

Facts and Fallacies of Diagnostic Ultrasound of the Adult Spine

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Introduction

A review of the various publications within the chiropractic profession will reveal numerous advertisements from equipment manufacturers wishing to sell diagnostic ultrasound (DUS) equipment. In some of these ads, spurious claims are made concerning the adult spinal applications of this modality. The majority of these claims are scientifically unsubstantiated and appear to have been written to entice buyers with "facts" that are exaggerations and, quite simply, "too good to be true." Although vendors are seldom the focus of articles related to diagnostic imaging, the aggressive tactics used by some companies to promote their equipment has created a high degree of curiosity among chiropractic practitioners.

Articles describing the use of real-time diagnostic ultrasound of the adult spine have recently been published in the "chiropractic literature." Some of these articles have suggested that this modality is an effective method of accurately imaging disorders of the vertebral column.^{1,2} Croft has been critical of its uses in this body region.³ The absence of supporting data for adult spinal applications of this imaging modality in indexed refereed scientific or clinical (medical or chiropractic) professional journals should raise the suspicion of any physician considering the use of this modality.

This article addresses this controversial issue and is based on a review of the most current information in the indexed scientific or clinical literature. This is intended to address only DUS of the adult spine. No attempt has been made by the authors of this article to address all possible uses of DUS, and in no way does this reflect upon the usefulness of this imaging modality in extraspinal body regions.

Current Applications

Historically, real-time diagnostic ultrasound has proven valuable in the evaluation of the soft tissues of the chest, abdomen and pelvis. Its use in imaging of the superficial neuromusculoskeletal structures, including the rotator cuff and surrounding anatomy,^{4-15,24,25} carpal tunnel and its contents,¹⁴⁻¹⁷ pediatric hip,^{18-20,24,25} and Achilles' tendon,^{12-14,21-25} have also been reported by numerous authors. Ultrasound evaluation of the neurologic system has also been shown to be useful in the neonatal spine,^{26,27} in intraoperative evaluation of the adult spine,²⁸⁻³⁰ and on a limited outpatient basis in evaluating the paraspinal musculature.³¹ In addition, investigational techniques have been described in the literature to evaluate bone density,³²⁻³⁴ intervertebral disc disease,³⁵⁻³⁹ the size of the spinal canal,⁴⁰⁻⁴⁷ and internal structures of the knee.⁴⁸⁻⁵⁰

Hagen³⁸ has reported suboptimal representation of the intervertebral disc height throughout the majority of the lumbar spine with diagnostic ultrasound. In particular, only 70 percent accuracy was noted at L5/S1 (the most common disc to be affected by pathologic change), while 18 percent accuracy was observed at L2/3. Merx et al.³⁷ also described disappointing results when comparing ultrasonographic evaluation of lumbar disc herniations to myelography and CT. DUS was inconclusive in 18 percent of patients examined and revealed a sensitivity in identifying disc herniations that varied from 63-77 percent. The authors concluded that their sensitivity level was too low to support the use of DUS in the evaluation of lumbar disc disease. Moreover, the vast majority of the available literature evaluating intervertebral disc disease and spinal canal stenosis describes a transabdominal technique. We found no indexed literature describing a paraspinal method (a technique that has been promoted by the equipment manufacturers to the chiropractic profession) for evaluating spinal canal stenosis or disc herniation, and only one article³⁶ using paraspinal transducer placement for identifying the level of disc herniation.

The use of real-time diagnostic ultrasound to evaluate the nerve root (or nerve root sheath) or facet joint inflammation has not been described in the mainstream scientific or clinical literature. In fact, Howie et al.⁵¹ found ultrasonography to be unreliable in identifying spinal cord and nerve root compression, when compared to surgical findings. The ultrasound beam failed to penetrate the spinal canal at 15 of the 50 examined levels and correctly detected spinal canal narrowing at only 10 of the remaining 35 sites.

Training

The majority of research-based articles describing DUS of the musculoskeletal system have shown a reasonable degree of accuracy in evaluating disorders of the superficial musculotendinous structures. These results, however, were obtained by experienced sonologists using state-of-the-art equipment in a research setting. There is much written about the steep learning curve required to demonstrate

proficiency in techniques necessary to produce these results.⁹⁻¹¹ Consequently, diagnostic ultrasound of the musculoskeletal system is not a widely utilized technique. The training to become proficient in operating the equipment and interpreting studies includes completion of a radiology residency (4-5 years) followed by specialized fellowship training.

Diagnostic ultrasound is a very operator-dependent imaging modality, requiring both detailed knowledge of three-dimensional anatomy, and considerable understanding of the appropriate transducer frequency and orientation for optimal and reliable evaluation of the structures in the anatomic region of interest.^{6,11,14,52,53} It is a very difficult modality to perform and requires highly-qualified doctors to interpret. Besides these technical difficulties, the emergence of new magnetic resonance techniques has limited the clinical utility of DUS in the evaluation of the neuromusculoskeletal system.

In contrast, the vendor-sponsored "training" courses that are available offer only a 12-hour introduction to diagnostic ultrasound. These programs do not qualify one to perform and/or interpret DUS studies. The information presented in these courses is inadequate to establish even a minimal level of proficiency in the use of this modality.

Equipment

"Low-end" ultrasound machines are currently being marketed to the chiropractic profession. It is worth noting that most, if not all, of the published data in the indexed literature on musculoskeletal ultrasonography uses "high-end" ultrasound equipment. The cost difference ranges from machines priced at approximately \$15-30,000 versus \$200-250,000 machines. The exact technical differences and how these differences relate to the cost and overall diagnostic quality of the examination have not been addressed in the scientific literature. Is this cost differential proportional to the difference in the resultant image quality?

It appears that the prime focus of the vendors marketing these DUS machines are their claims to "image pain," "diagnose nerve root and facet inflammation," and diagnose virtually any other paraspinal and/or intraspinal abnormality. These claims are simply unproven at the current time. The mainstream scientific or clinical literature does not support the opinion that these structures can be reliably visualized with any (low-end or high-end) ultrasound equipment. Although diagnostic findings may correlate with the clinical examination findings, pain is never imaged directly.

The vendors distributing DUS equipment claim that the machines are present and currently in use at 11 chiropractic colleges. However, they neglect to expound upon the capacity in which these machines are being utilized. The CCE accredited colleges that are currently using these machines use them strictly as research devices. The presence of the equipment at these institutions, therefore, does not validate them as a mainstream imaging modality for most neuromusculoskeletal disorders. In fact, at the 81st Scientific Assembly and annual meeting of the Radiological Society of North America (the largest combined meeting of radiologists and diagnostic imaging equipment vendors with over 50,000 attendees), held in November 1995, the vendors selling "low-end" DUS equipment for evaluation of the neuromusculoskeletal system were not represented. Furthermore, no literature on outpatient DUS of the adult spine was available for peer review, and no completed or "in-progress" work was presented during the scientific sessions of this meeting.

The Adult Spine

For over a decade, optimistic statements have appeared in the scientific literature from advocates for the various musculoskeletal applications of diagnostic ultrasound. Findings from these properly researched articles have been incorrectly extrapolated to include the adult spine by vendors selling "low-end" DUS machines. To date, there have been no appropriate randomized clinical trials that prove that ultrasound is as useful or accurate as computed tomography (CT) or magnetic resonance imaging (MRI) in evaluating spinal and paraspinal injuries.⁵⁴ Physicians must be aware that these unsubstantiated claims have no basis in the indexed scientific or clinical literature.

We do not negate the fact that there may be information that can be gleaned from studying the adult spine with DUS. However, without any controlled studies to establish normal anatomy, it cannot be assumed or implied that spinal pathology in the adult can be accurately evaluated with this modality. Diagnostic ultrasound of the spine must meet the same rigorous standards as general radiography, CT, nuclear medicine (bone scan) and MRI. In advance of these other modalities being released for human use, established normals and examination protocols were promulgated. Inter- and intraexaminer reliability and positive predictive values, as well as sensitivity and specificity need to be established before any new diagnostic test can be considered useful.

We are not naive to the fact that the clinical application of an established imaging modality can and will likely change with time. However, this change can only occur after the appropriate research and randomized clinical trials have been performed.

Clinical Utility

Currently, no normative data or procedural protocols for adult spinal diagnostic ultrasound have been promulgated to the scientific community. Do all patients with clinically diagnosed sprain/strain injuries need objective documentation that intramuscular edema is present? In most instances, mild to moderate muscle injury will be identified by a thorough history and clinical examination. The use of DUS to acquire information that is obtainable by other means which does not significantly affect case management decisions is not justified. Furthermore, placement of an imaging modality in the hands of a clinician without first establishing patient protocols is unscientific.³¹ The noninvasive nature and accessibility of this modality may encourage spurious and clinically unnecessary use of this equipment. It has been suggested by some vendors that other, more established, screening modalities (e.g., radiography) be supplanted by DUS. This is irresponsible and could result in the delay of a timely diagnosis of a radiographically apparent abnormality.

Organizational Policy Statements

The radiological specialties in both the chiropractic and medical professions are essentially in agreement on the present clinical utility of adult spinal DUS and have published the following policy statements:

The American College of Radiology:

"The use of diagnostic spinal ultrasound in the evaluation of pain or radiculopathy syndromes (facet joints and capsules, nerve and fascial edema, and other subtle paraspinal abnormalities) currently has no proven clinical utility as a screening, diagnostic or adjunctive imaging tool."⁵⁵

In a February 1996 bulletin published by the ACR's Commission on Ultrasound a recommendation that

"some key audiences - the medical press, major automobile and health insurers and other third party payers - need to be better informed about the unsubstantiated claims by some medical professionals and equipment manufacturers that ultrasound is effective in diagnosing spinal and paraspinal injuries."⁵⁴

The American Chiropractic College of Radiology:*

"Diagnostic ultrasound has been shown to be a useful modality for evaluating certain musculoskeletal complaints. Fetal, pediatric and intra-operative applications have been published in the scientific literature.

"The quality of ultrasound images is extremely dependent on operator skill. The resolution abilities of the equipment may have an impact on diagnostic yield, and accuracy. Consequently, the importance of training to establish technologic, as well as interpretive competency cannot be understated. The application of diagnostic ultrasound in the adult spine in areas such as disc herniation, spinal stenosis and nerve root pathology is inadequately studied and its routine application for these purposes cannot be supported by the evidence at this time."⁵⁶

In 1992, many well-known leaders in the chiropractic profession gathered to establish the practice guidelines contained in the Mercy Conference document. This document states that "[musculoskeletal ultrasound]...is a relatively new and controversial technique."⁵⁷

- These guidelines have been approved as policy by the American Chiropractic College of Radiology and the Board of Governors of the American Chiropractic Association. They will be submitted for review and ratification by the House of Delegates of the American Chiropractic Association at its next annual meeting [in 1996].

Conclusion

Finally, the authors offer a challenge for those who wish to further investigate or utilize adult spinal DUS in any capacity. Please provide or produce publishable research to a peer-reviewed, indexed journal that will establish:

- Protocols and determinates for patient selection. The research departments of the chiropractic colleges that have access to DUS should be responsible for initiating protocol development.
- The clinical relevance (if any) of objectively demonstrating facet inflammation, mild to moderate muscle injury and/or nerve root inflammation.
- How positive ultrasound findings impact patient management in a cost-conscious health care environment.
- Inter- and intraexaminer reliability and positive predictive values, as well as the sensitivity and specificity of adult spinal applications of DUS.

This research should come forth prior to widespread use of this modality. If this type of research is to be performed, it should be compared with the accepted imaging modalities, such as MRI, electrodiagnostic studies or surgical findings.

Diagnostic ultrasound of the musculoskeletal system is a time-tested imaging modality. However, several concerns have been raised regarding the recent proliferation of this modality amongst chiropractors, particularly as it relates to evaluation of the spine. Prior to the new application of any imaging modality, the appropriate research and clinical protocols for patient selection must be established. Currently, this information has not surfaced in the indexed literature. Until this information is available in the mainstream scientific or clinical literature, outpatient DUS of the adult spine should be considered investigational. There are no scientifically-based studies that support the use of this imaging modality in the adult spinal or paraspinal regions. Therefore, it is clear that "THE CART IS BEFORE THE HORSE" as it applies to diagnostic ultrasound of the adult spine.

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