



White paper

The Deep Abdominal transducer (DAX): See deeper with less force

Balancing the scale between image quality and
injury risk when scanning high BMI patients

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Introduction

All medical imaging is a balance – a balance between obtaining a high-quality, diagnostic image, with that of safe technology usage so as not to produce any biological effects on the body during the imaging process. Ultrasound adds yet another layer to this delicate equilibrium in the form of operator safety.

It is no secret that the world obesity rate is increasing. According to the World Health Organization (WHO), 1.9 billion adults 18 years and older, are overweight. Of this number, 650 million people are considered obese – a number that has tripled since 1975¹. Large body habitus patients affect image quality and present a challenge to all imaging modalities; ultrasound, however, is the most affected. The increased subcutaneous fat and adipose tissue encountered with these patients attenuates and scatters the ultrasound beam, resulting in image degradation. This loss of image quality is further impacted with increasing depth. As ultrasound users struggle to obtain diagnostic images on overweight and obese patients, exam time and

transducer pressure tend to increase. The increased transducer push force, coupled with long periods of static arm or body positions, can contribute to increased operator injury risk. With obesity on the rise, high body mass index (BMI) exam conditions are being encountered more and more often in ultrasound on a daily basis, thus propagating an injury-ripe environment **[Fig 1]**. Studies have shown that work related musculoskeletal disorders (WRMSDs) develop gradually over a period of time from repeated exposure; WRMSDs are the most frequently reported causes of restricted or lost work time.²

To combat these risks, Siemens Healthineers has looked toward innovation as the key to improving and/or customizing the main tool that ultrasound imaging uses for every exam – the transducer. Redefining this tool at an imaging and ergonomic level to better accommodate the difficulties encountered with high-BMI patient scanning, will ultimately benefit the end-user by reducing the risk of injury during these exams.

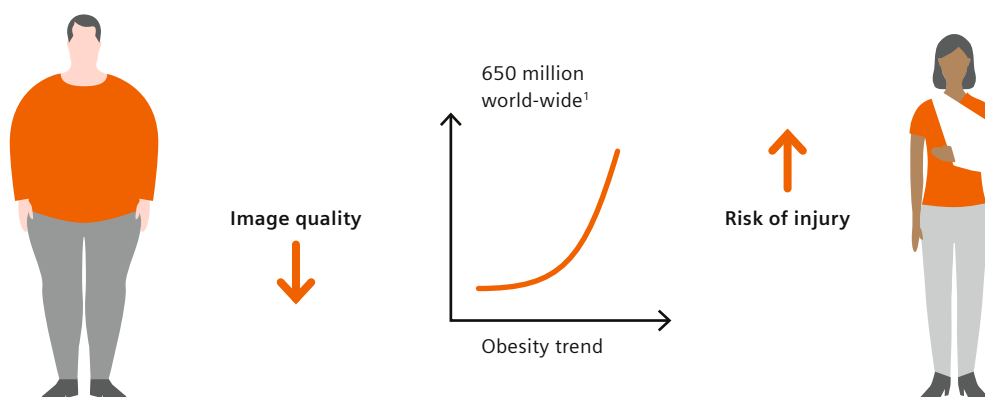
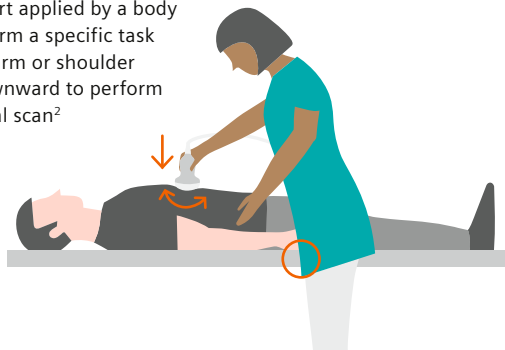


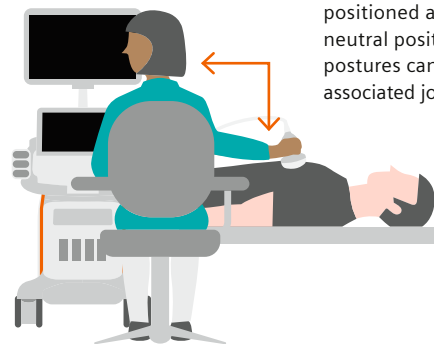
Figure 1: As the obesity trend continues to climb on a global scale, the impact to ultrasound is two-fold. Not only is the sonographic image quality decreased in overweight and obese patients, the ultrasound workforce is at an increased risk of injury while obtaining these images.

Force is the exertion of physical effort applied by a body part to perform a specific task such as the arm or shoulder pressing downward to perform an abdominal scan²



Repetition is performing the same or similar tasks repeatedly, either continually or frequently for an extended period of time without adequate recovery time²

Contact pressure is sustained contact between a body part and an external object, such as a bed or stretcher²



Awkward postures occur when body parts are positioned away from their neutral position. These postures can put stress on associated joints and muscles.²

Excessive reaching and/or abduction of the arm along with neck extension and rotation should be avoided during scanning. Longer times spent in non-neutral positions increase risk potential.²

Figure 2: The primary physical risk types that can be encountered in sonography practice – force (transducer push), repetition, contact pressure, awkward posture/positions, and excessive reaching or rotation.² Sonographers experience some or all of these risks on a daily basis in an effort to visualize the region of interest (ROI) or due to the inability to adjust equipment.

By the numbers: Sonography and Work Related Musculoskeletal Disorders

Work related musculoskeletal disorders (WRMSDs) are conditions that are caused and/or aggravated by workplace activities. These types of injuries affect the muscles, nerves, ligaments, and tendons and can result in (but are not limited to) strains, sprains, tears, and localized body pain, such as in the back or neck. In the diagnostic medical sonography world, there is a high incidence of WRMSDs among sonographers due to prolonged static postures of the arm, such as excessive abduction and extended reaching³, during the scanning process. Contact pressure with an external object, awkward and sustained postures coupled with repetition during the Sonographer's workday can all contribute to an WRMSD [Fig 2].

The shoulder is a very flexible joint that allows us to achieve many different positions with our arms, however the price for this flexibility is a joint that is fairly unstable. Overreaching and excessive arm abduction force the shoulder muscles to support the arm while it is in these non-neutral postures. When the arm is abducted more

than 30°, intramuscular pressure on the blood vessels of the rotator cuff muscles and the deltoid muscle can reduce flow to these muscles and their tendons. Prolonged muscle contractions caused by static arm positions, whether from overreaching or arm abduction, can overload the muscles fibers leading to fatigue and injury^{4,5}. Excessive reaching can be reduced by moving the patient closer and having the ultrasound system control panel close to the sonographer. Arm abduction while scanning can be reduced by lowering the exam table and/or raising the exam room chair.

Although equipment position changes and modifications of work postures can lead to a reduction in injury risk, one factor over which sonographers have no control is patient obesity. In an effort to provide images of diagnostic quality for the obese patient, sonographers feel compelled to exert excessive transducer pressure while scanning. This pressure, added to a shoulder that is already compromised by static posture, can result in a rapid onset of pain and muscle fatigue. This additional

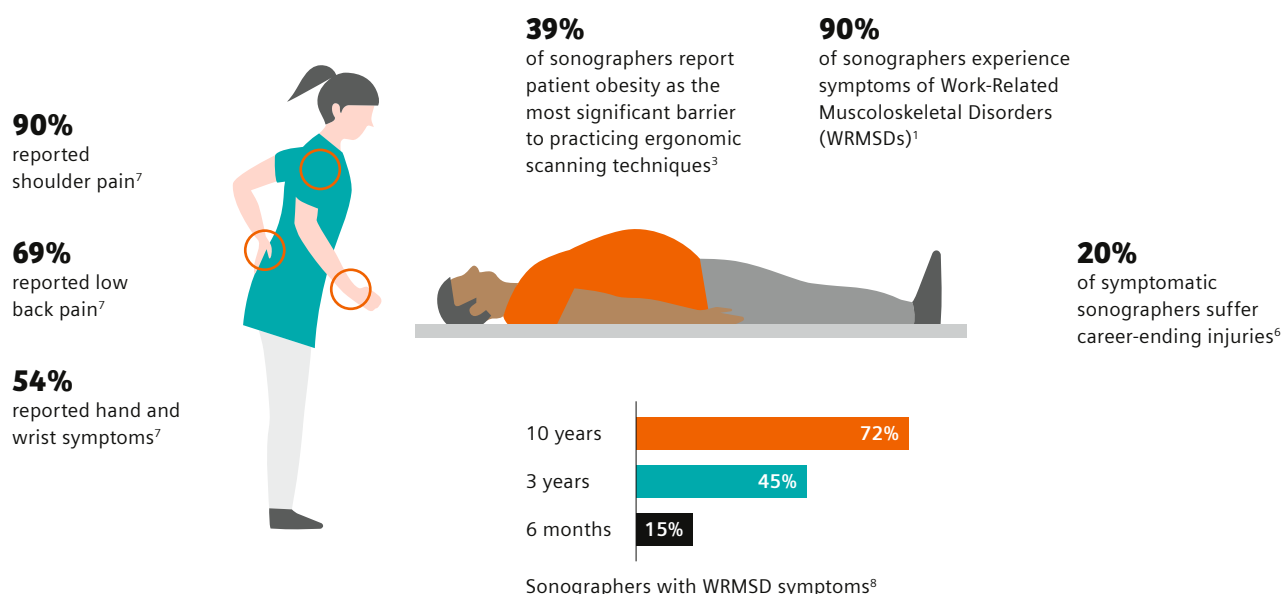


Figure 3: Sonography is a physically challenging imaging modality made even more so with the increase in patient size seen globally. In an analysis of occupational factors related to shoulder discomfort, 39% of sonographers cite patient obesity as the most significant barrier for ergonomic scanning. Shoulder pain, back pain and wrist symptoms can all result from poor ergonomic scanning. Sonographers have reported WRMSDs as early as 6 months into their career, and for some, these injuries can be career-ending. The impact of these occupational hazards can not only affect the user physically, it can also intensify workforce shortages and ultimately challenge patient care delivery resources.

force required by a traditional transducer, perpetuated throughout a sonographer's career, will have a cumulative negative impact on the arm and shoulder muscles. When this force is added to the muscle firing required to maintain arm abduction or excessive reach to the patient, the risk for injury could increase significantly. As the obese population continues to grow, injuries related to transducer pressure will also continue to grow.

Aside from the lasting personal toll of an WRMSD injury, an injured sonographer can intensify workforce shortages, which can cause unexpected operational and financial challenges for an ultrasound department or medical institution.

Recent studies have shown some troubling numbers that should be of concern to both sonographers and employers [Fig 3]:

- **90%** of clinical sonographers experience symptoms of WRMSD.²

- **20%** of those who were symptomatic suffered career-ending injuries.⁶
- **90%** of sonographers reported shoulder pain, with **69%** reporting low back pain and **54%** reporting work-related symptoms of the hand and wrist.⁷
- WRMSD symptoms caused by performing ultrasound exams occur as early as six months from the start of employment (**15%** incidence) to **45%** after three years, and as high as **72%** after ten years of employment.⁸

According to a 2017 study on ergonomic scanning techniques for sonographers, **39.3%** of sonographers interviewed reported that patient obesity was the most significant barrier to practicing ergonomic scanning techniques.⁹ With approximately 650 million people worldwide being considered overweight or obese, the problem of large BMI patients is not going away, and it is clear that a new and intelligent solution is needed to help combat these WRMSDs.

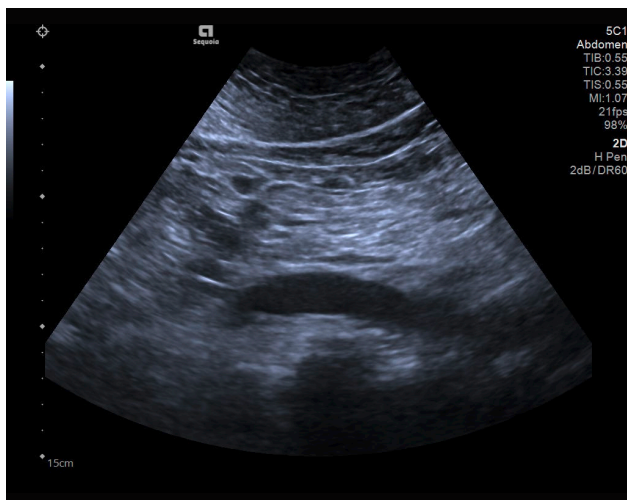


Figure 4: Abdominal aorta with conventional transducer exerting an average of 1.01 pounds of force.

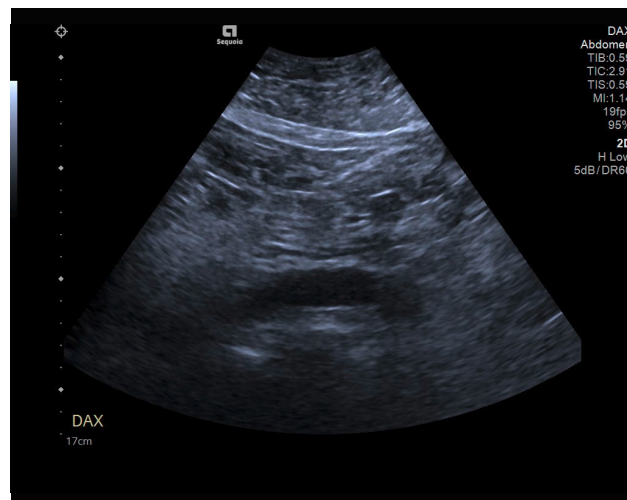


Figure 5: Abdominal aorta with DAX transducer exerting an average of 0.3 pounds of force, 70% less than conventional transducer technology.

DAX (Deep Abdominal Transducer): Innovation and injury prevention

Transducer development focuses mainly on two parameters: optimizing image quality and reducing the risk for work-related musculoskeletal disorders (WRMSD) in sonographers. An innovative solution for reducing the need to exert excessive transducer pressure is the Deep Abdominal Transducer (DAX) developed for the ACUSON Sequoia with BioAcoustic technology by Siemens Healthineers. DAX has the capability to image at diagnostic depths of up to 40 cm, whilst also reducing the need for excessive transducer pressure.

To demonstrate the penetrability of this new transducer, an analog pull-push force gauge by M&A Instruments, Inc., was used to provide a close estimate of the amount

of transducer pressure exerted while scanning a large person. Similar images of the abdominal aorta were obtained with a conventional transducer and with the DAX. The force exerted with the conventional transducer was an average of 4.5N or 1.01 pound-force (pounds of force) [Fig 4]. The force exerted with the DAX transducer was an average of 1.3N or 0.3 pound-force (pound of force) [Fig 5]. When compared, the DAX transducer resulted in a 70% reduction in push force over that of the conventional ultrasound transducer [Fig 6]. Since WRMSDs develop over time, this additional force spread over the span of a sonographer's career, will have a cumulative negative impact on the arm and shoulder muscles.

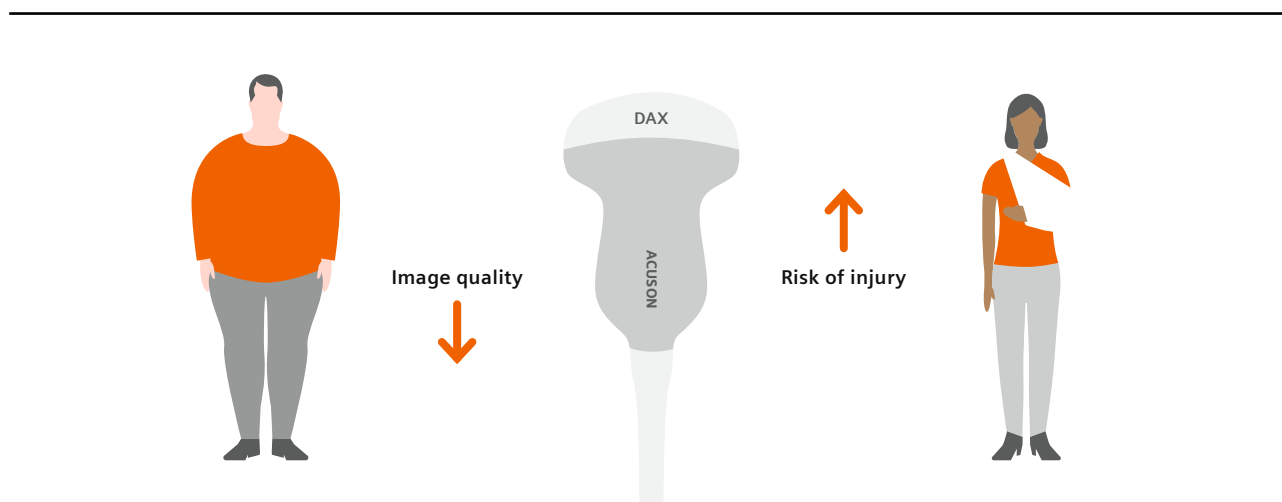


Figure 7: DAX helps balance the scale between image quality and injury prevention when scanning the high BMI patient.

Conclusion

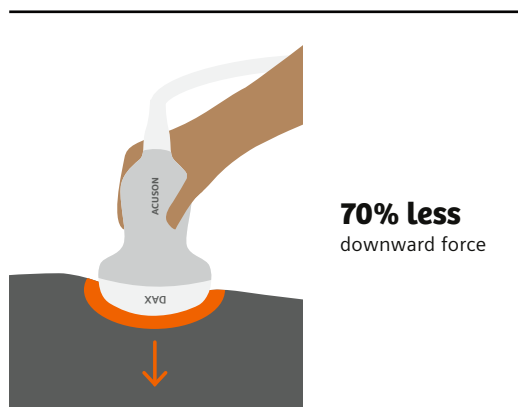


Figure 6: When compared to a conventional transducer, the DAX showed a 70% reduction in push-force when imaging a high BMI patient.¹⁰

The incidence of WRMSD in ultrasound is on the rise along with an increase in the overweight and obese population. The causes of WRMSD in sonographers are multifactorial, necessitating a variety of solutions to reduce the risks. These solutions include changes in the individual's work postures and patient scheduling, as well as replacing older equipment with those with the most current ergonomic features. The ACUSON Sequoia system and the innovative DAX transducer have these desired ergonomic features.

Designed for superior usability, the ACUSON Sequoia system has incorporated the latest industrial design and imaging architecture ideals along with industry recommendations and best practices to optimize the entire ergonomic experience. This intuitive design goes even further with the addition of the DAX transducer, an industry-exclusive solution, thereby giving the user a more innovative tool for imaging obese or high BMI patients [Fig 7]. With its improved penetrability and reduced scanning force, the DAX transducer helps to improve diagnostic confidence whilst simultaneously mitigating the risk of injury to the user.

Standalone clinical images may have been cropped to better visualize pathology. The products/features mentioned in this document may not be commercially available in all countries. Due to regulatory reasons, their future availability cannot be guaranteed.

Please contact your local Siemens Healthineers organization for further details.

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At Siemens Healthineers, our mission is to enable healthcare providers to increase value by empowering them on their journey towards expanding precision medicine, transforming care delivery, and improving patient experience, all enabled by digitalizing healthcare.

An estimated five million patients worldwide everyday benefit from our innovative technologies and services in the areas of diagnostic and therapeutic imaging, laboratory diagnostics and molecular medicine as well as digital health and enterprise services.

We're a leading medical technology company with over 120 years of experience and 18,500 patents globally. With over 50,000 employees in more than 70 countries, we'll continue to innovate and shape the future of healthcare.

References

- 1 World Health Organization statistics on obesity and overweight <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>
- 2 Murphey, Susan. Work Related Musculoskeletal Disorders in Sonography. Society of Diagnostic Medical Sonography Whitepaper 2018
- 3 Roll SC, Evans KD, Hutmire CD, Baker JP. An analysis of occupational factors related to shoulder discomfort in diagnostic medical sonographers and vascular technologists. *Work*. 012;42(3):355-365.
- 4 Garg A, Hegmann K, Kapellusch J. Short-Cycle overhead work and shoulder girdle muscle fatigue. *Int. J. Ind. Ergon.* 2006; 36:581-597.
- 5 Village J, Trask C. Ergonomic analysis of postural and muscular loads to diagnostic sonographers. *Int. J. Ind. Ergono.* 2007; 37:781-789.
- 6 Pike I, Russo A, Berokwitz J, Baker J, Lessoway V. The Prevalence of Musculoskeletal Disorders Among Diagnostic Medical Sonography. Available at <http://www.sdms.org/?ID=19>. Accessed Aug 2017.
- 7 Evans K, Roll S, Baker J. Work-Related Musculoskeletal Disorders (WRMSD) Among Registered Diagnostic Medical Sonographers and Vascular Technologists: A Representative Sample. *J. Diagnostic Med. Sonogr.* 2009;25(6):287-299.
- 8 Muir M, Hrynokow P, Chase R, Boyce D, Mclean D. The Nature, Cause, and Extent of Occupational Musculoskeletal Injuries among Sonographers: Recommendations for Treatment and Prevention. *J. Diagnostic Med. Sonogr.* 2004;20(5):317-325
- 9 Scholl, C., and Salisbury, H. (2017). Barriers to Performing Ergonomic Scanning Techniques for Sonographers. *J. Diagnostic Med. Sonogr.* 33, 406-411.
- 10 Data on file with Siemens Healthineers. Study performed by Sound Ergonomics, LLC

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