

Chapter 17

CONTRAST MEDIA

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X-Ray image is produced by the differential attenuation of x-ray photons by tissues of different densities in the body; giving radiographic contrast in the image.

A number of organs and anatomic regions do not have sufficient inherent contrast for the plain radiography e.g. kidneys, gastrointestinal tract, gallbladder, brain etc. To visualize these organs in the body, it is necessary to introduce into the patients a contrast medium that is deposited in the organs and that absorbs X-ray either more or less than the surrounding tissue. Contrast media in common uses are: air, barium sulphate in the gastrointestinal tract and iodinated compound in the gallbladder, kidneys, vascular system, and brain.

IODINATED CONTRAST MEDIA ARE USED IN THE FOLLOWING RADIOLOGICAL PROCEDURES :

- Contrast enhancement in the CT scan of brain and in different parts of body.
- Cardio angiography.
- Cerebral aortography.
- Thoracic aortography.
- Abdominal aortography.
- Peripheral aortography.
- Phlebography.
- Urography.
- Myelography.
- Hysterosalpingography.
- Arthrography.
- Fistulography.
- Dacryocystography.
- Galactography.

- Sialography.

Non ionic, low-osmolar iodinated contrast media is preferable and suitable for all the above indications.

BARIUM SULPHATE IS USED AS CONTRAST MEDIUM IN THE FOLLOWING EXAMINATIONS :

- Barium swallow-oesophagus
- Barium meal examination plain and double contrast
- Hypotonic duodenography
- Barium follow-through
- Small bowel enema or enteroclysis
- Barium enema examination

Barium sulfate of different suspension at different weight by volume strength is required for different examinations.

Biliary contrast is used for visualization of the gallbladder and common bile duct. For operative or post-operative choledochography and for visualization of the biliary tree and pancreatic duct in Percutaneous Transhepatic Cholangiography (P.T.C) and in Endoscopic Retrograde Cholecysto Pancreatography (E.R.C.P) the iodinated conventional water soluble contrast media is used.

Intravascular radiological contrast agent : Iodine (Atomic weight -53).

Iodine is the only element that has proved to be safe for an intravascular radiological contrast agent.

In the contrast media iodine molecule gives the radio-opacity, the other elements in the molecule provide no radio-opacity but acts as a carrier of the iodine, increasing the solubility and reducing the toxicity of the molecule. To perform a 2 vessel or 3 vessel angiogram of brain or heart, 70-80 gm of iodine is required, delivered into

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arterial tree for about one hour. Probably this is the largest quantity of any drug, used intravascularly in clinical practices. Thus, highest quality of precaution and care is required for iodinated compounds, which is to be injected into the circulation.

All conventional ionic water soluble contrast media are hypertonic with high osmolalities of 1200 to 2000 mosmol/kg of water.

The very high osmolality is due to the non-radio opaque carrier ion i.e. cation (sodium or meglumine), which exert just as great as osmolar load, like that of iodinated anions. The cation serves no radiographic function, so a contrast medium with fewer cation or no cation would sound better.

Factors predisposing to adverse reactions :

1. Previous significant adverse reaction increases the risk of second serious reactions by 10 times.
2. History of allergy : cardiac disease, sickle cell anemia.
3. Phaeochromocytoma.
4. Myelomatosis.
5. Diabetes mellitus.
6. Neonates, infants, and elderly patients.

Cautions :

- i. Most complications of contrast agents are unpredictable.
- ii. The smallest dose, the lowest concentration, and the smallest number of injection, which will give reliable and comprehensive diagnostic results should be used.
- iii. A negative test dose or previous uneventful contrast examination do not ensure the safety of the present examination.
- iv. Radiologist or Radiographer should remain by the side of the patients for first 15 minutes following injections and an

emergency trolley with all facilities should be immediately available.

Both conventional high osmolar ionic contrast and the newer more expensive low osmolar contrast media are very safe drugs, but like all other drugs care should be taken in high risk patients. Intravenous Urography (IVU) probably does not justify the use of the more expensive low osmolar contrast media except in special cases. The total dose of contrast medium in healthy persons should not exceed 75 gm of iodine at any one procedure or in a single day. High price of the low osmolar contrast is restricting their use, though they are safer and more comfortable.

ADVERSE REACTIONS :

This can be described as -

Unknown aetiology : Acute anaphylaxis - occurring in a previously sensitized individual within minutes of administering a contrast medium. Manifestations are - bronchospasm, glottic oedema, circulatory collapse, abdominal cramps. The patient may die unless immediate resuscitation is taken.

Anaphylactoid reactions: Similar but occurs in a non-sensitized individual.

Chemotoxic effects: Conventional high osmolar contrast media e.g. diatrizoate and iothalamate dissociate into ions. The anions are probably not a major cause of contrast medium reactions but the cations are clinically toxic. Sodium cations are more toxic than meglumine to brain (increased incidence of unconsciousness in patients with an altered blood-brain barrier) and myocardium (increased incidence of arrhythmias).

Hyperosmolar effects: Osmolality of contrast agents is 5-8 times higher than plasma (300 mosmol/kg of water) osmolality.

Haemodynamic and systemic effects: Injection of a conventional contrast medium produces a significant, transient decrease in systemic arterial pressure, a decrease in peripheral vascular resistance, peripheral

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vasodilatation, tachycardia and an increase in pulmonary arterial pressure. This is accompanied by clinical perception of heat and with intra-arterial injections there is often pain. Low osmolar contrast media produce significantly less fluid shifts, change in measurable parameters, heat and pain.

Cardiac effects: There is a decrease in peak left ventricular systolic pressure, an increase in left ventricular end diastolic pressure, a biphasic decrease then increase in coronary blood flow, and bradycardia. low-osmolar contrast media have less effect on these parameters.

Red cell effects: Increasing concentrations of contrast media have an increasing sickling effect on red cells in sickle-cell anaemia. Low osmolar contrast media have a lesser effect.

Vascular endothelial damage: Contrast medium-induced thrombophlebitis is a particular complication of lower limb venography but its incidence is reduced fourfold when low-osmolar contrast media are used.

Central nervous system effects: Patients with cerebral tumours show an increased incidence of convulsions following enhancement for CT scans.

Pulmonary effects: Most patients suffer bronchospasm following administration of a contrast medium although this is not clinically apparent in the majority. It occurs more frequently in asthmatic and atopic individuals. The aetiology is uncertain but possible mechanisms include: direct histamine release from mast cells and platelets; cholinesterase inhibition; vagal overtone; complement activation; direct effect of contrast media on bronchi.

Renal effects: Impaired renal perfusion due to cardiotoxic effects; increased peripheral vasodilatation; renal vascular bed changes (increased blood flow followed by a more prolonged decrease); increased rigidity of red blood cells; pre-dehydration; osmotic diuresis. Glomerular injury and tubular injury : Due to Impaired perfusion; hyperosmolar effects; chemotoxic effects.

Obstructive nephropathy: Cytoplasmic vacuolation in tubules. Precipitation of Tamm-Horsfall protein; precipitation of Bence Jones protein in multiple myeloma.

COMPLICATIONS :

MINOR REACTIONS: Flushing, nausea, arm pain, pruritus, vomiting, headache, mild urticaria. These are usually mild, of short duration, self limiting and require no treatment. Reassurance and restoration of patient's confidence is enough. Incidence of minor reaction is 5% to 30% only.

INTERMEDIATE REACTIONS: More serious degree of above symptoms, with moderate degree of hypotension, bronchospasm. They respond to appropriate therapy-reassurance, chlorpheniramine for urticaria, 5 mg diazepam for anxiety, hydrocortisone 100 mg IV, salbutamol inhalation for bronchospasm. Incidence of moderate reaction is 0.5 to 2% but with non-ionic low osmolar contrast, it is still lesser.

SEVERE LIFE THREATENING REACTIONS: Severe manifestations of the above mentioned minor and moderate symptoms and in addition the following-convulsions, unconsciousness, laryngeal oedema, severe bronchospasm, cardiac arrhythmia, arrest, circulatory collapse.

MANAGEMENT OF COMPLICATIONS:

The airway to be secured. Oxygen, artificial respiration, cardiac massage, electrical DC defibrillators are to be administered as required. IV fluid infusion and drug therapy should be given.

IV furosemide for pulmonary oedema, IV diazepam for convulsions, adrenaline, hydrocortisone, aminophylline IV for anaphylactic symptoms can be used.

Vasopressors - Noradrenaline or dopamine infusion for hypotension. Sodium-bi-carbonate for correction of acidosis.

Adrenaline 0.5 ml, 1/1000 solution by deep subcutaneous injection, repeated at 20 min. interval provides the rapid and

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reliable relief for bronchospasm, angioneurotic oedema and other anaphylactoid symptoms.

Adrenaline - If given IV may precipitate ventricular fibrillation; but in very severe anaphylactoid reactions, even this route should be considered - 1:10,000 solution in 2 to 5 ml quantity IV very slowly preferably under ECG control.

Incidence of these life-threatening reactions is 0.1% in conventional contrast media and 0.02% in non-ionic contrast media.

Deaths: Above mentioned reactions may not respond to treatment and patient may die. Death may however be

immediate also. Death rate is 1 in 40,000 in conventional ionic contrast reactions and 1 in 100,000 in low osmolar contrast media.

Indications for the use of low-osmolar contrast media :

Those at high risk from the hyperosmolar effects : Infants and small children, those with renal and/or cardiac failure; poorly hydrated patients, patients with diabetes, myelomatosis or sickle-cell anaemia, patients who have had a previous severe anaphylactoid or allergic reaction to a conventional contrast medium or those with strong allergic history.

Dose of non-ionic low osmolar contrast medium - Iopamidol in common radiological examination :

Indications	Route of administration	Iodine in mg/ml	Volume in ml
Myelography	Subarachnoid	200-300	5 -15
Cerebral arteriography	Intra-arterial	300	Variable
Coronary arteriography	intracoronary	370	Variable
Thoracic and abdominal aortography	Intra-arterial	370	1.2 ml/kg
Peripheral arteriography	Intra-arterial	300-370	40-50
Selective abdominal arteriography	Intra-arterial	300-370	Variable
Venography	Intravenous	200-300	30-50
Urography	Intravenous	370	30-50
		Adults	2-4 ml/kg
		Children < 8 kg	1.5-2 ml/kg
		Children > 8 kg	
Arthrography	Intra-articular	300-370	Variable
CT scanning	Intravenous	300-370	0.5-2 ml/kg

BILIARY CONTRAST MEDIA

Like conventional urographic contrast media, biliary contrast media are also triiodobenzoic acid derivative. Iopanoic acid (Telepaque) was introduced in 1951.

Oral cholecystography: Now a days, this examination is not done as other modalities like ultrasonography & CT scan are preferred for biliary tree evaluation. Previously, it was routinely done to demonstrate suspected pathology in the gallbladder. The

examination would not be successful, if serum bilirubin is greater than 34 micromol/litre.

Dose: iopanoic acid (Telepaque) 500 mg, six tablets or sodium ipodate (Biloptin) 500 mg six capsules is the usual dose

Timing: Six tablets are to be taken about 14 hours before the X-ray examination and no food or drink is to be allowed during this 14 hours. After the first film when gallbladder is opacified, a fatty meal is given and X-ray taken after 45 minutes to see its contraction.

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Occasional adverse effects: mild gastro intestinal disturbance in 50% cases. Skin reactions: urticaria, pruritus. Impairment of renal function may happen, if there is co-existent liver impairment, dehydration and repeat dose or double dose of contrast medium is used

For doing cholecystography - 25% hypaque or equivalent is used by diluting the contrast.

Contrast media used in radiography of the Gastro intestinal tract :

Water soluble contrast media: gastrografin, gastroconray; Barium sulphate.

Indications of water soluble contrast media: suspected perforation; meconium ileus. To distinguish bowel from other structures on a computerized tomography scan

Complications: pulmonary oedema if aspirated; hypovolaemia due to hypertonicity of the contrast medium; allergic reactions due to absorbed contrast may occur.

BARIUM

Barium suspension is made up from pure barium sulphate. Barium carbonate is poisonous. The particles of barium must be small (0.1 to 3 micron) since this makes them more stable in suspension.

There are many varieties of barium suspension in use. In most situations the preparation may be diluted with water to give a lower density.

Examination of different parts of the gastrointestinal tract require barium preparations with different properties :

1. Barium swallow - require about 100 ml of barium of density 150% w/v.
2. Barium meal - require about 135 ml of barium of density 250% w/v.

A high density, low-viscosity barium is required for a double contrast barium meal to give a good thin coating that is still sufficiently dense to give satisfactory shadow.

3. Barium follow through require about 300 ml of barium of density 100% w/v.
4. Small bowel enema - require about 1000 ml. of diluted barium of density 100% w/v.

Barium enema - require about 500 ml of barium of density 125% w/v.

Complications :

Perforation : The escape of barium into the peritoneal cavity is extremely serious and will cause peritonitis. Mortality rate is about 50%. Of those who survive 30% will develop peritoneal adhesions and granulomata. So, water-soluble contrast media should be used in suspected perforation or in any investigation if there is any risk of perforation.

Aspiration : Barium if aspirated, is relatively harmless. Only treatment required is physiotherapy.

Contrast agents used in CT scan :

Already mentioned Iodinated contrast media both ionic and low osmolar non-ionic are used according to the clinical situation. However non-ionic low osmolar Iodinated contrast media are safer and preferable. Different amount of iodinated contrast is used in different CT examinations. Non ionic low osmolar iodinated contrast is preferred & can be safely used. Dose should not exceed 1 to 2 ml/kg body wt. of contrast having concentration of 300 to 370mg iodine/ml.

Contrast agents used in Magnetic Resonance Imaging (MRI) :

The following agents can be used for enhancement MR scanning (a) Gadopentetic (b) Gadodiamide

Ioversal is an iodinated non-ionic monomeric contrast medium that is used by injection in angiography and urography.

Indications: cranial and spinal Magnetic Resonance Imaging (MRI) in particular for the demonstration of tumors and for further differential diagnostic clarification in suspected meningioma, invasive tumors and metastases; for the demonstration of small and or isointense tumors; in

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suspected recurrence after surgery or radiotherapy; for the differentiated demonstration of rare neoplasms such as haemangioblastomas, ependymomas and small pituitary adenomas; for improved determination of the spread of tumors not of cerebral origin. Additionally in **spinal MR**: Differentiation of intra and extramedullary tumours : demonstration of solid tumor areas in known syrinx; determination of intramedullary tumor spread

Dose: patient is to fast of for two hours before the examination. In general the administration of 0.2 ml Magnevist/kg body weight is sufficient for good shadow and to answer the clinical question

Side effects: nausea and vomiting and also allergy-type dermal and mucosal reactions were occasionally observed after the administration of Magnevist. In very rare case anaphylactoid reactions, convulsions have been observed. Transient headache, vasodilatation, dizziness, chills and syncope have occasionally been reported.

Nephrogenic systemic fibrosis (NSF) is a relatively uncommon condition in which fibrous plaques develop in the dermis and, often, in deeper connective tissues. Reported cases have occurred almost exclusively in patients with severe renal disease, and almost all have been associated with prior use of gadolinium-containing MRI contrast agents. The disease is often disabling, no proven treatments exist, and it may contribute to patient demise

17.1 DRUGS USED IN CONTRAST MEDIA

IOVERSOL

Proprietary Preparation

Optiray 300^(l) (Tyco Healthcare) Inj.
350/100ml Tk.1946.00/100ml;
320/10ml778.00/30ml

BARIUM SULPHATE ^[ED]

Proprietary Preparations

Visugut (Sonear), Powder, Tk. 102.51/150 gm
Viewgut (Popular), Powder, Tk.200.75/150 gm

GADODIAMIDE

One mL contains Gadodiamide 287mg (0.5m Mol/mL)

Proprietary Preparation

Diascan (Techno), Inj., 28.7 gm/100 ml , Tk. 980.00/20 ml ; Tk. 495.00/10 ml; Tk. 260/5 ml
Gadoscan (Popular), Inj.,28.7 gm/100 ml, Tk. 995.00/10 ml; Tk. 595.00/10ml
Omniscan ^(l) (GE Healthcare),Inj.,28.7 gm/100 ml, Tk. 2313.48/10ml

GATOPENTOTIC ACID

Proprietary Preparation

Magnevist^(l) (Schering), IV Inj. 469 mg/ml

IODIXANOL

One mL contains IODIXANOL 652 mg equivalent to 320 mg iodine/mL; trometamol 1.2 mg; sodium calcium edetate 0.1 mg; calcium chloride 0.04 mg; sodium chloride 1.11 mg; hydrochloric acid q.s.; water for injection q.s. to 1mL

Proprietary Preparation

Visipaque 320^(l) (GE Healthcare), Injection
Tk.3,041.60/50ml bottle
Gadoscan (Popular) Inj. 0.5m Mol/ml Tk. 995.00/10ml

IOHEXOL

Each mL contains Iohexol 755 mg corresponding to 350 mg of iodine/mL; trometamol 1.2 mg; sodium calcium edetate 0.1 mg water for injection q.s. to 1mL.

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Proprietary Preparations

Diapack (*Techno*), Inj., 300mg, Tk. 300/10ml; Tk. 500/20ml; Tk. 650/30 ml; Tk. 850/50ml; Tk. 1,530/100ml; 350 mg, Tk. 360/10ml; Tk. 600/20ml; Tk. 970/50ml; Tk. 1,880/100ml
Imiro (*Popular*), Inj., 350 mg, Tk. 1000/50 ml, Tk. 19/100ml
Omnipaque[®] (*GE health care*) Inj., 350 mg, Tk. 1143.98/50 ml, Tk. 2176.86/100ml

IOPAMIDOL

One 100mL bottle contains: active component Iopamidol 75.53 gm corresponding to 370mg of iodine/mL. inactive component trometamol 100 mg; calcium disodium edentate (dehydrate) 41 mg; hydrochloric acid q.s. to pH 6.9-7.1; water for injection q.s. to 100mL

Proprietary Preparations

Amidol (*Incepta*), Inj., 300 mg/ml, Tk. 1,203.00/50ml; 370 mg/ml, Tk. 1,318.00/50 ml; Tk. 2,636.00/100 ml

Diapamiro (*Techno*), Inj., 300 mg/ml, Tk. 1,450.00/100 ml; Tk. 750.00/50 ml; 370 mg/ml, Tk. 1,650.00/100 ml; Tk. 850.00/50 ml
Lopamiro (*Popular*), Oral Powder, 300 mg/ml, Tk. 1203.00/50 ml, Tk. 2407.00/100 ml; 370 mg/ml, Tk. 1318
Lopidam (*Beximco*), Inj., 370 mg/ml, Tk. 1,318.50/50 ml ;300 mg/ml, Tk. 2,636/100 ml

IOTHALAMIC ACID + MEGLUMINE

Generic Preparations

Inj. iothalamic acid 45.6% + meglumine 8.4%;
Inj. iothalamic acid 67.59% + meglumine 8.4%;
Oral Sol 57.94%.

IOPANOIC ACID

Proprietary Preparation

Visugall (*Sonear*), Tab, 500 mg, Tk. 0.89/Tab.