



Evaluation of the Impact of Control-free Ultrasound Image Optimization Technology on Ergonomic Factors, Workflow and Exam Quality

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Native TEQ Ultrasound Technology Addresses Ergonomic Factors; Benefiting Workflow and Exam Quality

Summary

Evaluation performed at the Karolinska University Hospital to evaluate what impact the availability of Native™ TEQ ultrasound technology on the ACUSON Sequoia™ ultrasound system would have on ergonomic factors in a variety of ultrasound examination types. Keystroke logs were analyzed for exams done with and without NTEQ ultrasound technology to quantify the benefit. In addition, the benefits of NTEQ ultrasound technology on workflow and examination quality and consistency were evaluated.

Introduction

Work-related musculoskeletal disorders (WRMSD) among sonographers and sonologists have become an increasing problem. This is a result of increased workload due to skilled labor shortages, lower reimbursement rates, obese patient populations, equipment design, poorly designed scanning environment and an aging workforce.

Surveys from the United States, Canada and Australia show that more than 80 percent of sonographers are scanning in pain and 20 percent of these are suffering from a career-ending injury. According to the U.S. Occupational Safety and Health Administration (OSHA), risk

factors that contribute to WRMSD include:

- frequent repetitive motions
- forceful and awkward movements
- duration of pressure
- poor posture/improper positioning
- frequent reaching above shoulder level
- excessive force and strain – the result of reaching over patients during bedside examinations
- overuse - the result of an increased number of examinations performed per day
- unfamiliar work activities

Many risk factors can be reduced or eliminated by appropriate ergonomic adaptations.

Background – Our Department

Karolinska University Hospital is a highly specialized hospital, which is reflected in the variety of examinations performed in the ultrasound department. About 50 percent are conventional diagnostic examinations, 15 percent are contrast-enhanced examinations and 30 percent represent procedures involving a form of intervention – biopsies (fine needle aspirations or core biopsies), drainage, radiofrequency ablations (RFA) or intraoperative ultrasound (IOUS) with or

without contrast. Many of our patients are severely ill and examinations have to be performed at the bedside.

Three specialized radiologists/sonologists, one sonographer and one to two residents take part in the ultrasound proceedings. Contrast-enhanced ultrasound examinations (CEUS), IOUS and advanced interventional procedures are performed by a specialized sonologist, and less advanced interventional and conventional examinations are performed by the sonographer and residents. The department is equipped with four Sequoia systems (Siemens, Mountain View, California), three of them with TEQ™ ultrasound technology and one with Native TEQ technology. All of the employees in the ultrasound department have had the opportunity to compare the two technologies during a variety of routine examinations.

Tissue Equalization Technology – TEQ

The introduction of single keystroke optimization TEQ technology made optimization of the image easier for non-experienced as well as experienced sonologists/sonographers. However the TEQ technology key has to be used several times during each examination, leading to repetitive motions and elevation ▶

of the non-scanning arm during the entire examination. Additionally some colleagues often forget to use the TEQ technology key.

Native Tissue Equalization Technology – NTEQ

We have had the opportunity to use NTEQ ultrasound technology and compare it to manual optimization of the image, and to TEQ technology. NTEQ ultrasound technology is turned on at the start of the examination, and the image is automatically and continuously optimized without the need to use any optimization keys. We compared the number of key-strokes used for optimization of the image in 10 consecutive abdominal examinations. The examinations were performed by an experienced sonologist. In eight of the examinations more than eight keystrokes (8-18, mean 13,2) were needed to optimize the image manually, and with NTEQ ultrasound technology one to three key-strokes (mean 1,7) were needed. In all 10 examinations the number was higher for manual optimization than with NTEQ ultrasound technology. In our experience the NTEQ ultrasound technology has influenced and improved our work in different ways depending on the type of examinations or procedures performed.

Conventional Ultrasound Examinations

In our department, conventional ultrasound examinations are usually performed by our sonographer or residents. The sonographer is experienced; the residents however are of various levels of experience, most of them with limited experience. During the past two to three years, we have implemented a dynamic clip technique instead of the conventional still image technique. The findings at each examination are saved as clips and stored on a dedicated workstation (KinetDx, Siemens). This has made it easier for a more experienced colleague to double check the findings and quality of examinations performed by a less experienced colleague. The less experienced colleagues often produce examinations of sub-optimal quality, either because they are not yet sufficiently familiar with the different possible ways to adjust the image, or because they do not realize that the image is not optimal. For our less experienced doctors, the initial, spontaneous response to NTEQ ultrasound technology was that it made scanning more difficult and the image quality was inferior. However, the main reason for this was because they were scanning too fast. ▶

The NTEQ ultrasound technology update can be set at different sensitivities, but even at the highest sensitivity of update, it is necessary to scan with moderate-to-low speed. Therefore, in addition to a higher average image quality and the advantage of not having to perform manual image optimizations, we noticed two positive side-effects. First, the less experienced residents learned to perform the examinations more systematically with slower sweeps, and as a result, the quality of the entire examination increased. The second positive effect was that both smaller and a higher number of pathologic changes could be found due to the improved general examination quality, and because the operator's concentration was focused on the image instead of the keyboard.

Contrast Enhanced Ultrasound – CEUS

CEUS has become a routine examination in our department during the past three years and it represents a major part of our daily workload. Every liver examination with a question of focal liver lesions is performed with contrast. During the arterial phase when the enhancement of the parenchyma is strong and the attenuation increases very rapidly, it may be necessary to adjust gain continuously and rapidly. This can be made manually or by using TEQ technology, but this takes focus off the screen. It is during this short period of time that characterization of vascular patterns in different hyper-vascular lesions is made and it is crucial to

be focused and to have an optimized image. NTEQ ultrasound technology continuous automatic image optimization has made it possible to achieve optimal image quality without having to concentrate on adjusting the DGC gain controls. As a result, this reduces frequent repetitive motions and also stress.

Interventional Procedures

Interventional procedures represent about 30 percent of our total number of examinations. Most patients are severely ill and biopsies and drainages usually have to be performed at the bedside. This often means working in an awkward position and having to stretch over the patient with both hands and arms. From this position it is difficult, sometimes even impossible, to reach the keyboard and optimize the image with TEQ technology, DGC or gain controls. Reaching out to the keyboard would require excessive force and strain, but the need for this is completely eliminated with NTEQ ultrasound technology. Because the image is automatically optimized, the needle, catheter or RFA electrode can be perfectly visualized. The sonologist can concentrate on the interventional procedure instead of adjustments of the image, resulting in faster and safer procedures with decreased risk for the patients. Additionally, most interventional procedures are performed under sterile conditions, so the fact that NTEQ ultrasound technology alleviates the need to touch the keyboard is an obvious advantage.

Intraoperative Ultrasound – IOUS

IOUS with or without contrast is routinely used during liver surgery at Karolinska University Hospital. The workspace in the operating theater is usually reduced due to other required space occupying equipment. The ultrasound system often has to be placed out of reach for the sonologist while scanning in the operating field, making it difficult to optimize the image. The keyboard then has to be draped in sterile drapes or the image adjustments have to be communicated to a second person. Not uncommonly this results in misunderstandings that during CEUS examinations can lead to misdiagnosis. If the keyboard can be reached, it usually leads to working with one or both arms elevated or abducted more than 30 degrees, leading to excessive strain to the shoulder muscles. NTEQ ultrasound technology allows the sonologist to scan in a relaxed position.

Conclusion

With NTEQ ultrasound technology, examinations can be performed using less force and pressure, achieving the highest image quality in a shorter time period. The number of necessary repetitive motions with the non-scanning arm is dramatically reduced and bedside examinations, interventional and intra-operative procedures can be performed in more relaxed postures with less strain when complex DGC and gain controls are automated. ■

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