



SPECIAL RADIOLOGICAL PROCEDURES

CONTRAST AGENTS IN IMAGING MAGNETIC RESONANCE

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Theoretical

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CONTRAST AGENTS IN IMAGING MAGNETIC RESONANCE



Historical Development

Contrast-enhanced MRI studies began in 1981 using ferric chloride in the gastrointestinal tract, followed by gadolinium in 1984 for diagnostic intravascular MRI, now used in approximately 25% of MRI examinations.



Mechanism Of Action

MRI contrast agents alter hydrogen ion properties in water and lipid, forming images by affecting protons relaxation rates within tissues. They shorten both T₁ and T₂ relaxation time

Types of MRI contrast media



- 1. Ferromagnetic contrast agents:** which retain magnetism even after removing the applied field, may cause particle aggregation and interfere with cell function, making them unsafe for clinical use.
- 2. Paramagnetic:** Gadolinium contrast agents are widely used in MRI contrast imaging due to their ability to shorten T1 relaxation time and increase signal intensity on T1 images.
- 3. Superparamagnetic particles,** like iron oxide, cause rapid proton dephasing, reducing T2 relaxation time and signal intensity on T2 images, providing gastrointestinal contrast preparations.

Gd agents are available in three forms



1. Extracellular fluid (ECF) agents—By far the most commonly used form of gadolinium. Includes:

- (a) Gd-diethylenetriaminepenta-acetic acid (DTPA), Gadopentetate dimeglumine (Magnevist)
- (b) Gd-DTPA-bismethylamide, Gadodiamide (Omniscan)
- (c) Gd-DO₃A, Gadoteridol (ProHance).

ECF agents, containing gadolinium ions and water molecules, are used for angiography but leak out into interstitial space, making them suitable for dynamic arterial studies.



2. Liver-agents : such as Gd-BOPTA, Gadobenate (Multihance), Gd-DTPA, and Gadoxetate disodium (Primovist), can be modified to improve the detection of liver lesions that do not contain hepatocytes, such as liver metastases, and characterize lesions that do take up contrast, such as hepatocellular carcinoma. These agents can also provide positive contrast imaging of the hepatobiliary system.

3. Blood pool agents: These bind reversibly to human albumin, forming large molecules with higher relaxivity and longer persistence in the vascular space than ECF agents, allowing a wider range of vascular imaging (e.g. Gadofosvesettrisodium; Vasovist).







Dose

For ECF gadolinium agents, usually 0.1 mmol kg^{-1} body weight; upto 0.2 mmol kg^{-1} when used in low-field magnets.

Adverse Reactions

Gadolinium contrast agents are very safe and well tolerated; they have a lower incidence of adverse reactions than iodinated contrast

Acute Adverse Reactions to Gadolinium



These are rare and are classified as:

1. **mild** - e.g. nausea, vomiting, headache, dizziness, shaking, altered taste, **itching**, rash, facial swelling
2. **moderate**- e.g. tachycardia or bradycardia, hypertension, generalized erythema, dyspnoea, bronchospasm, wheezing, mild hypotension
3. **severe** - e.g. laryngeal edema (severe or rapidly progressive), unresponsiveness, cardiopulmonary arrest, convulsions, **clinically** manifest cardiac arrhythmias



NOTE :

Patients with a history of adverse reactions to gadolinium contrast agents, asthma, allergies, or previous iodinated contrast reactions are at a higher risk of experiencing hypersensitivity reactions

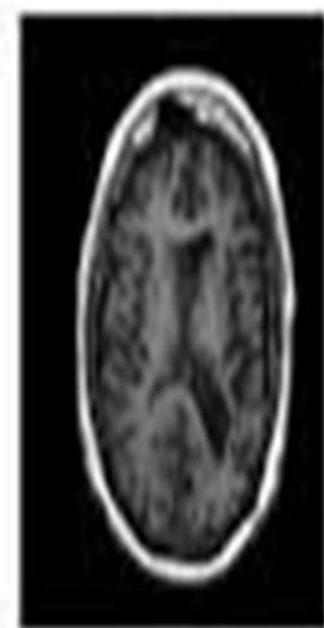
Delayed Adverse Reactions



1. Renal impairment Gadolinium contrast agents, when used at the standard doses, do not significantly affect renal function.

2. Nephrogenic systemic fibrosis (NSF) The disorder, first described in 2000, is characterized by increased collagen deposition, skin thickening, hardening, and contractures.

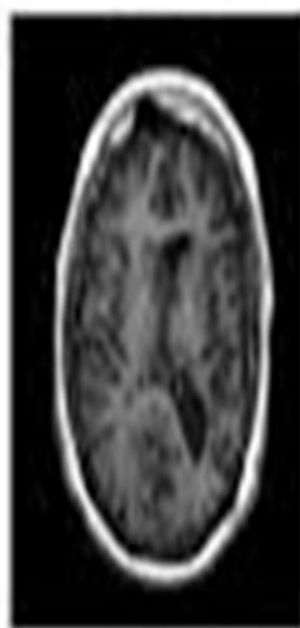
3. Nephrological stress disorder (NSF) is a common condition in patients with renal disease, with most being exposed to gadolinium-based contrast agents 2-3 months before the disease's onset



Pre-contrast MRI

Dosage = 0 mmol/kg

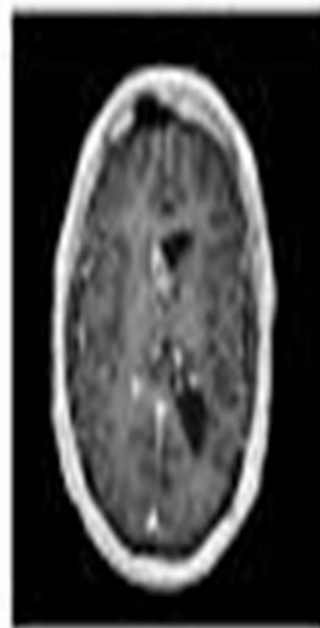
0.01mmol/kg



low-contrast enhanced MRI

Dosage = 0.01mmol/kg

0.09mmol/kg



full-contrast enhanced MRI

Dosage = 0.1mmol/kg
0.01mmol/kg+0.09mmol/kg

Methods Of Imaging The Gastrointestinal Tract



- 1- Plain film
- 2- Barium swallow
- 3- Barium meal
- 4- Barium follow-through
- 5- Barium enema
- 6- Ultrasound(US)(a) Transabdominal
(b)Endosonography
- 7- Computed tomography (CT)
- 8- Magnetic resonance imaging (MRI)
- 9- Angiography
- 10- Radionuclide imaging:



- (a) Inflammatory bowel disease
- (b) Gastro-esophageal reflux
- (c) Gastric emptying
- (d) Bile reflux study
- (e) Meckel's scan
- (f) Gastrointestinal bleeding

Water-soluble Contrast Agents



There are numerous water-soluble contrast agents available

Gastrografin and Gastromiro are commonly used contrast agents for diagnosing and treating bowel obstructions.

1. Gastrografin is a high osmolarity contrast agent used for CT colonography and diagnosing meconium ileus. It is diluted with water for rectal administration.

2. Gastromiro, a low osmolarity contrast agent containing iopamidol, is a more palatable option, but its taste is unpleasant.

Indications



- 1- Suspected perforation.
- 2- Meconium ileus.
- 3- To identify bowel lumen and communications with bowel lumen on CT
- 4- Low osmolar contrast media (LOCM) is advised if the patient is vulnerable to aspiration.



Advantages

- The main advantage of barium over water-soluble contrast agents is better coating resulting in better mucosal detail.
- Low cost.

Disadvantages

- Precludes accurate subsequent abdominal CT interpretation with potential delays of up to 2 weeks to allow satisfactory clearance of the barium.
- High morbidity associated with barium entering the peritoneal cavity.

Complication



1. Perforation. Water-soluble contrast medium is recommended for investigations involving perforation risk or suspicion. Barium leaks into the peritoneal cavity are rare but serious, causing pain and hypovolemic shock. Treatment involves resuscitation, surgery, and antibiotics. Mortality is around 50%.

2. Aspiration. Aspirated barium is harmless, but sequelae like pneumonitis and granuloma formation may occur. Physiotherapy is needed if patient cannot voluntarily clear barium before leaving hospital.

3. Intravasation. This very rare complication may result in a barium pulmonary embolus, which carries a mortality of 80%.

PHARMACOLOGICAL AGENTS



- **Hyoscine-N-Butylbromide (Buscopan)**

Adult dose

- 20mg i.v. may be repeated at 15min intervals up to a dose of 40mg in 1h.

- **Glucagon**

Adult dose

- 0.2–0.5mg i.v. over 1 min (or 1mg i.m.) for barium meal
- 0.5–0.75mg i.v. over 1 min (1.0–2.0 mg i.m.) for barium enema
- 1mg i.m. for CT or MRI small bowel imaging
- Bolus doses >1 mg administered may cause nausea and vomiting and are not recommended.

- **Metoclopramide (Maxolon)**

Adult dose

10–20mg oral OR 10mg i.m. OR 10mg by slow i.v. injection

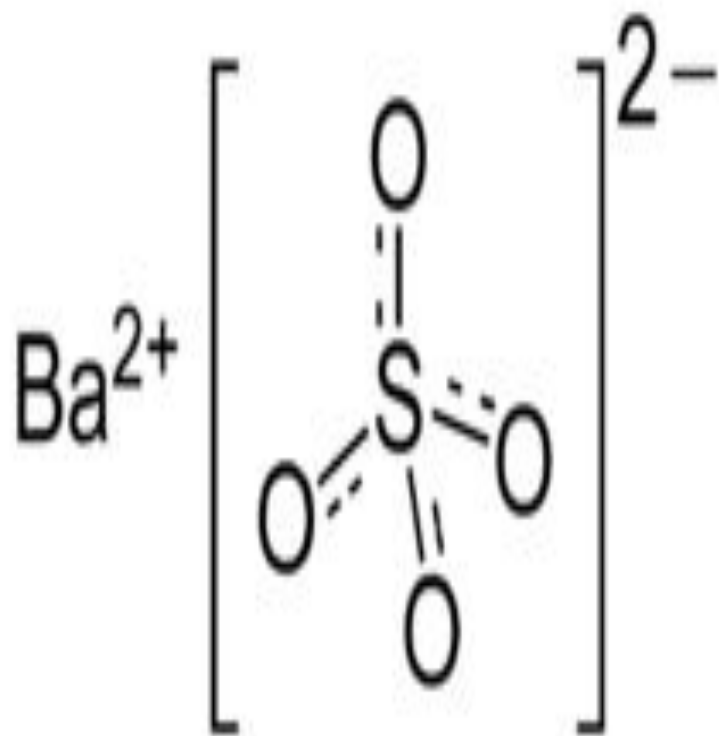
Barium sulfate

BaSO_4





Barium Sulphate





Thank
you

