CONTRAST RADIOGRAPHY IN HEAD AND NECK IMAGING

Contrast radiography is one of the most important adjunct procedures for imaging the oral and maxillofacial regions. Despite the advent of newer investigation techniques, it remains one of the most useful diagnostic tools1. Contrast radiography improves or allows the visualization of organs surrounded by tissues of the same radiographic opacity, thus providing information about the size, shape, and position of these structures and neighboring areas. It shows the internal structure of an organ, including its mucosal pattern, and may also occasionally help in assessing organ function2.

Contrast media (CM) enhance the quality of images, revolutionizing the radiologist’s ability to differentiate soft tissue densities. Ideally, CM should achieve a very high concentration in the tissues without producing any adverse effects.3

Artificial contrast can be produced in a variety of ways. Material with a high coefficient of absorption can be placed in or around the structure of interest. The use of artificially induced contrast has been helpful in allowing the evaluation of structures that would otherwise be radiographically invisible. The use of radiopaque agents is termed a positive contrast agent, whereas the use of gases (like air, oxygen, and carbon dioxide) is termed a negative contrast agent. When both are used concomitantly, it is known as ‘double contrast’. The contrast media that permit detailed visualization of the internal structure or organ that would not otherwise be demonstrable4.

**Definition:** It is defined as a radiopaque substance that has been developed to artificially, the density of different parts of the patient, thus altering the subject’s contrast4.

**Classification:**

Contrast agents are classified on the basis of their physical and chemical characteristics, including their chemical structure, osmolarity, iodine content, and ionization in solution. In clinical practice, categorization based on osmolarity is widely used.4, 5

**ACCORDING TO CHARR DH (1988)**

1. **Depending on their Nature of Material**

* Iodine Based
* Non-iodined based e.g barium sulphate

1. **Depending on the Solvent**

* Conventional ionic water soluble
* Oil soluble

1. **Depending on the Ionic Nature**

* Acidic monomer e.g diatrizoate, iothalamate
* Non-ionic monomer e.g iopamidol, iohexol, ioversol mono- acidic dimer
* Non-ionic dimer e.g iodixanol, iorrol4

**ACCORDING TO WHAIRESE (1996)**

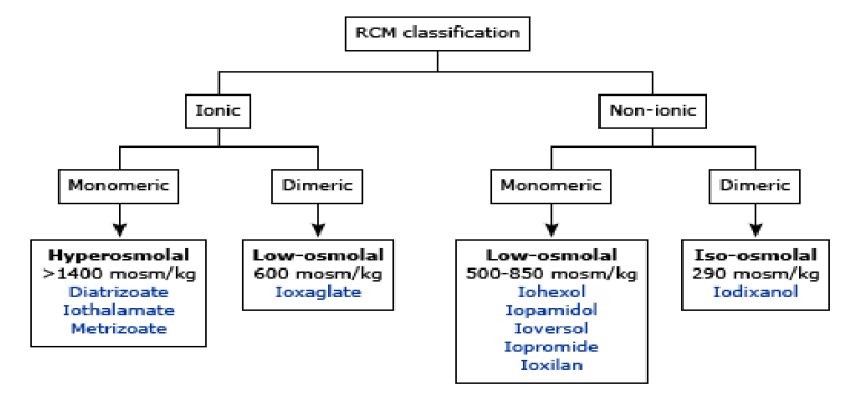
1. **Iodine based aqueous solution**

* Ionic monomer e.g iothalamate (Conray), Metrizoate ( Isopaque), diatrizoate (Urografin)
* Ionicdimmers, e.g ioxaglate (Hexabrix)
* Non-ionic monomer e.g iopamidol ( Niopan) , ioxhexol (Omnipaque), iopromide(Ultravist)

1. **Iodine based oil solution:** For example ethidol, pantopaque& lipiodol4

**ACCORDING TO THEIR PROPERTIES**

The radio contrast medium currently in used are based upon fully situated benzoic acid molecules with their atoms of iodine replacing the hydrogen atom at position 2,3 & 6 rings of benzoic ring, the different agents can be classified according to their properties5:-



**General property of contrast media**

1. **Viscosity:-**

The viscosity of the fluid is assessed by measuring its rate of flow through a standard thin capillary tube under standard conditions of pressure and temperature.

It helps determine or refers to the thickness of a fluid. Radiologically, viscosity can be explained as the amount of force needed to inject the contrast agent through a needle or catheter into a patient. The More viscous agent, more difficulty in injecting it.

1. **Osmolality:**

It refers to a process in which a solution of higher concentration draws water from a solution of lower concentration.

The sensations of heat and discomfort, or even pain, experienced by the patient are directly related to the osmolality of the contrast medium.4, 6, 7

1. **Chemotoxicity:**  Is defined as the mechanism responsible for causing the toxic effects of the contrast media. (e.g. osmolality, electrical charge)

There are a number of properties of contrast medium that are related to chemotoxicity, e.g.8

|  |  |
| --- | --- |
| Hydrophilicity | Aqueous in nature. |
| Lipophilicity | Fat, like (lipid) organic in nature. |
| Protein binding | It is a contrast medium that binds to plasma proteins in the blood stream. |
| Histamine release | It is a character of allergic reactions and the property of contrast medium to release histamine from mast cells may be responsible for the allergy like reaction with some contrast media. |

**IDEAL PROPERTIES OF CONTRAST AGENTS**

1. **Safe:** Contrast media should be safe to use and handle.
2. **Non - toxic:** They should be non-toxic and have no adverse reactions.
3. **Should not cross the blood-brain barrier:** It should not cross the cell membrane or penetrate the cells or the blood-brain barrier. Their transfer is to the breast milk, and placental passage should be limited.
4. **Similar physiologic properties when compared to blood, and saliva:** Their physiologic properties should be similar to the body fluids they come in contact with, e.g., saliva and blood, etc. should be miscible with saliva (body fluid).
5. **Inertness:** It should have pharmacologic inertness (local and systemic).
6. **Opacification:** It should produce satisfactory opacification.
7. **Low surface tension:** It should have low surface tension and low viscosity to allow the filling of fine components.
8. **Easy injectability:** It should be easy to inject with excellent x-ray absorption characteristics at the x-ray energies used in diagnostic radiology.
9. It should have minimum toxicity, chemical stability, and be acceptable to the patient with no carcinogenic effects.
10. **Elimination:** Elimination should be easy, but the elimination time should be such that it provides adequate time for satisfactory radiography.
11. **Residual contrast media:** The residual contrast media should beabsorbed by the body and detoxified by the liver or kidneys. They should not have any residual side effects.4,6

**APPLICATION OF CONTRAST AGENTS IN ORAL RADIOLOGY**

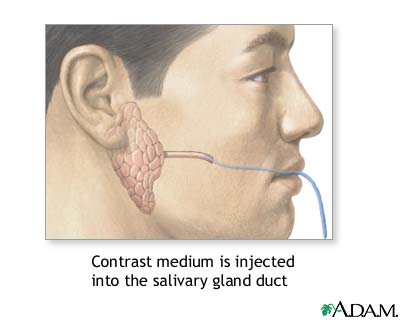
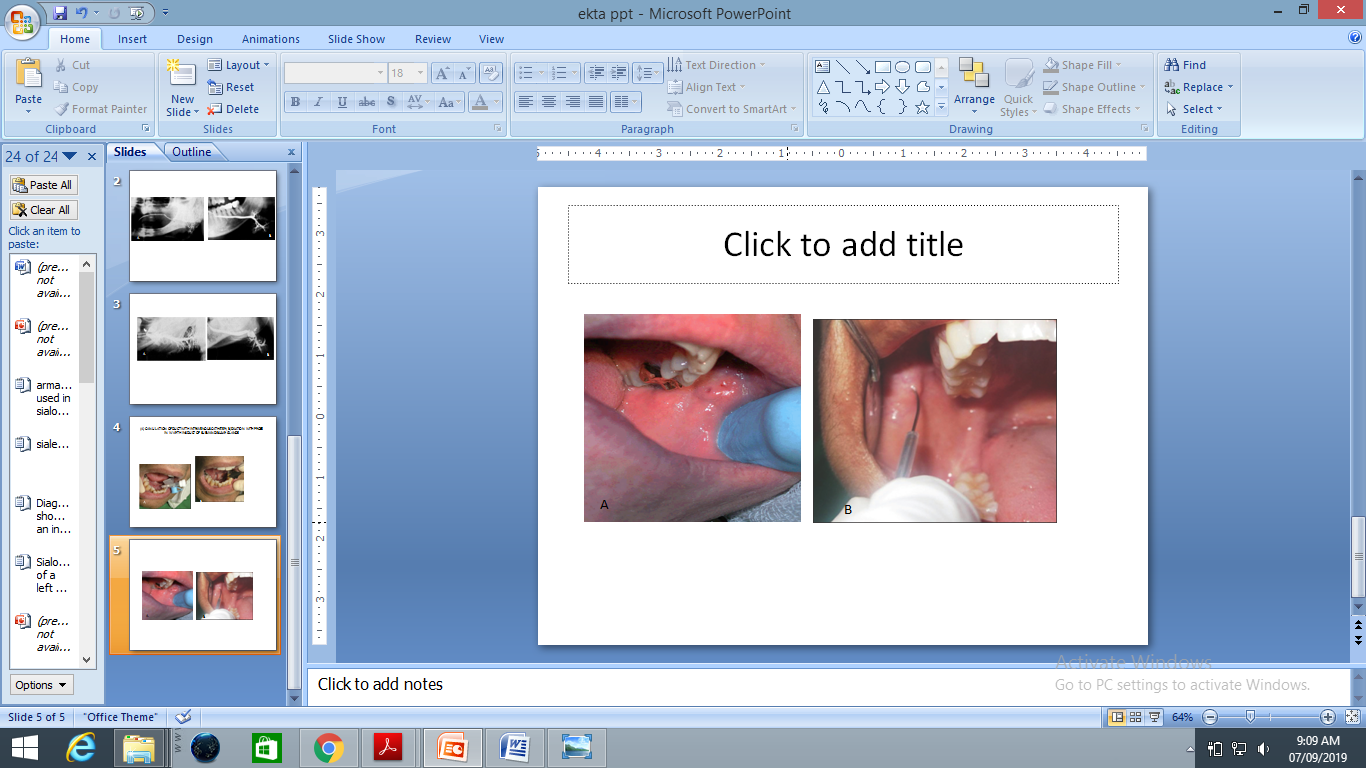
* Contrast media in Sialography
* Contrast media in Arthrography
* Contrast media in Lymphangiography
* Contrast media in Ultrasound Imaging
* Contrast media in Computed Tomography
* Contrast media in Magnetic Resonance Imaging
* Contrast media in Angiography

**SIALOGRAPHY:**  Sialography is a radiographic technique, in which a radiopaque contrast agent is infused into the ductal system of a salivary gland prior to imaging with plain films,

Fluoroscopy, panoramic radiography, tomography, or computed tomography (CT). Sialography provides a straightforward demonstration of the ductal system.

It is a useful diagnostic adjunct to reveal the location and integrity of the salivary gland, thus indicating the presence of disease that changes internal architecture.9, 10

**Technique for introducing the contrast media:**The three main techniques available for introducing thecontrast medium into the ductal system, having cannulated the relevant duct orifice, can be summarized as follows:



**Insertion of a cannulated probe into the stensen’s duct, showing contrast media is injected into the salivary gland.**

1. **Simple injection technique:**Oil-based or aqueous contrast medium is introduced usinggentle hand pressure until the patient experiences tightness ordiscomfort in the gland (about 0.7 ml for the parotid gland,0.5 ml for the submandibular gland).

**Advantages**

* Simple
* Inexpensive.

**Disadvantage**

* The arbitrary pressure that is applied may cause damage to the gland.
* The patient's responses may lead to underfilling or overfilling of the gland.11,12,13

1. **Hydrostatic technique:** Aqueous contrast media are allowed to flow freely into the gland under the force of gravity until the patient experiences discomfort.

**Advantages**

* The controlled introduction of contrast medium is less likely to cause damage or give an artifactual picture
* Simple
* Inexpensive.

**Disadvantages**

* Irritation of tissue
* Sometimes it may be painful11,12,13

1. **Continuous infusion pressure-monitored technique:** Using aqueous contrast medium, a constant flow rate is adopted and the ductal pressure is monitored throughout the procedure.

**Advantages**

* The controlled introduction of contrast media at known pressures is not likely to cause damage.
* Does not cause overfilling of the gland.
* Does not rely on the patient's responses.

**Disadvantages**

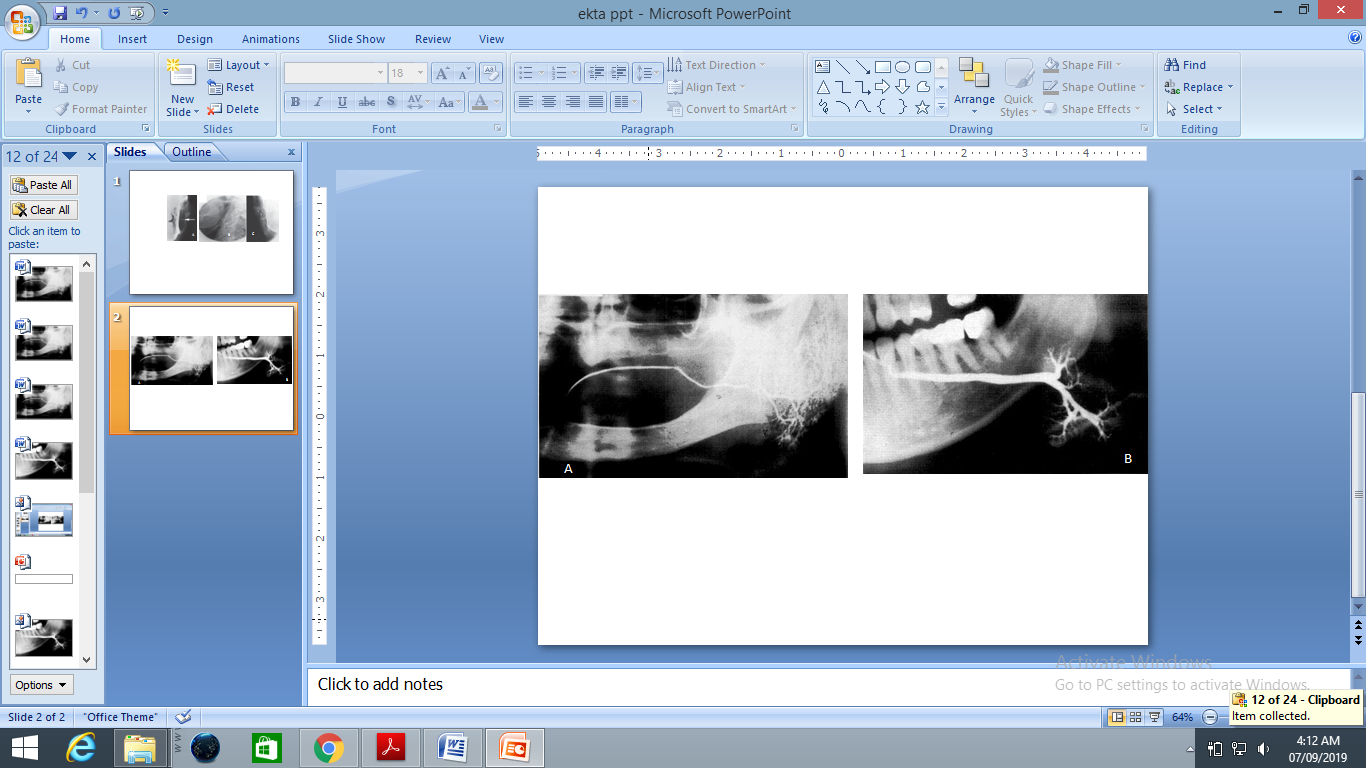
* Complex equipment is required
* Time consuming11,12,13

**Phases of sialography**

The procedure is divided into three phases:

* **Ductal phase:** It begins with the injection of the contrast medium and terminates when the parenchyma becomes hazy.
* **Acinar phase:** It begins with the competition of the ductal opacification and ends when there is a generalized increase in the density of the gland. The phase is of great importance in the pre CT ear, when sialography is indented to demonstrate the presence of intraglandular and extra glandular masses.
* **Evacuation phases:** It provides an estimate of the secretory function of the salivary gland. After the sialography view is taken, the catheter should be removed from the duct orifice. The patient is instructed to chew gum or suck on lemon or other sialagogue, like the 1% solution of citric acid given, and then ask to rinse. This will stimulate any glandular function and cause execration of dye. Normal salivary gland execrate 100 % dye contrast within 5 minutes after removal of the catheter.11,12,13,14

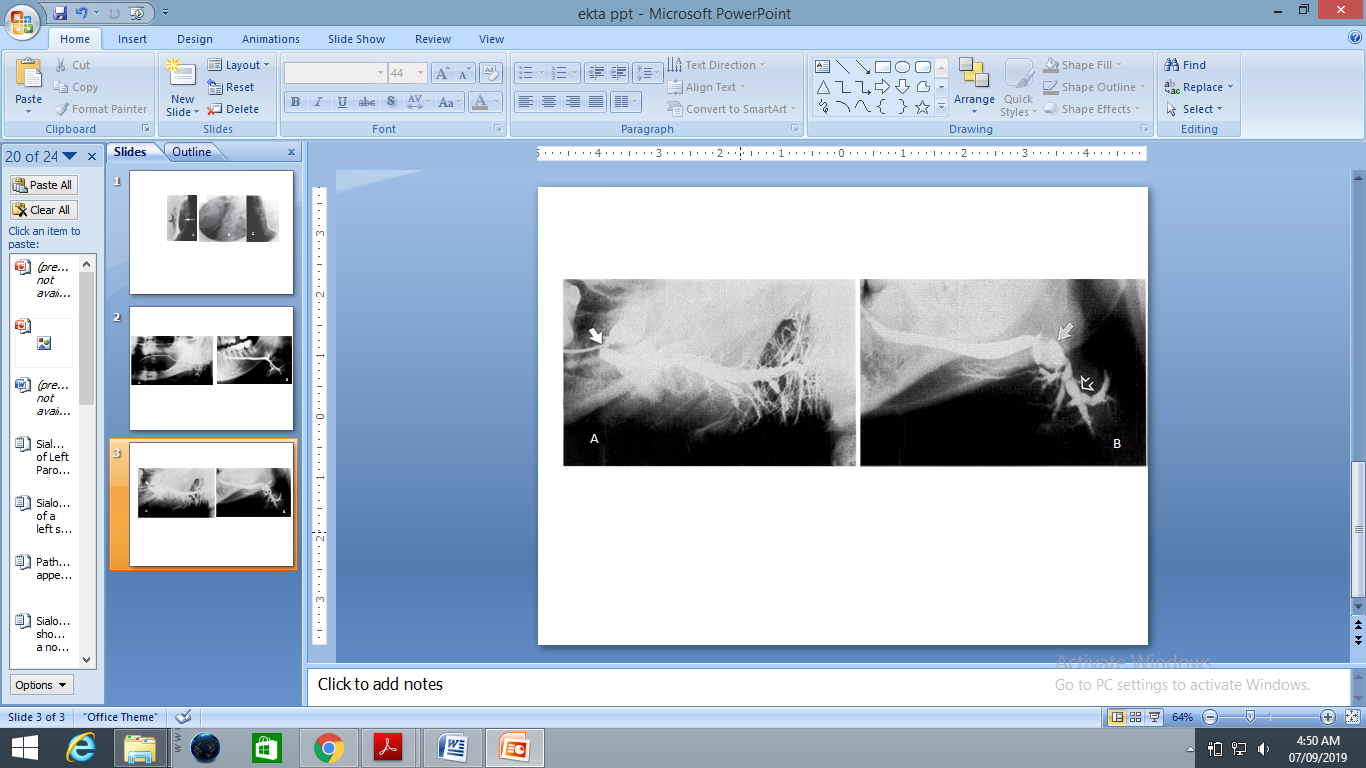
**Normal sialography: for the parotid gland: 11, 12, 13**

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**Sialograph showing a normal left parotid gland, the tree in winter appearance**

**Pathological appearances:**

There is also irregular salivary duct stricture (narrowing) of the duct, which creates an appearance known as the **"sausage link"** pattern on a sialogram, Suggestions of abscesses and autoimmune diseases such as Sjögren syndrome can also be elicited.5, 10,11,12,13,14,15,16

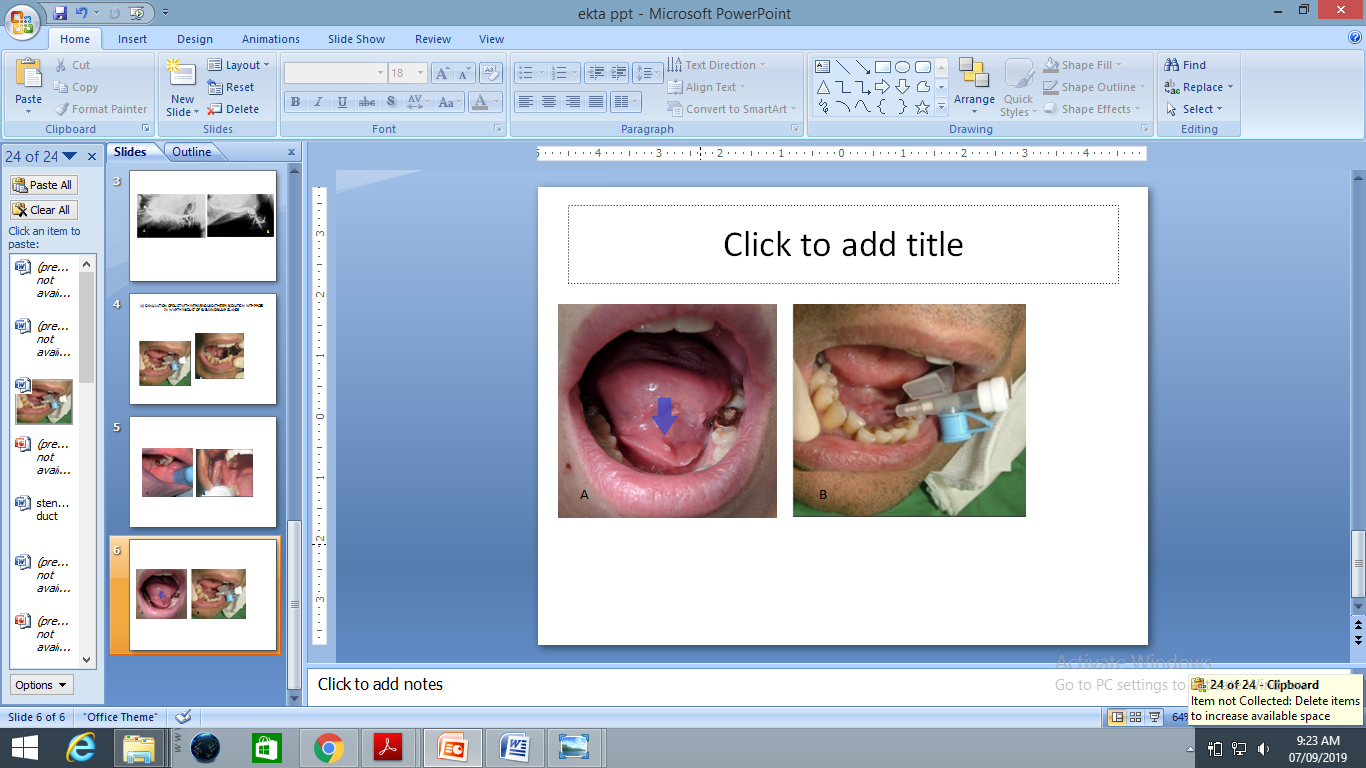


**Fig: Sialograph of a left parotid showing gross dilatation of the main duct caused by Sialodochitis secondary to stenosis at the orifice (arrowed).**

Sialadenitis is inflammation of the salivary glands, which may cause acinar atrophy and create an appearance known as **"pruning of the tree"** on a sialogram, where there are less branches visible from the duct system. A space occupying lesion that occurs within or adjacent to a salivary gland can displace the normal anatomy of the gland. This may create an appearance known as **"ball in hand"** on a sialogram, where the ducts are curved around the mass of the lesion.10, 11, 12, 13,14,15,16

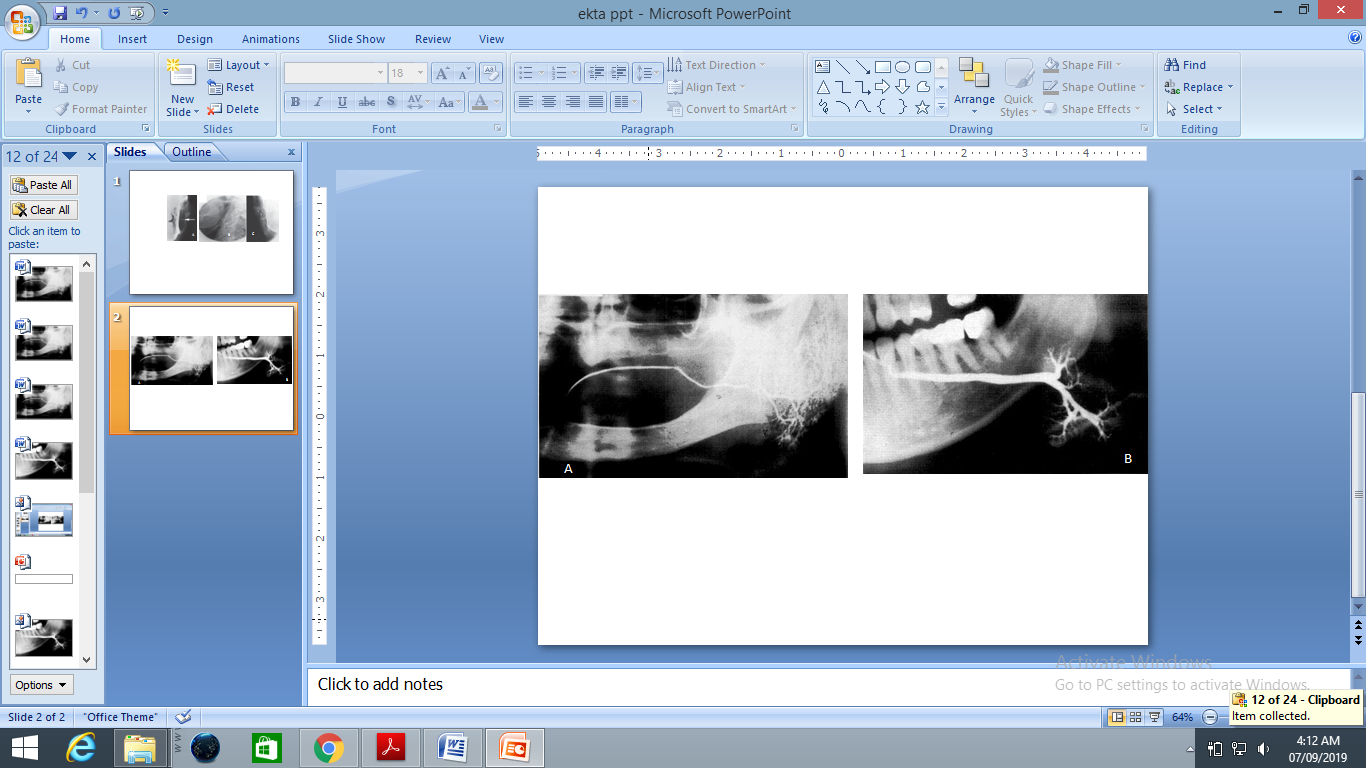
* **For the submandibular gland:** After the appropriate orifice has been identified, the duct can be explored with the lacrimal probe, and the probe should pass through the length of the floor of the mouth to the level of the posterior border of the mylohyoid muscle, a penetration of about 5 cm.
* Because of the tortuous course of the parotid duct, the cheek has to be turned outward before the probe is inserted into the duct. The aversion of the cheek will help to reduce the possibility of penetrating the duct at one of the sharp angles in its course.
* The probe should slide easily back and forth and also rotate freely without dragging.

Appropriate volumes of dye required vary from 0.0 to 0.75 ml for submandibular glands11



**Figure:** (A) Blue arrow the clinical picture of the submandibular duct orifice is situated on the summit of the small papilla at the side of the lingual frenum. (B) Insertion of a cannulated probe into the warthins duct

**Submandibular gland:** The main duct of even diameter (3-4mm wide) and should be filled completely and uniformly. This gland is small than the parotid but overall appearance is similar with branching duct structure tapering gradually towards the periphery that so called as a **bush in winter appearance.** 11, 12, 13

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**Figure: Sialograph is showing a normal left submandibular gland, the bush in winter appearance*.***

**Advantage of sialography**

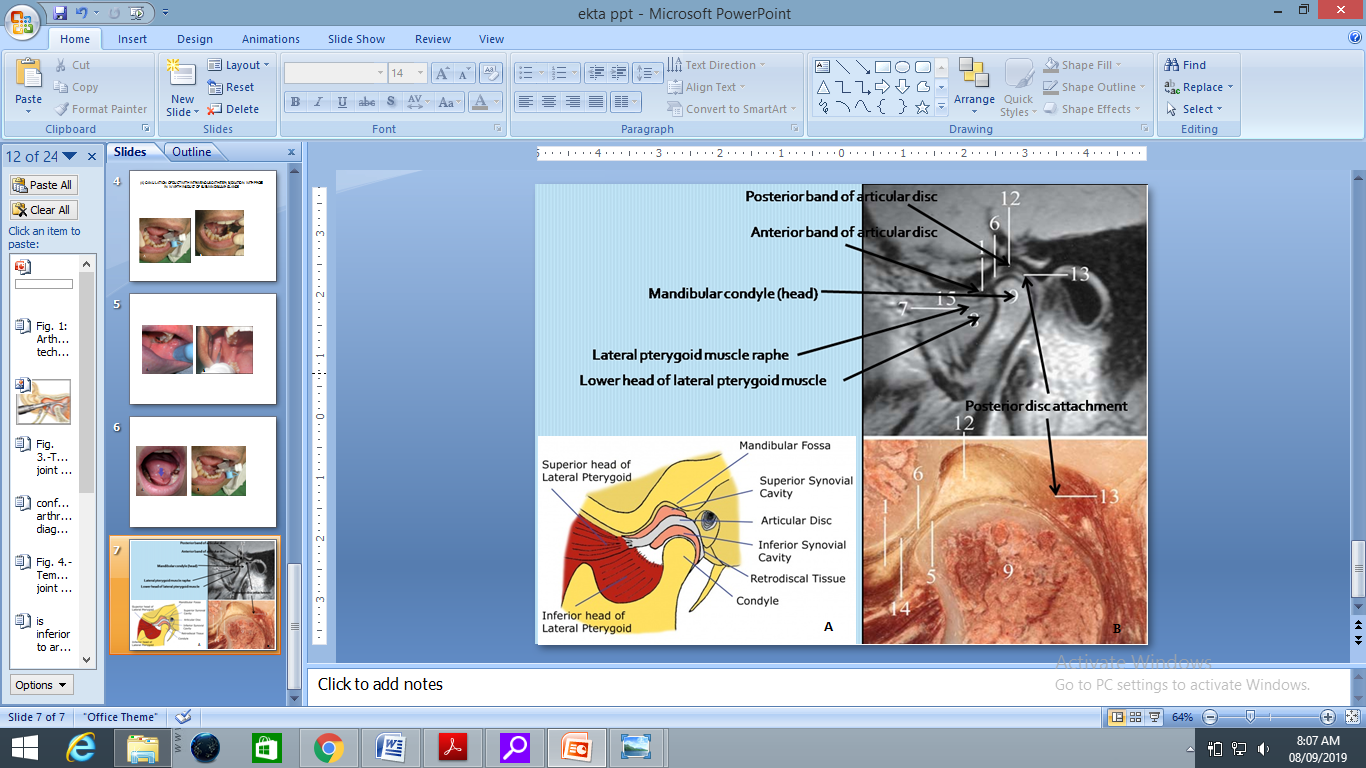
1. High resolution of ductal system
2. Controlled localized radiation dose
3. Much existing information on appearance of a specific dieses state (detection of radiolucent sialolith, duct strictures or derverticuls)11,12,13

**Disadvantage of sialography**

1. Painful on injection ,difficult to perform
2. Allergy to iodine
3. Difficult to interpret with precision
4. Extravasations into adjacent tissue causing irritation or necrosis
5. Single gland is examine at time
6. Difficult to obtain histological evidence to substantiate the sialographic interpretation.11,12,13

**ARTHROGRAPHY**

Arthrography involves the injection of a radiopaque contrast material into the joint spaces. The space occupied by the disc can then be visualized as lying between the layers of contrast material17.



**Arthrography technique**

**TYPES OF ARTHROGRAPHY**

1. Single contrast arthrography: Injection of a contrast agent into the lower TMJ space is referred to as lower joint space or single contrast arthrography. However, when we see the contrast material in the upper TMJ space without injecting in that space, we can suspect damage to the articular disc.11
2. Double contrast radiography: When the contrast agent is injected into both the upper and lower TMJ spaces, it is called double contrast arthrography. This further

helps in getting a clear picture of the outline of the articular disc. Opacification of both joint spaces following injection of only one denotes a pathological condition11.

**ADVANTAGES**

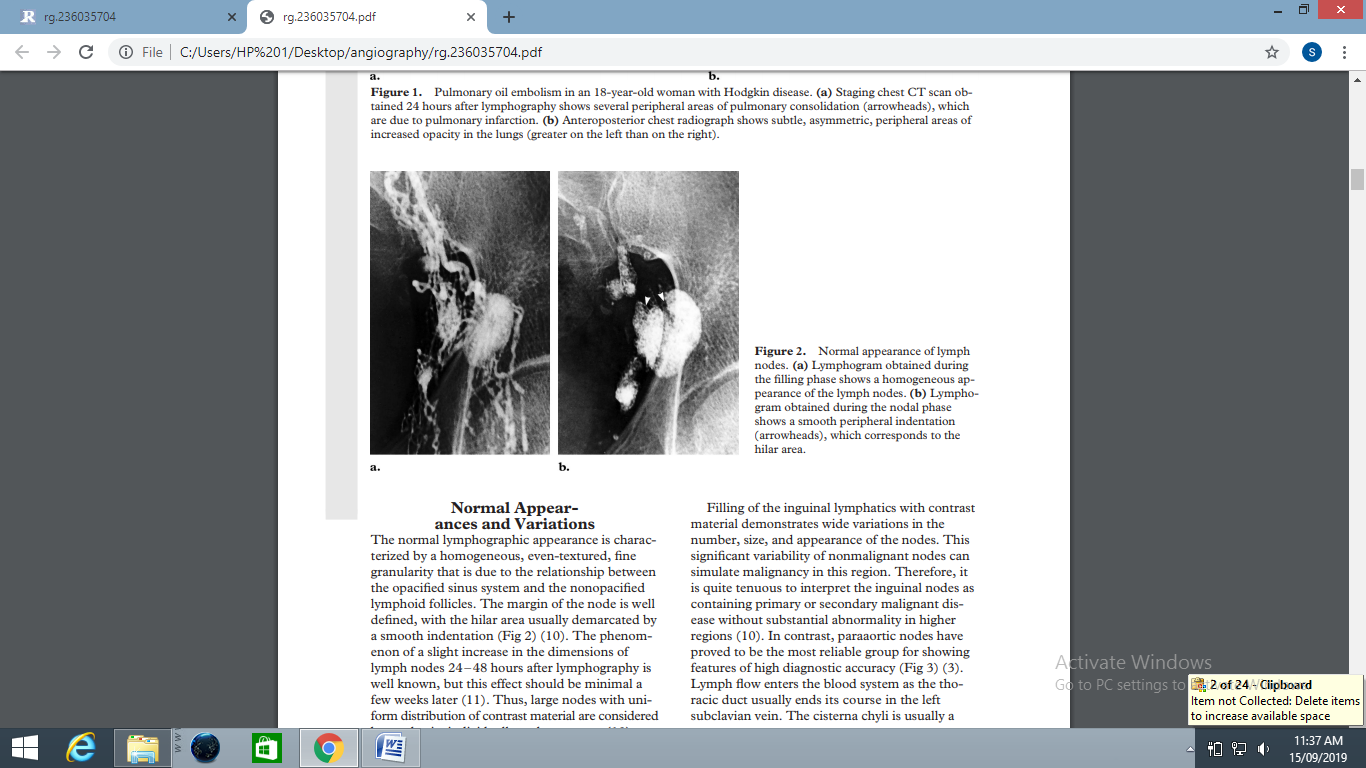
1. Arthrography provides information regarding the soft tissue components, specifically the shape and position of the articular disc.
2. Arthrography is indicated for an evaluation of the soft-tissue components of the TMJ.
3. More is accurate for anterior displacements of the disc, but relatively insensitive for medial and lateral displacements.
4. Arthrography assures a correct pre-operative diagnosis of loose bodies (joint mice).
5. An arthrogram can clearly distinguish the synovial changes of inflammatory arthritis from an internal derangement resulting from meniscal dysfunction.
6. The shape and position of the disc are appreciable, which can be enhanced with tomography.
7. Internal derangements and inflammation can be distinguished by an arthrogram.18

**Limitations and Disadvantages**

1. Severely deformed discs are excluded from this procedure.
2. Painful procedure.
3. Medial or Lateral articular disc displacements pose a challenge during interpretation.
4. Strict asepsis has to be maintained.
5. The capsule may rupture if too much contrast media is injected.
6. Contraindicated in acute joint infection.11

**Lymphangiography**

Lymphangiography (LG) is a valuable tool for the radiographic examination of the lymphatic system following the injection of contrast medium. It has a cornerstone role in the diagnosis and management of lymphatic circulatory disorders. Conventional lymphography has been considered the standard of reference for diagnosing pathologic conditions of the lymph nodes and lymphatics.19



Normal appearance of lymph nodes (a) Lymphogram obtained during the filling phase shows a homogeneous appearance of the lymph nodes. (b) Lymphogram obtained during the nodal phase shows a smooth peripheral indentation (arrowheads), which corresponds to the hilar area.

**Contrast medium used:**

* Oil-based contrast medium, e.g.,Llipiodol Ultra fluid, is used.
* Water soluble contrast media is used to demonstrate the distal lymphatic vessels, but because it diffuses so rapidly into the circulation, it cannot demonstrate the lymphnode.20

**Ultrasonography (US)**

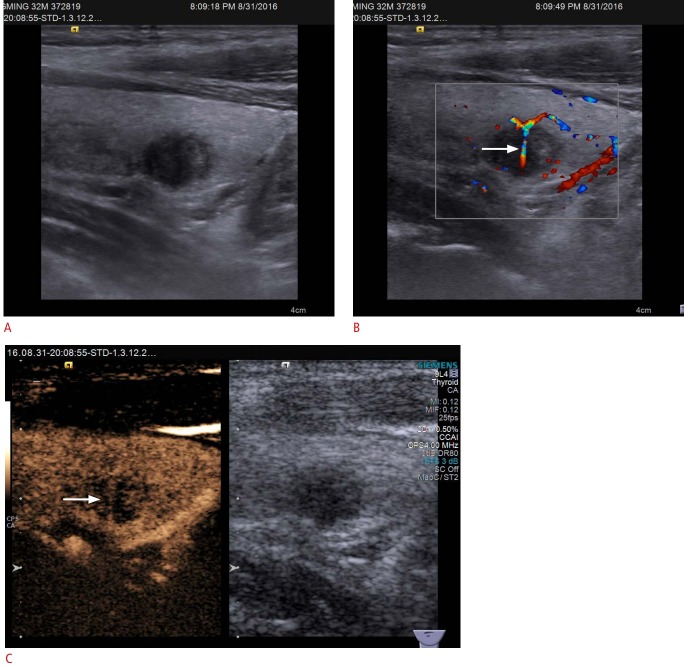
Contrast agents have their scope not only in radiology but also in ultrasonography. Ultrasonography contrast lacked substances to be administered to patients to improve or increase the diagnostic yield, which is very peculiar considering that contrast agents have long been used with all the other imaging techniques.21

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**An investigation with a USG machine in head and neck region**

# List of ultrasound contrast agents

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Shell composition | Gas | Manufacturer |
| AI-700 | Polymer | Perfluorocarbon | Acusphere |
| Biosphere | Gelatin/polymer | Air | Point Biomedica |
| BR14 | Phospholipid | Perfluorobutane | Bracco Diagnostics |
| BY 963 | Lipid | Air | Byk-Gulden |
| Levovist | Galactose/palmitic acid | Air | Schering |
| Definity | Lipid | Perfluoropropane | Bristol-Myers Squibb |
| Imagent | Surfactant | Perfluorocarbon | Imcor Pharmaceuticals |
| Optison | Albumin | Perfluoropropane | GE Healthcare |
| Sonazoid | Lipid | Perfluorobutane | GE Healthcare |



**Figure: -** Conventional ultrasonography (US) and contrast-enhanced ultrasound (CEUS) imaging of papillary thyroid carcinoma in a 32-year-old man. (A) Gray-scale US shows a

hypoechoic solid nodule in the right thyroid lobe with a poorly defined margin, assessed as thyroid imaging. (B) Color Doppler US shows branching vessels (arrows) within the mass. C. CEUS shows hypoenhancement with penetrating vessels (arrow) in the mass.

**Computed Tomography**

**Contrast agent used in CT: -** Iodine based dye, barium solution CT allows organs and

Structures to be seen easily.The most widely used material is 30mg of iodine for an average

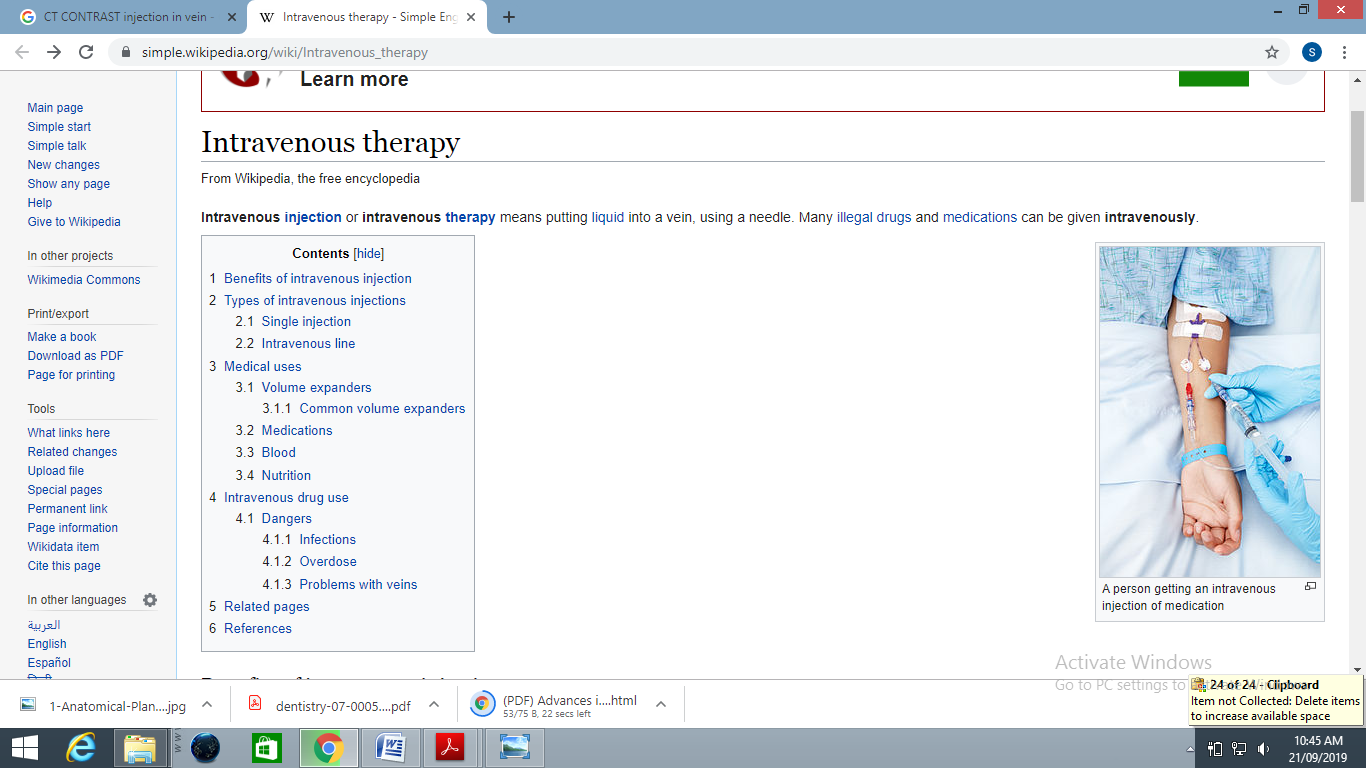
built adult, which can be scanned 5-15 minutes later**.**

Contrast can be administered via IV by injecting or taken orally. The Patient is usually

Instructed not to eat or drink for a few hours prior to injection of the contrast media.

because dye may cause stomach upset. Patients are made to drink an oral contrast solution

1-2 hours before the CT scan.4



**Figure: A person getting an intravenous injection of contrast media**

**Indications of contrast CT:**

1. Investigations of intracranial diseases, including tumors, hemorrhage, hypervascular lesions, and infarcts.
2. Investigations of suspected intracranial and spinal cord damage following trauma to the head and neck.
3. Investigation of the TMJ.
4. Preoperative assessment of maxillary alveolar bone height and thickness before inserting implants.
5. Assessment of fractures involving:
   * The orbits and nasoethmoidal complex.
   * The cranial base.
   * The odontoid peg.
   * The cervical spine
6. Investigations of tumors and tumor like discrete swellings intrinsic and extrinsic to the salivary glands. 22,23

**Contraindication-**

* Pregnancy
* History of an allergic contrast agent
* Hyperthyroidism
* Impaired renal function4

**Magnetic Resonance Imaging (MRI)**

It is one of the non-invasive imaging modalities that use electric signals generated from

Response of hydrogen nuclei to a strong magnetic field and a radio wave/RF pulse to produce

An image to allow specialists to explore inner working of human body, to detect and define the

difference between healing and diseased tissue without the use of x –ray.4

**Contrast- enhanced dental MRI:** Contrast agents are pharmaceuticals that increase

the information content of diagnostic images. They serve to improve the sensitivity and

Specificity of diagnostic images by altering the intrinsic properties of tissues, which influence

the fundamental mechanisms of contrast. Strategic localization of the agent can be done

regionally change the tissue properties and result in preferential enhancement.

Magnetic Resonance Imaging (MRI) contrast agents are widely used to increase the contrast

difference between normal and abnormal tissues.24

**MRI contrast agent use:**

* MRI contrast agents have been approved for clinical use in the United States since 1994.
* Six more MRI contrast agents were approved by the FDA for clinical use from 1995 through 2017: gadopentetate dimeglumine (gadolinium diethylene triamine pentaacetic acid (Gd-DTPA), gadodiamide (gadolinium diethylene triamine pentaacetic acid bis-methylamide (GD-DTPA-BMA), Gadoteridol (Gadolinium-1,4,7- tris (carboxymethyl)-10-(2' hydroxypropyl)-1,4,7 -10-tetraazacyclododecane (Gd-HPD03A]), gadoterate meglumine (gadolinium-tetraazacyclododecane tetraacetic acid (Gd-DOTA)25

**Indication:-**

* For the diagnosis and evaluation of benign and malignant tumors of the jaws.
* Soft tissue tumors and carcinomas.
* In surgery of the parotid gland, MRI can detect the cause of the facial nerve within the glandular tissue and help lessen the likelihood of post-operative facial nerve palsy.
* For the assessment of intracranial lesions involving particular posterior cranial fossas, the pituitary, and the spinal cord.
* For non-invasive evaluation of the integrity and position of the articular disk in the TMJ.
* Investigation of the TMJ to show both the bony and soft tissue components of the joint, including disc position.4,26

**Contraindications of contrast MRI:**

1. Patients with chronic, severe kidney disease (GFR < 30 mL/min/1.73m2 ) or acute kidney injury.
2. Pregnant and lactating women.4,26

**ANGIOGRAPHY**

The word itself comes from the Greek words angeion, "vessel", and graphein, "to write" or "record". The film or image of the blood vessels is called an angiograph, or more commonly, an angiogram. The word can describe both an arteriogram and a venogram.27

It is used to visualize the inside, or [lumen](https://en.wikipedia.org/wiki/Lumen_(anatomy)), of blood vessels and organs of the body, with particular interest in the [arteries](https://en.wikipedia.org/wiki/Artery), [veins](https://en.wikipedia.org/wiki/Vein), and  [heart chambers](https://en.wikipedia.org/wiki/Heart_chamber). This is traditionally done by injecting a radio-opaque [contrast agent](https://en.wikipedia.org/wiki/Radiocontrast) into the blood vessel and imaging it using [X-ray](https://en.wikipedia.org/wiki/X-ray) based techniques such as [fluoroscopy](https://en.wikipedia.org/wiki/Fluoroscopy).28



**Figure** (a) Pre-embolization right ECA angiogram shows intense vascularity in the temporal bone region suggestive of hemangioma, (band C) intra-operative frontal and lateral fluoroscopy images showing the embolization glue cast within the hemangioma.

(d) Post-embolization right ECA angiogram showing reduction in vascularity of the lesion.

**Side effects and management of contrast agents**

**MILD SIDE EFFECT:** Altered taste, cough, headache, nausea, vomiting, sweats, anxiety, dizziness, itching, and pallor, swelling of the eye & face, chills, flushing, nasal stuffiness, rash, hives, warmth.

**MODERATE SIDE EFFECT:** Bronchospasm, wheezing, hypertension, mild hypotension, dyspnea, laryngeal edema, tachycardia, bradycardia, generalized or diffuse erythema.

**SEVER SIDE EFFECT:** Cardiopulmonary Arrest convulsions, profund hypotension, clinically manifest arrhythmias laryngeal edema (severe or rapidly progressing)

Unresponsiveness.4, 29

**Management of adverse reaction:4, 29, 30**

|  |  |  |
| --- | --- | --- |
| **Detailed management and treatment of adverse reactions to Contrast agents (table 6)** | | |
| Symptom | Notes | Treatment |
| Urticaria | Monitor; most improve. If symptomatic,consider treatment. | 1. Diphenhydramine: 1 mg/kg (max ¼ 50 mg) PO/IM/IV (if IV dose, administer slowly over 1-2 minutes) 2. Epinephrine: IM 0.3-0.5 mL of 1:1000   OR   1. EpiPen: IM 0.3 mL of 1:1000 Pediatric dosing of epinephrine: 0.01 mg/kg IM |
| Facial/laryngeal oedema | -In severe; call emergency medical team  -If severely hypotensive, IV epinephrine preferred | 1. Oxygen by face mask 6-10 L/min 2. Epinephrine: IM 0.3-0.5 mL of 1:1000; can repeat every 5-10 minutes up to 1 mg total   OR   1. EpiPen: IM 0.3 mL of 1:1000; can repeat every 5-10 minutes up to 3, if required Pediatric dosing of epinephrine: 0.01 mg/kg IM   OR   1. (if severely hypotensive) Epinephrine: IV 1-3 mL of 1:10,000 given slowly over 2-3 min; repeat 1 mg dose as needed |
| Bronchospasm | * Continuously   Monitor. If progressively worse, consider adding additional treatment.   * IV epinephrine preferential for severe reactions, * if severely hypotensive - Call emergency medical team | 1. Oxygen by face mask 6-10 L/min 2. Beta-agonist (Albuterol?) inhaler: 180 mcg 3. Epinephrine: IM 0.3-0.5 mL of 1:1000; can repeat every 5-10 minutes up to 1 mg total   OR   1. EpiPen: IM 0.3 mL of 1:1000; can repeat every 5-10 minutes up to 3, if required Pediatric dosing of epinephrine: 0.01 mg/kg IM   OR   1. (if severely hypotensive) Epinephrine: IV 1-3 mL of 1:10,000 given slowly over 2-3 min; repeat 1 mg dose as needed |
| Hypotension with Bradycardia | * Usually spontaneous recovery | 1. Oxygen by face mask: 6-10 L/min 2. Elevate legs 3. Saline 0.9%: 10-20 mL/kg 4. Atropine: IV 0.6e1.0 mg, saline flush; can repeat up to 3 mg |
| Hypotension with tachycardia | * If severely hypotensive, IV epinephrine preferred | 1. Oxygen by face mask: 6-10 L/min 2. Elevate legs 3. Saline 0.9%: 10-20 mL/kg 4. Epinephrine: IM 0.3-0.5 mL of 1:1000; can repeat every 5-10 minutes up to 3, if required   OR   1. EpiPen: IM 0.3 mL; can repeat every 5-10 minutes up to 3, if required Pediatric dosing of epinephrine: 0.01 mg/kg IM OR   (if severely hypotensive)   1. Epinephrine: IV 1-3 mL of 1:10,000 given slowly over 2-3 min; Repeat 1 mg dose as needed |
| Hypertension | * Hourly Monitor BP level | 1. Oxygen by face mask: 6-10 L/min 2. Labetalol: IV 20 mg over 2 min; can double every 10 min 3. Flurosemide: IV 20-40 mg over 2 min |
| Seizures | * If continuous, call emergency medical team | 1. Turn patient onto side to avoid aspiration 2. Suction airway if required 3. Oxygen by face mask: 6-10 L/min 4. Lorazepam: IV 2-4 mg |
| Pulmonary oedema | * Call emergency medical team | 1. Oxygen by face mask: 6-10 L/min 2. Elevate head of bed 3. Furosemide: IV 20-40 mg over 2 min 4. Morphine: IV 1-3 mg; repeat as needed |
| Cardiac arrhythmia; normotensive | * Generally no treatment required. * Perform 12-lead ECG? | 1. Oxygen by face mask: 6-10 L/min |
| Cardiac arrhythmia; hypotensive | * Call emergency medical team * If severely hypotensive, IV epinephrine preferred | 1. Oxygen by face mask: 6-10 L/min 2. Saline 0.9%: 10-20 mL/kg 3. Epinephrine: IM 0.3-0.5 mL of 1:1000; can repeat every 5-10 minutes up to 3, if required   OR   1. EpiPen: IM 0.3 mL of 1:1000; can repeat every 5-10 minutes up to 3, if required Pediatric dosing of epinephrine: 0.01 mg/kg IM   OR   1. (if severely hypotensive) Epinephrine: IV 1-3 mL of 1:10,000 given slowly over 2- 3 min; repeat 1 mg dose as needed |
| Nausea/vomiting | * Monitory; if unrelenting/severe administer recommended treatment | 1. Available antiemetic |
| Hypoglycemia | * If patient can swallow * -If patient cannot swallow, | 1. Oxygen by face mask: 6-10 L/min 2. Ounces fruit juice   OR   1. Dextrose 50%: IV D50 0.5 ampule over 2 min   OR   1. Glucagon: IM 1 mg |
| Unresponsiveness | * Call emergency medical team * Initiate life support | 1. Life supporting drugs are used |

**List of safety measures in the use of contrast agents for the patients injectable contrast agents**

|  |  |
| --- | --- |
| 1 | Biographies of patients before contrast agent injection |
| 2. | Check the history of disease & preparation of the patient prior to injection |
| 3. | Complete consent form & questionnaire to identify patients at high risk(PAR) |
| 4. | Preventive measures for patients at high risk |
| 5. | Educating patients about the possible side effects of administration of the contrast agent |
| 6. | Hygiene of contrast agent injection site |
| 7. | Control suction and oxygen therapy equipment function properly prior to contrast injection |
| 8. | Preparation and injection of contrast agents under the suitable temperatures |
| 9. | Observe speed the injection |
| 10. | Care of the needle stick & Use of sterile injection technique |
| 11. | Use of safe disposal box after injection |
| 12. | Monitor the patient for 60 minutes after injection |
| 13. | Encouraging patients to drink liquids after the test |
| 14. | Patient education about the intern to the usual diet |
| 15 | Skilled use of defibrillator |
| 16. | Control access to cardiopulmonary resuscitation Tralee before administration of contrast agent.31 |

**List of safety measures in the use of contrast agents for the patients Non-injectable contrast agent**

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| --- | --- |
| 1. | Biographies of patients before contrast agent injection |
| 2. | Check the history of disease prior to prepare the patient |
| 3. | Check patient preparation prior to injection |
| 4. | Check pregnancy and lactation in women prior to prescribing contrast |
| 5. | Educating patients about the possible side effects of prescribing the contrast agent |
| 6. | Health measures about preparing and administering the contrast agent |
| 7. | Control access to resuscitation Tralee, before administration of contrast |
| 8. | Attention to sterile techniques during catheterization |
| 9. | Check the Suction equipment, oxygen therapy and proper functioning of the prescribing the contrast agent |
| 10. | Patient education about the Back to the usual diet |
| 11. | Contrast agents used immediately after opening and preparation |
| 12. | Use of separate contrast agent for each patient |
| 13. | Preparation and prescribing contrast agents in appropriate concentration, temperatures and volume |
| 14. | Keeping remaining oral contrast agents in good condition |
| 15. | Care for the prevention of infection when using reusable equipment |
| 16. | Catheterization done by physician |
| 17. | Access to the resuscitation team if necessary |
| 18. | Encouraging patients to drink liquids after the test.31 |

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