

Ultrasound-guided pain interventions

The use of ultrasound (US) to guide pain management procedures has shown a tremendous interest among pain specialist over the past few years. Most pain management guidelines have moved toward recommending image guidance such as US, fluoroscopy, or computed tomography (CT) scan for interventional procedures.^[1] This is largely due to the increased accuracy, reliability (precision), and safety associated with structure visualization.

Fluoroscopy is effective for visualization of bony structures but not soft tissues. It thus has limitations when performing procedures for peripheral procedures.^[2] Although CT scan is better than fluoroscopy for visualization of bony structures and soft tissue, it involves huge amount of radiation, forcing operator to move in-out the room. Understandably, access to CT scanner is not always easily available even in the most modern hospitals.

Since the article of Kapral *et al.*, in 1994 describing US-guided supraclavicular brachial plexus block, the number of publications in the field of regional anesthesia exceeds 1000.^[3]

However, it has been much slower uptake in pain management, perhaps due to technical limitations of US, lack of experience, formal training, and simply lack of evidences and publications. There have been 42 publications since 2003 and numbers are growing rapidly.

US has emerged as a popular modality in various disciplines because of its numerous advantages. It is generally more affordable and portable than other imaging modalities while avoiding any radiation exposure. US provides direct visualization of various tissue structures including muscles, tendons, ligaments, nerves, vessels, and bone surfaces.^[4,5] US technology now allows visualization of small peripheral nerves and their associated branches. Real time US guidance of needle placement and medication administration provides an advantage in ensuring

accuracy. Furthermore, US is increasingly being used for the diagnosis of various conditions that may be associated with the patient's presentation such as nerve and joint pathology.^[6-8]

Merging experience from various specialties seems to be a way forward. Musculoskeletal US experts (radiologists and rheumatologists) may help to develop skills in joint injections. Trigger point injections (including botulinum toxin A) are no longer to be blind, but specific group of muscle can be targeted and potential complications (pneumothorax, intraperitoneal, and intravascular injection) avoided.

Although US is associated with significant advantages, it does have limitations. High frequency probe providing high resolution pictures will not penetrate deep into tissue. Low frequency probe penetrates deep but the quality of picture is degraded. Bone has a high attenuation coefficient and casts an acoustic shadow; thus, structures hidden by bone are not well visualized.^[9] Another limitation is the time it takes to learn the technique as most of the pain physicians are anesthesiologist, rheumatologists, neurologist, or neurosurgeons. But the learning process has to start somewhere.

The technique required for US use is certainly user dependent. Obtaining an ideal image of the target structure while maintaining visualization of the needle requires practice and experience. This is particularly true when the target structure is deep and the needle insertion angle is more acute. Like other interventional techniques, US in pain medicine requires a sound understanding of anatomy and sonoanatomy. The architecture of different tissues and organs is variable, and interpretation of this is required when performing interventions.

When one performs US-guided interventions, the operator views image in either the transverse or sagittal axis. One is able to switch between these two axes by rotating the transducer through 90°. The operator then has to synthesize the three-dimensional (3D) image of the area of interest in his or her mind's eye. The 3D US imaging, which provides simultaneous images of a volume of interest in multiple planes without having to move the transducer, may overcome some of these limitations.

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In some interventions like stellate ganglion block, celiac plexus block, and superior hypogastric block and for superficial nerves like ilioinguinal/iliohypogastric nerves, intercostal nerves, and lateral cutaneous nerve of thigh and myofascial blocks, US has definite advantage and has replaced fluoroscopy in some centers.^[10-13]

For interventions where deeply localized targets like facet joints or medial branches, caudal epidural, cervical epidural, sacroiliac joints are of interest, can be accessed under US guidance but in degenerative spine, in obese patient a combination with fluoroscopy is recommended.

For advanced interventions like spinal cord stimulator, intrathecal pumps, vertebroplasty, trigeminal nerve intervention, current US systems does not seem to play any role.

New developments are under way, such as needle navigation systems, optical recognition of different tissues, photonic needles, and ultra-high-definition US. Validation studies comparing US with other traditional radiological methods are necessary to prove the comparability and in many cases the superiority of this rapidly progressing field of medical imaging. As ultrasonography becomes increasingly accessible and easier to use, it opens up many treatment and research opportunities. Importantly, assuming that cost and practicality continue to compare favorably, diagnostic sonography and US-guided interventions could become routine, especially as the technology improves and the images become easier to interpret.

Technological advancements continue to positively impact modern medicine. Nevertheless, new technologies must be introduced and managed with utmost care to ensure good clinical practice.

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