

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
Харківський національний медичний університет

**Medical imaging and endoscopic methods
in the practice of internal medicine
(gastroenterology, pulmonology,
endocrinology and hematology)**

Methodological recommendations for IV years students

**Методи медичної візуалізації та ендоскопії
в практиці внутрішньої медицини
(гастроентерологія, пульмонологія,
ендокринологія та гематологія)**

Методичні вказівки для студентів IV курсу

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Методи медичної візуалізації та ендоскопії в практиці внутрішньої медицини (гастроентерологія, пульмонологія, ендокринологія та гематологія) : метод. вказ. для студентів IV курсу / упор. Л.В. Журавльова, О.О. Янкевич, В.О. Федоров та ін. – Харків : ХНМУ, 2013. – 40 с.

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Методичні вказівки призначені для використання в аудиторній та позааудиторній роботі студентів IV курсу з дисципліни «Основи внутрішньої медицини» (модуль № 1) вищих медичних навчальних закладів України III–IV рівня акредитації.

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TYPICAL GROUPING O INSTRUMENTAL TESTS

1. Diseases of digestive system

- Esophagogastroduodenoscopy
- Colonoscopy
- Video Capsule Endoscopy
- Laparoscopy
- Abdominal X-ray
- Upper Gastrointestinal and Small-Bowel Series
- Barium Enema
- Endoscopic Retrograde Cholangiopancreatography
- Cholangiography
- Cholecystography
- Abdominal Sonogram
- Computed Tomography
- Magnetic Resonance Imaging
- Liver/Spleen Scan

2. Diseases of pulmonary system

- Chest X-ray
- Computed Tomography

3. Diseases of endocrine system

- Abdominal Sonogram
- Thyroid Sonogram
- Thyroid Scan
- Doppler Studies
- Magnetic resonance imaging

4. Diseases of blood system.

- Abdominal Sonogram
- Computed Tomography
- Bone Marrow Scan

ENDOSCOPIC STUDIES

Internal body structures can be visualized directly using an endoscope, a tubular instrument with a light source and a system of lenses through which body organs and hollow cavities can be observed. The endoscope can be inserted through a natural body orifice or through a small incision.

Specialized endoscopes of varying diameters and lengths are available, depending on the type of procedure to be performed and whether the client is an adult or child. Emerging technical applications include the use of lasers, video systems, and computers with endoscopic devices. Endoscopic procedures are generally considered invasive, and a signed informed consent is required unless specified otherwise in some of the procedures.

Endoscopic procedures are named for the organ or body area to be examined or treated, including the larynx, trachea, bronchi, pleurae, mediastinum, esophagus, stomach, duodenum, colon, rectum and etc.

Esophagogastroduodenoscopy (EGD, Gastroscopy, Upper Gastrointestinal Endoscopy)

Test Description

Esophagogastroduodenoscopy (EGD) is the direct visualization of the esophagus, stomach, and upper duodenum through the use of a flexible fiberoptic endoscope. This endoscope is a multilumen instrument which allows viewing of the organ linings, insufflation of air, aspiration of fluid, removal of foreign objects, obtaining of tissue biopsies, and passage of a laser beam for obliteration of abnormal tissue or control of bleeding.

Normal Values

Normal esophagus, stomach, and duodenum.

Possible Meanings of Abnormal Values

Barrett's esophagus \ Diverticula \ Duodenitis \ Esophageal hiatal hernia \ Esophageal stenosis \ Esophagitis \ Gastritis \ Mallory-Weiss syndrome \ Pyloric stenosis \ Tumors \ Varices \ Ulcers.

Contributing Factors to Abnormal Values

- Retention of barium following an upper gastrointestinal series hinders successful completion of this test.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Inform the patient that a topical anesthetic will be used on the throat to minimize discomfort during scope insertion. Explain that pressure in the stomach may be experienced during movement of the endoscope and during insufflation with air or carbon dioxide.
- Obtain a signed informed consent.
- Fasting for 8 to 12 hours is required prior to the test.

- Dentures are removed.
- Resuscitation and suctioning equipment should be readily available.
- Administer preprocedure medications as ordered. An anticholinergic such as atropine may be used to decrease bronchial secretions. A medication such as midazolam may be used for sedation and relief of anxiety.

Procedure

- The patient is assisted into the left lateral decubitus position on the endoscopy table.
- Baseline vital signs are obtained. Periodic vital sign assessment is performed during the procedure.
- A maintenance IV infusion is initiated.
- A topical anesthetic is sprayed into the throat.
- The endoscope is inserted into the mouth and passed through the esophagus and stomach, and into the duodenum.
- The anatomy of the esophagus, stomach, and duodenum is inspected. Biopsy forceps may be used to remove a tissue specimen, or a cytology brush may be used to obtain cells from the surface of a lesion. Removal of foreign bodies is accomplished, if needed.
- Videotaping of the procedure is often done via a camera attached to the endoscope.
- Gloves are worn throughout the procedure.

Posttest

- Monitor vital signs every 15 minutes until stable.
- Oversedation of the patient may require administration of a narcotic antagonist, such as naloxone.
- Withhold fluids and food until the gag reflex returns (approximately 2 hours).
- Provide an emesis basin for the patient. Instruct the patient to spit out saliva rather than swallow it until the gag reflex returns.
- Inform the patient that a bloated feeling is normal.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- Possible complications: aspiration of gastric contents, bleeding, perforation, and oversedation.
- Observe the patient for indications of the following types of perforation: *esophageal perforation* (pain on swallowing and with neck movement), *thoracic perforation* (substernal or epigastric pain which increases with breathing or movement), *diaphragmatic perforation* (shoulder pain or dyspnea), and *gastric perforation* (abdominal or back pain, cyanosis, fever).

CONTRAINDICATIONS!

- Patients with large aortic aneurysm.
- Patients with recent gastrointestinal surgery.
- Patients with recent ulcer perforation.
- Patients with Zenker's (esophageal) diverticulum.
- Patients unable to cooperate with the exam.

Colonoscopy

Test Description

Colonoscopy is the direct visualization of the large intestine through the use of a flexible fiberoptic endoscope. This endoscope is a multilumen instrument which allows viewing of the organ linings, insufflation of air, aspiration of fluid, removal of foreign objects, obtaining of tissue biopsies, and passage of a laser beam for obliteration of abnormal tissue or control of bleeding. This procedure is performed when the patient has experienced lower gastrointestinal bleeding or a change in bowel habits and when the patient is at high risk for colon cancer due to having polyps, ulcerative colitis, or previous colon cancer. As a screening test, it is recommended as a part of preventive health maintenance.

Normal Values

Normal colon.

Possible Meanings of Abnormal Values

Benign lesions \ Colon cancer \ Crohn's disease \ Diverticulosis \ Granulomatous colitis \ Hemorrhoids \ Polyps \ Proctitis \ Pseudomembranous colitis \ Ulcerative colitis.

Contributing Factors to Abnormal Values

- Retention of barium following previous tests, inadequate preparation of the colon resulting in retained feces, and active gastrointestinal bleeding hinders successful completion of this test.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Inform the patient that pressure in the colon may be experienced during movement of the endoscope and during insufflation with air or carbon dioxide.
- Obtain a signed informed consent.
- The colon is prepared for the examination as follows:
 - clear liquid diet for 2 days prior to the test
 - either a strong cathartic is given the evening before the test, followed by an enema the morning of the test, *or* the patient drinks a large volume of a bowel prep solution (polyethylene glycol/electrolyte solution) the day before the test
- Monitor the patient for dehydration.
- Fasting for 8 to 12 hours is required prior to the test.
- Resuscitation and suctioning equipment should be readily available.
- Administer preprocedure medications as ordered. An anticholinergic such as atropine and a medication such as midazolam may be used for sedation and relief of anxiety.
- The patient is assisted into the left lateral decubitus position on the endoscopy table.

- Baseline vital signs are obtained. Periodic vital sign assessment is performed during the procedure.
- A maintenance IV infusion is initiated.
- The endoscope is inserted through the anus and advanced through the rectum into the sigmoid colon and continuing to the cecum. The patient may need to be assisted to change positions to aid in advancement of the endoscope.
- During the procedure, insufflation of the bowel with air is used for better visualization.
- Encourage the patient to take slow, deep breaths to induce relaxation and to minimize the urge to defecate.
- Biopsy forceps may be used to remove a tissue specimen, or a cytology brush may be used to obtain cells from the surface of a lesion. Removal of foreign bodies or polyps is accomplished, if needed.
- Videotaping of the procedure is often done via a camera attached to the endoscope.
- Gloves are worn throughout the procedure.

Posttest

- Monitor vital signs every 15 minutes until stable.
- Observe the patient for indications of bowel perforation: rectal bleeding, abdominal pain and distention, fever.
- Oversedation of the patient may require administration of a narcotic antagonist, such as naloxone.
- Once fully awake, fluids and food may be resumed.
- Inform the patient that passage of a large amount of flatus is normal after this procedure.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- Possible complications of the procedure include: Bleeding, perforation of the bowel, and oversedation.
- The patient may be drowsy due to the medications administered during the procedure. Someone else will need to drive the patient home and plan to stay with the patient until fully recovered.
- Findings of the colonoscopy determine recommended follow-up. For example, if the test is normal, the recommended subsequent colonoscopy is in 10 years. If polyps are found, recommended follow-up ranges from 1 to 5 years.

CONTRAINDICATIONS!

- Patients with acute diverticulitis, peritonitis, ischemic bowel disease, or fulminant ulcerative colitis.
- Patients with suspected perforation of the colon.
- Patients who are medically unstable.
- Patients unable to cooperate with the examination.

Video Capsule Endoscopy (VCE)

Test Description

Video capsule endoscopy (VCE) was approved for use in 2001. It involves the patient swallowing a miniature high-resolution camera that is propelled through the gastrointestinal (GI) tract by peristalsis. Data is picked up through sensors attached to the skin and recorded in a portable data recorder.

The major clinical application of VCE is in the evaluation of obscure GI bleeding. Typically, patients with obscure GI bleeding (noted through recurrent iron deficiency anemia or positive fecal occult blood testing) undergo esophagogastroduodenoscopy (EGD) and colonoscopy. However, these procedures are unable to visualize the majority of the small intestine. Currently, intraoperative endoscopy is used to visualize the small intestine, but it involves exploratory laparotomy and general anesthesia. Use of VCE provides a noninvasive way to view the entire small intestine. Limitations of VCE are that biopsy and therapeutic interventions are not able to be performed.

Normal Values

Normal anatomy of GI tract.

Possible Meanings of Abnormal Values

Abnormalities of the small intestine

Angiodysplasia \ Angioectasia \ Carcinoma \ Crohn's disease \ Erosion \ Obscure GI bleeding \ Polyp \ Stricture \ Ulcer.

Contributing Factors to Abnormal Values

- Too rapid movement of capsule through the GI tract may provide inadequate visualization of the entire small intestine.
- Very slow movement of the capsule through the small intestine may prevent the entire small intestine from being visualized before the battery pack shuts down.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Note that there is no discomfort with the test.
- Fasting for 12 hours is required before the test.
- The patient must refrain from taking any medications that could delay gastric emptying.
- No bowel preparation is necessary.
- Obtain a signed informed consent.

Procedure

- Eight sensors are attached to the patient's abdomen.
- A belt holding a data recorder and battery pack is applied to the patient's waist.
- The patient swallows the video capsule with a small amount of water.
- The patient is allowed to participate in usual daily activities.
- Clear liquids are allowed beginning 2 hours after capsule ingestion, and a light meal is allowed 4 hours later.

Posttest

- The patient returns after 8 hours for removal of the data recorder. Images are downloaded and processed.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- Potential complications include: capsule retention if there is an obstruction or stricture and capsule failure.
- Patients should avoid magnetic resonance imaging (MRI) and radio transmitters until the video capsule is passed in the stool (in 10 to 48 hours).
- Instruct patients to notify the primary care provider if nausea, vomiting, or abdominal pain occurs, or if they do not pass the capsule within 1 week.

CONTRAINDICATIONS!

- Patients with known or suspected GI obstruction, strictures, or fistulae.
- Patients with Zenker diverticulum or swallowing disorders.
- Patients who are pregnant.
- Patients with multiple previous abdominal surgeries.
- Patients who cannot or refuse to undergo surgery.
- Patients who are unable to cooperate because of age, mental status, pain, or other factors.
- Patients with implanted pacemakers or defibrillators (relative contraindication).

Laparoscopy

Test Description

Laparoscopy is the direct visualization of the peritoneal cavity via a laparoscope inserted through the anterior abdominal wall. During the procedure, one or two small incisions are made to allow insertion of the laparoscope and other instruments. The limited incisional size is advantageous in shortening the surgical time and recovery time from this procedure.

This procedure is used to evaluate patients complaining of abdominal/pelvic pain, for detecting carcinoma, ectopic pregnancy, endometriosis, pelvic inflammatory disease, and abdominal/pelvic masses, for staging of cancer, for evaluating ascites. Laparoscopy is also used to perform such procedures as lysis of adhesions, cholecystectomy and appendectomy.

Normal Values

Normal abdominal organs.

Possible Meanings of Abnormal Values

Abdominal organ abnormalities \ Adhesions \ Ascites \ Cancer \ Ectopic pregnancy \ Endometriosis \ Hydrosalpinx \ Ovarian cyst \ Ovarian tumor \ Pelvic inflammatory disease \ Salpingitis \ Uterine fibroids.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test and the procedure to be done. Note that some abdominal and shoulder pain will be felt for 24 to 36 hours after

the procedure, but that mild analgesics will control it. Shoulder pain is due to pressure on the diaphragm by carbon dioxide used during the procedure.

- Fasting for 8 hours is required prior to the test.
- Obtain a signed written consent.
- An enema prior to the procedure is sometimes ordered.
- Ask the patient to void prior to the procedure.
- The patient's abdomen is shaved as ordered.

Procedure

- This sterile procedure is usually conducted in the operating room.
- For gynecologic procedures:
 - The patient is typically given a general anesthetic and is then placed in the lithotomy position with her legs supported in the stirrups. A Trendelenburg position may be used to move the intestines away from the pelvic organs.
 - The bladder may be catheterized and a bimanual examination of the pelvis performed to detect abnormalities.
 - A uterine manipulator is inserted through the vagina and cervix and into the uterus to permit the pelvic organs to be moved for better visualization.
- For abdominal procedures, the patient is supine.
- The abdomen is cleansed and draped.
- A small incision is made in the subumbilical area into the peritoneal cavity.
- The Veres (pneumoperitoneum) needle is inserted into the incision and used to fill the peritoneal cavity with approximately 3 L of carbon dioxide. This gas lifts the abdominal wall from the intra-abdominal viscera.
- The needle is removed and a trocar and sheath are inserted into the peritoneal cavity.
- The trocar is removed and replaced with the laparoscope.
- When visual examination and any other planned procedures, such as tubal ligation, are completed, the laparoscope is removed, the carbon dioxide is evacuated, and the sheath is removed.
- The incision is closed with sutures, clips, or Steri-strips, and a dressing is applied.
- The uterine manipulator is removed and a perineal pad is applied.
- Videotaping of the procedure is usually done via a camera attached to the laparoscope.

Posttest

- Remind the patient that abdominal and shoulder discomfort is not unusual following the procedure. Analgesics may be taken.
- Instruct the patient to report immediately any excessive pain.
- Monitor vital signs and urinary output until stable.
- Resume diet as taken prior to the procedure.
- Instruct the patient to restrict activity for 2 to 7 days.
- Report abnormal findings to the primary care provider.

Clinical Alerts

• Possible complications include: hemorrhage, punctured visceral organ, such as the intestine. The patient should be periodically assessed for abdominal tenderness and distention, fever, decreased bowel sounds, tachycardia, and hypotension.

CONTRAINDICATIONS!

- Patients with advanced abdominal wall malignancy.
- Patients with advanced respiratory or cardiovascular disease.
- Patients with intestinal obstruction, abdominal mass, or abdominal hernia.
- Patients with chronic tuberculosis.
- Patients with history of peritonitis.
- Patients with possible adhesions due to multiple previous surgical procedures.
- Patients with suspected intra-abdominal hemorrhage.

Bronchoscopy

Test Description

Bronchoscopy is the direct visualization of the larynx, trachea, and bronchi through use of either a rigid bronchoscope (which requires general anesthesia) or, more frequently, a flexible fiberoptic bronchoscope (using local anesthesia). The scope is less than 1 cm in diameter and approximately 60 cm long. This procedure is used diagnostically to visually examine abnormalities found on x-ray and to obtain sputum specimens for bacteriologic and cytologic examination. Tissue biopsy may also be done. Therapeutically, the procedure can be used to control tracheobronchial bleeding, to remove foreign bodies, to conduct endobronchial radiation therapy, to obliterate neoplastic obstruction through use of a laser, and to place a stent in the airway.

Normal Values

Normal larynx, trachea, bronchi, and alveoli.

Possible Meanings of Abnormal Values

Carcinoma \ Foreign body \ Hemorrhage \ Infection \ Inflammation \ Lung abscess \ Sarcoidosis \ Strictures \ Superior vena cava obstruction \ Tracheal stenosis \ Tuberculosis.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Note that a local anesthetic will be used in the throat. Reassure the patient that breathing will not be obstructed during the procedure.
- Obtain a signed informed consent.
- Fasting for 8 to 12 hours is required prior to the test. Administer preprocedure medications as ordered. An anticholinergic such as atropine may be used to decrease bronchial secretions. A medication such as midazolam may be used for sedation and relief of anxiety.
- Dentures are removed.
- Resuscitation and suctioning equipment should be readily available.

Procedure

- The patient is assisted to either a sitting or supine position.
- A local anesthetic is sprayed into the patient's throat.
- The bronchoscope is then introduced through the patient's mouth or nose. When it is located just above the vocal cords, more local anesthetic is sprayed into the trachea to anesthetize deeper areas and to inhibit the cough reflex.
- The anatomy of the trachea and bronchi is inspected. Biopsy forceps may be used to remove a tissue specimen, or a bronchial brush may be used to obtain cells from the surface of a lesion.
- Lavage of the lungs may also be done. This involved instilling saline solution through the scope into the lungs, which is then removed, providing samples of lung cells, fluids, and any other materials inside the lungs.
- Removal of foreign bodies or mucous plugs is accomplished, if needed.
- Gloves are worn throughout the procedure.

Posttest

- Monitor vital signs until stable.
- Withhold fluids and food until the gag reflex returns (approximately 2 hours).
- Provide an emesis basin for the patient. Instruct the patient to spit out saliva rather than swallow it until the gag reflex returns. Observe the sputum for frank bleeding.
- Observe for and immediately report indications of respiratory dysfunction: laryngeal stridor, dyspnea, cyanosis, diminished breath sounds, and wheezing. Assess for presence of subcutaneous crepitus around the face and neck, which would indicate tracheal or bronchial perforation.
- Inform the patient that normal temporary consequences of the procedure include hoarseness, loss of voice, and sore throat.
- Label the specimen and transport it to the laboratory immediately.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- Possible complications of the procedure include: aspiration, bacteremia, bronchial or tracheal perforation, bronchospasm, cardiac arrhythmias, fever, hemorrhage from biopsy site, hypoxemia, laryngospasm, pneumonia, and pneumothorax.

CONTRAINDICATIONS!

- Patients with severe respiratory failure.
- Patients who cannot tolerate interruption of high-flow oxygen.

RADIOLOGIC STUDIES

Radiographs (also called x-rays and roentgenograms) are used to evaluate the bones and soft tissues of the body. The x-rays are produced by applying an electron beam to a vacuum tube containing tungsten. The resulting rays have a shorter wavelength than that of visible light rays and are able to penetrate many substances that are opaque to visible light.

In photographic film, x-rays cause silver to precipitate. This precipitation causes the film to turn black when it is developed. Objects placed between the beam of x-rays and the photographic film absorb some of the x-rays and cause a shadow to be cast upon the film.¹ The amount of x-rays absorbed varies with the thickness and composition of the object. Metal, for example, absorbs all of the x-rays and no silver is precipitated; when the film is developed, the object appears solid white. In contrast, soft tissues absorb only part of the x-rays and cause a grayish shadow to be cast on the film. The usefulness of diagnostic radiography is based on the differences in the absorption of rays by various substances or objects. Radiographic procedures can be either invasive or noninvasive, and client preparation varies accordingly. In the case of noninvasive procedures such as plain-film x-rays, tomography, and those using barium sulfate as a contrast medium, the client should be told what to expect, but a signed consent form is not required. A signed consent form is required for invasive procedures that use iodinated dyes administered intravenously (IV) or directly into an organ or area to be examined.

Abdominal X-ray

Test Description

The abdominal x-ray, often referred to as a flat plate of the abdomen or KUB (kidney, uterus, bladder), provides an overall view of the lower abdomen that shows the position of the kidneys, ureters, and bladder. The test is a simple x-ray film with the patient in a supine position. It requires no physical preparation of the patient. In addition to abnormalities of the urinary tract, the KUB may be used to assess for the presence of ascites and for gas within the intestines, which may occur with intestinal obstruction.

Normal Values

Normal size, shape, and location of kidneys. Ureters not seen. Bladder shown as shadow. Normal intestinal gas pattern.

Possible Meanings of Abnormal Values

Accumulation of gas in intestine \ Ascites \ Calculi \ Congenital abnormalities \ Cysts \ Hydronephrosis \ Intestinal obstruction \ Paralytic ileus \ Renal trauma \ Tumor \ Vascular calcifications.

Contributing Factors to Abnormal Values

- Any movement by the patient may alter quality of films taken.
- Retained barium, gas, or stool in the intestines may alter the test results.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Note that the test involves no discomfort.
- No fasting is required before the test.
- The test should be completed before the patient has any diagnostic tests involving barium.

Procedure

- The patient is assisted to a supine position on the radiography table.
- The patient's arms are extended overhead.
- Films are taken of the patient's abdomen.

Posttest

- Report abnormal findings to the primary care provider.
- Schedule any additional testing for differential diagnosis as ordered.

Clinical Alerts

- The test should be scheduled prior to or at least 24 hours after any barium studies are conducted.

CONTRAINDICATIONS!

Pregnancy, unless benefits of performing the procedure greatly outweigh the risks to the fetus.

Upper Gastrointestinal and Small-Bowel Series (Gastric Radiography, Small-Bowel Study, Stomach X-ray, Upper GI Series)

Test Description

The upper gastrointestinal and small-bowel series is the fluoroscopic examination of the esophagus, stomach, and small intestine after ingestion of barium sulfate. During this procedure, a fluoroscopic screen is positioned over the structures being studied. These structures are then projected onto the fluoroscopic screen. The image remains on the monitor for continuous observation as the patient swallows barium and it passes into the stomach. The patient's position is changed throughout the exam to allow visualization of the structures and their function, including peristalsis.

This test is especially useful in the evaluation of patients experiencing dysphagia, regurgitation, burning or gnawing epigastric pain, hematemesis, melena, and weight loss. Videotapes of the fluoroscopic procedure enable the movements to be studied at a later time.

Normal Values

Normal size, shape, position, and functioning of the esophagus, stomach, and small bowel.

Possible Meanings of Abnormal Values

Achalasia/chalasia \ Cancer: esophageal, gastric, duodenal \ Congenital abnormalities \ Diverticula: esophageal, duodenal \ Esophageal motility disorders, such as spasms \ Esophageal varices \ Esophagitis \ External compression by pancreatic and hepatic cysts and tumors \ Gastric inflammatory disease \ Gastric tumors \ Gastritis \ Hiatal hernia \ Perforation of the esophagus, stomach, or small bowel \ Polyps \ Small-bowel tumors \ Strictures \ Ulcers: esophageal, gastric, duodenal.

Contributing Factors to Abnormal Values

- Under- or overexposure of the film may alter film quality.
- When patients are unable to hold still, due to pain or mental status, the quality of the film may be affected.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test and the benefits and risks associated with the test. Provide any written teaching materials available on the subject. Note that no discomfort is associated with this procedure. The barium, although in a milkshake-type solution, may taste chalky.
- Fasting for 8 hours is required prior to the test.
- Instruct the patient to remove all objects containing metal, such as jewelry or undergarments, as these will show on the film.

Procedure

- The patient is first assisted to a supine position on the exam table.
- The table is tilted so that the patient is placed in an upright position for the first part of the procedure.
- The fluoroscopic screen is placed in front of the patient and the heart, lungs, and abdomen are viewed.
- The patient is instructed to take several swallows of a thick barium mixture while the videotape is made of the pharyngeal action.
- As the patient then continues to drink the barium mixture, in addition to the fluoroscopic viewing, spot films are made of the esophageal area from a variety of angles.
- The patient is then instructed to finish drinking the barium mixture, while films are made of the filling of the stomach and the emptying of the stomach into the duodenum.
- The small intestine is observed for passage of barium, with films made at 30 to 60 minute intervals until the barium reaches the ileocecal valve.

Posttest

- Resume the patient's diet and medications as taken prior to the test.
- Encourage fluid intake to promote excretion of the barium.
- Instruct the patient on the need to evacuate all of the barium. Administer a cathartic as ordered. Check all stools for presence of barium, explaining to the patient that the stools will be white initially and return to normal color following passage of all of the barium.
- Notify the primary care provider if the barium is not expelled within 2 to 3 days.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- If cholangiography and/or a barium enema test are ordered, these should be completed *before* the barium swallow is performed. Otherwise the barium sulfate ingested during the barium swallow may obscure the films made during the other exams.
- Possible complication: fecal impaction due to retention of barium.

CONTRAINDICATIONS!

- Pregnant women.
- Caution: A woman in her childbearing years should undergo radiography only during her menses or 12 to 14 days after its onset to avoid any exposure to a fetus.
- Patients with intestinal obstruction.
- Patients with a perforated viscus (gastrografin, a water-soluble contrast medium, would be used in place of barium).
- Patients who are unable to cooperate due to age, mental status, pain, or other factors.
- Patients with unstable vital signs.

Barium Enema (Large Bowel Study, Lower GI Series, Colon X-Ray, Air Contrast Barium Enema)

Test Description

The barium enema is the fluoroscopic examination of the large intestine after instillation of barium sulfate into the rectum. If a “double contrast” or “air contrast” study is being used, air is also instilled. During this procedure, a fluoroscopic screen is positioned over the intestines. These structures are then projected onto the fluoroscopic screen. The image remains on the monitor for continuous observation; therefore, as the barium is instilled, the flow of barium can be monitored on the screen. The patient’s position is changed throughout the exam to allow visualization of the structures and their function, including peristalsis. This test is especially useful in the evaluation of patients experiencing lower abdominal pain, changes in their bowel habits, or the passage of stools containing blood or mucus, and for visualizing polyps, diverticula, and tumors. Videotaping of the fluoroscopic procedure enables the movements to be studied at later times.

Normal Values

Normal size, shape, position, and functioning of the large intestine.

Possible Meanings of Abnormal Values

Crohn’s disease \ Diverticulosis \ Fistulas \ Gastroenteritis \ Granulomatous colitis \ Hirschsprung’s disease \ Intussusception \ Irritable bowel syndrome \ Perforation of the colon \ Polyps \ Sigmoid torsion \ Sigmoid volvulus \ Tumors \ Ulcerative colitis.

Contributing Factors to Abnormal Values

- Under- or overexposure of the film may alter film quality.
- When patients are unable to hold still, due to pain or mental status, the quality of the film may be affected.
- Barium retained from other exams and inadequate bowel preparation will interfere with the procedure.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test and the benefits and risks associated with the test. Provide any written teaching materials available on the subject. Explain to the patient that instillation of the barium and/or air may

cause cramping and the urge to defecate. Reassure the patient that there is a balloon on the tube which will prevent leakage of the barium from the rectum.

- Explain to the patient the importance of all aspects of the preparation to ensure complete emptying of the intestinal tract. If fecal material has been retained, the test must be repeated at another time.
- Preparation of the patient includes:
 - a liquid diet with no dairy products for 24 hours prior to the exam;
 - intake of at least 1200 cc of fluids the day prior to the exam;
 - stool softeners, laxatives, and enemas as per institutional policy the evening before and the morning of the exam (Note: Enemas may occasionally be ordered “until clear”. This means that enemas are given until the solution returned is clear and colorless.);
 - being NPO (nothing by mouth) after midnight before the exam.
- The patient should be monitored throughout the bowel preparation for fatigue and fluid and electrolyte imbalance.
- Instruct the patient to remove all objects containing metal, such as jewelry or undergarments, as these will show on the film.

Procedure

- The patient is first assisted to a supine position on the exam table, and a preliminary film is taken. This provides verification that no stool remains in the large intestine. If preparation is adequate, the test may continue.
- The patient is then turned to the side (Sims’ position) and a lubricated rectal tube is inserted.
- The barium is allowed to flow slowly into the intestine until the entire intestine up to the ileocecal valve is filled. During this time, the flow of barium is observed on the fluoroscopic screen and periodic films are taken.
- Once the intestine is filled, the rectal tube is removed. The patient is assisted to the restroom, or provided a bedpan, and is instructed to expel as much barium as possible.
- After expulsion of the barium, an additional film is taken of the intestine.
- If a double-contrast barium enema has been ordered, air is then instilled in the intestine and additional films taken.
- The procedure takes 45 minutes to 1 1/4 hours.

Posttest

- Resume the patient’s diet and medications as taken prior to the test. Encourage fluid intake.
- Instruct the patient on the need to evacuate all of the barium. Administer a cathartic or enema as ordered. Check all stools for presence of barium, explaining to the patient that the stools will be white initially and return to normal color following passage of all of the barium.
- Instruct the patient to report any abdominal pain, fever, or weakness.
- Notify the primary care provider if the barium is not expelled within 2 to 3 days.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- If a barium swallow or an upper gastrointestinal and small-bowel series test is ordered, these should be completed after the barium enema is performed. Otherwise the barium sulfate ingested during the other exams may obscure the films made during the barium enema.
- If an intestinal perforation is suspected, a water-soluble contrast medium (Gastrografin) is used. No bowel preparation is performed.
- Possible complications include: perforation of the colon, fluid and electrolyte imbalance, and fecal impaction due to retention of barium.

CONTRAINDICATIONS!

- Pregnant women.
- Caution: A woman in her childbearing years should undergo radiography only during her menses or 12 to 14 days after its onset to avoid any exposure to a fetus.
- Patients with tachycardia.
- Patients with severe active ulcerative colitis accompanied by systemic toxicity and megacolon.
- Patients with suspected intestinal perforation.
- Patients who are unable to cooperate in retaining the barium due to age, mental status, pain, or other factors.

Endoscopic Retrograde Cholangiopancreatography (ERCP)

Test Description

Endoscopic retrograde cholangiopancreatography (ERCP) is the radiographic viewing of the pancreatic ducts and the hepatobiliary tree through an endoscope. The procedure involves injection of a contrast medium through the ampulla of Vater. ERCP and percutaneous transhepatic cholangiography are the only procedures which allow direct visualization of the biliary and pancreatic ducts. Due to the comparatively low risk of complications, ERCP is the most commonly performed of these two procedures. The procedure is especially useful in the evaluation of patients with jaundice, since visualization of the biliary ducts can occur even when the patient's bilirubin level is high. Thus the test can provide information helpful in the diagnosis of obstructive jaundice and cancer of the duodenal papilla, pancreas, and biliary ducts, and in locating calculi and stenosis in the pancreatic ducts and hepatobiliary tree. Unfortunately, pancreatitis occurs in 5% to 7% of ERCP procedures despite efforts to reduce the incidence of this complication. Newer techniques such as magnetic resonance cholangiopancreatography (MRCP) now offer a noninvasive alternative to ERCP for diagnostic purposes.

Possible Meanings of Abnormal Values

Biliary cirrhosis \ Carcinoma of the bile ducts \ Carcinoma of the duodenal papilla \ Carcinoma of the head of the pancreas \ Chronic pancreatitis \ Pancreatic cysts \ Pancreatic fibrosis \ Pancreatic tumor \ Papillary stenosis \ Pseudocysts \ Sclerosing cholangitis \ Stones of the bile or pancreatic ducts \ Strictures of the bile or pancreatic ducts.

Contributing Factors to Abnormal Values

- Retained barium for other exams, vomiting, and diarrhea will affect test results.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test and the benefits and risks associated with the test. Provide any written teaching materials available on the subject.
- Obtain a signed informed consent from the patient.
- Inform the radiologist of any potential allergy to the contrast dye and obtain an order for an antihistamine and a steroid to be given prior to the procedure.
- Patients receiving metformin for Type 2 diabetes mellitus should discontinue the drug 2 days before elective surgery or angiographic exams. This is due to the possible occurrence of lactic acidosis, a potentially fatal complication of biguanide therapy.
- Baseline labs including BUN and creatinine are obtained.
- The patient is to be NPO for 12 hours prior to the test.
- Instruct the patient to remove all objects containing metal, such as jewelry or undergarments, as these will show on the film.

Procedure

- A maintenance IV is started.
- A topical anesthetic is applied to the oropharyngeal area.
- The patient is placed in a left lateral position.
- A narcotic or sedative/hypnotic is administered.
- The endoscope is inserted through the mouth, esophagus, and stomach, and then advanced to the duodenum.
- The patient is assisted to a prone position.
- An anticholinergic drug such as atropine or glucagon is given IV to reduce duodenal spasm and to relax the ampulla of Vater.
- A catheter is inserted through the ampulla and into the common bile or pancreatic ducts.
- The contrast medium is injected and several films are taken.

Posttest

- Assess the patient's vital signs until stable.
- Withhold food and fluids until the gag reflex returns.
- Some abdominal discomfort may be present for several hours postprocedure. However, prolonged, sharp abdominal pain, especially in conjunction with nausea or vomiting, is to be reported to the physician.
- Renal function is reassessed and when appropriate, metformin may be restarted.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- Possible complications include: cholangitis, hemorrhage, pancreatitis, perforation of ducts, and urinary retention.

- Observe for indications of cholangitis (hyperbilirubinemia, fever, chills) and pancreatitis (upper left quadrant pain, tenderness, elevated serum amylase levels and transient hyperbilirubinemia).
- If a barium swallow or an upper gastrointestinal and small-bowel series test is ordered, these should be completed *after* the ERCP is performed. Otherwise the barium sulfate ingested during the other exams may obscure the films made of the gallbladder.

CONTRAINDICATIONS!

- Pregnant women
- Caution: A woman in her childbearing years should undergo radiography only during her menses or 12 to 14 days after its onset to avoid any exposure to a fetus.
- Patients with hypersensitivity to iodine, seafood, or contrast media.
- Patients with known pancreatic and biliary problems: pancreatitis, pancreatic pseudocysts, stricture or obstruction of the esophagus or duodenum.
- Patients with cardiac and respiratory disease.
- Patients who are unable to cooperate due to age, mental status, pain, or other factors.

Cholangiography (Bile Duct X-ray, Percutaneous Transhepatic Cholangiogram, Operative Cholangiogram, T-Tube Cholangiogram)

Test Description

Cholangiography involves visualizing the bile ducts through use of a contrast medium. In this section, three techniques will be discussed: percutaneous transhepatic cholangiography, operative cholangiography, and T-tube cholangiography.

Percutaneous transhepatic cholangiography is the fluoroscopic examination of the biliary ducts using an iodine-based contrast dye which is injected directly into the bile duct. This test is performed in jaundiced patients since, in these patients, the cells of the liver are unable to transport the dye if administered orally or by intravenous infusion. With this procedure, the cystic, hepatic, and common bile ducts can be visualized and their diameter and filling evaluated. This allows differential diagnosis of obstructive jaundice and nonobstructive jaundice. If the ducts are found to be of normal size and intrahepatic cholestasis is indicated, further testing, such as a biopsy of the liver, is needed to distinguish among other problems such as cirrhosis or hepatitis. Percutaneous transhepatic cholangiography may be performed when a diagnostic endoscopic retrograde cholangiopancreatography (ERCP) cannot be performed or has failed in the past. Because this is an invasive procedure, there is the chance of complications such as bleeding and peritonitis occurring. However, for patients who are jaundiced, this procedure and ERCP are the only methods available for visualization of the biliary tree. Thus, benefits and risks to the patient must be weighed. Currently, ERCP is more commonly performed due its lower complication rate.

In *operative cholangiography*, the procedure occurs while the patient is undergoing a cholecystectomy. Common bile duct (CBD) stones are discovered in about 15% of patients with acute cholecystitis. For this reason, an intraoperative

cholangiogram is usually done during surgery and common bile duct exploration is performed if necessary. If a stone is discovered near the distal part of the CBD, ERCP may be used to perform a sphincterotomy and stone extraction. When a patient undergoes a cholecystectomy with an exploration of the CBD, a rubber T-tube is usually inserted into the duct to facilitate bile drainage. Every effort is made to find and remove any obstructions, such as stones, from within the duct. Approximately 7 to 10 days after surgery, the patient is taken to the radiology department for a *T-tube*, or *postoperative, cholangiogram*. This test involves the injection of contrast dye through the T-tube into the biliary ducts. The flow of the dye is observed with the fluoroscope, allowing for the verification of patency of the CBD prior to removal of the T-tube.

Possible Meanings of Abnormal Values

Biliary sclerosis \ Biliary tract carcinoma \ Carcinoma of the papilla of Vater \ Carcinoma of the pancreas \ Choledocholithiasis \ Cholelithiasis \ Sclerosing cholangitis \ Strictures of the ducts.

Contributing Factors to Abnormal Values

Under- or overexposure of the film may alter film quality.

When patients are unable to hold still, due to pain or mental status, the quality of the film may be affected. Retained barium from other exams will affect test results.

Pretest

For all cholangiograms

- Inform the radiologist of any potential allergy to the contrast dye and obtain order for antihistamine and steroid to be given prior to the procedure.
- Patients receiving metformin for Type 2 diabetes mellitus should discontinue the drug 2 days before elective surgery or angiographic exams. This is due to the possible occurrence of lactic acidosis, a potentially fatal complication of biguanide therapy.
- Baseline BUN and creatinine should be obtained.

For percutaneous transhepatic cholangiogram

- Explain to the patient the purpose of the test and the benefits and risks associated with the test. Provide any written teaching materials available on the subject. Explain that the patient will experience discomfort when the injection site is anesthetized and as the dye is injected.
- Obtain a signed informed consent from the patient.
- The patient is given a low-fat or fat-free diet for 1 day, prior to the test.
- Obtain baseline laboratory tests to assess for coagulopathy (clotting time, platelet count, and prothrombin time).
- The patient is to be NPO after midnight prior to the test.
- Additional aspects of the preparation *may* include:
 - type and crossmatch of blood in case of bleeding during the procedure
 - administration of IV antibiotics 24 to 48 hours prior to the procedure
 - administration of a sedative prior to the procedure.

- Instruct the patient to remove all objects containing metal, such as jewelry or undergarments, as these will show on the film.

For T-tube cholangiogram

- Explain to the patient the purpose of the test and the benefits and risks associated with the test. Provide any written teaching materials available on the subject.
- Obtain a signed informed consent from the patient.
- The patient is to be fasting for 4 to 6 hours before the test.
- Clamp the T-tube the day before the procedure, if ordered.

Procedure

For percutaneous transhepatic cholangiogram

- The patient is in a supine position on the examination table.
- The skin of the right upper quadrant is cleansed, draped, and anesthetized with Xylocaine.
- Conscious sedation may be used.
- The patient is instructed to inhale and exhale several times and then to hold the breath after a full expiration. A long, flexible needle is inserted into the liver and advanced under fluoroscopy until bile is aspirated from the duct. Placement of the needle is checked by injecting a small amount of the dye. If visualization by fluoroscopy verifies correct placement, the remaining dye is injected. As the flow of the dye is observed, films are periodically taken.
- When the films are found to be satisfactory for diagnostic purposes, the needle is removed, and a sterile dressing is applied.

For operative cholangiogram

- Contrast medium is injected into the cystic duct and common bile duct during cholecystectomy.
- X-rays are taken and reviewed.
- If x-rays are negative, the surgery can be completed without need for CBD exploration.

For T-tube cholangiogram

- The patient is placed in a supine position on the examination table.
- The T-tube is cleansed with povidone-iodine and contrast medium is injected.
- Films are taken as the contrast medium flows through the ducts and into the duodenum.

Posttest

- Most allergic reactions to radiopaque dye occur within 30 minutes of administration of the contrast medium. Observe the patient closely for: respiratory distress, hypotension, edema, hives, rash, tachycardia, and/or laryngeal stridor. Emergency resuscitation equipment must be readily accessible.

For percutaneous transhepatic cholangiogram

- Assess the patient's vital signs until stable. Observe for signs of respiratory distress, hemorrhage, and peritonitis (chills, fever, abdominal pain, distention, and tenderness).

- Check the puncture site for bleeding, swelling, and tenderness often.
 - Assist the patient to a right side lying position, which is to be maintained for 6 hours.
- For All Cholangiograms*
- Resume the patient's diet and medications as taken prior to the test. Encourage fluid intake.
 - Renal function should be assessed before metformin is restarted.
 - Report abnormal findings to the primary care provider.

Clinical Alerts

- Possible complications include: adverse reaction or allergy to dye, peritonitis caused by bile extravasation from the liver after needle removal, hemorrhage, and tension pneumothorax.
- If a barium swallow or an upper gastrointestinal and small-bowel series test is ordered, these should be completed *after* the cholangiography is performed, otherwise the barium sulfate ingested during the other exams may obscure the films made of the ducts.

CONTRAINDICATIONS!

- Pregnant women
- Caution: A woman in her childbearing years should undergo radiography only during her menses or 12 to 14 days after its onset to avoid any exposure to a fetus.
- Patients with hypersensitivity to iodine, seafood, or contrast media.
- Patients with cholangitis, since injection of the dye will increase biliary pressure and cause bacteremia.
- Patients with massive ascites.
- Patients with uncontrolled coagulopathy (platelet count $<50,000/\text{mm}^3$, prolonged bleeding time).
- Patients who are unable to cooperate due to age, mental status, pain, or other factors.

Cholecystography (Gallbladder Radiography, Gallbladder [GB] Series, Oral Cholecystogram)

Test Description

The oral cholecystogram is used when a patient is experiencing symptoms of biliary tract disease, such as right upper quadrant pain, fat intolerance, and jaundice, and is suspected of having gallbladder disease. This test is used to study the gallbladder after ingestion of a contrast medium, in this case, a radiopaque, iodinated dye. The dye is processed by the liver, excreted in the bile, and then accumulates in the gallbladder. The peak concentration of the dye in the gallbladder occurs 12 to 14 hours after ingestion, at which time films are taken. This test often performed in conjunction with an ultrasound examination of the gallbladder.

Normal Values

Normal functioning of the gallbladder.
No stones in gallbladder or ducts.

Possible Meanings of Abnormal Values

Benign tumor \ Cancer of the gallbladder \ Cholecystitis \ Cholesterol polyps \ Cystic duct obstruction \ Duct defects \ Gallstones.

Contributing Factors to Abnormal Values

- Under- or overexposure of the film may alter film quality.
- When patients are unable to hold still, due to pain or mental status, the quality of the film may be affected.
- Retained barium for other exams, vomiting, and diarrhea will affect test results.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test and the benefits and risks associated with the test. Provide any written teaching materials available on the subject. Note that no discomfort is associated with this procedure.
- The patient is given a low-fat or fat-free diet the evening before the test.
- Two hours after the meal and after assessing for allergy to the dye, the patient is given six tablets (3 g) of iopanoic acid. These should be taken at 5 minute intervals with at least 2 ounces of water each time.
- Fasting is required from the time of dye ingestion until the time of the test.
- Most allergic reactions to radiopaque dye occur within 30 minutes of administration of the contrast medium. Observe the patient closely for: respiratory distress, hypotension, edema, hives, rash, tachycardia, and/or laryngeal stridor. Emergency resuscitation equipment must be readily accessible.
- Instruct the patient to remove all objects containing metal, such as jewelry or undergarments, as these will show on the film.

Procedure

- Films are taken of the right upper quadrant area with the patient in prone, left lateral decubitus, and erect positions.
- Occasionally, the patient is given a high-fat meal or a synthetic fat-containing agent to stimulate and test for gallbladder contractility. Films are taken 1 to 2 hours after this fat stimulus.

Posttest

- Resume the patient's diet and medications as taken prior to the test. Encourage fluid intake to enhance excretion of the dye.
- Inform the patient that the dye is excreted in the urine and may cause mild dysuria.
- If the gallbladder does not visualize, the test may be repeated following ingestion of a double dose of the dye tablets.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- If a barium swallow or an upper gastrointestinal and small-bowel series test is ordered, these should be completed *after* the cholecystography is performed, otherwise the barium sulfate ingested during the other exams may obscure the films made of the gallbladder.
- Possible Complication: Allergic reaction to dye.

CONTRAINDICATIONS!

- Pregnant women.
- Caution: A woman in her childbearing years should undergo radiography only during her menses or 12 to 14 days after its onset to avoid any exposure to a fetus.
- Patients with renal or hepatic failure.
- Patients with hypersensitivity to iodine, seafood, or contrast media.
- Patients with bilirubin of >2 mg/dL (gallbladder will not be visualized by the dye).
- Patients who are unable to cooperate due to age, mental status, pain, or other factors.

Chest X-ray (CXR, Chest Radiography)

Test Description

Radiography is the use of radiation (roentgen rays, or “x-rays”) to cause some substances to fluoresce and affect photographic plates. X-rays penetrate air easily; therefore, areas filled with air, such as the lungs, appear very dark on the film. Conversely, bones appear almost white on the film because the x-rays cannot penetrate them to reach the x-ray film. Organs and tissues such as the heart appear as shades of gray because they have more mass than air but not as much as bone. Chest radiographs are used to identify abnormalities of the lungs and other structures in the thorax, including the heart, ribs, and diaphragm. Common pulmonary disorders detected are pneumonia, atelectasis, and pneumothorax. The chest x-ray may be performed in the radiology department or through use of a portable x-ray machine. When taken in the radiology department, the chest x-ray is a posteroanterior (PA) view, since the patient is positioned with the anterior part of the body next to the film. Portable x-rays are done with the film behind the person, resulting in an anteroposterior (AP) view. Other views such as lateral, oblique, supine, and lateral decubitus positions may also be obtained. Ideally, the part of the body which needs to be studied should be next to the film.

Normal Values

Normal lungs and other thoracic structures.

Possible Meanings of Abnormal Values

Asthma \ Atelectasis \ Atherosclerosis \ Bronchitis \ Cardiomyopathy \ Congestive heart failure \ Cor pulmonale \ Diaphragmatic hernia \ Emphysema \ Enlarged lymph nodes \ Foreign body \ Fractures of sternum, ribs, or vertebrae \ Kyphosis \ Lung cancer \ Mediastinal tumor \ Pericardial effusion \ Pericarditis \ Phrenic nerve paresis \ Pleural effusion \ Pleurisy \ Pneumonia \ Pneumothorax \ Pulmonary abscess \ Pulmonary fibrosis \ Pulmonary infiltrates \ Scoliosis \ Tuberculosis.

Contributing Factors to Abnormal Values

- Portable chest x-rays are less reliable than those taken in the radiology department.
- Under- or overexposure of the film may alter film quality.
- When patients are unable to hold a deep breath due to pain or mental status, the quality of the film may be affected.
- Obesity.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test and the benefits and risks associated with the test. Provide any written teaching materials available on the subject. Note that no discomfort is associated with this procedure.
- No fasting is required prior to the test.
- Instruct the patient to remove all objects containing metal, such as jewelry or undergarments, as these will show on the film.

Procedure

- The patient's reproductive organs should be covered with a lead apron to prevent unnecessary exposure to radiation.
- Position the patient as ordered. If able, the patient stands during the procedure. The patient is instructed to take a deep breath and to hold it while the films are taken.

Posttest

- No special physical posttest nursing care is needed.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- If the chest x-ray is positive for pneumonia, it is suggested that a follow-up chest x-ray be done in 4 weeks to check for resolution of the infection.

CONTRAINDICATIONS!

- Pregnant women.
- Caution: A woman in her childbearing years should undergo radiography only during her menses or 12 to 14 days after its onset to avoid any exposure to a fetus.

ULTRASOUND STUDIES

Ultrasonography is a noninvasive method of diagnostic testing in which ultrasound waves are sent into the body with a small transducer pressed against the skin. The transducer then receives any returning sound waves, which are deflected back as they bounce off various structures. The transducer converts the returning sound waves into electric signals that are then transformed by a computer into a visual display on a monitor.

The diagnostic value of ultrasound studies is in the ability of the sound waves of varying intensities to outline the shape and position of organs and tissues of the body and the ability to detect pathology such as masses, edema, stones, and displacement of adjacent tissues.

Abdominal Sonogram (Abdominal Ultrasound)

Test Description

In this particular type of ultrasonography, the areas evaluated include those studied in the liver and pancreatobiliary system sonogram (gallbladder, biliary system, liver, and pancreas) along with the spleen, kidneys, and aorta.

Possible Meanings of Abnormal Values

Ascites \ Cholecystitis \ Cholelithiasis \ Dilation of the bile ducts \ Gallbladder carcinoma \ Gallbladder polyps \ Hepatocellular disease \ Cirrhosis of the liver \ Hepatic abscess \ Hepatic tumor \ Liver metastases \ Liver cyst \ Pancreatic carcinoma \ Pancreatitis \ Pseudocyst of the pancreas \ Hydronephrosis \ Renal calculi \ Renal carcinoma \ Renal cysts \ Pheochromocytoma \ Ruptured spleen \ Splenomegaly \ Aortic aneurysm \ Hematoma.

Contributing Factors to Abnormal Values

- The transducer must be in good contact with the skin as it is being moved. A waterbased gel is used to ensure good contact with the skin.
- Test results are hindered by the presence of bowel gas, retained barium, or obesity.

Pretest.

- Explain to the patient the purpose of the test available on the subject. Note that there is no discomfort involved with this test.
- The patient is to eat a fat-free meal in the evening and then fast for 8 to 12 hours before the test. This promotes accumulation of bile in the gallbladder, resulting in better visualization during ultrasonography.

Procedure.

- The patient is assisted to a supine position on the ultrasonography table.
- A coupling agent, such as a water-based gel, is applied to the area to be evaluated.
- A transducer is placed on the skin and moved as needed to provide good visualization of the structures.
- The sound waves are transformed into a visual display on the monitor. Printed copies of this display or videorecording are made.

Posttest.

- Cleanse the patient's skin of any lubricant.
- Report abnormal findings to the primary care provider.

Comments.

- The investigation of stomach and intestine is less informative because of ultrasound waves attenuation through excessive gases.
- The plural effusion may be detected at abdominal ultrasound.
- If urine bladder is full of urine, the transabdominal investigation of urine bladder, prostate, uterine and ovaries is possible.

Thyroid Sonogram (Ultrasonography of the Thyroid)

Test Description

In thyroid ultrasonography, the size, shape, and position of the thyroid gland can be evaluated. This test is useful in distinguishing between a cyst and solid tumor of the thyroid gland, and can be used to provide guidance of needle positioning during fine needle aspiration of a suspicious nodule. It is also used to monitor the response of the thyroid gland to suppressive therapy treatment of hyperthyroidism.

Normal Values

Normal size, shape, and position of the thyroid gland.

Possible Meanings of Abnormal Values

Goiter \ Thyroid cyst \ Thyroid tumor.

Contributing Factors to Abnormal Values

- The transducer must be in good contact with the skin as it is being moved. A waterbased gel is used to ensure good contact with the skin.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Note that there is no discomfort involved with thyroid ultrasound. Some discomfort may be experienced if a biopsy is also performed.
- No fasting is required before the test.
- Signed informed consent is needed prior to biopsy being performed.

Procedure

- The patient is assisted to a supine position on the ultrasonography table. A pillow is placed beneath the shoulders and the neck is hyperextended.
- A coupling agent, such as a water-based gel, is applied to the area to be evaluated.
- A transducer is placed on the skin and moved as needed to provide good visualization of the thyroid gland.
- The sound waves are transformed into a visual display on the monitor. Printed copies of the display are made.

Posttest

- Cleanse the patient's skin of remaining gel.
- Report abnormal findings to the primary care provider.

Doppler Studies (Doppler Ultrasonography, Venous Doppler, Arterial Doppler) Test Description

The transducer converts the returning sound waves into electric signals that are then transformed by a computer into audible sounds (Doppler method). This particular form of ultrasonography is used to evaluate blood flow in the major veins and arteries of the arms and legs. The sound waves strike moving red blood cells and are reflected back to that transducer. The sound which is emitted by the transducer corresponds to the velocity of the blood flow through the vessel. This provides valuable information used in the diagnosis of chronic venous insufficiency, venous thromboses, peripheral artery disease, arterial occlusion, and arterial trauma.

Normal Values

Normal Doppler signal with no evidence of vessel occlusion

Possible Meanings of Abnormal Values

Arterial occlusion \ Arterial stenosis \ Arteriosclerosis \ Deep vein thrombosis
Peripheral arterial disease \ Venous disease \ Venous occlusion.

Contributing Factors to Abnormal Values

- The transducer must be in good contact with the skin as it is being moved. A lubricant, such as mineral oil, glycerin, or a water-based jelly, is used to ensure good contact with the skin.
- Cigarette smoking may alter test results due to vasoconstriction.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Note that there is no discomfort involved with this test.
- Explain the importance of limiting movement during the test to ensure accurate measurements.
- No fasting is required prior to the test.

Procedure

- The patient is assisted to a supine position on the ultrasonography table.

For peripheral arterial studies

- A blood pressure cuff is wrapped about the extremity, pressure readings are taken, and waveforms are recorded for the arteries distal to the cuff location.

The cuff application sites and the arteries assessed include:

- calf: dorsalis pedis, posterior tibial arteries;
- thigh: popliteal artery;
- forearm: radial and ulnar arteries;
- upper arm: brachial artery.

For peripheral venous studies

- The transducer is placed over the appropriate vein and waveforms are recorded. Variations in the waveforms due to respiratory influences are noted.
- Veins to be tested include: popliteal, superficial femoral, common femoral, posterior tibial vein, brachial, axillary, subclavian, and jugular.

Posttest

- Cleanse the patient's skin of remaining coupling agent.
- Report abnormal findings to the primary care provider.

IMAGING STUDIES

Imaging (non-nuclear scan) studies include computed tomography and magnetic resonance imaging, neither of which uses radiopharmaceuticals and the detectors or devices that are needed to count or image the uptake of these substances by body tissues. Each procedure uses a special machine and scanning system. Both use computer-generated images on a screen for viewing and recording.

Non-nuclear scan procedures are not considered invasive and a signed informed consent form is not required for diagnostic computed tomography unless a contrast medium is used. A signed consent is required for MRI procedures.

Computed Tomography (CT Scan, Computerized Axial Tomography [CAT], CT of Abdomen/Brain/Chest, Electron Beam Computed Tomographic Coronary Calcium Scanning [EBCT])

Test Description

Computed tomography (CT) is considered a radiographic procedure. X-rays are projected along the lines of the area of the body being assessed. An x-ray detector records the intensity of the x-rays as they are transmitted through the tissue. Different types of tissue cause differences in how the tissue decreases the x-ray beam as it passes through the tissue (tissue attenuation). This leads to an assignment of a *density coefficient* to the various tissues. The information is compiled and results in a visual display. The image may be enhanced by repeating the procedure after IV administration of iodine-based contrast dye.

CT of the abdomen is performed to diagnose pathologic conditions of the abdominal organs. Such conditions include inflammation, cysts, and tumors of the liver, gallbladder, pancreas, spleen, kidneys, and pelvic organs. Unenhanced helical (spiral) CT can accurately detect acute appendicitis, thereby avoiding possible allergic reactions and cost associated with contrast enhancement. The recent introduction of 64-slice CT is providing a possible future alternative to more invasive procedures by providing a “virtual colonoscopy.”

CT of the chest is performed to diagnose pathologic conditions of the organs contained within the chest. Such conditions include inflammation, cysts, and tumors of the lungs, esophagus, and lymph nodes. Spiral (or helical) CT of the chest captures images of the chest from many angles, making it very useful in the evaluation of suspected pulmonary embolism.

Normal Values

No abnormalities.

Possible Meanings of Abnormal Values

CT of Abdomen

Abdominal aortic aneurysm \ Abscesses \ Appendicitis \ Bile duct dilation \ Cysts \ Diverticulitis \ Gallstones \ Hemorrhage \ Infection \ Laceration of spleen \ Prostatic hypertrophy \ Tumors.

CT of Chest

Aortic aneurysm \ Cyst \ Enlarged lymph nodes \ Esophageal tumors \ Granuloma \ Hiatal hernia \ Inflammation \ Mediastinal tumors \ Metastatic tumors \ Pleural effusion \ Pneumonitis \ Pulmonary embolism \ Pulmonary tumor.

Contributing Factors to Abnormal Values

- Any movement by the patient may alter quality of films taken.
- For CT of abdomen: retained barium, gas, or stool in the intestines may result in poor quality films.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Note that minimal discomfort during the test

is due to the venipuncture, and that during injection of the dye, transient sensations including warmth, flushing, a salty taste, and nausea may be experienced. Explain that no movement is allowed during the procedure.

- Check for allergies to iodine, shellfish, or contrast medium dye. Inform the radiologist of such possible allergy and obtain order for an antihistamine and steroid to be administered prior to the test.
- Patients receiving metformin for Type 2 diabetes mellitus should discontinue the drug 2 days before elective surgery or angiographic exams. This is due to the possible occurrence of lactic acidosis, a potentially fatal complication of biguanide therapy.
- Baseline BUN and creatinine levels are obtained.
- Fasting for at least 4 hours is required prior to the test if contrast dye is to be administered. The patient should be well hydrated prior to the beginning of the fasting period.
- For CT of abdomen: the patient will need to drink a contrast agent, such as barium sulfate, the evening prior to the test and again 1 hour before the test.
- Obtain a signed informed consent.
- For CT of brain, instruct the patient to remove any metal items from the hair or mouth prior to the procedure.

Procedure

- The patient is assisted to a supine position on the CT scan table.
- A maintenance IV line is initiated.
- The contrast dye is administered by IV injection. Resuscitation and suctioning equipment should be readily available.
- The patient is then placed in the CT scanner.
- Films are made, during which the patient may be asked to hold his or her breath.

Posttest

- Most allergic reactions to radiopaque dye occur within 30 minutes of administration of the contrast medium. Observe the patient closely for: respiratory distress, hypotension, edema, hives, rash, tachycardia, and/or laryngeal stridor. Emergency resuscitation equipment must be readily accessible.
- Observe for allergic reaction to the dye for 24 hours.
- Discontinue the IV infusion. Apply pressure at venipuncture site. Apply dressing, periodically assessing for continued bleeding.
- Resume the patient's diet. Encourage fluid intake of at least three glasses of liquid to speed the excretion of the dye from the body.
- Monitor urinary output.
- Inform the patient that if oral contrast dye was ingested, diarrhea may occur.
- Renal function should be assessed before metformin is restarted.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- Possible complications include: allergic reaction to dye and acute renal failure from dye.
- Patients who are claustrophobic may require sedation prior to the CT exam.

CONTRAINDICATIONS!

- Patients who are allergic to iodine, shellfish, or contrast medium dye.
- Pregnant women.
- Caution: A woman in her childbearing years should undergo radiography only during her menses or 12 to 14 days after its onset to avoid any exposure to a fetus.
- Patients who are morbidly obese or claustrophobic.
- Patients whose vital signs are unstable.
- Patients who are unable to cooperate due to age, mental status, pain, or other factors.
- Patients with renal failure or those susceptible to dye-induced renal failure (dehydrated patients).

Magnetic Resonance Imaging (MRI)

Test Description

Magnetic resonance imaging (MRI) is based upon the knowledge that a magnetic field causes atoms, especially the nuclei of hydrogen ions, to line up in a parallel configuration. Radio-frequency energy is then directed at the atoms, knocking them out of their alignment and causing them to spin. When the radio-frequency energy is discontinued, the atoms realign themselves within the magnetic field. During their realignment, the atoms emit radio-frequency energy as a tissue-specific signal based on the relative density of their nuclei and their realignment time. These signals are interpreted by the MRI computer, which then produces a very high-resolution image.

The MRI holds several advantages over computed tomography (CT). The image provided by the procedure is of excellent quality. The MRI uses no contrast medium and no radiation, thus it presents no hazards of allergic reaction or radiation exposure to the patient. Bone artifacts which can obscure the viewing in a CT scan do not occur with an MRI. Blood vessels appear dark on the MRI, so that they can be easily viewed. MRI is quickly replacing other diagnostic tests as the standard of care for various conditions. MRI can evaluate cerebral infarction within hours of the event. It is used for diagnosis of most abnormalities of the brain and spine, has almost entirely replaced arthrography for diagnosis of knee injuries, and has virtually eliminated the need for myelography. A disadvantage is that the MRI is more expensive to perform than the CT; however, its diagnostic value is well worth the additional cost. CT is more effective than MRI in studying the chest.

The MRI machine is enclosed in a special room designed to protect it from interference by outside radio signals. The magnetic field in the room is always present and will cause watches to stop and will erase the magnetic strips found on the back of credit cards. The magnetic field also affects the functioning of computer-based equipment such as electronic infusion devices and ventilators. The magnet may move metal objects which may be present in the body, thus the test is contraindicated for any patient with a pacemaker, intracranial aneurysm clips, inner ear implants, metal fragments in the eyes, or gunshot wounds to the

head. The patient is put on a moving pallet that is pushed into a large cylinder which houses the magnet.

Normal Values

No evidence of pathology.

Possible Meanings of Abnormal Values

MRI of the abdomen/pelvis

MRI can be used to evaluate organs within the abdomen and pelvis. MRI is especially useful for imaging of the liver, male and female pelvis, pancreas, kidneys, and adrenals. It is also good for staging of cancers that involve retroperitoneal structures (lymph nodes) and peritoneal metastases.

MRI of the brain

When choosing between CT and MRI, it is best to use unenhanced CT to evaluate patients with an acute neurologic event (such as acute head injury, stroke, and subarachnoid hemorrhage). The MRI is used for all other suspected neurologic processes, including venous occlusion, neoplasm, demyelination, cerebral or cerebellar abscess, neurodegenerative disease, cysts, hydrocephalus, congenital or developmental defects. Evaluation of suspected tumors requires gadolinium-enhanced MRI.

Contributing Factors to Abnormal Values

- Excessive movement by the patient can blur images.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test and the procedure to be performed. Note that no radiation exposure is involved in this test. Explain that the patient will be moved into a large cylinder for the test and will need to remain completely still during the test. A variety of noises will be heard during the test.
- No fasting is required prior to the test.
- Obtain a signed informed consent.
- Preprocedure medication with antianxiety drugs for those patients with claustrophobia may be needed.
- Remove all metal objects from the body, including medication patches, prior to the test.
- Instruct the patient to void prior to the test.
- Sedation may be ordered for patients who are very young, who are uncooperative, or who are claustrophobic.

Procedure

- The patient is assisted to a supine position on the padded table and moved into the MRI cylinder.
- The patient and MRI staff may communicate via microphone during the procedure.
- As the radio signals are switched on and off and images produced, the patient hears a variety of noises.

Posttest

- If sedation was given prior to the exam, ensure the patient is fully awake prior to ambulation.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- Use of an “open” MRI is an option for claustrophobic patients, however, the “closed” MRI provides a higher quality result.
- Medication patches, such as nitroglycerin, contraception, or nicotine patches, must be removed prior to scanning. Many of these have a small metal wire inside and can cause thermal injury.
- Some eye makeup has a metallic base and may cause fluttering of the eyelids. It is best to remove all eye makeup before having an MRI of the brain/head.
- Patients with embedded wires, stimulators, or batteries cannot be scanned.

CONTRAINDICATIONS!

- Patients who are morbidly obese.
- Patients who are pregnant, although there is no evidence of teratogenic or development abnormalities associated with MRI.
- Patients who are unable to cooperate during the procedure.
- Patients who are claustrophobic.
- Patients who require continuous life-support equipment which cannot be used inside the MRI room.
- Patients with implantable metal objects such as pacemakers, intracranial aneurysm clips, infusion pumps, inner ear implants, or heart valves manufactured prior to 1964, or those with metal fragments in the eye(s) or gunshot wounds of the head. (*Note: Most stainless steel orthopedic implants and prosthetic devices are not ferromagnetic and are not affected by MRI.*)

NUCLEAR SCAN STUDIES

Radionuclide-mediated scanning studies are performed to measure the amount of a specific radionuclide distributed in the body or specific organs by scanning and imaging. The studies are named for the organ or region of the body to be examined or imaged. The radiopharmaceutical and route used, as well as the time involved to perform the study, are specific to the organ studied. Commonly used radiopharmaceuticals and their tissue sites are:

Thyroid gland (Iodide I 123);

Parathyroid gland (Thallium chloride Tl 201);

Liver/spleen (technetium Tc 99m);

Pancreas (Selenium 75Se);

Body imaging for tumor or inflammatory process (Gallium citrate Ga 67).

The scanning procedure provides a picture of the location, shape, size, and functional disturbances of an organ. Almost all organs can be scanned for diagnostic information related to the presence of tumors or other abnormalities.

Thyroid Scan

The thyroid scan involves administration of a radioactive isotope. Scanning of the thyroid gland is then conducted to assess the size, shape, position, and function of the thyroid. Areas in which there is increased uptake of the isotope are called *hot spots*. These areas are caused by hyperfunctioning thyroid nodules which are usually benign. *Cold spots* are nodules that do not take up the isotope. These areas have hypofunctioning tissue and are more likely to be malignant. For patients who have had cancer of the thyroid, a *whole-body thyroid scan* may be performed periodically. Radioactive iodine (¹²³I) is administered to the patient and whole-body scanning is conducted. This not only provides evidence of how much thyroid tissue is left after surgery, but it also notes areas of possible metastasis of the thyroid cancer in other parts of the body.

Normal Values

Normal size, shape, position, and function of the thyroid gland.

Equal uptake of isotope throughout the thyroid gland.

Possible Meanings of Abnormal Values

Adenoma \ Cyst \ Goiter \ Graves' disease \ Hashimoto's thyroiditis \ Hyperthyroidism \ Hypothyroidism \ Medullary carcinoma of thyroid \ Multiple endocrine neoplasia \ Papillary carcinoma of the thyroid \ Plummer's disease \ Thyroiditis

Contributing Factors to Abnormal Values

- Any movement by the patient may alter quality of films taken.
- Recent receipt of x-ray contrast agents or ingestion of iodine-containing foods will alter test results.
- Drugs that may alter test results: anticoagulants, antihistamines, corticosteroids, cough medicines, iodides, multiple vitamins, oral contraceptives, phenothiazines, salicylates, thyroid drugs.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Note that discomfort involved with this test is primarily due to lying on a hard table for an extended period of time and the needle puncture. Reassure the patient that only trace amounts of the radionuclide are involved in the test.
- Check for allergies to iodine.
- Medication that may alter test results should be withheld for 21 days before the test, if possible.
- The patient must remain still while the scan is being performed.
- Fasting for 8 hours is required before the test.
- Obtain a signed informed consent.

Procedure

- Oral radioactive iodine (preferably ¹²³I) is administered.

- The IV route can also be used for isotope administration. If used, scanning can begin 1/2 to 2 hours later.
- Scanning is done at 4 to 6 hours and again at 24 hours.
- The patient is assisted to a supine position on the examination table.
- A scintillation camera is positioned over the patient's thyroid. This camera takes a radioactivity reading from the body. This information is transformed into a two-dimensional picture of the thyroid.
- Gloves are worn during the radionuclide injection, if used.

Posttest

- Check the injection site for redness or swelling.
- If a woman who is lactating *must* have this scan, she should not breast-feed the infant until the radionuclide has been eliminated, possibly for 3 days.
- Although the amount of diagnostic radionuclide excreted in the urine is low, the urine should not be used for any laboratory tests for the time period indicated by the nuclear medicine department.
- Gloves are worn when dealing with the urine.
- Encourage fluid intake by the patient to enhance excretion of the radionuclide.
- Resume medications as taken before the test.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- No other radionuclide tests should be scheduled for 24 to 48 hours.
- Monitor patients closely who have had thyroid surgery. Their ability to tolerate holding their medication prior to the test may depend on the extent of their surgery. For some patients, the medication will have to be continued throughout the testing period.

Normal Values

Normal size, shape, and position of the thyroid gland.

Possible Meanings of Abnormal Values

Goiter \ Thyroid cyst \ Thyroid tumor.

Contributing Factors to Abnormal Values

- The transducer must be in good contact with the skin as it is being moved. A waterbased gel is used to ensure good contact with the skin.

CONTRAINDICATIONS!

- Pregnant women.
- Caution: A woman in her childbearing years should undergo scanning only during her menses or 12 to 14 days after its onset to avoid any exposure to a fetus.
- Patients who are lactating.
- Patients who are allergic to iodine, shellfish, or contrast medium.
- Patients who are unable to cooperate because of age, mental status, pain, or other factors.

Liver/Spleen Scan

For a liver/spleen scan, the patient is given a radionuclide compound, usually a technetium-99m radiopharmaceutical via an IV injection. A scintillation camera is used to take a radioactivity reading from the body. These readings are fed into a computer, which translates these readings into a two-dimensional gray scale picture. These pictures are obtained 30 minutes following the injection. This test is used in the diagnosis of abscesses, hematomas, tumors, and infiltrative processes of the liver and/or spleen, and to evaluate jaundice.

Normal Values

Normal size, shape, and position of liver and spleen.

Possible Meanings of Abnormal Values

Abscesses of the liver/spleen \ Amyloidosis of the liver/spleen \ Budd-Chiari syndrome \ Cirrhosis \ Granulomas of the liver/spleen \ Hepatitis \ Hematomas of the liver/spleen \ Hepatic cysts \ Infection \ Injury \ Portal hypertension \ Primary or metastatic tumors of the liver/spleen \ Sarcoidosis of the liver/spleen.

Contributing Factors to Abnormal Values

- Any movement by the patient may alter quality of films taken.
- Retained barium from previous exams may interfere with the test.

Interventions/Implications

Pretest

- Explain to the patient the purpose of the test. Provide any written teaching materials available on the subject. Note that discomfort involved with this test is primarily due to lying on a hard table for an extended period of time and the needle puncture. Reassure the patient that only trace amounts of the radionuclide are involved in the test.
- The patient must remain still while the scan is being performed.
- No fasting is required prior to the test.
- Obtain a signed informed consent.

Procedure

- The radiopharmaceutical is administered by IV injection in a peripheral vein.
- The patient is assisted to a supine position on the examination table.
- A scintillation camera is positioned over the right upper quadrant of the patient's abdomen. This camera takes a radioactivity reading from the body. This information is transformed into a two-dimensional picture of the area.
- Scans are obtained 30 minutes post injection. Scans with the patient in the lateral and prone positions are also performed.
- Gloves are worn during the radionuclide injection.

Posttest

- Check the injection site for redness or swelling.
- If a woman who is lactating *must* have a nuclear scan, she should not breast-feed the infant until the radionuclide has been eliminated, possibly for 3 days.

- Although the amount of diagnostic radionuclide excreted in the urine is low, the urine should not be used for any laboratory tests for the time period indicated by the nuclear medicine department.
- Gloves are worn whenever dealing with the urine.
- Encourage fluid intake by the patient to enhance excretion of the radionuclide.
- Report abnormal findings to the primary care provider.

Clinical Alerts

- Whenever possible, schedule the liver/spleen scan prior to any testing involving barium.

CONTRAINDICATIONS!

- Pregnant women.
- Caution: A woman in her childbearing years should undergo radiography only during her menses or 12 to 14 days after its onset to avoid any exposure to a fetus.
- Patients who are lactating.
- Patients who are unable to cooperate due to age, mental status, pain, or other factors.

Bone Marrow Scan

Bone marrow scanning is a nuclear study performed to assist in diagnosing pathological conditions of active bone marrow in the axial skeleton in adults and in the full length of extremities in infants, with a gradual retraction in children until 10 years of age. The marrow moves peripherally in the long bones as red blood cell production requirements increase, and this distribution can be detected on the scan. The degree of bone marrow activity and bone marrow distribution revealed provides the clinical information related to pathological processes. The abnormalities seen on the scan include focal defects, increased size of the liver and spleen, decrease in the central marrow, peripheral extension, and increased uptake outside of normal areas (extramedullary hematopoiesis). Depending on the suspected pathology, ^{99m}Tc administered as technetium Tc 99m sulfur colloid is used when imaging the entire body about 1 hour after injection, or ¹¹¹In as indium In 111 chloride is used when imaging the entire body 48 hours after injection.

Normal Values

Normal distribution of active marrow in the axial skeleton.

Possible Meanings of Abnormal Values

Extramedullary hematopoiesis sites (liver, spleen, lymph nodes, lungs, kidneys, breasts, or adrenal glands) \ Thalassemia \ Sickle cell anemia \ Hereditary spherocytosis \ Polycythemia vera \ Leukemia \ Hemolytic anemia \ Aplastic anemia \ Myelofibrosis \ Hodgkin's and non-Hodgkin's lymphoma \ metastases of malignant tumor to bone.

Contributing Factors to Abnormal Values

Inability of client to remain still during the procedure.

Interventions/Implications

- The client is placed on the examining table in a supine position and reminded to remain very still during the scanning procedure.

- The radiopharmaceutical technetium Tc 99m sulfur colloid is injected IV, and imaging is begun after 30 minutes to 1 hour.
- Scanning of the entire body, both anteriorly and posteriorly, is performed. Technetium Tc 99m sulfur colloid is used to examine for avascular necrosis, bone marrow infarct and hemolytic anemias, metastatic tumors, and diffuse hematologic disorders.
- If indium In 111 chloride is injected, imaging is started in 48 hours, and scanning of the entire body is performed. This agent is used to examine the client for extramedullary hematopoiesis and sites of occurrence.
- Care and assessment after the procedure are the same as for any nuclear scan study.

CONTRAINDICATIONS!

Pregnancy, unless the benefits of performing the procedure greatly outweigh the risks to the fetus.

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ендокринологія та гематологія)**

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for IV years students*