Radiology Team 429

Contrast media & Safety

Radiology team 429

- In this team we used the outlines from the:
- Dr slides
- Lecture notes
- 427 Radiology team
- Diagnostic Imaging –PETER ARMSTRONG – 6Th Edition

- Sorry we don't hold responsibility for any missinginformation or perhaps – perhaps -wrong material.
- We tried our best to present this lectures in the best way , and wehope that what we wrote is enough to cover the subjects.

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Best Wishes :)

CONTRAST

Definition:

It is a substance used to enhance the contrast of structures or fluids within the body in medical imaging. It is commonly used to enhance the visibility of blood vessels and the gastrointestinal tract.

Types:

- Radiocontrast (ex: Iodine and barium)
- MRI contrast (ex: gadolinium)

A) Contrast agents for radiography and CT:

Barium: widely used to outline the gastrointestinal tract

Procedure of Barium Enema: The patient is given an enema with a white, chalky solution that contains barium. Air is then blown to push in the barium around the colon, distending it and lining the mucosa with barium

CONTRAINDICATED IF THERE PERFORATION (FOREXAMPLE:ULCER)MCQ!!!

If barium is used and there is a perforation, it will leak and cause chemical peritonitis

If there is a perforation, usegastrographine(water soluble)also it is used in post-surgical conditions.

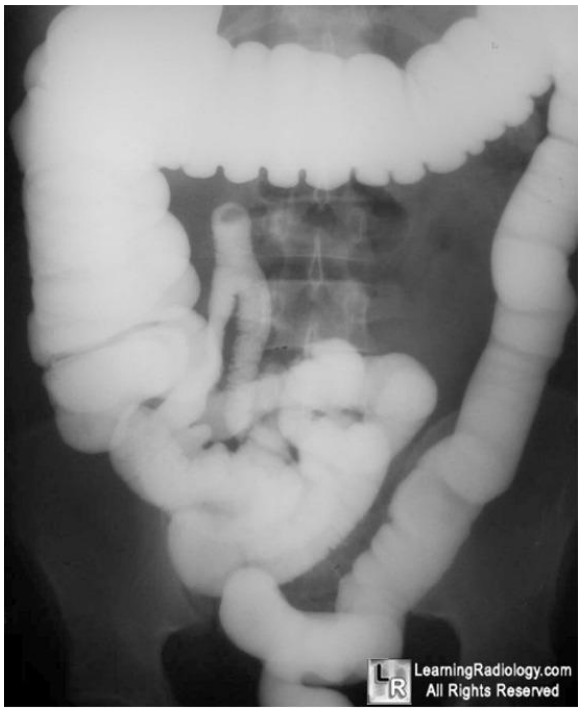
*Double contrast means = air + contrast

*Single Contrast= only the contrast, no air

-fluroscope : give barium swallow to the patient then expose him to continuous X-ray for gastrointestinal tract to observe barium movement in the gastrointestinal tract.

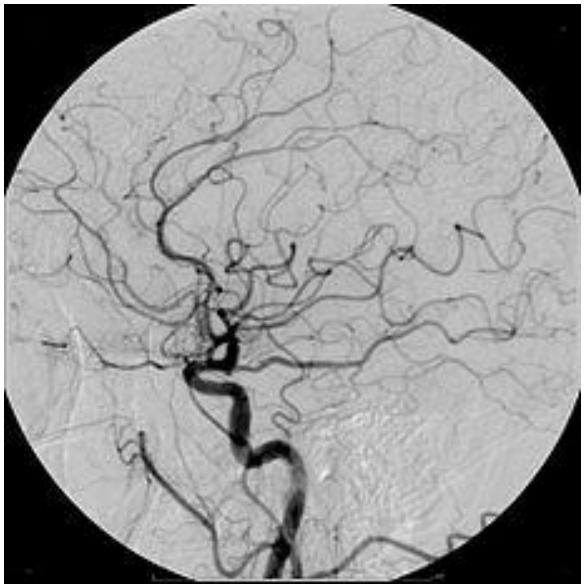
Double Contrast Barium

Single Contrast Barium



Iodine: used for urography and angiography.

The greater the iodine concentration, the brighter the image.



Example of iodine-based contrast in cerebral angiography

Side effects:

- Feeling of warmth spreading over the body (as iodinated contrast injected)
- Painful feeling in the site of injection (if contrast injected outside the vein)
- Urticarial rash (subside spontaneously)
- Bronchospasm
- Laryngeal oedema
- Hypotension

allergic manifestation, they could me mild m moderate or severe :Before the procedure we give the patient " steroids" to stop or minimize the reaction

- Deleterious effect on renal function (patient with impaired kidneys)
- Patient with known allergic manifestations (ex: asthma)
- Peritonitis (as patient injected by Barium contrast rarely cases will develop to perforation of the peritoneum)

B) Contrast agents for MRI: SAFER THAN CT`S CONTRASTS

Gadolinium: safer than Radiocontrast, only cross BBB when it is damaged by disease, it concentrates in tissues and disease processes with high blood supply.

Gadolinium-based contrast agents are generally safe and anaphylactic reactions are rare.

But there are some contraindicationsas:

- Pregnancy
- Patients with renal failure, on dialysis or awaiting for liver transplantation

(have a high risk of developing nephrogenic systemic fibrosis (NFS) **MCQ!!!**

- Cardiac *pacemaker* patient (contraindicated for MRI with or without contrast)

High-Risk Patients in using contrast agents:

- Asthmatic
- Renal impairment
- Diabetes mellitus
- Atopic dermatitis
- Pregnancy
- Multiple myeloma
- SCA -Multiple myeloma
- Previous reactions

SAFETY

There are two types of harmful ionizing radiation effects:

A) Deterministic effects

Effects that are associated with a threshold radiation dose. Below the threshold dose, no effect is observed. Above will cause an effect will occur 100% and the severity increases with the dose.

Examples:

1. Bleeding
2. Lung fibrosis
3. Skin responses: erythema, epilation, desquamation
4. Hematopoietic damage
5. Cataract
6. Infertility

B) Stochastic effects:

Effects that increase the probability of occurrence with increase to exposure, but do not affect the severity of occurrence (when the effecthappen, the increase in the dose will not make that effect worse, but will increase the possibility for that effect to happen)

Examples: Carcinogenic radiation induced cancer, genetic effect (mutation)

	CT	MRI
Contrasts	**Barium** , iodine	**Gadolinium**
Indication	Barium → gastrointestinal tract Iodine →urography and angiography	
Contraindication	Barium → if there is perforation	-Pregnancy. -Patients with renal failure, on dialysis or waiting for liver transplantation. -Cardiac *pacemaker*patient(contraindicated for MRI with or without contrast).
Patients at risk		-Asthmatic -Renal impairment -Diabetes mellitus -Atopic dermatitis -Pregnancy -Multiple myeloma -SCA -Multiple myeloma -Previous reactions

INVESTIGATION	RISK/ PA CHEST X RAY (0.03 m SV)
LUMBAR SPINE	100
ABDOMINE	50
IVU	150
CT HEAD	100
CT CHEST	300
CT ABDOMEN	400
BONE SCAN	200

Side effects	-Feeling of warmth spreading over the body (as iodinated contrast is injected) - Painful feeling in the site of injection (if contrast injected outside the vein) -Urticarial rash (subside spontaneously) -Bronchospasm -Laryngeal oedema -Hypotension -Deleterious effect on renal function (patient with impaired kidneys) -Patient with known allergic manifestations (ex: asthma) -Peritonitis (as patient injected by Barium contrast rarely cases will develop to perforation of the peritoneum)	

Here is the handout for this lec from the DR

2. RADIATION SAFETY AND PROTECTION

Eric L. Gingold, Ph.D.

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1. Is the radiation used in diagnostic radiology harmful?

Potentially, yes. In actual practice, adverse health effects from ionizing radiation used in diagnostic radiology are extremely rare.

2. What are the potential harmful effects of ionizing radiation?

The effects can be classified into two broad categories: stochastic effects and deterministic effects.

3. What are stochastic effects?

Effects in which the probability of occurrence increases with radiation exposure. Examples of stochastic responses are carcinogenesis and genetic effects. An important property of these effects is that the probability, but not the severity of the endpoint condition, is related to the quantity of the radiation dose.

4. What is meant by deterministic effects?

Deterministic effects are associated with a threshold radiation dose, below which the effect is not observed. Above the threshold dose, the probability that the effect will occur is virtually 100%, and the severity of the effect increases with an increased dose.

5. What are examples of deterministic effects?

Skin responses such as erythema, epilation, desquamation, cataracts, fibrosis, and hematopoietic damage.

6. What are the threshold doses for deterministic effects?

The deterministic effect with the lowest dose threshold is early transient erythema, with a threshold dose in the 2–3 Gray range, when delivered acutely. (The Gray, or Gy, is a unit of absorbed dose equal to 1 joule of energy absorbed per kilogram of tissue.) When the radiation exposure is spread over time, the threshold dose is greater than for an acute exposure, due to the ability of cells to repair nonlethal radiation damage.

7. What are some typical entrance skin exposures delivered in common x-ray examinations, such as a chest PA film, an AP cervical spine film, and an abdominal AP film?

Typical doses in milliGrays (mGy) for a PA of the chest, an AP cervical spine film, and an AP abdominal film are 0.15, 0.95, and 3.0 (using a grid and 400 speed film, for an average patient).

8. How many chest radiographs would one need to receive before the erythema dose threshold is reached, if 1 Roentgen of entrance skin exposure results in a skin dose of approximately 1 cGy?

Approximately 10,000 chest x-rays (or 100 CT studies or greater than 30 minutes of fluoroscopy)!

9. Do hospital workers risk receiving an exposure that would result in a deterministic effect?

No. Hospital personnel, in the course of normal clinical work, receive at most only a small radiation exposure, due primarily to scatter.

10. How concerned should we be about stochastic effects?

There is some legitimate reason to be concerned about stochastic effects, since they have no known dose threshold. This implies that even the smallest amount of radiation exposure may increase the probability of the induction of a stochastic effect. However, the most common stochastic

effects have a fairly high spontaneous incidence, so there may be a radiation dose below which further reduction in radiation dose does not reduce the likelihood of producing the effect. Since such "negligible risk" levels have not been determined, the conservative approach is to assume that all radiation exposure is potentially harmful.

11. What is ALARA?

"As Low As Reasonably Achievable," which refers to achieving the lowest radiation exposures possible to patients, health care workers, and the general public.

12. What is meant by "background radiation"?

All inhabitants of the Earth receive a certain amount of radiation exposure each year in the form of "natural background" radiation. This comes from rocks and soil, from outer space, from radon gas produced in the ground, and natural isotopes of elements found in living tissue (such as carbon-14 and potassium-40). The background radiation in the United States results in an average annual effective dose equivalent of 3.2 milliSieverts. The Sievert is the SI unit of effective dose, which takes into account partial-body irradiation and the particular type of radiation that results in an absorbed dose.

13. What is the average annual occupational effective dose that radiologists and x-ray technologists are exposed to?

Radiologists, 0.71 milliSieverts; x-ray technologists, 0.96 milliSieverts. These exposures are still below the natural background level.

14. What is the purpose of occupational dose limits?

Although the ALARA principle presumes that there is no absolutely safe level, occupational dose limits are chosen to keep radiation exposures to low levels, based on the following objectives:

- To prevent radiation-induced deterministic effects, by adhering to dose limits that are below the apparent threshold levels.
- To limit the risk of stochastic effects to a reasonable level in relation to social needs, values, benefits gained, and economic factors.

Radiologists and x-ray technologists receive an average annual occupational effective dose well below the occupational limit of 50 milliSieverts/year to the whole body.

15. Which health care workers are most likely to approach the occupational limit?

Angiographers and cardiologists, who perform fluoroscopically guided diagnostic and interventional procedures.

16. What are the main principles in radiation protection?

Time, distance, and shielding. That is, minimize exposure time, maximize the distance between oneself and the source of radiation, and take advantage of protective shielding such as lead garments and lead-lined partitions. The distance rule is particularly effective, since radiation exposure varies inversely with the square of the distance from the radiation source.

17. By what percent do standard 0.5-mm lead aprons reduce radiation exposure?

By 95%.

18. What other principles should be used while working with radiation or around radioactive materials to reduce exposure?

- Exercise proper hygiene (no drinking or eating).
- Limit the x-ray field to only the anatomy of interest.
- Use any dose-saving features such as fast screen-film combinations, pulsed or slow-scan video fluoroscopy, or low-dose fluoroscopy whenever possible.
- Use digital image receptors to reduce the number of radiographic studies that must be repeated because of underexposure or overexposure.

3

19. What does radiation exposure to a pregnant woman do to the embryo before implantation (first 9 days postconception)?

Either the embryo is lost, or there is no effect and the embryo recovers completely (Fig. 1).

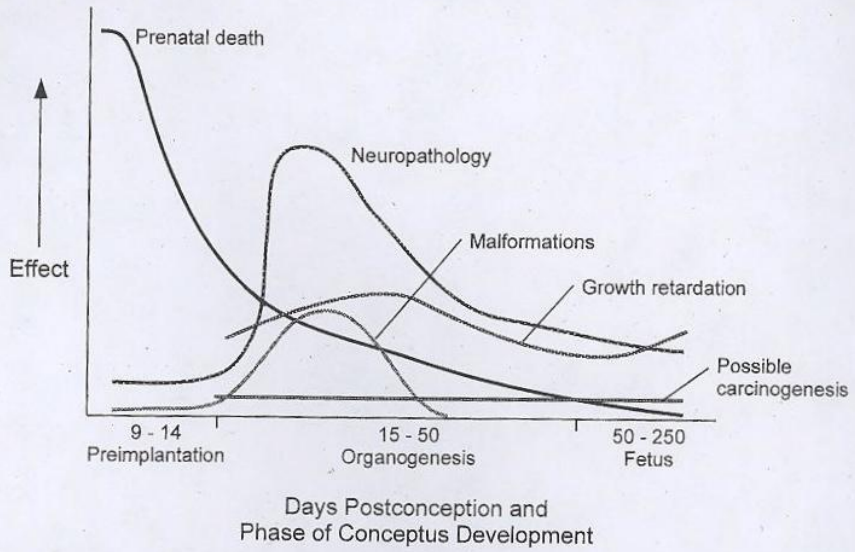

FIGURE 1. Adverse effects and relative risks associated with radiation exposure in utero at various stages of gestation. Adapted from Lewis JT, Miller JN: US Public Health Service Monitoring Program, 1977–1983. Rockville, MD, Office of Health Physics, Center for Devices and Radiological Health, Department of Human Services, 1985.

20. When is the fetus most sensitive to the effects of radiation?

During the organogenesis period, 8–15 weeks postconception, exposure to radiation may result in developmental problems such as small head size and mental retardation, with an observed increase in risk above a threshold dose of 40 cGy.

21. What is the risk of developing childhood cancer from radiation exposure in utero?

There is disagreement about the risk of radiation-induced leukemia and other childhood cancers, but a conservative estimate of the increased risk due to in utero exposure is 4–6 per 10,000 children per cGy. The monthly occupational dose limit for pregnant health care workers has been set at 0.5 milliSieverts (50 millirem) to limit these risks.

22. What practical steps can be taken to limit radiation exposure to pregnant patients?

Extra thought should be given to whether an examination that does not use ionizing radiation (e.g., ultrasound) can be used to substitute for a radiographic or fluoroscopic procedure. If ionizing radiation must be used, the field of view and the number of views should be limited as much as possible. These concerns are of greatest importance during the first trimester of pregnancy. Also, the dose to the fetus should be monitored, which can be done by a medical physicist. Only a fraction of radiologic examinations involve doses greater than 1 cGy, so in practice the risk of radiation-induced fetal injury from diagnostic radiology is extremely small. If the information to be obtained from the exam may significantly alter patient management, the small additional risk associated with the radiation exposure should be of less concern. If the results of the imaging study will not affect patient management, it should not be performed.

23. What are the risks of exposure to low levels of ionizing radiation? ("Low levels" are defined as levels of ionizing radiation that are well below levels at which a clear and quantifiable connection is seen between the radiation exposure and a biologic effect.)

There is still disagreement over the risk of biologic injury from low levels of ionizing radiation, delivered over an extended time. Investigators use "dose-response models" to predict the low level dose response from data obtained at higher levels of exposure (Fig. 2). The controversy can be summarized as "which model curve is correct?"

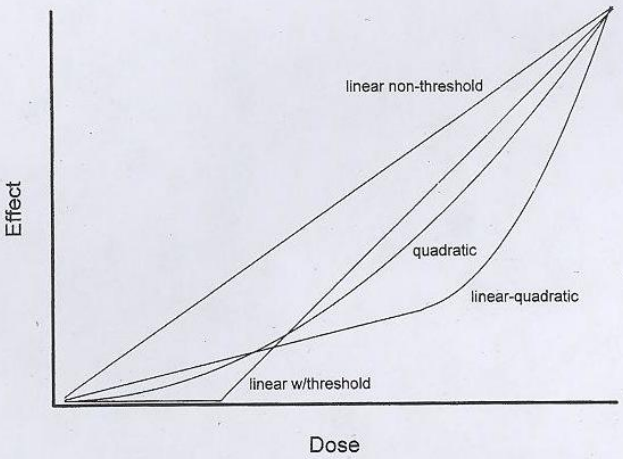

FIGURE 2. Dose-response curves corresponding to various models of radiation damage, used to extrapolate the radiation risk of low-level exposures from data obtained at intermediate-level exposures.

The available data do not provide a definitive answer. Radiation-induced cancers are indistinguishable from nonradiation-induced cancers, so for a given population it is impossible to tell whether an increased cancer incidence is the result of radiation exposures or other factors.

Implicit in the "linear, no threshold model" is the assumption that any amount of radiation is potentially harmful. This is the most conservative of the various dose response models and is the basis of ALARA. If, however, a threshold dose does exist, many of the resources used to protect people against small radiation exposures could be eliminated. Supporting the theory that a negligible risk radiation threshold might exist is the fact that biologic radiation repair mechanisms do exist and are well-understood. At low dose rates, repair mechanisms may be able to keep up with radiation damage, while at higher rates the repair mechanisms may not keep pace with the damage and significant injury may occur.

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3. GASTROINTESTINAL CONTRAST STUDIES

Douglas S. Katz, M.D., *and* Burton M. Gold, M.D.

1. What are the two major types of contrast agents that are used to image the bowel during fluoroscopic studies?

Barium and water-soluble iodinated contrast, such as Gastrografin, which is an "ionic" contrast agent.

2. What are the advantages of using barium for GI contrast studies versus using water-soluble iodinated contrast?

Barium, an inert substance, can be prepared in a variety of ways—as a suspension that can be diluted or mixed in a paste. Barium is denser than water and is therefore more visible than water-soluble iodinated contrast. Also, barium preparations, especially when "thicker" barium is used, are designated to coat the bowel mucosa, whereas water-soluble contrast just fills the bowel lumen.

3. What is meant by "single" versus "double" contrast studies?

The term "single" contrast usually applies when a single contrast agent is used (typically, barium). A "double" contrast GI study is performed using both air and barium.

4. What type of barium preparation is used for single contrast studies and for double contrast studies?

When single contrast is used for an upper GI study, for example, thinner barium is used so that abnormalities of the mucosa or in the lumen of the bowel will not be obscured by dense overlying barium. For double contrast studies, thicker barium that coats the bowel mucosa is used; air is introduced into the bowel lumen, which distends it and profiles the mucosa.

5. In what situations is water-soluble iodinated contrast contraindicated?

- When a patient has a past history of significant allergy to iodinated contrast
- When contrast is to be administered orally and the patient is at risk of aspirating, because aspirated ionic iodinated contrast can induce pulmonary edema and chemical pneumonitis

6. In what situation is barium contraindicated?

When bowel perforation is suspected. Water-soluble contrast is then indicated. Barium in the peritoneum can cause several problems: it may further add to the contamination of the peritoneum if a bowel perforation is present, and there is the theoretical risk of developing adhesions secondary to the barium in the future, although this is somewhat controversial.

7. Why is a patient kept NPO for upper gastrointestinal contrast studies?

For a variety of reasons but particularly so that food and ingested medications and fluids do not interfere with barium coating of the mucosa and are not confused with true abnormalities.

8. What are some indications for an esophagram?

- To evaluate dysphagia, swallowing problems, and motility disorders
- To search for complications of gastroesophageal reflux
- To examine the esophagus for suspected esophagitis, stricture, varices, or tumor

9. How is an esophagram performed?

In a variety of ways. The specific technique used by the radiologist will depend on institutional and personal preference. The pharynx and cervical and thoracic esophagus are examined. A typical examination includes studying swallowing (in the frontal and lateral positions) in both the supine (to eliminate the effects of gravity on peristalsis in the thoracic esophagus) and the standing positions. The examination is videotaped and reviewed, and fluoroscopic spot films are obtained. Many radiologists obtain images using both single and double contrast; double contrast is ideal to study fine mucosal detail.

10. What is the diameter at which an esophageal narrowing can lead to significant obstruction?

13 mm or less. To test for such a narrowing, a radiopaque tablet measuring 13 mm can be given to the patient to swallow under fluoroscopy.

11. What is a "modified" barium swallow (or swallowing study)?

A specialized study that may be performed in conjunction with a speech pathologist. A variety of substances are swallowed under fluoroscopy; if specific problems are identified during swallowing, the speech pathologist can test a variety of compensatory maneuvers in an attempt to minimize problems such as aspiration.

12. What structures are routinely examined during an upper gastrointestinal series (UGI)?
The thoracic esophagus, the stomach, and the duodenum.

13. What are the indications for UGI series?
The most common indications include:
- Evaluation of upper abdominal pain
- Suspected gastric or duodenal ulcer
- Suspected gastric outlet obstruction or tumor
- Evaluation of the folds of the stomach for gastritis or suspected tumor
- Unexplained weight loss or anorexia

14. How is UGI performed?
This depends on the condition of the patient and the preference of the radiologist/institution. As with most fluoroscopic examinations of the upper GI tract, there is no one correct way to perform a procedure, and the examination should always be tailored to answer the specific question(s) being raised by the referring physician(s). At the same time, a routine series of maneuvers and views should be performed so that a systematic examination is obtained.

For example, if the patient is elderly and cannot easily maneuver on the fluoroscopic table, a UGI series using single contrast is appropriate. The patient swallows thin barium, and a variety of images are obtained. Some of the images are obtained using compression, where the abdomen is compressed—either by the radiologist's hand using a leaded glove or by a compression device—so that lesions are not obscured by the overlying barium.

If the patient is a relatively healthy outpatient, a double contrast study can be performed. The patient swallows effervescent crystals as well as thick barium, and the patient rolls on the fluoroscopy table to coat the stomach with barium. A series of images are then obtained.

15. What are some potential pitfalls of a double contrast UGI series?
The double contrast study provides excellent mucosal detail, but there are some potential pitfalls. It may be difficult to see the anterior wall of the stomach, and ulcers may be missed there. Fortunately, gastric ulcers are much more common on the posterior wall of the stomach. If the stomach is overdistended, mucosal abnormalities may be missed; if the stomach is underdistended, it may be difficult to determine if the folds of the stomach are truly thickened.

16. What are some potential pitfalls of a single contrast UGI series?
If adequate compression is not used, lesions may be missed. Mucosal detail is poor compared to double contrast studies.

17. What are the indications for a small bowel series?
The common indications include:
- To evaluate a known or suspected small bowel obstruction
- To search for a lesion, especially in a patient with significant symptoms and/or lower GI bleeding, in whom evaluation of the lower (and upper) GI tracts has failed to reveal a cause
- To search for causes of diarrhea and malabsorption

18. How is a small bowel series performed?
Also known as a small bowel follow-through, it may be performed as a separate test or at the end of an upper GI series. The patient drinks barium (additional barium if an UGI has just been performed) and serial radiographs are obtained. Periodically during the exam, and when barium reaches the cecum, the radiologist uses a compression paddle and presses on the abdomen while examining the small bowel and the terminal ileal region under fluoroscopy.

19. Is barium or water-soluble contrast preferable as a contrast agent for a small bowel series?
Barium is superior to water-soluble contrast. In fact, many radiologists will not use water-soluble contrast for this study; the contrast gets diluted easily, especially when an obstruction is present, and mucosal detail is not seen.

20. Is there a superior test to a small bowel series, especially when an intermittent or "low-grade" small bowel obstruction is suspected?

Yes, enteroclysis.

21. How is an enteroclysis performed?

The radiologist places a long nasogastric tube—often one that is specially made for this procedure—just past the duodenal-jejunal junction and instills barium, often followed by methylcellulose, through the tube, often using a pump that delivers these materials at a standard rate. The bowel is observed under fluoroscopy, and multiple images are obtained. To improve patient tolerance, the patient may be given nasal or oral topical anesthetic, and/or intravenous or oral light sedation can be administered.

22. What are the advantages of enteroclysis over a standard small bowel series?

Because the small bowel is directly challenged with a bolus of contrast and methylcellulose, subtle transition points may be discovered (e.g., adhesions) that cannot be detected using techniques such as a routine small bowel series or CT. Mucosal detail is outstanding, and unusual lesions such as primary small bowel tumors, which are notoriously difficult to discover by other means, may be identified.

23. What is a major contraindication to enteroclysis?

"High-grade" small bowel obstruction.

24. What are some of the indications for a barium enema?

- Evaluation of lower gastrointestinal bleeding
- Screening for colon cancer or polyps
- Suspected diverticulitis
- Rule out obstructing lesion
- Inflammatory bowel disease
- Colon incompletely evaluated at endoscopy (i.e., the more proximal colon was not reached)

25. When is a barium enema contraindicated?

- When there is peritonitis and/or free intraperitoneal air
- If toxic megacolon is suspected

(This is why it is extremely useful to obtain scout views of the abdomen and pelvis prior to performing a BE)

26. What are the differences between a single and a double contrast barium enema?

Double contrast is ideal when evaluating relatively healthy patients who can cooperate with the relatively rigorous examination. To perform a double contrast study, both barium and air are instilled under fluoroscopic observation into the colon. Multiple spot films are obtained during the procedure, as well as multiple "overhead" radiographs. The radiologist also "spots" the terminal ileal region, meaning that he or she uses a compression balloon to press on the right lower quadrant, which spreads the structures in this area apart and allows them to be identified and examined (i.e., the cecum, terminal ileum, ileocecal valve, and appendix). Double contrast provides excellent mucosal detail.

Single contrast is ideal when the patient cannot tolerate a double contrast exam, when obstruction of the colon needs to be excluded, or to evaluate for the presence of a fistula. If perforation is suspected but there is no free air and no evidence of peritonitis, water-soluble contrast should be utilized, in case a perforation is encountered.

27. Can a barium enema be performed if the patient has an ostomy?

Yes, the study can be performed through the ostomy; either single or double contrast techniques can be used. However, in contrast to the typical BE where a balloon (which is present near the end of the tip of the enema tube which is inserted into the rectum) may be inflated, this type of apparatus

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