

# Classes of radiopaque contrast media



**ASSIGN  
BUSTER**

## **INTRODUCTION**

In medical imaging, contrast media have been search because the differences in density among body tissues is too small. Contrast media is used to provide more adequate contrast for good visualization and differences of anatomical details. This will be advantages to radiographer to provide more clearly image that can be easily to anylize. It is necessary to increase or decrease density of interested organ to provide desired contrast. Because the use of computed tomography(CT), magnetic resonance imaging(MRI) and digital subtraction angiography(DSA) increase, the use of contrast media is also increase. Example procedures using contrast media is barium enemas and excretory urograms. In advance procedures they increase the region of interest density by addition of radiopaque substance that render organ opaque. However, in some situation density of organ can be decrease by addition of radiolucent substance. Amount of contrast media that being use are greater than those used for therapeutic drugs. This procedure is designed to make contrast media remain in organ of interest for very short period of time which not cause any changes biologically or chemically in the body.

## **TYPES OF CONTRAST AGENTS**

Contrast agents are classified into two group that depending on their interaction with x-ray radiation. Positive contrast agents that is radiopaque and negative contrast agents that is radiolucent.

There are four negative agents that always be used in medical imaging. That is the air, oxygen, carbon dioxide and nitrous oxide. This is the most

commonly used as radiolucent contrast agents. Negative contrast agents are also used in conjunction with positive contrast agents. It known as common procedure double contrast barium enema. This negative contrast agents has it disadvantages that air and oxygen can cause gas emboli in certain procedure. However differently for carbon dioxide and nitrogen that not pose risk of gas emboli although it can be used with relatively safety. Moreover carbon dioxide and nitrogen able to be absorbed rapidly by the body. This is advantageous when rapid absorption is needed but not suitable in a cases when many radiographs are taken.

Positive contrast agents are use because they have high atomic number that can cause an increases in the attenuation of x-rays, thats why it is considered as radiopaque. It produce an area decreased radiographic density on the image receptor. Positive contrast agents that commonly used in radiographic procedure is iodine, bromine and barium. When this contrast agents is filled in organ, it will make that organ become radiopaque and image appears clear or white on radiograph (image receptor). It can be taken in form of liquids, tablets and powders also can be inserted to body through a variety of routes. This contrast are relatively nontoxic in most cases but certain patient may exhibit reactions of varying severity especially to agents containing iodine and in some cases small amount of these agents may cause death.

## **Classes Of Radiopaque Contrast Media**

Osmolarity and osmolality refer to the osmotic pressure of a solution.

Osmolarity refer to the concentration per volume of solution while osmolality refer to weight or milliosmols per kilogram of water.

<https://assignbuster.com/classes-of-radiopaque-contrast-media/>

The contrast agents used for intravenous injections has two major classes. That is ionic and non ionic. The ionic compounds are further subdivided into high osmolarity ionic compounds(HOCA) and low osmolality ionic compounds(LOCA) . All positive contrast agent used intravenous injection are organic iodine compound that use iodine as the substance that provides the contrast

C: UsersluzzDownloadscontra1. gif

## **Characteristic Of Radiopaque Contrast Media**

Characteristics that important for radiopaque contrast agent is viscosity, toxicity, iodine content, miscibility and persistence. When contrast agent the iodine concentration increase, viscosity increase. More viscous cotrast agent need greater injection to send same amount of material then icrease possibilities of patient trauma and catheter damage.

The miscibility or immiscibility of contrast agent is important as angiographic contrast medium must completely miscibility with the blood to avoid any possibilities of contrast medium embolization.

Contast agent persistent in body is important. It was foreign substance that instilled into body organs. It more good that they can be excreted fastly from body but they must stay and concentratein the body organs for long enough to provide an adequate radiographic study.

Selective localization has become more a part of the route of elimination of the substances rather than a means to get it to specific location. Mostly positive contrast agents eliminated through urinary system tha make blood

urea nitrogen(BUN) and creatinine test is important. If urinary system is already stressed, additional load will caused some major patient reaction.

## **Excretory Pathways**

Every contrast solution that being use has it elimination routes. The main routes used to eliminate positive contrast agents used in the vascular international studies are urinary system and hepatic portal system. Those agents that utilize the hepatic portal system are primarily used to study the organs associated with the system. The primarily route for the elimination of most of the organic iodide compounds is through the urinary system. So it is important to know the status of the kidney's ability to take this task before the examination. Patient must take both BUN and creatinine test to determine renal status. And results must be checked before doing the examination. Renal insufficiency is indicated if the BUN exceed 30mg/dl and creatinine is above 1.5mg/dl. Physician should be noticed regarding the results of these tests prior to the injection.

## **General Precautions**

Before injection, patient must be inform about the procedure and its risk. Obtain an informed consent from the patient for precaution and establish a set of baseline vital sign for the patient for our reference.

Know the patient, by checking the chart for history of allergy or hypersensitivity to take care patient and avoid from any mistake. Make sure patient take a blood work test and checking the result of the patient's blood work before examination. Test of blood work is to investigate about blood

urea nitrogen, creatinine, prothrombin time in cases of arterial access, partial thromboplastin time and platelet count.

Check whether patient has other medical problems about hepatic or renal disease, pregnancy, multiple myeloma, congestive heart failure, Graves' disease, Homozygosity for sickle cell disease, known or suspected pheochromocytoma (solid tumors of neurogenic origin), severe cardiovascular disease bronchial asthma, severe cardiovascular disease bronchial asthma and lastly Hyperthyroidism.

Know about the procedure of contraindications and limitations to the specific special procedure. Know the possibilities reaction that can occur with the contrast agent used. Checking the emergency equipment and know the location and contents of crash cart.

After injection we must know where physician may be reached. Evaluate patient's vital functions for abnormalities, respiration rate, pulse rate, blood pressure and presence of cyanosis. Must remain with and monitor the patient for at least 20 minutes after injection.

## **Reactions**

In this examination, approximately 70% reactions occur within 5 minutes of the injection. 16% will occur more than 5 minutes after injection and lastly 14% occur 15 minutes after injection. So it is advisable to radiographer remain with patient at least 15 minutes after the injection. There are five major group of reactions occur during contrast examination:

Overdose reactions; infant, adults with acute renal failure, adults with cardiac failure in the beginning stage, and adults with hepatic failure and ascites are particularly at risk receiving an excessive osmotic load.

Anaphylactic reactions; considered allergic-type reactions caused by hypersensitivity to the substance.

Cardiovascular reactions; tend to cause peripheral vasodilation and a decrease in systemic blood pressure which can result in reflex tachycardia because they are related to the effect of the vagus nerve on cardiovascular system, they are referred to as vasovagal or vagal-type reaction. Vasovagal reactions can affect myocardial contractility and cardiac electrophysiology and can ultimately be serious. The most severe of cardiac reaction is cardiac arrest.

Psychogenic reactions; if patient are overanxious, they may respond to the subjective side effects produced as a result of the introduction of the contrast agent with an autonomic response. The response becomes the basis for the adverse reaction. Substances less likely to cross the blood-brain barrier and enter the central nervous system reduce the likelihood of reactions precipitated by this mechanism.

Activation system-triggering reactions; activation of variety system such as complement, coagulation, fibrinolysis and histamine can be triggered as a response to damage to the vascular endothelium at the injection site. These system do not cause the same type of reaction in every patient because of individual variations in the presence and action of inhibitors in the pathways.

## **Symptoms of reactions to contrast agents administered intravenously**

Mild to moderate symptoms

Severe symptoms

Sneezing

Nausea

Chest pain

Shivering

Flushing

Facial swelling

Abdominal pain

Heat sensation

Vomiting

Warm feeling

Vascular pain

Itching

Edema

Hoarseness



Coughing

Urticaria

Pain at injection site

Paralysis

Loss of consciousness

Paresthesias

Cardiac arrest

Dyspnea

Convulsions

Tissue necrosis

Sudden drop in blood pressure

The possibility of a reaction should always be anticipated, and proper emergency medication should be available in the special procedure suits.

The following is the list of typical emergency equipment:

Oxygen wall system and oxygen tank and mask

Airways(pediatric and adult)

Physiologic saline

Suction apparatus

Emergency drugs(by physician preference)

- hydrocortisone sodium succinate
  
- metaraminol
  
- phenylephrine hydrochloride
  
- diphenylhydramine hydrochloride
  
- epinephrine

Aromatic spirits of ammonia

Syringes and needles for drug injection

Blood pressure device(sphygmomanometer) and stethoscope

## **Complications**

The complication is divide into three categories that is those occurring at the puncture site, systemic complication and complication induced by the catheter during the procedure.

## **Outcomes classification of complication to Arteriographic procedures referred to the effect of the complication on the patient or the level of treatment required**

Classification level

Resultant potential outcomes

Minor complications

No therapeutic intervention

<https://assignbuster.com/classes-of-radiopaque-contrast-media/>

Minor therapeutic intervention

Admission for observation-minimum 24 hours

No permanent effect

Major complications

Requires therapeutic intervention

Observation for <48 hours

Major therapeutic intervention

Hospitalization for > 48 hours

Permanent effects

Death

\*Outcomes from The Society of Interventional Radiology(SIR)

Potential for drug or medication taken by patient to interact with contrast media must be taken seriously. Example combination of contrast medium with metformin hydrochloride (glucophage taken by patient with type 2 diabetes) increases risk for buildup of lactic acid in the blood. It is referred to as lactic acidosis. By a natural process by mitochondria, breakdown of sugars and fat to make energy will produce lactic acid (waste product). Normally this lactic acid will be broken down into simpler products and is eliminated from the body, but under some circumstances mitochondria is damaged and lactic acid does not break down then it accumulates in the body. This condition will

show a symptoms of nausea, muscle weakness, vomiting, weight loss, abdominal pain, dyspnea and cardiac rhythm abnormalities.

Also radiographer must alert to patient creatinine level before the examination. If it within normal level under 1.5mg/dL risk for patient to use contrast is reduced but if creatinine level above normal limits, suspend or replaced use of metformin.

Complications that occur in puncture site is hematoma, occlusion, and pseudoaneurysm, extravasation of the contrast agent. Risk factor for extravasation is tourniquets does not release during injection, improper use of the automatic injection devices, indwelling catheters in place more than 24 hours, tapes and bandages over intravenous access site that prevent adequate monitoring of injection site, injection into small peripheral veins almostly in the dorsum of foot and hand, multiple attempts to gain vessel access, use of metal needles rather than plastic catheters, use of high osmolarity contrast agents, examination requiring large amounts of contrast agents, abnormalities caused by atherosclerotic vessels, diabetic vascular disease and venous thrombosis, patients with a history of compromised lymphatic or venous drainage, increased risks in children, infants, the elderly, and chronically ill patients.

### **Specialty contrast agent**

Problems occur for magnetic resonance imaging(MRI) procedures because organic iodine compound cannot be contrast agents for this procedure as it only function through absorption of x-ray beam. MRI does not use x-ray to produce image. So, iodinated contrast media only useful in special procedure

of radiography and computed tomography(CT). The substance that has been found suitable to becoming contrast media for MRI is gadolinium diethylenetriamine penta-acetic acid (Gd-DTPA) because it is metal chelate. This metal ion have tend to bind wih certain body tissue like in kidneys, liver, heart, brain, bone, spleen and lungs so they can remain in the system for a long period of time. Also it does not cause unneeded side effect and not has shows toxicity to organs system. Primary excretory pathway is via kidneys, 80% Gd-DTPA eliminated in 3hours, 98% eliminated through urination and defecation within 1week of administration.

## **INTRAVENOUS UROGRAPHY(IVU)**

### **Introduction**

Intravenous urography(IVU) also known as intravenous pyelogram(IVP) is a radiological procedure used to visualize urinary system by using intravenous contrast agent. Its show the kidneys, ureters and bladder in radiographic film in white and clear image because contrast radiopaque are being used. This will easily for radiographer to anylize and observe any abnormalities in patient urinary system. The intravenous injection of a contrast agent is the mostly ways that was being use to obtain images of the urinary system. Although, ultrasound or computed tomography (CT), are better for some disease processes. When intravenous is injected into blood flow, the kidneys excrete the contrast into the urine and becomes visible when x rayed (radiopaque), creating images of the urinary collection system.

There are procedure name antegrade pyelography differentiates from retrograde pyelography, the contrast agent are injected directly into the lower end of the system that make contrast agents flow backward. That why <https://assignbuster.com/classes-of-radiopaque-contrast-media/>

its name is retrograde. This retrograde pyelography is the most suitable x-ray procedure to observe the lower ureters when kidneys are non-functional.

Nephrotomography or also known as tomographic slices of the kidney, taken by moving x-ray source emit x-ray exposure onto a film and moving in opposite direction. The image upper and lower level of the kidney are blurred that allowing a more detailed image of the kidneys with no over imposed material such as gas or fecal material.

Many available exams suitable for detecting kidney abnormalities, with varying risks and costs:

In a save, simple, quick and inexpensive way to obtain views of internal organ is by using ultrasound. By using ultrasound, renal size can be measured as well as the visualization of abnormalities of cysts, renal calculi, hydronephrosis, and tumors. But small stones in the ureters are not as well visualized and the function of the kidneys cannot be determined.

Then by using nuclear renal scans that rely on the radiation given off by certain atoms (isotopes), that are injected into the bloodstream. It will reach the kidneys, and images are constructed by measuring the radiation emitted. The radiation is not dangerous as standard x-rays. However, this exam has limited applications, including the evaluation of reflux, chronic obstruction, and renal function. It is also used to evaluate high blood pressure that is refractory to treatment, and is commonly used to evaluate the kidney of a renal transplant patient for early rejection where renal artery stenosis is suspected as the cause.

Magnetic resonance imaging (MRI) are mainly using magnetic fields and radio frequency signals and does not use ionizing radiation to create computerized images. This method using magnetic field energy are safe as long as no metal in patient body. It has limited applications and usually is not done for common problems, such as pain and hematuria (blood in the urine). MRI usually is done if other tests are inconclusive. MRA (magnetic resonance angiography) may be done to evaluate the renal arteries, particularly if renal artery stenosis is suspected as a cause of hypertension that is refractory to treatment. MRI need special apparatus and installation and is a very costly exam.

Retrograde pyelography is the most suitable to define problems in the lower part of the ureters, and is the only way to completely opacify the ureters in patients with malfunction kidney. This exam is performed in an operating room by a urologist. A cystoscope is placed into the bladder and a catheter is placed into each ureter to inject the contrast agent. The advantage of this method is that small stones can be removed immediately by the urologist.

Lastly is computed tomography scans (CT or CAT scans) use a fine beam of x-rays creating images at accurate levels in the body. The information is processed by a computer and imaged onto film using laser printer. Three-dimensional images will be constructed from this technique of imaging. An injection of a contrast agent is required to visualize the kidneys in detail. The CT scan is done without IV contrast to look for stones (calculi). In some centers, this modality has replaced IVPs and ultrasound for this application. Special equipment is necessary and the exam can be costly.

## **Indication**

This procedure is being made to investigate of patient urinary incontinence, anuria, hematuria or pyuria not arising from the lower urogenetal tract, suspect urinary bladder disease when bladder cannot be catheterized, abnormal size, shape and position of urinary system, investigation of rretroperitoneal swellings, suspect ureteric disease such as ectopic ureters and identification of kidneys when not visible on plain radiographs.

[http://upload.wikimedia.org/wikipedia/commons/thumb/f/f5/lvu\\_1.jpg/300px-lvu\\_1.jpg](http://upload.wikimedia.org/wikipedia/commons/thumb/f/f5/lvu_1.jpg/300px-lvu_1.jpg)

Example radiographic image of urinary system with intravenous contrast.

## **Diagnoses**

This procedure are also being made to diagnose any abnormalities or disease in urinary system such as chronic pyelonephritia, renal cell carcinoma, kidney stone, polycystic kidneys, transitional cell carcinoma, anatomical variation like horeshoe kidney or duplex collecting system and also obstruction commonly at the pelvic-ureteric junction or PUJ and the vesicoureteric junction or VUJ.

## **Purpose**

An intravenous urogram is perform to demonstrate the structure and function of the kidneys, ureters, and bladder. Patients that compalin about their abdominal pain at the back may needed to do this exam to rule out kidney stones. Patients with high blood pressure (hypertension) and has bladder infections may also would liketo do intravenous urogram (but hypertension usually is imaged with MRA or nuclear medicine imagery and <https://assignbuster.com/classes-of-radiopaque-contrast-media/>



this exam is done when renal artery stenosis is the suspected cause of refractory hypertension). Hematuria may also be an indication of kidney stones, infection, or tumors. On occasion the exam is planned to evaluate the function of the kidney in a renal transplant patient. The transplanted kidney is located in the iliac fossa, so special films of the pelvis area are done as a replacement for of the normal routine views. The radiographic technologist may also be required to take x-rays in the operating room when a retrograde pyelogram is ordered by a urologist during a C and P (cystoscopy and pyelography).

Emergency patients with blunt abdominal trauma are usually evaluated with a CT scan or occasionally ultrasound instead of an intravenous urogram.

## **Precautions**

A serious problem of an intravenous urogram is an allergic reaction to the iodine-containing contrast agent. Severe reactions are rare, but can be dramatic and even lethal and dangerous. Because of this, all radiology departments performing this exam are equipped and prepared with emergency drugs and oxygen in the x-ray room itself.

## **Description**

The patient will be asked to change into a hospital gown and take off any artifact from the region of interest. The x-ray technologist will confirm that the patient has followed the bowel preparation and complete a detailed questionnaire on the recent medical history of the patient. This includes previous contrast reactions, known allergies, current medications and risks of pregnancy. The x-ray technologist will explain the exam in detail to the

patient as well as the risks of the contrast material that will be injected intravenously. The patient must sign a consent form before the examination is started to give us permit to do our job to patient. The x-ray technologist will pass on this information to the radiologist who will decide on what type of contrast will be used. Patients who have had an injection with no reaction can be given less expensive iodine-based contrast, whereas patients who take various heart medications or those with known allergies or asthma will be injected with a more expensive contrast agent (known as non-ionic contrast) that has fewer side effects. Some departments use the non-ionic contrast exclusively.

The patient will be instructed to lie supine (face-up) on the x-ray table and a general KUB test will be done. This is an abdominal view of the kidneys, ureter, and bladder used to make sure patient preparation, centering, and the radiographic technique needed to demonstrate all the required structures.

Kidney stones may or may not be visualized on the preliminary film. The x-ray technologist will prepare the required amount of contrast to be used depending on the weight of the patient (1 ml per pound). Normally 50-75 cc of contrast for an average-sized patient. The contrast will be injected all at once (bolus injection) or in some cases, through an intravenous drip. Some radiologists prefer to start an intravenous drip with saline as a precautionary measure while others inject with a small butterfly needle. The needle usually remains in place for 10-15 minutes, in case more contrast is needed or in case drugs need to be administered because of an allergic reaction. Most

reactions occur immediately but some can take place 10 or 15 minutes after the injection.

The first film is taken right away after the injection to see a detail of the renal outline (nephrogram). Films are usually taken at five-minute intervals depending on the schedule of the radiologist. Compression may be applied to the lower abdomen with a large band to keep the contrast material stay in the kidneys longer. This will creates a more detailed image of the renal collecting system. When the compression is released after around 10 minutes the contrast material drains quickly and a detailed, filled image of the ureters is obtained. Films is made in the upright or prone (face-down) position may also be planned to improved visualization of the lower ureters. Some departments require routine renal tomographic images to be done as well when the kidneys are well visualized. This allows the kidneys to be seen free of gas or fecal shadows. Sometimes the radiologist requires oblique views of the kidneys or bladder to find out the exact location of calculi (stones). At approximately 20 minutes after the injection a film centered on the bladder may be necessary. The x-ray tube is angled slightly caudad (towards the feet) so that there is no superimposition of the pubic area of the pelvis over the bladder. The films are shown to the radiologist and if no further films are necessary the patient will be asked to void (urinate) and a post-void film will be taken. The exam can take from 30 minutes to one hour depending on the number of films required. If the kidney is obstructed, delayed films may be required to complete the exam.

## **Preparation**

To obtain the best visualization of the kidneys, ureters, and bladder, the intestines must be free of gas and fecal substance. Most include a laxative such as X-Prep or Dulcolax tablets taken around 4 p. m. the day preceding the exam. Followed with a light fat-free dinner which includes lean meats, noodles, white rice, bread with no butter, and tea or black coffee. Fluids are permitted until midnight, after which no food or liquid is allowed until after the intravenous urogram is completed. Patients who are diabetic are sometimes done early in the morning to avoid any complications. Patients who have had a previous reaction to a contrast material can be given a series of steroids and antihistamines the day before the exam as well as the morning of the exam. The patient must discuss with their physician before this is administered. In patients with known or suspected renal failure, lab tests, including BUN and creatinine, may be ordered prior to the IVP.

## **Complications**

An allergic reaction to the contrast agent is the most important risk, even though kidney damage is also a potential complication. Patients with a possible iodine allergy or a previous reaction to a radiographic contrast agent should inform the x-ray technologist. A detailed history of known allergies, risk of pregnancy, and current medications is required before an intravenous urogram. All radiology departments have consent forms that must be signed by the patient before starting the exam. Emergency equipment and specific drugs such as adrenaline, antihistamines (Benadryl), and atropine are kept in the x-ray room. All radiography technologists must have specific training and education on the various signs and symptoms of

an allergic reaction. A mild reaction consists of a skin rash or hives, whereas a more serious reaction includes swelling of the larynx, difficulties in breathing, asthmatic attacks, and a severe drop in blood pressure (hypotension).

Since x-rays are involved during this procedure, there is a minimal risk due to radiation. This exam is not done on pregnant women or women who think they may be pregnant.

## **Results**

A normal intravenous urogram will indicate no visible abnormality in the structure or function of the urinary system. The radiologist looks for a smooth non-lobulated outline of each kidney, no clubbing or other abnormality of the renal calyces (collecting system), no abnormal fluid collection in the kidneys that could suggest obstruction. The ureters must contain no filling defects (stones) or deviations due to an adjacent tumor. The bladder must have a smooth outline and empty normally as visualized on the post-void film.

Abnormal results include hydronephrosis (distension of the renal pelvis and calices due to obstruction) as a result of tumors or calculi (stones). Cysts or abscesses may also be present in the urinary system. A delay in renal function can also indicate renal disease. An abnormal amount of urine in the bladder after voiding may indicate prostate or bladder problems.

Intravenous urograms are often done on children to rule out a rapidly developing tumor in the kidneys, called a Wilms' tumor. Children are also

prone to infections of the bladder and kidneys due to urinary reflux (return backflow of urine).

## **Health care team roles**

The x-ray technologist must work in coincidence with the doctors and nurses in making sure the patient has not had a previous allergic reaction to a contrast agent. All hospitals have an emergency team ready to react in such a situation, so the technologist must be aware of the procedure to follow when assistance is necessary due to a severe reaction. Details of patient preparation must also be communicated to the hospital wards. In some hospitals the radiologic technologists are trained to give injections, but if this is not the case nurses may be asked to install an intravenous drip before the patient is brought to the radiology department.

## **Patient education**

The x-ray technologist must explain the risks of an allergic reaction to each patient even though severe reactions are particularly rare due to the advances made in the preparation of contrast agents. The x-ray technologist must explain to the patient that a warm, flushed feeling or a metallic taste in the mouth are normal reactions in some patients. Breathing instructions are also important since the kidneys change position depending on the phase of respiration and to prevent motion artifacts. Sometimes an emergency patient with renal colic (acute abdominal pain) is asked to urinate through a special filter used to trap small stones. All radiographic technologists must be certified and registered with the American Society of Radiologic Technologists or an equivalent organization. Continued education credits are mandatory to remain registered.

<https://assignbuster.com/classes-of-radiopaque-contrast-media/>

## **BARIUM MEAL**

### **Introduction**

A barium swallow is a radiographic examination for the upper gastrointestinal tract that use barium based as the contrast agent. Upper gastrointestinal tract region is the pharynx (back of the mouth and throat) and the esophagus (hollow tube of muscle extending from below the tongue to the stomach). A barium meal, is a radiographic examination of an upper gastrointestinal tract that is the esophagus, stomach and duodenum are taken after barium sulfate is ingested by a patient. Barium meals are useful in the diagnosis of structural and motility abnormalities of the foregut. This procedure is taken in AP (anteriorposterior) and lateral projection.

Barium solution is a white, dry, chalky, metallic powder that have been mixed with amount of water and must be thick, milkshake-like drink. Barium is a positive contrast agent because of it has high atomic number that make it as a x-ray absorber. It classified as radiopaque and always be used as contrast agent for gastrointestinal tract procedure in radiographic imaging. When swallowed, a barium drink will coats at the wall of pharynx and esophagus so that swallowing motion inside wall lining and size with shape of these organ can be seen white, clear and visible in x-ray film (film receptor). This process shows difference that might not be seen in general or standard x-rays. Barium is us