

Lesson 6: Iodinated contrast agents (1) - Osmolality

Aims

- Learning the following topics:
- Iodinated contrast agents
- Structural characteristics
- Physical characteristics
- Osmolality

Iodinated contrast agents

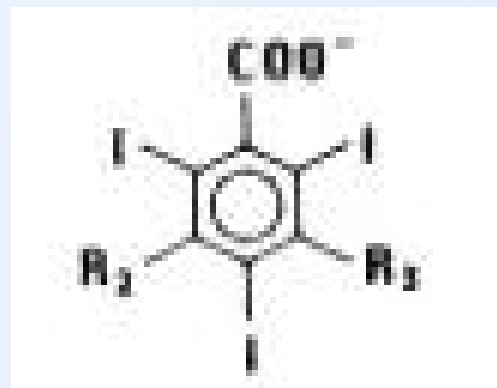
- The relatively high atomic weight of iodine provides radiodensity and allows for radiographic contrast with surrounding tissues.

Iodinated contrast agents

- The degree of opacity produced is directly proportional to
.....
- the total amount of iodine in the path of the x-rays.
- The biggest difference in iodinated contrast agents is
.....
- their adverse reaction

Structural characteristics

- A benzene ring with three iodine molecules attached at positions 2, 4, and 6.
- Side chains (at positions 3 and 5) are modified with hydroxyl groups or other molecules
- The agents may exist as monomers (one benzene ring) or dimers (two benzene rings).



Physical characteristics

- Osmolality
- Ionicity
- Viscosity
- These physical characteristics play an important role in the tolerance and adverse reaction of contrast agents.

Osmolality

- Definition:
- The measurement of the number of molecules and particles in a solution per kilogram of water.

Osmolality

- An indication of the osmolality of an agent is given by the contrast medium ratio which is derived by dividing the number of iodine atoms in solution by the number of particles in solution:

$$\text{Contrast medium Ratio} = \frac{\text{Number of iodine atoms}}{\text{Number of particles in solution}}$$

- The higher osmolality agents:
- Have more particles per iodine atom →
- Have lower ratios

Osmolality

- According to osmolality, contrast agents are classified into three groups:
- High-osmolar (≥ 1400 mOsm/kg) agents usually include the ionic monomers.
- Low-osmolar (780–800 mOsm/kg) agents include the nonionic monomers.
- Iso-osmolar agents (approximately 300 mOsm/kg) include the nonionic dimers.

High-osmolar contrast media (HOCM)

- The first generation
- Osmolality: 5 to 8 times of blood
- These agents are associated with high rates of adverse reactions when administered by the intravascular route due to
- the biological effects of high osmolality.

Low-osmolar contrast media (LOCM)

- The second generation contrast agents
- They were developed to circumvent the problems associated with the HOCM.
- These nonionic monomers have water-soluble molecules that do not further dissociate in solution →
- Allowing for a lower osmolality product
- LOCM are associated with considerably fewer adverse reactions and improved intravascular tolerability.

Iso-osmolar contrast medium

- The third generation
- Iodixanol (Visipaque): an iso-osmolar nonionic dimer
- An iso-osmolal agent is preferable for any procedure that exposes the patient to **central nervous system, cardiovascular, or renal problems.**

Table

Structure	Viscosity		<u>Osmolality</u>	Generic name	Trade name
	20°	37°			
<u>ionic</u> monomer	5 9	3 5	1500-1600	iothalamate metrizoate amidotrizoate ioxithalamate	Conray Vasoray Isopaque Urografin Angiografín Gastrografín Telebrix
<u>Ionic</u> dimer	12	6	600	ioxaglate	Hexabrix
<u>non-ionic</u> monomer	11	6	500-700	iohexol iopamidol iopromide ioversol	Omnipaque Iopamiro Ultravist Optiray
<u>non-ionic</u> dimer	25	10	300	iodixanol iotrolan	Visipaque Isovist

Osmolality

- Osmolality is an important characteristic.
- As the osmolality of agents is reduced towards iso-osmolality →
- Tolerability and safety profiles improve
- Patients report an increased incidence of pain or warmth sensations when higher osmolar contrast agents are administered.

Comparing the risks

- An iso-osmolar contrast agent may be preferable in any vascular region where the endothelium is sensitive to the osmolality, such as
- the brain, heart, and kidneys.
- Iso-osmolar contrast agents affect the blood-brain barrier and also the rhythm and the function of the heart to a lesser degree than LOCM and they have the least nephrotoxic effect.
- LOCM are associated with an overall lower risk of contrast-induced nephropathy than HOCLM.

Effect of high-osmolar CM on heart

- When a high-osmolar load is injected intravascularly →
- Water may be pulled from the interstitium into the vascular system →
- Blood volume expansion
- Patients with impaired cardiac function may become decompensated because of right heart volume overload.
- These effects are significantly reduced when iso-osmotic agents are used.

Effect of high-osmolar CM on RBC

- Another deleterious effect of a high-osmolar load may be the physical effects on red blood cells.
- In a high-osmotic environment, water can also be drawn from red blood cells →
- A deformed and rigid cell that may not be able to pass easily through capillary beds. →
- Thrombosis or ischemia may occur, especially in the brain and myocardium.

Summary

- Iodinated contrast agents
- Chemical structure
- Physical properties
- High-osmolar contrast media
- Low-osmolar contrast media
- Iso-osmolar contrast media

References

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