Use of Ultrasound as an Alternative to Fluoroscopy

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PART 1: INTERVENTIONAL PROCEDURES

Fluoroscopy has significantly contributed to the advent and proliferation of image-guided interventions across the gamut of clinical medicine. While these procedures allow for the execution of often complex internal manipulations through a small skin nick rather than a surgical incision, they are not without risk, including the risks of ionizing radiation [1].

In these procedures, fluoroscopy simply serves as an image-guidance tool, and as such, alternative imaging modalities that do not rely on ionizing radiation can and should be considered. For example, as a real-time, high-resolution imaging modality, ultrasound shares many characteristics with fluoroscopy. However, due to its lack of reliance on ionizing radiation, ultrasound is often the imaging tool of choice for a number of image-guided interventions for which fluoroscopy may also be considered, particularly in the pediatric population.

The following examples illustrate specific indications in which ultrasound is preferred over fluoroscopy for interventional procedures.

Ultrasound Instead of Fluoroscopy for Musculoskeletal Procedures

Ultrasound is ideally suited for image-guided interventions upon the musculoskeletal system [2], as the depth of penetration required for these procedures is typically within several centimeters. A wide array of musculoskeletal interventions can be performed with ultrasound guidance, including arthrocentesis [3,4], joint and soft tissue steroid/anesthetic injections [5,6,7], and aspirations [8,9].

Moreover, while fluoroscopy is the most common imaging modality used for cervical nerve blocks and facet injections, there has recently been tremendous growth in the use of ultrasound for these interventions. Beyond the advantage of no ionizing radiation, ultrasound allows for the direct visualization of key soft-tissue structures such as the nerve bundles to target and the blood vessels to avoid [10].

In a randomized trial comparing fluoroscopy with ultrasound for third occipital nerve block procedures [11], ultrasound guidance was associated with a shorter procedure time and fewer needle passes, with an identical success rate to fluoroscopy. Importantly, there were fewer complications in the ultrasound-guidance group compared to the fluoroscopy group as well.

Ultrasound Instead of Fluoroscopy for Inferior Vena Cava Filter Placement

Intravascular ultrasound (IVUS) has been used to guide placement of inferior vena cava (IVC) filters in settings where fluoroscopic imaging is not available or feasible. Such patients include trauma patients in the operating room or critically ill patients in the intensive care unit who are unable to travel to a fluoroscopy suite.

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Ultrasound Instead of Fluoroscopy for Urinary Tract Infection in Children

For children with urinary tract infections (UTI), the two imaging tests that are most often considered to identify an underlying structural or functional problem are renal ultrasound and fluoroscopic voiding cystourethrography (VCUG). The ACR Appropriateness Criteria® [15] specify that for infants younger than 2 months with their first febrile UTI, ultrasound should be considered before VCUG [16,17,18,19], particularly in female patients; VCUG can be considered in male patients following the renal ultrasound if an abnormality is identified.

Likewise, for children aged between 2 months and 3 years with a febrile UTI that responds well to antibiotics and without a documented normal 3rd trimester fetal ultrasound, renal ultrasound should be considered before VCUG [20]. Ultrasound is also preferred over VCUG in the setting of an atypical UTI, characterized by poor response to antibiotics, sepsis, atypical bacteria isolated by urine culture or recurrent UTI.

Ultrasound Instead of Fluoroscopy for Vomiting in Infants

In infants younger than 3 months, new onset bilious vomiting raises the concern for malrotation with midgut volvulus or sepsis, and upper GI series fluoroscopy is considered the best approach [21]. However, for infants who are otherwise healthy and develop non-bilious vomiting at 6 weeks of age, hypertrophic pyloric stenosis is the chief differential consideration, and ultrasound is the most appropriate imaging test to evaluate for this diagnosis [22,23,24].

Ultrasound Instead of Fluoroscopy for “Sniff Test”

Diaphragmatic paralysis can be the sequela of multiple clinical conditions, including iatrogenic or traumatic phrenic nerve injury, muscular dystrophy and intrathoracic masses. Improper diaphragmatic function results in poor lung aeration, and so an accurate assessment of diaphragmatic motion can significantly impact patient care and prognosis.

Fluoroscopy has traditionally served as the imaging modality of choice to directly visualize diaphragmatic excursion during respiration. However, multiple studies [25,26] have demonstrated that ultrasound is an accurate and reliable alternative to fluoroscopy in this setting, particularly for evaluation of the right hemidiaphragm given the acoustic window provided by the liver. Moreover, the use of M-mode ultrasound imaging can provide a degree of quantitation for diaphragmatic excursion.

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