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Hot Topics

Contrast Enhanced Ultrasound: An Introduction for Nurses

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The use of ultrasound technology dates back to the 1700s when Lazzaro Spallanzani, an Italian physiologist, discovered that bats used echolocation to fly in the dark (The History of Ultrasound, 2018). Throughout the 1800s and 1900s, numerous research scientists with varying backgrounds (physics, mathematics, engineers, medicine, computer science, physiology, and so forth) continued to develop the use of sound waves for a variety of purposes including detection of icebergs and submarines under water, aircraft in the sky, flaws in metal, measurement of the atmosphere, and other. The use of sound waves for diagnostic ultrasound was identified by neurologist and psychiatrist Karl Theodore Dussik in 1942, when he began using this technology to diagnose brain tumors (Shampo & Kyle, 1995). In 1975, ultrasound images were able to be coded in color; in 1987, the ability to scan three-dimensional images was made possible, and in 1996, four-dimensional images became possible. The discoveries of many (scientists, sonographers, investors, and companies) over the years have lead to the development of the modern-day ultrasound.

Ultrasound images are created by transmitting high-frequency sound waves using a probe against the patient's skin, a transducer that collects the sound waves as they bounce back, and a computer that gathers the sound waves to create the image. In the past 2 decades, interest in the ability to use contrast to enhance the ultrasound images has grown as the contrast can assist in distinguishing the diseased tissue from the healthy tissue. Ultrasound technology is favored over other types of imaging as there is no radiation exposure and renal function is not of concern in the type of contrast available for ultrasound imaging usage (Ignee et al., 2016; Nolsøe et al., 2018; RadiologyInfo.org, 2018). Patients can remain on a stretcher or bed, instead of being positioned on a scanner or X-ray table that may be found to be uncomfortable, and there is a more personal connection between the patient and ultrasonographer as the technician remains at the bedside throughout the entire examination period instead of being in a control room running the equipment and computers.

Experiments with hand-agitated air and saline injections to create microbubbles, which enhanced ultrasound studies, began in the 1960s (Kogan et al., 2010). It was not until the 1990s that the use of microbubbles started to really be developed. Initially, air was used to create the microbubbles that were injected intravascularly but was soon replaced with a more durable and longer lasting high-molecular-weight gas that was less soluble (i.e., perfluorocarbons). The bubbles were encapsulated with a phospholipid material or a protein shell. The size of these microbubbles ranged from 1 to 10 μm (um). These bubbles are bolused into the circulation, and depending on the substance used to coat the bubbles, they will target different organs and accumulate at different disease sites within the patient. For some specific studies, nanobubbles (400-800 nm) may be used to target certain tumors. (Ignee et al., 2016; Unnikrishnan & Klibanov, 2012). Depending on the timing of the microbubble injection and the type of product used, what type of image the technician will be able to capture can be determined. The radiologist and technician will accurately time the imaging with the injection of the contrast to optimize the type of images desired. Because the microbubbles can be easily crushed by compression with the probe or the use of the probe in one plane for too long, the technician must be highly skilled in this type of study or the image quality will be decreased. The use of microbubbles can be helpful when imaging the heart, liver, gallbladder, spleen, kidneys, breast, bowel, bladder, pancreas, and some vasculature, as well as some muscle fiber trauma. They can also be used during interventional studies of cavities (peritoneal, pleural, abscesses, cysts, diverticular, and so forth) or tracts (biliary, gastrointestinal, urinary, and so forth). As with other types of imaging studies, specific protocols must be followed (Dietrich et al., 2018; Hotfiel et al., 2018; RadiologyInfo.org, 2018; Williams et al., 2011). Alternatively, a technique of dynamic microbubble contrast injection is performed when an intravenous infusion disrupts blood flow and is particularly helpful when imaging renal carcinoma, large heterogeneous lesions, and bowel inflammation. This method of contrast administration is useful when tracking a tumor's response to treatment.

When the microbubbles reach the area of interest for the ultrasound study, they will begin to vibrate because of the ultrasound sound wave intensity from the probe and create images that can identify the following key information:

- Timing (when the microbubbles arrive to the area, when they peak in the area, and when they leave the area)
- Enhancement (the volume of blood in an area and the pulsation or movement noted)

Creating a proper environment for the capture of quality images is essential. The ultrasonographer should position the patient so that images of the intended region can be optimized. The

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intravenous catheter may best be placed in the arm opposite the ultrasonographer using a short 20-gauge catheter to minimize the destruction of the microbubbles when injected. If the patient has a central venous catheter in place, this can be used for the injection; however, considerations will need to be made to determine the amount of contrast to be injected and an adjustment to the timing of the injection (Dietrich et al., 2018). Unlike other contrasts that may be used in the imaging settings, repeated doses of microbubbles can be safe and may be indicated to image multiple nodules, different timing sequences, or to capture an improved image.

Recovery from this imaging study is relatively quick. Within 10 minutes of administration, the microbubbles will have disappeared. There is little chance of an allergic reaction or lasting effects from the use of microbubble contrast.

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