and more stress is given to a radiological diagnosis in medical education curriculum. In the light of above, every medical student is being exposed to the subject of radiology more widely.

The aims of the diagnostic radiology are forming complex of knowledge, abilities and skill of students.

The tasks of the diagnostic radiology are selection of radiology method for investigation different organs and systems; recognize and difference abnormal radiological signs from normal radiological signs.

The students have to know:

1. X-ray methods of examination: radiography, fluoroscopy, fluorography, conventional tomography, computed tomography (CT); contrast methods.
2. Principles of obtaining images with X-Ray methods.
3. MRI.
4. Principles of obtaining MRI.
5. Methods of ultrasound examination: M-mode, B-mode of ultrasonography, Doppler sonography, duplex scanning.
6. Principles of obtaining images with ultrasound.
7. Radionuclide methods of examination - scintigraphy, positron emission tomography (PET), radiography and radiometry.
8. Principles of obtaining information with radionuclide methods of examination.

The students to able to

- to be able to interpret the principles of obtaining images with radiological methods and purpose of using radiological methods of examination (X-ray methods – radiography, fluoroscopy, fluorography, conventional tomography, computed tomography (CT); methods of radionuclide imaging: scintigraphy, positron emission tomography (PET), radiography and radiometry; methods of diagnostic ultrasound: single-dimensional, two-dimensional scanning (sonography), Doppler technique; MRI - magnetic resonance imaging).

Summary of Procedures

At the beginning of the practice to check student’s level of training to the practice the homework will be analyzed.

Equipment of the class

1. situation tasks

2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	Procedure duration (min)	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, CT scan, roentgenoscopy, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. David Sutton.- Radiology and imaging. Seventh edition 2003.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

4. Grainger and Allison's. - A textbook of medical imaging. Section three. 2008

TOPIC 3.
METHODS VISUALIZATION OF THE CHEST

Importance of the subject

The chest radiograph (CXR) is useful to diagnose or identify primary cardiac and pulmonary pathology, abnormal pleural processes, thoracic aortic dilation, aspirated foreign bodies, and thoracic trauma. In cardiac disease, the CXR reveals pulmonary edema, moderate to large pericardial effusion, and cardiomegaly. CXR shows multiple primary pulmonary processes. It reveals infectious processes, such as lobar pneumonia, tuberculosis, atypical pneumonia, empyema, and lung abscess. Pulmonary processes such as pneumonitis, hyperaeration due to chronic obstructive pulmonary disease and asthma, and lung masses are evident on CXR. Pleural processes such as pleural thickening, pneumothorax, hemothorax, and pleural effusions are also evident on CXR. CXR is the first radiologic screening test for thoracic aneurysm.

In thoracic trauma, CXR evaluates for multiple bony and soft tissue injuries. CXR is the screening exam for thoracic aortic injury, pulmonary contusion, pneumothorax, hemothorax, and traumatic pericardial effusion. Skeletal injuries, including rib, scapular, clavicular, shoulder, and sternal fractures and dislocations, can be seen on CXR.

There are limitations to the chest radiograph, and diseases may not be sufficiently advanced to be detected or may not result in detectable abnormalities. Other imaging methods are needed to complement the conventional chest radiograph.

These imaging methods include computed tomography (CT), positron emission tomography/computed tomography (PET/CT) and other radionuclide studies, magnetic resonance (MR) imaging, and ultrasound (US).

Chest radiograph is usually sufficient to diagnose pneumonia. Many patients, especially immune compromised patients, may undergo CT when there is high clinical suspicion for pneumonia in the absence of positive radiographic findings.

Pneumonia may also be discovered when CT is performed o rule out other causes of chest pain, such as pulmonary embolism.

Chest CT is also indicated to characterize the extent of pleural effusions, empyemas, and infectious lung processes, such as tuberculosis.

CT angiography is performed for pulmonary embolism and aortic dissection. CT is two to four times more sensitive than chest radiograph in detecting intrathoracic injuries following trauma. It is especially more sensitive in detecting pulmonary, pleural, and osseous injuries.

MR imaging of the thorax is most commonly used for cardiovascular imaging, but there are indications for MR imaging in mediastinal and pulmonary parenchymal imaging as well.

MR is helpful when bronchogenic carcinoma is suspected of invading vascular structures, including the cardiac chambers, pulmonary arteries and veins, and the superior vena cava. In a patient with suspected Pancoast's (superior sulcus) tumor.

Ultrasound of the chest is typically performed to evaluate fluid collections within the pleural space. Ultrasound may be used to guide thoracentesis, especially when the fluid collection is small or loculated.

Nuclear medicine techniques used in evaluating diseases of the thorax include ventilation-perfusion (V/Q). The V/Q scan is often the imaging study of choice for a patient with suspected pulmonary thromboembolism.

Aims and tasks of the discipline

To learn optimal radiological method for visualization chest.

To learn X-Ray methods of examination of chest: fluoroscopy, radiography, CT.

To learn ultrasound, MRI, radionuclide methods of examination of lung and mediastinum.

To learn anatomical structures of lungs and mediastinum on radiological images.

To interpret general radiological semiotics.

The students have to know:

1. Methods visualization of the chest: x-ray film, conventional radiography, roentgenoscopy, computed tomography of the chest, nuclear medicine perfusion imaging of the chest, positron emission tomography/computed tomography imaging of the chest, magnetic resonance imaging of the chest, ultrasonography of the chest.
2. Major indications for: x-ray film, conventional radiography, roentgenoscopy, nuclear medicine perfusion imaging of the chest, positron emission tomography/computed tomography imaging of the chest, magnetic resonance imaging of the chest, ultrasonography of the chest, CT of the chest.
3. Perfusion scintigraphy. Ventilation scintigraphy.
4. Suggested imaging procedures for various chest problems. Circumstances in which a chest X-ray is not indicated.
5. Limitations of the plain chest film.
6. Physiological considerations of the lung.
7. Normal anatomy of the chest and variants: ribs, bony structures, soft tissues, lobes, segments, lung pattern, hila fissures, mediastinum, diaphragm, heart.

8. Congenital anomalies of the chest.
9. The chest film of the elderly person.

The students to able to

- to be able to choose the more informative radiological method of examination for revealing chest pathology
- to be able to detect x-ray film, conventional radiography, roentgenoscopy, computed tomography of the chest, nuclear medicine perfusion imaging of the chest, positron emission tomography/computed tomography imaging of the chest, magnetic resonance imaging of the chest, ultrasonography of the chest
- to be able to choose the main radiological syndromes of lung and mediastinal pathology
- to be able to interpret their morphological substratum
- to be able to recognize anatomical structures of chest on radiological images

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analysed. Then each of the students will get radiological images of lungs and mediastinum.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. video-tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

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TOPIC 4.
RADIOLOGICAL FEATURES OF LUNG DISEASES

Importance of the subject

The chest radiograph is the most frequently performed radiographic study in our countries. It should usually be the first radiologic study ordered for evaluation of diseases of the thorax. The natural contrast of the aerated lungs provides a window into the body to evaluate the patient for diseases involving the heart, lungs, pleurae, tracheobronchial tree, esophagus, thoracic lymph nodes, thoracic skeleton, chest wall, and upper abdomen. In both acute and chronic illnesses, the chest radiograph allows one to detect a disease and monitor its response to therapy. For many disease processes (eg, pneumonia and congestive heart failure) the diagnosis can be established and the disease followed to resolution with no further imaging studies. There are limitations to the chest radiograph, and diseases may not be sufficiently advanced to be detected or may not result in detectable abnormalities. Other imaging methods are needed to complement the conventional chest radiograph. These imaging methods include computed tomography (CT), positron emission tomography/computed tomography (PET/CT) and other radionuclide studies, magnetic resonance (MR) imaging, and ultrasound (US

Aims and tasks of the discipline

To learn different radiological examination in obtaining information about lungs and mediastinum.

To learn X-Ray signs of pathology of chest.

To learn the main X-Ray syndromes of chest.

The students have to know:

- Algorithm of clinical imaging of respiratory system.
- X-Ray semiotics of lungs and mediastinum diseases: pneumonia, bronchopneumonia, emphysema, chronic bronchitis, bronchiectasis, lung abscess, tuberculosis, mediastenitis.
- Pleural effusion

- Types of brocho obstruction.
- Atelectasis
- Lung tumors (central and peripheral). Pancoast tumor.
- Pneumothorax.
- The main X-Ray syndromes of lung and mediastinum pathology and their morphological substratum
- Radionuclide, ultrasound and MRI semiotics of lungs, pleura and mediastinum diseases.

The students to able to

- to be able to analyze and describe chest X - ray film, chest tomogram
- to be able to analyze of chest radioisotope imaging
- to be able to analyze of chest MR imaging
- to be able to choose the initial method of visualization for lungs, pleura and mediastinum
- to be able to measure advantages of methods of visualization for lungs and mediastinum
- to be able to create algorithm of clinical imaging for respiratory system
- to be able to analyse the radiological semiotics of functional and morphological changes at lungs, pleura and mediastinum and cardiovascular system pathology

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analysed. Then each of the students will get radiological images of lungs and mediastinum.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms

6. MRI films

7. video-tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.OttISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

4. Grainger and Allison's. - A textbook of medical imaging. Section three. 2008

5. David Sutton. - Radiology and imaging. Seventh edition 2003.

TOPIC 5.
COMPLEX CLINICAL IMAGING OF THE CARDIOVASCULAR SYSTEM.

Importance of the subject

There is a wide array of imaging tests that can be used to evaluate the cardiovascular system. The initial screening study should always be a chest radiograph. This study gives important information about the cardiac contour and the status of the lungs, and it is a good examination for excluding disorders that would require immediate treatment, such as pneumothorax. Furthermore, evaluation of the chest radiograph can often lead to a specific diagnosis and treatment, such as in congestive heart failure, or can help determine the need for another imaging study.

Depending on the history and physical examination findings, echocardiography, nuclear cardiac imaging, CT, MR, or conventional coronary angiography may follow.

Echocardiography is a good screening test to assess cardiac and great-vessel valvular motion and structural abnormalities, cardiac chamber morphology, and flow.

Angiography delineates the structural status of the coronary arteries and can give information on blood flow through the cardiac chambers, valves, and proximal great vessels, mainly in patients with suspected atherosclerosis. It is also used to guide interventions such as stent placement in the coronary arteries.

In patients with suspected pulmonary emboli, helical CT is the most appropriate test in the setting of an abnormal chest x-ray. The ventilation-perfusion (V/Q) scan can be performed if the chest radiograph is normal and is also the preferred examination in young females because of the radiation dose to the breast by CT. Both of these tests can confirm the clinically suspected diagnosis of pulmonary embolic disease and often provide a useful “map” of the most suspicious regions of the lung for the angiographer if an angiogram is required for the definitive diagnosis of pulmonary embolism.

MR imaging has become the preferred imaging test in the pediatric population. MR imaging is noninvasive, uses no ionizing radiation, is less operator-dependent, and can be performed in multiple planes. It is limited by availability and imaging time and because it cannot be used in patients with certain implanted devices, particularly pacemakers.

Aims and tasks of the discipline

To learn X-Ray methods of examination of cardiovascular system: fluoroscopy, radiography, angiocardiography, CT.

To learn ultrasound, MRI, radionuclide methods of examination of cardiovascular system: scintigraphy of myocardium, single photon emission computed tomography (SPECT), positron emission tomography (PET).

To be able to choose the more informative radiological method of examination for revealing heart and vessel pathology.

The students have to know:

1. X-Ray methods of examination of cardiovascular system: fluoroscopy, radiography, angiocardiography, CT.
2. Ultrasound methods of examination of cardiovascular system: M-mode, B-mode sonography, Doppler sonography, duplex scanning.
3. MRI of cardiovascular system.
4. Radionuclide methods of examination of cardiovascular system: scintigraphy of myocardium, single photon emission computed tomography (SPECT), positron emission tomography (PET).

5. Radiological anatomy of cardiovascular system.

The students to able to

- to be able to detect radionuclide, ultrasound and MRI signs of diseases of heart and vessels
- to be able to choose the main radionuclide, ultrasound and MRI syndromes of heart and vessel pathology
- to be able to interpret their morphological substratum
- to be able to choose the more informative radiological method of examination for revealing heart and vessel pathology
- to be able to interpret possibilities of different radiological examination in obtaining information about cardiovascular system
- to be able to recognize anatomical structures of cardiovascular system on radiological images

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analysed. Then each of the students will get radiological images of heart and vessels. The practice will finish with summary.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizingtime	10	academicjournal
2.	Checking level of students training to practice	45	academicjournal,tables
3.	Individualwork of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit ofradiologicaldepartment Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1.O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.OttISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

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TOPIC 6.
PATHOLOGICAL CONDITIONS OF THE CARDIOVASCULAR SYSTEM

Importance of the subject

The heart is often the “forgotten” structure in thoracic imaging studies. Yet a tremendous amount of information regarding cardiac structure and function can be gleaned from careful analysis of studies, regardless of whether they are dedicated to cardiac imaging. Critical evaluation of the findings on the imaging examinations of this region is not possible without paying attention to the lungs, as these two organ systems mirror changes in each other. The most common abnormalities encountered in the cardiovascular system are hypertension, pulmonary arterial hypertension (usually secondary to chronic pulmonary disease), congestive heart failure, atherosclerotic disease, and valvular disease. Less common cardiac and great vessel diseases such as congenital heart disease, neoplasms, and diseases of the pericardium are described in less detail.

Aims and tasks of the discipline

To learn different radiological examination in obtaining information about cardiovascular system.

To learn X-Ray signs of pathology of heart and vessels.

To learn the main X-Ray syndromes of heart and vessel pathology.

The students have to know:

1. X-Ray semiotics of heart and vessel pathology: Left atrial enlargement. Right atrial enlargement. Left ventricular enlargement. Right ventricular enlargement. Pulmonary arterial hypertension. Pericardial effusion. Aortic stenosis. Aortic regurgitation. Mitral stenosis. Mitral regurgitation. Aortic lesions.
2. The main X-Ray syndromes of heart and vessel pathology and their morphological substratum.

The students to able to

- to be able to interpret possibilities of different radiological examination in obtaining information about cardiovascular system

- to be able to estimate X-Ray signs of pathology of heart and vessels
- to be able to choose the main X-Ray syndromes of heart and vessel pathology;
- to be able to interpret their morphological substratum.

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analysed. Then each of the students will get radiological images of heart and vessels.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. video-tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram,

			computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1.O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

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TOPIC 7.
GASTROINTESTINAL IMAGING.

Importance of the subject

Varieties of radiographic and endoscopic techniques are now available to examine the gastrointestinal tract. Selection of an appropriate technique depends on many factors, including the clinical indications for the examination and the efficacy of the various techniques.

Luminal contrast examinations of the gastrointestinal tract can be performed with a variety of contrast materials. Barium sulfate suspensions are the preferred material for most examinations. Water-soluble contrast agents, which contain

organically bound iodine, are used less often, primarily to demonstrate perforation of a hollow viscus or to evaluate the status of a surgical anastomosis in the gastrointestinal tract.

CT imaging of the chest and abdomen can portray the various hollow organs of the gastrointestinal tract. Mucosal disease, such as ulcers, and small neoplasms will not be shown with this imaging modality. Larger gastrointestinal neoplasms, thickening of the walls of the hollow organs, and extrinsic processes can be easily detected. Also, with the use of luminal distention and intravenous contrast material, a variety of gastrointestinal disorders are more readily evaluated. A major role of CT scanning, especially in the esophagus and colon, is staging malignancy of these organs. CT colonography (CTC) is yet another expanding application for colon cancer screening and detection of polyps and malignancies ofthe large bowel.

MR imaging of the hollow organs of the gastrointestinal tract is increasingly being used to evaluate a wide assortment of gastrointestinal tract disorders. As with CT imaging, mild mucosal diseases and small focal lesions are not well detected with this technique; however, malignancies can be similarly evaluated and staged. Also, with the use of luminal distention and intravenous agents of various types, assessment of obstructive and inflammatory bowel disease has shown dramatic results. Small-bowel obstruction and Crohn disease in particular have become common indications for use of MR imaging. With the newer technologies, both CT and MR imaging offer multiple options for viewing the gastrointestinal tract, including multiplanar viewing and 2-D and 3-D reconstructions. Dynamic MR imaging has also emerged with application in several areas, such as assessment of pelvic floor dysfunction in women.

Abdominal ultrasound has had an increasing impact on evaluation of the hollow organs of the gastrointestinal tract. The location of the hollow organs and the presence of gas interference remain technical problems; however, inflammatory disorders can be evaluated, such as acute appendicitis, especially in pediatric patients. Endoluminal ultrasound using blind probes or those attached to

an endoscope has been used in the upper gastrointestinal tract and the colorectum to detect and stage malignancy; other indications include fine-needle aspiration (FNA) of pancreatic masses through the gastroduodenal wall.

Aims and tasks of the discipline

To learn different radiological methods of examination in obtaining information about state of digestive system.

To learn the anatomical structures of digestive system on radiological images.

To learn the main radiological syndromes of digestive system.

The students have to know:

1. Radiological methods of examination of gastrointestinal tract: fluoroscopy and radiography with contrast media, CT.
2. The principle and technique of barium meal examination
3. The principle and technique of double-contrast examination
4. Radiological anatomy of gastrointestinal tract: oesophagus, stomach, small intestine, large intestine.

The students to able to

- to be able to interpret possibilities of different radiological methods of examination in obtaining information about state of digestive system.
- to be able to recognize anatomical structures of digestive system on radiological images.

Summary of Procedures

At the beginning of the practice to check student’s level of training to the practice the homework will be analysed. Then each of the students will get radiological images of oesophagus, stomach, small intestine, large intestine.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms

6. MRI films

7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	5	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	30	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	40	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	15	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

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TOPIC 8.

ABNORMAL IMAGING OF THE GASTROINTESTINAL TRACT.

Importance of the subject

Varieties of radiographic and endoscopic techniques are now available to examine the gastrointestinal tract. Selection of an appropriate technique depends on many factors, including the clinical indications for the examination and the efficacy of the various techniques.

Plain films of the abdomen are still used primarily to assess intestinal perforation (intraperitoneal air) or bowel obstruction or assessment for catheter placement. The plain radiograph is commonly used as a preliminary radiograph before other studies such as CT and barium enema. The yield of plain radiographs is higher in patients with moderate or severe abdominal symptoms and signs than in those with minor symptoms.

The classical radiological imaging methods such as upper GI examination still play an important role whenever physiological motion plays a role (swallowing, peristalsis of the esophagus, gastric motility, etc.) and in postoperative patients, e.g., when the evaluation of an anastomosis has been requested. The oral administration of contrast is obligatory in these cases. For intestinal segments that are inaccessible for the normal endoscope—in particular the mid to distal small bowel—radiological procedures remain a diagnostic mainstay. Capsule endoscopy is an emerging direct, nonionizing modality that uses a small radiofrequency transducer that is swallowed and acts as a camera imaging the small bowel; this might turn the tide in the near future.

Sectional imaging techniques such as ultrasound, CT, and MRI are increasingly gaining ground in the radiological evaluation of the hollow viscera: virtual colposcopy is just one example (Fig. 9.1a, b). On the other hand, contrast-enhanced sectional imaging undoubtedly is the gold standard of the radiological evaluation of the solid organs in the abdomen.

Aims and tasks of the discipline

To learn the main radiological syndromes of GIT: filling defect, deposition of barium, stricture. To learn the X-Ray signs of pathology of gastrointestinal tract: esophageal diverticula, achalasia, foreign bodies of the esophagus, malignant tumors of the esophagus, gastritis and gastric ulcer disease, duodenal ulcers, malignant tumors of the stomach, ulcerative colitis, Crohn’s disease, polyps, colon carcinoma, perforation, volvulus, small-bowel obstruction.

The students have to know:

1. X-Ray semiotics of diseases of GIT.
2. The main X-Ray syndromes of oesophagus, stomach, intestine, colon and their morphological substrate.
3. Algorithm of clinical imaging of oesophagus carcinoma, stomach carcinoma and colon carcinoma.

The students to able to

- to choose the main radiological syndromes of GIT: filling defect, deposition of barium, stricture
- to evaluate of gas patterns, abdominal calcifications, strictures and dilatation
- to estimate the X-Ray signs of pathology of gastrointestinal tract: esophageal diverticula, achalasia, foreign bodies of the esophagus, malignant tumors of the esophagus, gastritis and gastric ulcer disease, duodenal ulcers, malignant tumors of the stomach, ulcerative colitis, Crohn’s disease, polyps, colon carcinoma, perforation, volvulus, small-bowel obstruction
- to be able to interpret their morphological substratum

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analysed. Then each of the students will get radiological images of oesophagus, stomach, small intestine, large intestine. The practice will finish with summary.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. **Chapter 6 –** Gastrointestinal system.

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TOPIC 9.

THE LIVER. THE BILIARY SYSTEM. IMAGING TECHNIQUE

Importance of the subject

The diagnosis of diseases of the liver, biliary tract, and pancreas optimally depends on using both clinical and radiographic data. Understanding the proper use of these data and ordering radiographic studies in the optimal sequence are helpful for making the diagnosis most efficiently. Frequently, the clinical presentation and associated laboratory work provide most of the clues for diagnosis. Physical examination, history, and pertinent laboratory values are often helpful in making the diagnosis or at least in providing clues for selecting the optimal radiographic studies. If clinical information is insufficient or if radiographic confirmation is necessary, plain films and contrast studies may be performed.

Upright and supine plain radiographs are helpful for the detection of free air, calcifications, and other abnormalities.

Contrast studies such as endoscopic retrograde cholangiopancreatography (ERCP), magnetic resonance cholangiopancreatography (MRCP) and percutaneous transhepatic cholangiography (PTC) are often helpful in analyzing diseases of the liver, biliary tree, and pancreas. For instance, pancreatic or biliary ductal systems, fistulae from these ductal systems, and associated abnormalities such as encasing tumors can be diagnosed by cholangiography.

Digital cross-sectional imaging, nuclear medicine (NM) and an important form of NM called positron emission tomography (PET), and angiography have provided considerable information in analyzing diseases of these organs, which cannot be directly visualized with plain radiography, even using traditional contrast material, that is, barium.

Cross-sectional techniques consist of ultrasound (US), computed tomography (CT), and magnetic resonance (MR) imaging. This chapter reviews the use of cross-sectional imaging and, where pertinent, nuclear medicine and angiography to evaluate abnormalities of the liver, biliary tract, and pancreas.

Aims and tasks of the discipline

To learn optimal radiological method for visualization of hepatobiliary system.

To learn the X-Ray signs of pathology of biliary tract: congenital abnormalities, gall stones and cholecystitis, carcinoma of the head of the pancreas, trauma, carcinoma of gall bladder.

The students have to know:

1. X-Ray semiotics of diseases of liver, gall bladder, biliary ducts (gall stones and cholecystitis, carcinoma of the head of the pancreas, trauma).
2. The main X-Ray syndromes of liver, gall bladder, biliary duct pathology and their morphological substratum.
3. Complex liver and bile-excreting ways, normal radiological anatomy and physiology
4. Ultrasound semiotics of diseases of liver, gall bladder, biliary ducts.

5. The principle and technique of CT, MRI of the liver gall bladder, biliary ducts.

6. The principle and technique of operative cholangiography and endoscopic retrograde cholangiopancreatography.

The students to able to

- to be able to analyse the radiological semiotics of functional and structural changes at pathology of hepatobiliary system
- to estimate the morphological and functional changes at pathology of hepatobiliary system
- to be able to estimate the X-Ray signs of pathology of biliary tracts.

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analysed. Then each of the students will get radiological images and ultrasound images of liver, gall bladder, biliary ducts.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables

3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

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TOPIC 10.
RADIOLOGY OF THE URINARY TRACT.

Importance of the subject

The urinary system may be imaged in a number of ways. The most common radiographic method is by intravenous injection of an iodine-based contrast agent, which is rapidly cleared by the kidneys. This is called an intravenous pyelogram (IVP). Initially, a plain x-ray image of the abdomen (KUB) is obtained. Students should examine this carefully, looking for abnormalities in the skeleton; soft tissue margins of the liver, spleen, and psoas regions; and the gas pattern in the bowel; as well as for calcifications. Of particular interest are those calcifications that project or overlie the region where you expect to find kidneys, ureters, and bladder. After injection of a contrast material, a tomogram may be obtained as part of the procedure. The tomogram essentially blurs structures in front of and behind the kidneys, leaving only the kidneys and part of the spine in focus

The kidneys should be examined for size, shape, position, and axis. The length of kidneys on a radiographic study is typically about 13 cm.

Ultrasound is a useful technique for evaluation of the urinary tract, with its principal advantages including wide availability, no need for intravenous contrast material, and lack of ionizing radiation.

Just as with CT, technical advances in MR imaging have led to increasing use in urinary tract imaging. Fast scanning techniques allowing breath-hold imaging, combined with the spectacular tissue contrast of MR imaging and the ability to directly image in any plane, make this an attractive modality for evaluating the urinary tract. Lack of ionizing radiation adds to its appeal, although cost, availability, claustrophobia, and the contraindication of certain materials including pacemakers remain major drawbacks.

In general, the value of nuclear imaging in the urinary tract is several fold: functional information related to the quantifiable collected data, lower radiation dose than traditional radiographic techniques, and very low incidence of

complications. Renal evaluation is typically performed by intravenous bolus injection of renal specific agents such as technetium-labeled mercaptoacetyltriglycine (Tc-MAG3). Images are acquired every few seconds demonstrating renal blood flow with additional images obtained over several minutes showing renal uptake and excretion. The recorded data can be used to produce images, but it also is quantifiable and is employed to generate time activity curves. Information about renal perfusion, morphology, relative function of each kidney, and excretion can be extremely useful in evaluation of conditions such as renovascular hypertension, obstruction, and renal transplant examination.

Aims and tasks of the discipline

To learn optimal radiological method for visualization of urinary tract.

To learn the imaging techniques of the urinary system: abdominal plain x-ray film, intravenous urography, ultrasound (US), computed tomography (CT), magnetic resonance imaging (MRI), scintigraphy, angiography.

The students have to know:

1. Imaging techniques of the urinary tract: abdominal radiography, computed tomography, ultrasonography, magnetic resonance imaging, nuclear medicine, retrograde pyelography, antegrade pyelography, cystography, urethrography, and angiography.
2. Normal anatomy of the urinary tract.
3. Contrast agents and radiopharmaceuticals.
4. Patient preparation.

The students to able to

- to be able to analyze and describe plain x-ray film of the abdomen, intravenous pyelogram, tomogram of the urinary tract
- to be able to analyze ultrasonogram of the urinary tract
- to be able to analyze of radioisotope imaging of the urinary tract
- to be able to measure advantages of methods of visualization for urinary tract
- to be able to analyze of MR imaging of the urinary tract

- to be able to choose the initial method of visualization for urinary tract
- to be able to determine normal radiological anatomy of the urinary tract

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analyzed. Then each of the students will get radiological images and ultrasound images of the urinary tract.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	5	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	30	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	40	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram,

			computer tomograms, MRI films, situation tasks
5.	Summary	15	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

4. Grainger and Allison's. - A textbook of medical imaging. Section three. 2008

5. David Sutton. - Radiology and imaging. Seventh edition 2003.

TOPIC 11.
ALGORITHM OF CLINICAL IMAGING OF THE URINARY TRACT.

Importance of the subject

Uroradiology remains a discipline that utilizes all imaging techniques to provide answers to specific clinical questions. The required information can be obtained most rapidly and efficiently by using the correct test or tests performed in the correct order. The wealth of recent technological developments in genitourinary imaging and interventional techniques means that the opportunity to image or intervene has advanced beyond our understanding of exactly when such techniques are best applied.

The number of intravenous urograms (IVUs) performed over the last 15 years has decreased as the use of other imaging techniques, particularly CT, and US has increased. The IVU is still a valuable procedure for examination of the urinary tract. It gives excellent anatomical images of the pelvicalyceal systems and, to some extent, an indication of renal function

Ultrasound (US) is an exceedingly useful technique for examination of the urinary tract. The advantages of using a non-invasive test, which is painless and does not involve irradiation to either patient or operator, are obvious. When a renal mass is found at IVU, then an ultrasound examination will easily and rapidly differentiate a tumour from a cyst. Combining a limited IVU, with its ability to demonstrate the pelvicalyceal system in detail, and ultrasound, which will show abnormalities of the renal outline, is a very efficient method of imaging the urinary tract accurately.

One of the most frequently performed urological ultrasound examinations is the estimation of residual urine in the bladder of patients with outflow obstructive symptoms.

Computed tomography (CT) has become the preferred investigation for acute loin pain, renal mass, renal arteries and, more recently, the urothelium (CT urography).

Just as with CT, technical advances in MR imaging have led to increasing use in urinary tract imaging. Fast scanning techniques allowing breath-hold imaging, combined with the spectacular tissue contrast of MR imaging and the ability to directly image in any plane, make this an attractive modality for evaluating the urinary tract. Lack of ionizing radiation adds to its appeal, although cost, availability, claustrophobia, and the contraindication of certain materials including pacemakers remain major drawbacks.

In general, the value of nuclear imaging in the urinary tract is several fold: functional information related to the quantifiable collected data, lower radiation dose than traditional radiographic techniques, and very low incidence of complications. Renal evaluation is typically performed by intravenous bolus

injection of renal specific agents such as technetium-labeled mercaptoacetyltriglycine (Tc-MAG3). Images are acquired every few seconds demonstrating renal blood flow with additional images obtained over several minutes showing renal uptake and excretion. The recorded data can be used to produce images, but it also is quantifiable and is employed to generate time activity curves. Information about renal perfusion, morphology, relative function of each kidney, and excretion can be extremely useful in evaluation of conditions such as renovascular hypertension, obstruction, and renal transplant examination.

Aims and tasks of the discipline

To learn optimal radiological method for visualization of urinary tract.

To learn the X-Ray signs of pathology of urinary tract: congenital abnormalities, renal cysts, renal stone disease, hematuria, pyelonephritis and renal infections, renal trauma, renal tumors, obstruction of the renal collecting system, dilatation of a ureter, trauma of urinary bladder, tumors of the bladder.

The students have to know:

1. Ultrasound, radionuclide, MRI and CT semiotics of diseases of kidneys, urinary tract.

2 The main ultrasound, radionuclide, MRI and CT-syndromes of kidneys, urinary tract pathology and their morphological substratum.

3. The main X- Ray syndromes of kidney, urinary tract pathology and their morphological substratum.

4. X- Ray semiotics of diseases of kidneys, urinary tract: congenital abnormalities, renal cysts, renal stone disease, hematuria, pyelonephritis and renal infections, renal trauma, renal tumors, obstruction of the renal collecting system, dilatation of a ureter, trauma of urinary bladder, tumors of the bladder.

The students to able to

- to be able to detect the X-Ray signs of diseases of kidneys, urinary tract diseases
- to be able to chose the main X-ray syndromes of kidney, urinary tract pathology
- to be able to interpret their morphological substratum

- to be able to detect the ultrasound, radionuclide, and MRI-signs of diseases of kidneys, urinary tract
- to be able to chose the main radiological syndromes of kidney, urinary tract pathology
- to be able to interpret their morphological substratum.

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analyzed. Then each of the students will get radiological images and ultrasound images of the urinary tract. The practice will finish with summary.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI

			films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

4. Grainger and Allison's. - A textbook of medical imaging. Section three. 2008

5. David Sutton.- Radiology and imaging. Seventh edition 2003.

TOPIC 12.

GYNECOLOGICAL IMAGING. RADIOLOGY OF THE BREST.

Importance of the subject

The most common and fruitful gynecological imaging methods are pelvic ultrasound and CT. Ultrasound is undoubtedly the most widely used method,

because it can easily image the uterus and adrenal regions. Because it does not use ionizing radiation, it can even be used during pregnancy. Imaging of the female pelvis with a plain x-ray is usually of low yield, because most significant pathology associated with female pelvic organs is not calcified.

Female pelvic ultrasound is done either transabdominally or transvaginally. Transvaginal ultrasound has a much smaller field of view, and it is often very difficult to orient yourself with respect to the images unless you were actually there when they were taken. With transabdominal ultrasound, orientation is much easier. Remember that ultrasound imaging gives you a “slice” picture. The slices are typically either longitudinal or transverse. In the longitudinal plane, you can easily see the vagina, cervix, uterus, and bladder. Areas of high-intensity echoes can be seen in the vagina and sometimes in the center of the uterus as a result of mucus production, hemorrhage, or decidual reaction. Fluid in the bladder, uterus, or cul-de-sac appears as an area without echoes. A small amount of fluid within the cul-de-sac can be a normal finding in the middle of the menstrual period, but in patients in whom an ectopic pregnancy is suspected, this may represent hem**.**

Hysterosalpingography is contrast study to visualize the uterus and fallopian tubes.

The role of CT in the evaluation of gynaecological diseases in the pelvis has declined since the advent of endovaginal scanning and MR1.

As a general rule, benign disease should be investigated initially by ultrasound and then MRI, rather than CT, which is used to solve specific problems. Staging of malignant disease requires CT or MRI, depending on the site of the primary tumor. MRI is superior to CT for staging cervical and uterine carcinoma, particularly with respect to local disease, but CT still has a role in ovarian carcinoma because of its ability to detect peritoneal deposits.

Currently CT and MRI have similar capabilities for detecting lymphadenopathy, although the use of different imaging planes and development of specific contrast suggest that MRI will eventually prove to be more accurate.

However, CT is frequently used as an imaging modality in patients with non-specific lower abdominal symptoms such as pain, or to determine the site of origin of a mass, so it is clearly necessary to be aware of the CT appearances of gynecological conditions.

Breast imaging generally refers to mammography. Mammography is complementary to physical examination, and each can detect a significant number of tumors not found by the other. The primary purpose of mammography is to detect small breast cancers and, by so doing, to improve survival. In young women, the breast is extremely dense.

Ultrasound examination is often used as an adjunct to mammography to determine whether a lesion is cystic. Ultrasound can be a useful adjunctive method but should not be relied on as a screening method for breast cancer.

Computed tomography (CT) scanning is not indicated for examination of the breast, and the role of magnetic resonance imaging (MRI) and nuclear medicine for evaluation of a suspicious mass or screening for breast cancer remains in the realm of research.

Aims and tasks of the discipline

To learn different radiological methods of visualization of the women's imaging.
To learn the anatomical structures of uterus, adrenal regions and mammary gland.
To learn the main radiological syndromes of the mammary gland and genitourinary system.

The students have to know:

1. Complex methods of visualization of the women's imaging (roentgenography, ultrasonography, radioisotope scan, MRI, CT scan, Doppler ultrasound, plain radiograph, hysterosalpingography, percutaneous aspiration and drainage, angiography,)
2. Normal radiological anatomy and physiology of the mammary gland and genitourinary system
3. The role of CT in the evaluation of gynaecological diseases.
4. Ovulation disorders and ovarian morphology. Screening for ovarium cancer

5. X- Ray semiotics of diseases uterus and adrenal regions: ovarian tumours, congenital uterine abnormalities, endometrial carcinoma.

6. Technique and normal anatomy of the brest: film-screen and digital radiography (radiomammography), ultrasonography, magnetic resonance imaging, ductography, guided needle aspiration and biopsy, image-guided needle localization, biopsy specimen radiography. Patient Preparation

7. Limitations of the mammography.

8. Brest pathology: cysts, fibroadenoma and related conditions, classification of invasive breast cancer

9. The differential diagnosis of malignancy. Benign microcalcifications. Malignant microcalcifications.

The students to able to

- to be able to detect the X-Ray signs of uterus and adrenal regions diseases
- to be able to chose the main X-ray syndromes of uterus and adrenal regions diseases pathology
- to be able to interpret their morphological substratum
- to be able to detect the ultrasound, radionuclide, and MRI-signs of diseases of uterus and adrenal regions
- to be able to chose the main radiological syndromes of breast
- to be able to interpret their morphological substratum.
- to be able to detect the ultrasound, radionuclide, and MRI-signs of diseases of brest.

Summary of Procedures

At the beginning of the practice to check student’s level of training to the practice the homework will be analyzed. Then each of the students will get radiological images and ultrasound images of the uterus and adrenal regions, mammary gland.

Equipment of the class

1. situation tasks
2. video films

3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

4. Grainger and Allison's. - A textbook of medical imaging. Section three. 2008

5. David Sutton.- Radiology and imaging. Seventh edition 2003.

TOPIC 13

COMPLEX CLINICAL IMAGING OF THE SKELETAL SYSTEM.

Importance of the subject

Radiography should always be the initial imaging test to evaluate the skeletal system after the patient has had a thorough history and physical examination and there is a clear indication to obtain the study. Various projections may be used depending on the clinical indication or the situation, but at least two orthogonal projections should be obtained.

When a strongly suspected fracture is not identified, you may choose among repetition of conventional radiograph in 7 to 10 days, nuclear medicine bone scanning, and MRI. CT may be substituted for MRI if the latter is unavailable or there are contraindications to its use. If a fracture is noticed and more information is needed concerning the location of fragments, CT is useful.

For local staging of both bone and soft-tissue neoplasms, MRI is the best technique. When a bone tumor is suspected but is not discovered with conventional radiographs, MRI is a useful secondary screening tool.

Symptomatic sites suspected of being involved by metastatic neoplasm are best evaluated initially with radiographs. An overall survey for osseous metastases

may be performed by nuclear medicine bone scan or by MRI. Conventional radiography is then used to evaluate sites of possible tumor involvement. MRI best evaluates suspected soft-tissue metastases. PET/CT scans are also useful in staging of many tumors.

Conventional radiographs should be obtained first for suspected osteomyelitis. If these are normal or inconclusive, then MRI, nuclear medicine bone scan, or white blood cell scanning may be helpful. MRI is also useful for detecting the soft-tissue extent of infection and for finding complications including abscesses or necrotic tissue.

Aims and tasks of the discipline

To learn different radiological methods of examination in obtaining information about state of bones and joints.

To learn the anatomical structures of bones and joints on radiological images.

To learn the main radiological syndromes of bones and joints pathology.

The students have to know:

1. Imaging techniques of the skeletal system: radiography, skeletal scintigraphy, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound (US), arthrography.
2. Indications and contraindications.
3. Algorithm of clinical imaging of the skeletal system
4. Normal structures of the bones and joints.
5. Typical x-ray projections.
6. Basic interpretation of x-ray film of the skeletal system.
7. The bone x- film of the elderly person.
8. Radiological features of the: osteonecrosis, osteoporosis, periosteal reaction.

The students to able to

- to be able to interpret possibilities of different radiological methods of examination in obtaining information about state of bones and joints.
- to be able to recognize anatomical structures of bones and joints on radiological images.

- to be able to detect radionuclide, ultrasound, magnetic resonance tomographic signs of diseases of bones and joints.
- to be able to chose the main radionuclide, ultrasound, magnetic resonance tomographic syndromes of bones and joints pathology.
- to be able to interpret their morphological substratum.

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analyzed. Then each of the students will get radiological images and ultrasound images of the skeletal system.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films

4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

4. Grainger and Allison's. - A textbook of medical imaging. Section three. 2008

5. David Sutton.- Radiology and imaging. Seventh edition 2003.

TOPIC 14

COMPLEX CLINICAL IMAGING OF THE SKELETAL SYSTEM PATHOLOGY.

Importance of the subject

Radiography should always be the initial imaging test to evaluate the skeletal system after the patient has had a thorough history and physical examination and

there is a clear indication to obtain the study. Various projections may be used depending on the clinical indication or the situation, but at least two orthogonal projections should be obtained.

When a strongly suspected fracture is not identified, you may choose among repetition of conventional radiograph in 7 to 10 days, nuclear medicine bone scanning, and MRI. CT may be substituted for MRI if the latter is unavailable or there are contraindications to its use. If a fracture is noticed and more information is needed concerning the location of fragments, CT is useful.

For local staging of both bone and soft-tissue neoplasms, MRI is the best technique. When a bone tumor is suspected but is not discovered with conventional radiographs, MRI is a useful secondary screening tool.

Symptomatic sites suspected of being involved by metastatic neoplasm are best evaluated initially with radiographs. An overall survey for osseous metastases may be performed by nuclear medicine bone scan or by MRI. Conventional radiography is then used to evaluate sites of possible tumor involvement. MRI best evaluates suspected soft-tissue metastases. PET/CT scans are also useful in staging of many tumors.

Conventional radiographs should be obtained first for suspected osteomyelitis. If these are normal or inconclusive, then MRI, nuclear medicine bone scan, or white blood cell scanning may be helpful. MRI is also useful for detecting the soft-tissue extent of infection and for finding complications including abscesses or necrotic tissue.

Aims and tasks of the discipline

To learn optimal radiological method for visualization of skeletal system.

To learn the X-Ray signs of skeletal trauma. To learn the X-Ray signs of pathology of skeletal system: osteomyelitis, spinal degenerative disease, ankylosing spondylitis, septic arthritis, Paget’s disease, giant cell tumors, aneurismal bone cyst, metastatic tumor involvement of bone, osteoid osteoma, osteosarcoma, Ewing’s sarcoma.

The students have to know:

1. Skeletal trauma.
2. Evaluation of fracture.
3. Displacement of fractured fragments.
4. Mechanism of fracture healing.
5. Complication of bone healing.
6. Osteomyelitis (causes, features, complication).
7. Special forms of osteomyelitis.
8. Causes of periosteal new bone.
9. Radiological features of the spinal degenerative disease, ankylosing spondylitis, septic arthritis, Paget's disease, giant cell tumors, aneurismal bone cyst.
10. Classification of bone tumors.
11. Metastatic tumor involvement of bone.
12. Radiological features of osteoid osteoma, osteosarcoma, Ewing's sarcoma.

The students to able to

- to be able to detect the X-ray signs of traumatic injury of bones and joints.
- to be able to diagnose traumatic injury of bones and joints.
- to be able to detect X-ray signs of diseases of bones and joints.
- to be able to chose the main X-ray syndromes of bones and joints pathology.
- to be able to interpret their morphological substratum.
- to be able to detect radionuclide, ultrasound, magnetic resonance tomographic signs of diseases of bones and joints.
- to be able to chose the main radionuclide, ultrasound, magnetic resonance tomographic syndromes of bones and joints pathology.
- to be able to interpret their morphological substratum.

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analyzed. Then each of the students will get radiological images, radionuclide, ultrasound, magnetic resonance tomographic images of the skeletal system.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

4. Grainger and Allison's. - A textbook of medical imaging. Section three. 2008

5. David Sutton.- Radiology and imaging. Seventh edition 2003.

TOPIC 15

COMPLEX RADIOLOGICAL IMAGING OF THE THYROID GLAND.

Importance of the subject

Usually, US is the first modality used to investigate a palpable thyroid nodule and in searching for a primary lesion in a patient with systemic metastases. US may be the only examination required in cases of hemorrhagic cyst and multinodular goiter. Ultrasound is the most important imaging modality in evaluating thyroid cancer, and ultrasound-guided fine-needle aspiration of suspicious lymph nodes may be useful in guiding the extent of surgery. US is the most sensitive method for diagnosing intrathyroid lesion. It can depict 2-mm cystic lesions and 3-mm solid intrathyroid lesions. The challenge is differentiating a few malignant nodules from common benign nodules. Despite US's ability to clearly identify nodules, no single US criterion is reliable in differentiating benign ones from malignant thyroid nodules. Even so, many US features may aid in predicting the benign or malignant nature of a given nodule.

Doppler US is an extension of US and provides valuable information regarding the vascularity of nodules.

Most intervention in the thyroid, such as fine-needle aspiration (FNA) and guided thyroid ablation, are performed under US guidance.

Currently, scintigraphy is reserved for characterizing functioning nodules and for staging follicular and papillary carcinomas. Lymphoma of the thyroid is the only gallium-67–avid thyroid nodule. Iodine-123 is the radioisotope of choice. However, this isotope is cyclotron produced and relatively expensive, and the short half-life necessitates frequent shipments from the producer. Scintigraphy with iodine-123 is the preferred modality for functional evaluation of the thyroid. Palpable nodules can be visualized as areas of increased (hot) or decreased (cold) tracer activity.

The role of plain radiography in the evaluation of thyroid disease is limited. Plain radiographs can show soft-tissue masses and tracheal deviation. Retrosternal extension and metastatic lung disease also can be detected on a chest radiograph.

Computed tomography (CT) scanning is an effective method for detecting regional and distant metastasis from thyroid cancer.

At the present time, magnetic resonance imaging (MRI) has a limited role in characterizing thyroid nodules, although it appears to be effective in the diagnosis of cervical lymph node metastasis.

Percutaneous needle aspiration remains the key procedure in the diagnosis of thyroid lymphoma; however, thyroid lymphoma's differentiation from thyroiditis occasionally can be difficult. US helps in diagnosing thyroid lymphoma most accurately, and CT helps in staging the disease most accurately. However, MRI also can be useful in staging the lymphoma. A tissue-specific diagnosis of a lymphoma can be achieved by using US-guided.

Aims and tasks of the discipline

To learn different radiological methods of examination in obtaining information about state function of thyroid.

To learn the anatomical structures of thyroid on radiological images.

To learn the main radiological syndromes of thyroid pathology.

The students have to know:

1. Normal anatomy and function of thyroid.
2. Ultrasound features pathology of the thyroid gland: benign cyst, thyroid malignancy, metastatic disease.
3. Radionuclide imaging of the thyroid gland (techniques, agent, indications, preparation, normal appearances).
4. Thyrotoxicosis, thyroid nodules, ectopic thyroid, thyroid cancer.

The students to able to

- to be able to detect the X-Ray, radionuclide, ultrasound, magnetic-resonance tomographic signs of diseases of thyroid gland;
- to be able to chose the main radiological syndromes of thyroid gland pathology;
- to be able to interpret their morphological substratum;
- to be able to choose the more informative radiological method of examination for revealing pathology of thyroid gland.

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analyzed. Then each of the students will get radiological images and ultrasound images of the endocrine system.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks\
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

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5. David Sutton.- Radiology and imaging. Seventh edition 2003.

TOPIC 16.
SKULL AND BRAIN: METHODS OF EXAMINATION AND ANATOMY

Importance of the subject

Technological advances in radiology during the past 30 years have vastly improved our ability to diagnose neurologic diseases.

Prior to the introduction of computed tomography (CT) in 1974, neuroradiologic examinations of the brain consisted primarily of plain films of the skull, cerebral arteriography, pneumoencephalography, and conventional nuclear medicine studies. Unfortunately, these techniques, for the most part, provided only indirect information about suspected intracranial processes, were insensitive in detecting subtle or early brain lesions, or were potentially harmful to the patient.

Computed tomography revolutionized the radiologic workup of central nervous system (CNS) abnormalities because for the first time normal and abnormal structures could be directly visualized with minimal risk to the patient.

In the late 1980s, it became apparent that magnetic resonance (MR) imaging would become the procedure of choice for evaluating many neurologic disorders, as well as for demonstrating vascular flow phenomena. Since then, there have been many technological advances associated with this modality. These include improvements in magnet and coil design, decrease in imaging time, and the development of new pulse sequences. In addition to advances in conventional anatomic imaging, there has also been substantial growth of “physiologic” MR imaging including MR spectroscopy (MRS), diffusion-weighted (DW) and perfusion-weighted (PW) MR imaging, and functional MR imaging (fMRI), among others. These imaging modalities provide functional information about the brain and have the potential to greatly extend our understanding of neuropathology beyond structure alone.

Revolutionary breakthroughs in CT scanning technology during the 1990s facilitated the development of advanced CT applications, namely, dynamic contrast-enhanced CT angiography (CTA) and CT perfusion (CTP). These

techniques, which allow high spatial resolution imaging of the cervical and intracranial vasculature, are currently being used in the evaluation of the acute stroke patient in many medical centers.

Furthermore, recent technologic advances in CT imaging have markedly decreased scan times and have allowed evaluation of very tiny anatomic structures because of improvement
in spatial resolution.

Recent advances in nuclear medicine functional imaging techniques, including single photon emission computed tomography (SPECT) and positron emission tomography (PET), improvements in conventional angiographic methods, and expansion of catheter-based therapeutic procedures have provided the neuroradiologist today with an even greater variety of strategies for diagnosing and treating neurologic abnormalities.

Aims and tasks of the discipline

To learn optimal radiological method for visualization of skull, brain and spinal cord.

To learn the X-Ray signs of pathology of CNS : congenital anomalies, craniocerebral trauma, intracranial hemorrhage, aneurysm, and infarction. Radiological investigations in intracranial tumors

The students have to know:

1. Methods of examination of skull, brain and spinal cord: plain radiography, cross-sectional imaging techniques, magnetic resonance imaging, magnetic resonance diffusion imaging, functional magnetic resonance imaging, computed tomography angiography, magnetic resonance angiography.
2. Advanced magnetic resonance imaging (indications, contraindications**,** **c**omplications).
3. Intravenous contrast medium.
4. Radiological features of the congenital anomalies, craniocerebral trauma, intracranial hemorrhage, aneurysm, and infarction.
5. Radiological investigations in intracranial tumors.

The students to able to

- to be able to detect the X-Ray, radionuclide, ultrasound, magnetic-resonance tomographic signs of diseases of brain, spinal cord;
- to be able to chose the main radiological syndromes of brain, spinal cord pathology;
- to be able to interpret their morphological substratum;
- to be able to choose the more informative radiological method of examination for revealing pathology of bones and joints, CNS.

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analyzed. Then each of the students will get radiological images, MRI images, CT images and ultrasound images of the CNS.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram,

			computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

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2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

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5. David Sutton.- Radiology and imaging. Seventh edition 2003.

TOPIC 17.

ALGORITHM OF CLINICAL IMAGING OF THE DIFFERENT ORGANS AND SYSTEMS.

Importance of the subject

Radiological methods play the leading role in the diagnosis of most diseases. That is why all physicians should be able to chose optimal radiological method and use the information obtained to make diagnosis.

Detection and interpretation of radiological semiotics of different organs and systems pathologies is the basis of radiology.

Aims and tasks of the discipline

To learn optimal radiological method for visualization of different organs and systems: lungs and mediastinum, heart and vessels, digestive tract, hepatobiliary system, urinary system, genital system, bones and joints, central nervous system; thyroid gland, mammary gland.

To interpret general radiological semiotics: X-Ray (including CT), radionuclide, ultrasound, MRI.

The students have to know:

1. Methods of x-ray examination: x-ray film, fluoroscopy, tomography. Advantages and disadvantages methods of x-ray examination. Indications and contraindications methods of x-ray examination. Basic interpretation of x-ray film.
2. Methods of CT scan examination. Advantages and disadvantages methods of CT scan examination.
3. Methods of ultrasound examination. Advantages and disadvantages methods of ultrasound examination. Indications and contraindications methods of ultrasound examination. Doppler examination.
4. Radioisotope imaging. The physical basis of radioisotope examination Advantages and disadvantages of radioisotope examination. Indications and contraindications of radioisotope examination.
5. Principles of positron emission tomography. Hybrid systems: SPECT-CT and PET-CT. Quantification and image processing. Image interpretation. Nonimaging applications. Radiopharmaceuticals.
6. Magnet resonance imaging. The physical basis of MRI diagnostic imaging. Advantages and disadvantages of MRI examination. Indications and contraindications MRI examination. Contrast substances.
7. Algorithm of clinical imaging of the chest, abdomen, urinary system, gynecological system, breast, skeletal system, thyroid gland, skull and brain, urgent conditions.

The students to able to

- choose the initial method of visualization for different organs and systems
- measure advantages of methods of visualization for different organs and systems
- create algorithm of clinical imaging for different organs and systems

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analyzed. Then each of the students will get radiological images, MRI images, CT images and ultrasound images of the chest, abdomen, urinary system, gynecological system, breast, skeletal system, thyroid gland, skull and brain, urgent conditions. The practice will finish with summary.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	10	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	45	x-ray films, sonogram, computer tomograms, MRI films

4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	45	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	20	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

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5. David Sutton.- Radiology and imaging. Seventh edition 2003.

TOPIC18.

METHODS EXAMINATION OF THE URGENT CONDITIONS.

Importance of the subject

Acute atraumatic abdominal pain requires urgent evaluation. Evaluation of the location, onset, progression, and character of abdominal pain is necessary to begin development of a reasonable differential diagnosis. A thorough medical history and physical examination are necessary because abdominal pain may be associated

with GI, genitourinary, cardiovascular, or respiratory disorders. An electrocardiogram may be necessary to exclude myocardial causes. In addition to physical examination of the chest and abdomen, pelvic and rectal examinations also may yield useful information. Sudden onset of pain is often associated with bowel perforation, ruptured ectopic pregnancy, ovarian cyst, aneurysm, or ischemic bowel. Gradually increasing and localizing pain is more common in appendicitis, cholecystitis, and bowel obstruction.

After the patient has been assessed clinically, a reasonable approach to imaging can be formulated. In most cases of acute abdominal pain, the best initial imaging study is an upright posterior-anterior (PA) chest x-ray and a supine and upright view of the abdomen (the so-called “three-way abdomen”). CT scanning is used when abscess, aneurysm, or retroperitoneal pathology is suspected. Ultrasound is the best initial examination if gallbladder, obstetric, or gynecologic etiologies are suspected.

The students have to know:

1. Methods of examination: plain radiography, ultrasound, computed tomography (CT), magnetic resonance imaging, nuclear medicine, positron emission tomography.
2. Radiological features of the: myocardial infarction, pulmonary oedema, pulmonary embolism, pericardial effusion, hydrothorax, pneumothorax, foreign bodies of the bronchus, foreign bodies of the GIT, intestine obstruction, perforation, abdominal trauma.
3. Algorithm of clinical imaging of the urgent pathologies.

The students to able to

- to be able to choose the more informative method of radiological examination for the detection of the urgent states;
- to be able to reveal the radiological signs of the urgent states;
- to be able to diagnose the urgent states.

Summary of Procedures

At the beginning of the practice to check student's level of training to the practice the homework will be analyzed. Then each of the students will get radiological images, MRI images, CT images and ultrasound images of the urgent states.

Equipment of the class

1. situation tasks
2. video films
3. x-ray films
4. sonograms
5. computer tomograms
6. MRI films
7. tests

Plan and structure of the class

№	Steps of activity	**Procedure duration (min)**	Equipment
1.	Organizing time	5	academic journal
2.	Checking level of students training to practice	45	academic journal, tables
3.	Individual work of students	30	x-ray films, sonogram, computer tomograms, MRI films
4.	Visit of radiological department Analysis, discussion and estimation of all student's papers	40	Radiograph, roentgenoscopy, CT scan, USG, radioisotope scan, x-ray films, sonogram, computer tomograms, MRI films, situation tasks
5.	Summary	15	

Independent work

Student's individual work will be followed with analysis and discussion of all images and estimation of all their papers.

The practice will finish with summary.

Literature

1. O. Kovalsky, D. Mechev, V. Danilevych. Radiology Radiotherapy Diagnostic imaging. Vinnitsia 2013

2. Robert N/ Gibson. - Essential medical imaging. Radiation and radiology basics, 1991. Chapter 6 – Gastrointestinal system.

3. Basic radiology. Michael Y.M. Chen, Thomas L. Pope, David J.Ott ISBN: 978-0-07-176664-7 MHID: 0-07-176664-2 2011.

4. Grainger and Allison's. - A textbook of medical imaging. Section three. 2008

5. David Sutton.- Radiology and imaging. Seventh edition 2003.

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Basic

1. Kovalsky O. V. Radiology. Radiotherapy. Diagnostic imaging : textbook / O. V. Kovalsky, D. S. Mechev, V. P. Danylevyc. - Vinnytsya : Nova Knyha, 2013. - 496 p.
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