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GE Ultrasound

Advanced Ultrasound Platform Delivers High-Quality 3D Rendering To Enhance Workflow

Marnix T. van Holsbeeck, M.D.
J. Antonio Bouffard, M.D.

Department of Radiology and Imaging Division of the Department of Orthopaedics and Sports Medicine, Henry Ford Health System, Detroit, MI

Executive Summary

Henry Ford Health System's Division of Orthopaedics and Sports Medicine recently added Tru3D™ capability via the GE LOGIQ® 9 ultrasound system and the new LOGIQworks™ workstation. This sensor-based and quantitative data-acquisition and post-processing capability has helped the Division realize progress – including improved clinical decision-making, enhanced patient workflow, improved accuracy in localizing and measuring pathology, and the potential for a significant economic return. This technology has a number of useful applications, including interventional procedures; in this report, we will describe its advantages for musculoskeletal ultrasound.

In September of 2002, Henry Ford Health System added an important new capability to our diagnostic arsenal: high-quality Tru3D image acquisition via the GE Medical Systems LOGIQ 9 ultrasound system, and equally high-caliber data post-processing via the LOGIQworks workstation. This new combination of imaging platform and workstation has allowed us to capitalize on the advantages of compromise-free 3D rendering, including:

- Improved clinical decision-making
- Enhanced patient workflow
- Improved accuracy in localizing and measuring pathology
- The potential for a significant economic return

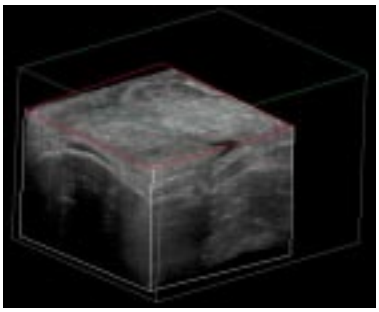
Orthopaedic applications of 2D ultrasound

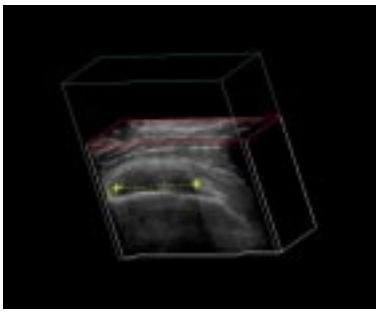
2D ultrasound has long been invaluable for our musculoskeletal imaging, particularly for visualizing soft tissues. We use it routinely on patients from young athletes to the elderly, to assess problems ranging from ligament and tendon tears to rotator cuff damage and the detection of loose bodies. It is also very useful for evaluating osteomyelitis as well as infections in and around joints and muscles.

Because of superior contrast resolution, detail in fractions of a millimeter can be shown. This proves particularly useful in assessing foreign bodies. In addition, ultrasound permits off-axis imaging; the technique is not bound by the standard imaging planes. This gives it a unique perspective in demonstrating pathology in the extremities. For example, it allows us to visualize nerves that take an irregular course in the extremities, following them through the tunnels that can inflict damage on their structure.

Such problems could be evaluated with MRI or CT, but ultrasound offers a number of significant advantages.

For example, ultrasound is not only considerably less expensive; it is also so fast that exams usually take no longer than a few minutes, and we're normally able to report on patients as soon as we're through scanning. Because of the unique location of our imaging division within the department of Orthopaedics, the study, the report and the consult are often concluded within the examination room at the time of the initial scanning when the orthopaedic surgeon drops in for advice.





In addition, the ultrasound study is immune to the artifacts normally associated with orthopedic implants. Stainless steel, cobalt, nickel and titanium do not cause the beam-hardening seen in CT exams, nor do they cause magnetic susceptibility in MRI.

Finally, ultrasound is a dynamic modality, which often means it provides us with more diagnostic information than what we can gain from any static examination technique.

Adding 3D processing to the equation

Until now, ultrasound's primary limitation for musculoskeletal applications has been the lack of high-quality 3D capability, with poorly rendered images being the rule rather than the exception.

This is no longer the case, however. LOGIQworks Tru3D software overcomes the limitations of earlier generations of software, for the first time making 3D a practical and clinically useful tool for musculoskeletal ultrasound.

At the touch of a button, we're able to transmit raw image data from the LOGIQ 9 scanner into the LOGIQworks workstation, and reformat the information into volumetric presentations that are intelligible to the referring physician or surgeon. The interface is very user-friendly; as a result we use this capability at least 50% of the time and expect it to become part of our clinical routine for the full range of studies.

The clinical advantages

There have been cases where our Tru3D renderings have actually made the diagnostic difference, even for physicians who are accustomed to viewing 2D ultrasound data through a mental 3D "filter." In a recent case, for example, a 2D study was unable to depict the extent of an ankle tear, and therefore left the appropriate remedy open to question. After 3D processing of the raw image data, however, we were able to see that the tear extended from within the tendon all the way to the surface. As a result, surgery was clearly indicated.

Cases in which 3D alone makes the diagnosis possible are relatively unusual. More commonly, it is the clinician who benefits most significantly from seeing the volumetric presentation.

We believe 3D has also made us more accurate in our work. For example, in many cases we are able to provide orthopedic surgeons with more detailed and precise information on which to base their surgical plans. It also makes possible more precise localization, measurement and monitoring of therapeutic progress.

Thanks to the level of information this technology has placed at our fingertips, we also expect 3D ultrasound to obviate the need for more extensive imaging and more invasive procedures – including MRIs and arthrograms.

Improved patient workflow

Equally important, Tru3D technology may have a significant impact on patient throughput. Once we've gathered the raw image data at the LOGIQworks workstation, we can re-optimize the data in an endless variety of ways – as if we were rescanning the anatomy of interest.

This means our sonographers don't have to spend as much time gathering the data, whether they are here at Henry Ford's main campus or working at any of our satellite locations. Instead of acquiring images at multiple angles to capture suspicious anatomy, they simply perform one quick sweep of the area and send the data on to us. The diagnosis no longer has to be made in the exam room. The raw data can be rendered by Tru3D and oriented in the appropriate planes or at desired angles of insonation. We can do this while the patient is still in the scan room, if it looks like we might need additional data, or well after the patient has been dismissed.

This capability also means that even more inexperienced sonographers can benefit from this technology. That has important implications for any department facing a shortage of experienced sonographers.

Highly useful capabilities

The LOGIQ 9 system equips us with a number of very useful capabilities.

LOGIQView™ extended field-of-view imaging is one that is particularly helpful for explaining a diagnosis to a referring physician – especially when the pathology extends over several centimeters. We use this capability routinely.

Simultaneous display of B-mode and colorflow data is another practical feature, because it allows us to localize the vascular anatomy in relation to the tissue. Although we use this capability less frequently than the LOGIQview display, it has proven helpful for explaining our findings to sports physicians, who are accustomed to viewing our gray-scale images.

The LOGIQ 9 system also improves our biopsies. It helps us create excellent maps for vessel avoidance, for example. A side-by-side image display can be handy in cases of infection, because we can utilize the B-mode and observe the vascular flow as we introduce the needle. Both Power and Color Doppler can also be added to this toolbox to further improve our understanding of the anatomy. Power Doppler, for instance, not only provides us with a roadmap for needle placement but also allows us to view tissue movement, to determine the vascularity of tumors and to look for inflammation in infected tissues.

We are also interested in Tru3D technology's potential for calculating tumor volume. Although fortunately we don't see many new tumors in the Division of Orthopaedics and Sports Medicine, this function could certainly come in handy in these relatively rare cases.

Excellent return-on-investment potential

It is impossible at this point to gauge the financial impact Tru3D technology will have on our practice. However, it is clear that it could deliver an excellent return on investment.

Improved workflow is the primary reason. As reimbursements continue to stagnate or decline, providers must make up for lost revenues by increasing patient volume. This technology allows us to accommodate growing numbers of studies without the need for additional staff or equipment. In fact, it may actually help us attract the patients we need; faster report turnaround, prompt initiation of the most appropriate treatment, and reductions in lost sick days for our patients should help to ensure a continuing flow of referrals.

In addition, we expect Tru3D capability to reduce our call-back rates – perhaps dramatically. Because we can reformat the data on the LOGIQworks workstation, there is rarely a need to conduct a second acquisition.

Another advantage that could become important for some sites is related to sonographers themselves. Tru3D software not only makes it possible to use less experienced staff without compromising the quality of results; but by minimizing actual scan time, it may also reduce the incidence of carpal tunnel syndrome among these professionals.

Materials and Methods

3D data acquisition can be easily achieved with the Tru3D option on the LOGIQ 9 ultrasound scanner from GE Medical Systems. This capability utilizes an electromagnetic sensor device consisting of an electromagnetic field transmitter and a field receiver. The transmitter generates an alternating spherical electromagnetic field. The receiver, which is attached to the ultrasound system's probe, functions as a position sensor. For 3D data acquisition, the probe with position sensor attached can be moved freely in a hemisphere of 0.7m around the transmitter.

During data acquisition, the electromagnetic sensor device generates, at a frequency of about 100 Hz, a set of three translation and three angulation values. These values describe the position of the ultrasound probe in space — a position that is automatically calculated at the same time that the ultrasound images are stored.

In the subsequent post-processing step, the corresponding translation and angulation values are used to transform the acquired images into an isotropic rectangular (Cartesian) coordinate system. After post-processing, the visualization and image processing features used in CT and MRI can be applied to the 3D ultrasound dataset. The data can then be displayed as either multiplanar reformatted 2D images or volume-rendered 3D images.

In addition, various rendering modes can be applied — including Texture (photorealistic) Shading, Minimum Intensity (transparent) Shading, Maximum Intensity Projection and Grey Surface. Tru3D capability can also be used for quantitative measurements such as distance, angle, area, and volume. Since the 3D ultrasound dataset can be sliced in any arbitrary position, it is possible to obtain information that is not available through conventional 2D ultrasound scanning techniques.

About LOGIQworks and 3D rendering

GE Medical Systems' exclusive LOGIQworks workstation equips clinicians with a powerful new raw-data processing technology called TruAccess™, a technology allows users to re-optimize previously acquired raw image data.

One of this workstation's most outstanding capabilities is Tru3D software. With this capability, users can easily perform 3D reconstructions from stored cine loops acquired via LOGIQ 9 or LOGIQ 7 scanners – in essence, scanning and re-scanning the stored data to create easy-to-interpret volumetric presentations of virtually any study. This means it can produce anatomical views that are unavailable with conventional ultrasound scanning. For example, instead of limiting the clinician to axial and longitudinal views, it makes it possible to generate images in the coronal plane.

The future of 3D ultrasound

We feel this technology's future appears bright, and envision a time when all our remote sites have their own LOGIQworks workstations for immediate study analysis. We can also imagine a day when long-distance reading will be common, with image data moving instantly around the country for 3D analysis by physicians specializing in this application.

In the meantime, we are delighted to have this capability in our practice, and expect to use it routinely, for virtually all musculoskeletal imaging applications, within a matter of months.

Marnix van Holsbeeck, M.D., *has authored and co-authored more than 75 peer-reviewed papers on orthopedic radiology, and has presented over a hundred scientific lectures both nationally and internationally. Over the last ten years, Dr. van Holsbeeck published two books entitled Musculoskeletal Ultrasound (Mosby Yearbook). Recently, he has been a guest editor for the bimonthly Radiologic Clinics of North America, lending his expertise on the subject of musculoskeletal ultrasound.*

J. Antonio Bouffard, M.D., *has conducted more than 300 lectures worldwide on subjects ranging from pediatric radiology and nuclear cardiology to emergency radiology, interventional ultrasound, and musculoskeletal ultrasound and MRI. He has presented papers and scientific exhibits at national meetings, as well as authoring and co-authoring numerous papers in peer-reviewed scientific journals. In addition, he has contributed book chapters on musculoskeletal ultrasound and orthopedic imaging.*

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Internet – gemedical.com
GE Medical Systems – Americas: Tel: (866) 344-3633
P.O. Box 414, Milwaukee, Wisconsin 53201 U.S.A.

GE Medical Systems – Europe: Tel: (49) 212 2802-0
Solingen, Germany

GE Medical Systems – Asia:
Shanghai, China – Tel: (86) 21-52080200