MRAD 223 – Patient Care 1

Contrast Media Information

Purpose: *Identify the complications associated with intravenous (IV) injections and contrast media.*

Contrast can cause adverse reactions, but the reasons are relatively unknown. The reactions are classified as either **physiochemotoxic** or **idiosyncratic** in nature.

Physiochemotoxic reactions are believed to result from the ability of the contrast to upset the homeostasis of the body, especially regarding the blood and circulatory system. When contrast media is injected, it has the potential to alter blood cells and the circulation of blood as well as other organ systems in the body. Systems that most commonly experience physiological changes include cardiovascular, respiratory, urinary, gastrointestinal, neurologic and integumentary.

Physiochemotoxic reactions are commonly related to the following:

- Physical properties of the contrast media
- Iodine concentration of the contrast media
- Total dose or volume of the contrast media
- Rate or speed of injection

1. Physical Properties of Contrast Media

Contrast media can be classified as either **ionic** or **non-ionic**, based on its chemical composition. The defining difference between an ionic or non-ionic compound is its ability to dissociate (break down) into charged particles when placed in a solution. Typically, contrast media contains the element **iodine** due to its low toxicity, high atomic number and ability to bind to organic (carbon-containing) molecules in the body.

Ionic contrast media breaks down into *positively* charged particles called **cations** and *negatively* charged particles called **anions**. For every three iodine molecules present in an ionic solution, **one cation** and **one anion** is produced when placed in solution. Ionic contrast media are generally referred to as **3:2 compounds**, referring to the ability of three iodine molecules to dissociate into one cation and one anion. The cations and anions are produced through the dissociation of the characteristic "side chains" found bound to the central contrast molecule.

Non-ionic contrast media iodine molecules *do not dissociate* into **charged** particles when mixed in a solution. Non-ionic contrast media are referred to as **3:1 compounds**.

Physical properties of contrast media include:

- The chemical breakdown of the contrast media when mixed in a solution.
- The number and size of the iodine compounds.
- The number and size of additional chemical compounds.

Osmolality

Osmolality is a measure of concentration that considers the number of **osmoles** (the number of moles with regards to osmotic pressure) per litre of solution. Osmolality is significant in radiography when it comes to the relationship between blood and contrast media. Any contrast media solution that has an osmole per kilogram (Osm/kg) value **greater** than blood plasma is said to be hyperosmolar. Both ionic and non-ionic contrast media are typically hyperosmolar:

- Average mOsm/kg of blood/CSF = 300
- Average mOsm/kg of non-ionic contrast = 400-750
    - **Isosmolar/Isotonic non-ionic contrast = 300 mOsm/kg*
- Average mOsm/kg of ionic contrast = 1400-1800

Contrast media can be divided into **three categories**: **High Osmolar** Contrast Media (**HOCM**), **Low Osmolar** Contrast Media (**LOCM**) and **Isosmolar** Contrast Media (**IOCM**). Typically, most non-ionic contrast media are defined as LOCM and all ionic contrast media are HOCM. When contrast media is injected into the blood stream it results in an increase in the number of particles present in the vascular system (especially with HOCM). The presence of contrast media particles causes H_2O found in body tissues to move into the vascular system in an attempt to maintain the concentration equilibrium (via osmosis). **Hypervolemia**, an abnormal increase in the **volume** of circulating blood,

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occasionally causes pain due to dilation of vessels, flushing, red cell changes, nausea, vomiting and dehydration. All of these changes are associated with **kidney** problems.

2. Iodine Concentration

The concentration of iodine in a solution is determined by the **number of iodine molecules** (mol) present in a litre of solution (mol/L). This concentration can also be expressed in milligrams per millilitre (mg/mL). The amount of iodine present in the media determines the **radiopaqueness** of the media. The higher the concentration of iodine the more x-ray photons will be absorbed; therefore, a low concentration of iodine will produce an image that is less radiopaque and less diagnostic. Iodine concentration also has a direct effect on how severe an adverse reaction to the contrast media may be.

3. Total Volume or Dose of Contrast Media Given

The amount of contrast media administered depends on several factors such as the iodine concentration of the contrast media, the nature of the contrast media (ionic vs. non-ionic), body weight of the individual and anatomical structures or regions needing to be demonstrated. The **increase** in injected **volume** of contrast media increases the chances of an adverse reaction occurring. We can manipulate this by increasing the amount of contrast agent injected, but injecting a contrast agent with a lower concentration of iodine.

4. Rate or Speed of Contrast Media Injections

The speed with which contrast media is injected can be directly related to physiochemotoxic reactions. Simply put, *increasing the rate by which the media is injected increases the chances of an adverse reaction taking place.* **Viscosity** is a qualitative way of describing the **thickness** of a liquid (or contrast media) and its **resistance** to flow. A very viscous liquid is one that is thick and does not flow easily (e.g., molasses), whereas a liquid that is not very viscous flows easily (e.g., H_2O).

The **concentration of contrast media is directly related to its viscosity**. The **more particles** present in a drop of solution, the **slower** that drop is going to move. Two other variables that affect viscosity are **temperature** (increasing temperature decreases viscosity) and the **size of the particles** present in the solution (increased size leads to an increase in viscosity). The **viscosity of a contrast media limits the rate at which it can be injected**. A thicker (more viscous) contrast media cannot be injected as easily.

Factors that affect viscosity of contrast media:

- Iodine concentration
- Temperature of contrast media
- Inner catheter diameter
- Catheter length
- Number of catheter holes (lumen)

Idiosyncratic Reactions to Contrast Media

Idiosyncratic reactions **cannot be related** to any particular property of the contrast media. Reactions occur randomly and are generally **unpredictable**. These types of reactions resemble allergic reactions or hypersensitivity to a particular molecule such as those found in the contrast media. The reasons behind these reactions are relatively unknown and cannot be contributed to iodine concentration, chemical properties or the rate/volume of injection. Antibodies create the symptoms of an allergic reaction in response to the presence of antigens. This antibody-antigen stimulated response releases histamine. Idiosyncratic reactions can be classified as mild, moderate or severe (i.e., anaphylaxis).

References

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