Past, Present, and Future Considerations for Musculoskeletal Ultrasound

Scott J. Primack, DO

KEYWORDS

• History • Injection • Intervention • Musculoskeletal • Neurologic • Sonography • Sports • Ultrasound

KEY POINTS

- Musculoskeletal ultrasound has been used since 1958, but its use has increased significantly in recent years.
- Training curricula, certifications, organizational guidelines, and position statements in recent years have helped formalize and standardize the practice of musculoskeletal ultrasound, particularly among nonradiologist musculoskeletal clinicians.
- Future developments in musculoskeletal ultrasound will be fostered by formal ultrasound education programs integrated into residency and fellowship programs.

Confucius stated, "study the past if you would define the future." This clearly holds true for musculoskeletal ultrasound. *Echolocation*, the term used to detect objects and measure distances, was originally developed for nautical purposes. After the sinking of the Titanic, Reginald Fessenden patented the first sonar device capable of detecting an iceberg 2 miles away. By World War I, Paul Langevin and Constantin Chilowsky constructed an underwater sandwich sound generator using quartz and steel plates.[1] The first recorded sinking of a German U-boat using a hydrophone was on April 23, 1916.[2] Between World War I and World War II, ultrasound techniques were used as "reflectoscopes," as a method of detecting flaws or defects in ships and aircraft. The application of echolocation was more widely applied during World War II. These technologies led to the development of the medical diagnostic use of ultrasound.

Ultrasound as a medical diagnostic tool was first used by Dr Karl Dussik in 1942. He attempted to diagnose brain tumors and visualize the cerebral ventricles by measuring transmission of ultrasound beams through the head.[3] The integration of ultrasound into clinical practice was established by Donald and colleagues.[4] He was able to

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Colorado Rehabilitation and Occupational Medicine, 1390 South Potomac Street, Suite 100, Aurora, CO 80012, USA
E-mail address: sprimack@coloradorehab.com

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demonstrate the utility of ultrasound in differentiating between cystic and solid abdominal masses.

The first report of musculoskeletal ultrasound was in 1958. Dussik and colleagues[5] was able to describe and measure acoustic attenuation of articular and periarticular tissues. This work led to the first description of anisotropy and the effects of different articular injuries and diseases on ultrasound attenuation, thus laying down the foundation of diagnostic musculoskeletal ultrasound. In 1972, the first B-scan image of a human joint was reported. The clinicians were able to differentiate between a Baker cyst and thrombophlebitis.[6] Just a few years later, Cooperberg and colleagues[7] used ultrasound to demonstrate synovitis in rheumatoid arthritis patients.

With improved technology, musculoskeletal ultrasound began to be increasingly used for detecting shoulder pathology. Crass and colleagues[8] demonstrated the efficacy of ultrasound in the diagnosis of rotator cuff pathology, using surgical correlation as the gold standard. The first outcome-oriented study that used diagnostic ultrasound with a functional outcome measure was done by Harryman and colleagues.[9] Their research demonstrated that a valid functional outcome measure, the Simple Shoulder Test questionnaire, correlated with the integrity of the repaired rotator cuff tendon complex at postsurgical follow-up. The recurrent rotator cuff defect was measured via specific criteria, as described by Mack and colleagues.[10] At the same time, radiologists Fornage[11] and Van Holsbeeck and Introcaso[12] contributed significantly to ultrasound description of the musculoskeletal system.

With advanced engineering in transducers, lower machine cost, and wider availability, there has been a larger trend for nonradiologists to integrate musculoskeletal ultrasound into the clinical assessment. Primack[13] demonstrated that musculoskeletal ultrasound can be used as an extension of the clinical examination. Using ultrasound as the first-line modality for occupational shoulder injuries, it was shown that there was a 40% reduction in imaging cost without compromising quality or accuracy of diagnosis.[14]

Before the twenty-first century, European physicians used sonography as a primary diagnostic tool for neuromusculoskeletal imaging. Martinoli and colleagues[15] were able to describe tendon and nerve sonology. They were able to demonstrate the utility of ultrasound in the detection of loose bodies in joints. One of the challenges of musculoskeletal ultrasound has been that it is operator dependent. Jacobson[16] reviewed that the “non-operator-dependent” quality of MRI is complementary to musculoskeletal sonography. Nazarian[17] pointed out 10 reasons why musculoskeletal ultrasound was an important imaging modality to complement MRI. It has been suggested that MRI is the gold standard for further musculoskeletal ultrasound studies.

By the twenty-first century, musculoskeletal ultrasound was thought efficacious in the musculoskeletal clinician’s office. Given the unique ability to visualize soft tissue and bony landmarks accurately, ultrasound has been used for both diagnostic and therapeutic interventions in the outpatient clinical setting with increasing frequency. Given the increasing use of ultrasound as an adjunct in patient management, education has been an ongoing focus for many musculoskeletal clinicians. The American Academy of Physical Medicine and Rehabilitation, American Medical Society for Sports Medicine, American Osteopathic College of Physical Medicine and Rehabilitation, and American Institute of Ultrasound in Medicine, among other organizations, have instituted educational programs to support high demand from clinicians as well as create objectives for competency. A formal musculoskeletal sonography credential was initiated in 2012 by the American Registry for Diagnostic Medical Sonography.