The Importance of an Ergonomic Workstation to Practicing Sonographers

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Musculoskeletal disorders have been described in a number of professions over the years. They are defined as injuries that are caused by or aggravated by workplace activities, and they account for up to 60% of all workplace illnesses. They are known by different names, such as musculoskeletal disorder, repetitive strain injury, cumulative trauma disorder, and repetitive motion injury. Musculoskeletal disorders have only been identified in sonographers since 1997 but are increasing in incidence. Surveys done among American and Canadian sonographers in 1997 showed an 84% incidence; however, this incidence had increased to 90% by 2008. Understanding the importance of optimal body mechanics and how to maintain neutral postures will enable sonographers to reduce the risk factors associated with their profession. Even with the most advanced equipment, an ergonomic workstation is only as effective as the person using it.

Key Words—bedside studies; best practices; ergonomics; sonography; work-related musculoskeletal disorders; workstation

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Work-related musculoskeletal disorders have been described in a number of professions over the years. They are defined as injuries that are caused by or aggravated by workplace activities, and they account for up to 60% of all workplace illnesses. They are known by different names, such as musculoskeletal disorder, repetitive strain injury, cumulative trauma disorder, and repetitive motion injury.

Work-related musculoskeletal disorders were first identified in cardiac sonographers in 1993[1] and again in 1996 and 1997.[2,3] Surveys performed by the Health Care Benefit Trust of British Columbia and the Society of Diagnostic Medical Sonography using the American Registry for Diagnostic Medical Sonography database in 1997 showed an 84% incidence; however, this incidence had increased to 90% in a survey reported by Evans et al[4] in 2008. There are a number of possible explanations for this increased incidence[2–4]:

1. *Aging Work Force*—In 1997, 8.3% of sonographers were 50 years of age or older; by 2008, 30% of sonographers were 50 years of age or older, and 46.9% of vascular technologists were older than 50 years.[4]
2. *Increased Patient Volumes*—Reimbursements have decreased over the past 15 years, causing managers to increase throughput to maintain economic stability. In 2001, Baker provided testimony regarding work-related musculoskeletal disorders in sonographers to a presidential panel conducted by US Secretary of Labor Elaine Chao. Her testimony referred to the American Healthcare Radiology Administrators manpower studies of 1992 and 1995. These studies indicated that for a medium-sized hospital (300 beds), the ultrasound department performed 1528 procedures per sonographer per year in 1992.[5] This number increased in the 1995 study to 1667 procedures per sonographer per year,[5] demonstrating a 9.1% increase in patient volume per sonographer per year from 1992 to 1995.[5] The Sonography Benchmark Survey[6] results conducted by the Society of Diagnostic Medical Sonography in 2000, found that the average number of procedures a sonographer performs per day was 10.4, and based on 260 working days a year, the number of procedures was 2704 per sonographer per year. This number demonstrated a 55.7% increase in patient volume per sonographer per year from 1992 to 2008.
3. *Employee Awareness*—Publications, word of mouth, and lectures on this subject have permeated the field, essentially making all sonographers worldwide more aware of this problem. Pain and discomfort were often experienced away from work, including at night, and sonographers did not associate this discomfort with their daytime work activities until published articles pointed out the connection.
4. *Challenging Working Conditions*—There is increased pressure to work beyond an employee's regularly scheduled hours, and rapid technological changes have resulted in redefining the nature of many jobs.[7,8] Furthermore, if no replacement or temporary staff are hired when sonographers are absent because of pregnancy, other types of leave, or recovery from work-related musculoskeletal disorders, the remaining staff have to cover for their colleagues and may incur longer working hours and busier schedules.[9] This situation, in turn, can lead to decreased muscle recovery time and an increased risk of injury.
5. *Job Satisfaction*—Pressures and stress in the workplace have been identified as potentially affecting worker health.[7,8] Automated work practices often leave employees with the feeling that they have little control over their workload.[7,8] Although job satisfaction has been more strongly correlated with psychosocial problems than with physical illness, there is some correlation between job satisfaction and musculoskeletal disorders.

Causes and Conditions

The main causes of work-related musculoskeletal disorders according to the Occupational Safety and Health Administration[10] are

- Vibrations;
- Overuse;
- Excessive force and strain;
- Forceful or awkward movements;
- Poor posture/improper positioning;
- Repetitive motions; and
- Duration of pressure.

With the exception of vibrations, all of these causes of work-related musculoskeletal disorders apply to the sonography profession. Overuse can result from staffing shortages and busier schedules. Excessive force and strain can be the result of an increase in the obese patient population, according to the US Centers for Disease Control and Prevention.[11–13]

Severe and extreme obesity rates have increased in all age groups, to a prevalence of 1 per 50 in children and 1 per 400 in adults. Obesity may require the sonographer to use increased force, often involving awkward movements to achieve diagnostic images. The use of force is necessary to reduce the thickness of the fat layers and thereby reducing the attenuation induced by the fat layers. This use of force may permit the use of a higher-frequency transducer.[11,12,13]

Poor posture and improper positioning, examples of which are illustrated in this article under "Best Practices," include wrist flexion and extension, neck and trunk twisting and flexion, reaching, and arm abduction. Repetitive motions occur when sonographers perform the same examination continuously throughout the workday. The duration of pressure is related to the length of each examination and the amount of pressure exerted by sonographers to acquire images during these examinations.[14]

A very important work-related musculoskeletal disorders prevention factor is movement. A substantial risk factor for injury is static posture because it reduces the blood supply to the muscle, thereby decreasing the oxygen levels. Oxygen deficiency is unavoidable during static muscular effort, and it lowers the effective working level of the muscle.

During static effort, the flow of blood is constricted in proportion to the force exerted. If the effort is 60% of maximum, the flow is almost completely interrupted. At 15% to 20% of the maximum, the blood flow should be normal. The onset of muscular fatigue from static effort will be more rapid the greater the force that is exerted. Research has shown that work can be maintained for several hours per day without symptoms of fatigue if the force exerted does not exceed approximately 10% of the maximum force of the muscle involved.[15–17] Muscles and tendons are designed to stretch and to be used regularly. However, when the frequency and duration of loading exceed the ability of the muscles and tendons to adapt, inflammation occurs, followed by degeneration, micro tears, and scar formation.[1,11]

Among ultrasound professionals, the parts of the body most often named as experiencing the most pain and discomfort[2,3,4,18] are

- Shoulder (76%);
- Neck (74%);
- Wrist (59%);
- Back (58%); and
- Hands (55%).

The symptoms reported by sonographers who are in pain[2–4] include

- Muscle spasms;
- Inflammation;
- Swelling;
- Loss of sensation;
- Numbness;
- Clumsiness;
- Deterioration of tendons and ligaments;
- Burning/tingling; and
- Visual symptoms, including eye strain, headaches, and blurred vision.

Symptoms of work-related musculoskeletal disorders can be intermittent and transient, may persist throughout the workday, or may even occur at night. Although some symptoms are mild, if left unaddressed, many of these symptoms can lead to more serious, chronic, debilitating symptoms and disorders: for example, loss of sensation, clumsiness, or weakness. Eye strain should not be overlooked because it leads to poor posture, and postural alignment is an important contributor to these injuries.

The most common diagnosis related to occupational injury among sonographers is inflammation of the tendons and/or tendon sheath referred to as tendonitis or tenosynovitis.[2,3,14] The most common cause of tendonitis is repetitive strain. Performing the same type of scan without enough recovery time between scans is all that it takes to inflame a tendon or tendon sheath. Sonographers who specialize in a single modality are at higher risk: for example, high-risk obstetric or cardiac sonography. In sonographers, the most common sites of tendonitis are the shoulder, hands, and wrist.[10,19] As we age, our tendons lose their elasticity, making it harder for joints to move. This loss of elasticity can also lead to inflammation of the tendons. After a long examination involving repetitive motion, many sonographers may find their fingers locked onto the transducer. This condition has been diagnosed in some sonographers as trigger finger and results from the tendon sheath becoming inflamed at the tendon's narrowest point. The tendon will then become entrapped by the edematous sheath and unable to glide over the finger. Another form of tendonitis occurs at the base of the thumb and is known as de Quervain tendonitis. In sonographers, this condition is often caused by pushing on the ledge of the transducer while exerting pressure on the patient. It is seen more often in cardiac sonographers.

Nerve entrapment syndromes, such as carpal tunnel syndrome, cubital syndrome, and thoracic outlet syndrome, can become debilitating and affect not only muscles and tendons but also nerves, blood vessels, and the circulation to the arm and hand. Carpal tunnel syndrome can be the result of hyperextension of the hand, which puts pressure on the median nerve in the wrist. Cubital tunnel syndrome may occur in cardiac sonographers due to pressure on the elbow when they rest it on the examination table, which can cause entrapment of and mechanical injury to the ulna nerve.

An Ergonomic Workstation

Ergonomically correct scanning requires examination of how the worker interacts with all of the components and equipment within the work environment. Minimizing risk for work-related musculoskeletal disorders requires evaluation of sonographer postures and possible modifications of the examination table, chair, ultrasound systems, and other equipment to achieve good postural alignment.[20]

Table

One of the most important pieces of equipment in an ultrasound workstation is an electrically height-adjustable table. Manually adjustable tables are not likely to get adjusted because either the controls interfere with the chair legs, making it difficult to adjust the table height from a seated position, or the sonographers have to get up to adjust the table from the foot end. Stretchers are very useful for patient transportation, which is what they are designed to do, but they lack other features available on ultrasound tables. Side rails should retract under the table and not increase the distance between the patient and the sonographer. The table frame should not have any metal parts that can increase the distance between the sonographer and the side of the table. The table should be long enough to accommodate the patient's height and just wide enough for the patient population being scanned. Wide tables may be necessary for certain patient populations, but they must also fit into the room in which they are being used and allow for all of the examination protocols performed in that room (Figure 1). A head rest for carotid and thyroid examinations can be helpful (Figure 2). Retractable leg supports allow for ergonomic endovaginal scanning. Most facilities need to have an electrically adjustable Fowler position, as well as Trendelenburg for obstetric examinations and reversed Trendelenburg for venous examinations. The table should adjust in height from approximately 22 to 37 inches (Figure 3). The minimum height allows patients to transfer from a wheelchair to the table with little or no assistance or to sit on the table from a standing position without a step stool or other assistance. The maximum table height is useful for lower extremity deep venous thrombosis studies since the patient can dangle his or her leg over the side of the table. This height also accommodates tall physicians, who stand while performing invasive procedures.[20]

Chair

An ergonomic workstation should include an ergonomic task chair if the sonographers perform examinations seated.[20] The chair should be easy to operate and be adjustable from a seated position. The configuration of the examination room chair is not the same that would be used in an office setting. It should have a different lift, vinyl upholstery that is antimicrobial, a foot ring, special casters, and detailed instructions on its use for different types of studies. Special features are also necessary for stress echocardiographic examinations and venous reflux applications (Figure 4).

Examination Room

Features of the examination room are as important as the workstation equipment. An ultrasound examination room should be large enough so that all of the equipment can be easily rearranged within the room. The more multipurpose the room, the larger it should be. A room capable of accommodating carotid and endovaginal examinations must be long enough to allow the sonographer to perform a carotid examination from the head of the table or an endovaginal examination from the foot of the table using leg supports (stirrups).[20]

Lighting should be indirect and controlled with a rheostat. Lighting should not interfere with viewing the system's monitor, thus reducing screen glare and eye strain. Most current ultrasound systems gave backlighting for the

Figure 1. Multipurpose table.

keys on the control panel. Sonographers also generally develop good muscle memory, which makes lighting for the control panel itself unnecessary.[20]

When designing new ultrasound rooms or remodeling existing ones, a minimum of 150 square feet should be allowed. Architects may assume that 100 square feet is all that sonography requires. However, when cupboards and sinks are included, 100 square feet is not enough space to accommodate a good ergonomic setup.

Figure 2. This table allows for ergonomic scanning.

Figure 3. Low-enough table height (22 inches) for unassisted wheelchair transfer.

Picture-Archiving Computer

The picture-archiving computer workstation is just as important as the scanning workstation. Computer workstations were often an afterthought since the computerized archival system is a newer addition, which has resulted in little to no accommodation for a computer workstation. If risk management or occupational health personnel are not knowledgeable about ergonomic workstation setup, it is worth considering hiring an expert consultant to assist with setting up this workstation (Figure 5):

1. Place the computer tower so it does not interfere with leg room under the desk (Figure 5C).
2. Use a height-adjustable chair with the proper casters for the type of flooring (Figure 4A).
3. Position the monitor straight so you do not have to view it at an angle (Figure 5, B, D, E, and F).
4. Use a keyboard tray, preferably with reverse tilt. The keyboard tray is intended to help keep the wrist in a neutral position and avoid overreaching (Figure 5, A, B, and E).
5. Make the desk height adjustable if there are multiple users.
6. Have the mouse close to the keyboard (Figure 5, A and E).
7. Keep the top of the monitor at eye level and an arm's length away (Figure 5, D–F).
8. Make sure corrective lenses are properly adjusted for an 18- to 24-inch monitor distance.
9. Adjust lighting to avoid glare on the monitor.

Best Practices

Sonographers must be willing to learn and practice good ergonomics. They must also take the necessary time to set up the ultrasound workstation correctly and scan in a safe manner. Operator responsibility is imperative if these work-related musculoskeletal disorders are to be prevented.[20,21]

Whether an ultrasound facility is equipped with the newest, most ergonomic equipment, sonographers must become aware of the behaviors that have led to their pain and discomfort in the past and make the necessary changes. The most common improper postures followed by best practices illustrate how injury might be reduced.

1. Arm abduction is defined as an angle greater than 30° between the torso and the upper extremity (Figure 6). If the arm is abducted for long periods during the workday, it results in diminished blood flow and muscle fatigue and may ultimately lead to pain and discomfort.

2. Overreaching is defined as a reach that requires the sonographer to use the muscles of the shoulder. If it is a static posture, it can impair blood flow to the shoulder muscles.[18,20] This condition applies to the non-scanning arm as well as the scanning arm.

Best Practice—Adjust the height of the examination table and/or the chair so that your arm comes closer to the side of your body. If the table is not height adjustable, you may have to stand up to lower your arm. Supporting the scanning arm can reduce muscle

Figure 4. A–C, Chair configuration.

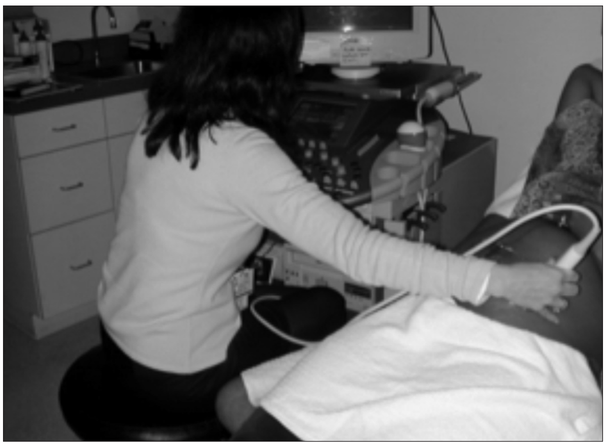
A B C

Figure 5. A, Mouse too far away. **B**, Monitor at an angle. **C**, Tower obstructing knees. **D**, Counter too high. **E**, This sonographer is at risk for wrist and neck issues. **F**, Abduction and reach.

A B C

firing and helps prevent fatigue. Moving the patient closer to you will reduce both abduction and overreaching. This adjustment may require a complete repositioning of the patient to bring his or her left side closer to you. For example, during a lower leg vascular examination, you can ask a patient who is mobile to turn around after you have scanned the right leg, which will bring the patient's left leg close to you (Figure 7A). Another option for this examination is to have the patient seated on the examination table with his or her foot resting on your thigh (Figure 7B). Right-handed cardiac sonographers can sit on the patient's left side with the ultrasound system positioned at the foot of the examination table. This position allows you to reach the cardiac scanning windows without reaching over the patient (Figure 8). You should move closer to the control panel of the ultrasound system to avoid overreaching with your nonscanning arm. For some examinations, you may be able to reduce reaching and abduction by having the patient sit on a chair or stool for the examination (Figure 9).

Figure 6. Abduction of the right shoulder and twisting of the neck, a result of sharing the monitor with the patient. The patient is also too far away from the sonographer, and the table is too low.



3. Neck flexion, extension, and protraction—These postures cause an increase in pressure on the intervertebral disks in the cervical spine and increased tension on the neck muscles (Figures 10 and 11).

   Best Practice—Position the ultrasound monitor so that you are looking at the top of the screen. This location will enable you to achieve a comfortable neck flexion of 15° to 20° when looking at the center of the monitor. Never position the monitor too high, causing you to look up at it. This rule also applies to the position of the workstation computer and picture-archiving computer monitors.

4. Neck twist—An improper monitor position or sharing the ultrasound monitor with patients can result in an uncomfortable neck position and the necessity to twist the neck to view the monitor. Twisting of the neck can cause lateral shear forces on the intervertebral disks in the cervical spine.

   Best Practice—Position the monitor of the ultrasound system directly in front of you. New ultrasound systems have articulated monitor arms that allow you to move the monitor into a number of different positions. If you have an older type of monitor (Figures 12 and 13),

Figure 7. **A** and **B**, Alternative ways of performing lower extremity venous studies in a more ergonomic fashion. The left leg causes overreaching when it is scanned without turning the patient around. Note the sonographer is looking directly at the monitor, and her neck is not twisted.

A **B**

Figure 8. Scanning the heart from the left side of the patient. The position can be used by right-handed cardiac sonographers to avoid scanning over the patient's back. Reproduced with permission from Philips Healthcare (Bothell, WA).

Figure 9. Carotid and thyroid scans can be performed with patients in a seated position. This positioning can be very helpful in stroke patients or those who cannot easily lie down or get up onto a table.

Figure 10. Demonstration of neck flexion.

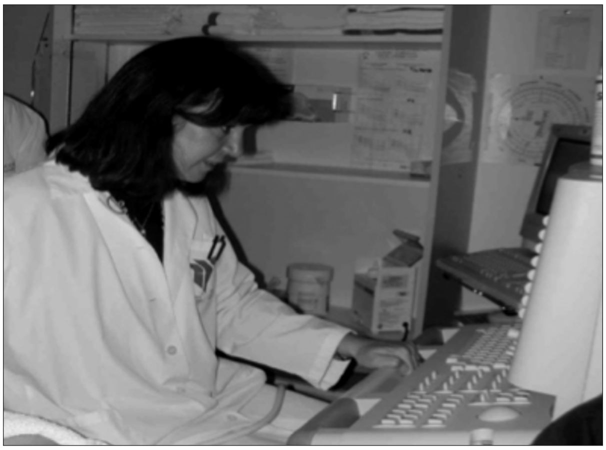


Figure 11. Demonstration of protraction of the cervical spine. The equipment has a fixed-height monitor that only swivels.

Figure 12. This monitor has good articulation, allowing many different positions. It can be placed to reduce neck issues. Reproduced with permission from Philips Healthcare.

Figure 13. Older equipment with a fixed monitor.

you can add a second monitor that can be positioned more within your line of sight. If you share the examination images with your patients, consider adding an auxiliary monitor that can be positioned for patient viewing. You will then be able to position your monitor so that it is comfortable for your viewing.

5. Trunk twist—This position increases pressure and shear force on the intervertebral disks and can cause back pain and disk disease.

   Best Practice—Position all examination room equipment and the patient so that you minimize your need to twist to access either the ultrasound system or the patient. When performing lower extremity venous studies, instruct patients to self-augment by flexing and extending their foot (Figure 14). This maneuver reduces the need for you to twist your trunk to compress the calf veins with your left hand (Figure 1B). Whenever possible, endovaginal examinations should be performed from the end of the examination table (Figure 16). It will be necessary to bring the ultrasound system to the end of the examination table when performing this examination from the end of the table.

6. Trunk bending—This position increases pressure and sheer forces on the intervertebral disks.

   Best Practice—Adjust the height of the examination table to avoid bending over (Figure 17). Position the patient and the ultrasound system so that you can view the monitor without bending or twisting. This factor is especially important when using a computer workstation, which should ideally have a height-adjustable desk and chair if it is to be used by multiple users. The computer workstation and the picture-archiving computer workstation are part of your workday tasks and should have the same adjustable features as the examination room equipment.

7. Wrist flexion, extension, or deviation—These positions increase the pressure in the carpal tunnel and compress the median nerve (Figure 18). Injury to this nerve can result from contact pressure, such as resting your wrist on the edge of a desk or the control panel, or from pressure against the nerve from the carpal bones or the surrounding soft tissues.

Figure 14. The patient is flexing the foot to self-augment the Doppler signal in a deep venous thrombosis leg study. The cable is trapped in a cable brace to take the weight of the cable and resultant torque off the wrist. Note that the wrist is in a neutral position.

Figure 15. **A** and **B**, Both of these sonographers have twisted trunks and necks. The positions are high risk for work-related musculoskeletal disorders.

A **B**

Best Practice—Avoid resting your wrist on the ultrasound control panel. Try to grip the transducer in new ways that allow you to keep your wrist in a neutral position (Figures 1, 19, and 20). It is also important to keep your wrists straight when working on the computer, which may require a negative tilt keyboard tray or a wrist rest. Be careful when moving equipment for bedside studies, especially when going over the threshold of elevators or pushing equipment up ramps. When pushing the equipment, use your legs and keep your forearms and wrists straight.

8. Grip—Pinch grips increase strain on the forearm muscles. It takes up to 5 times more muscle and tendon force to hold an object in a pinch grip.[22]

Figure 16. Endovaginal scanning should be performed from the bottom of the table rather than the side. This position reduces arm abduction and resultant shoulder pain and discomfort. The sonographer can sit or stand to perform this test.

Best Practice—Try to use a palmar grip as much as possible. The hand is stronger in a palmar grip, and strain on the muscles of the forearm and hand is reduced. Using this grip might require some practice but will result in less pain and discomfort during each workday.[22]

Economics of Ergonomics

It is important to reduce injury risk to your staff. Not only do you prevent ending the career of a valuable member of the medical team, but you also maintain a stable, experienced, productive staff in which you have diagnostic confidence. It is not safe to assume that "there are more where that one came from."

The US Bureau of Labor Statistics reported 650,000 work-related musculoskeletal disorders, resulting in costs to employers of more than $20 billion.[23] The financial impact of these injuries to the employer can be grouped into direct costs and indirect costs. Direct costs include the medical costs associated with treating the injury and the workers' compensation costs. The mean cost of treatment per case of upper extremity work-related musculoskeletal disorder is $8070 versus a mean cost of $4075 per case for all types of work-related injuries. Medical bills for the average shoulder injury, excluding surgery, are $20,000 per year; $1 of every $3 of workers' compensation costs is spent on work-related musculoskeletal disorders, and each injury claim can be approximately $29,000 to $32,000 per year. Employers pay $15 to $20 billion per year in workers' compensation costs for lost workdays.[23,24]

Figure 17. **A** and **B**, These sonographers are bending their trunks. To correct these positions, the table and the equipment need to be raised and the patient moved to the right and closer to the sonographer.

A

B

Indirect costs are 3 to 5 times higher than the direct costs and are approximately $150 billion per year.[23,24] These include the cost of hiring and training replacement staff and the loss of revenue secondary to decreased productivity during time lost.[23,24]

It is not well known that improving ergonomics almost always can improve a company's productivity.[25] A study on the relationship between ergonomic work environments and productivity from a broad cross section across North America found that absenteeism fell from 4% to 1% after workstation design changes were implemented. Blue Cross Blue Shield found that after implementing ergonomic designs in employee workstations, there was a 4.4% improvement in productivity. A comprehensive ergonomics program at Johns Hopkins Hospital resulted in an 80% reduction in musculoskeletal disorders over a 6-year period. Productivity is increased if employees' work areas are arranged to suit them and the type of work being done. Dollars spent on improving the ergonomic design of the workstation have an excellent return on investment. This investment leads to improved performance of workers and improved employee well-being. Ergonomics provides the foundation for effective management and well-trained workers to perform at their best level, thus increasing productivity and profits. When a task is matched with the ability of the people who will perform it, they will make fewer errors and produce less waste. Simply put, reducing unnecessary or awkward postures and exertions almost necessarily reduces the time it takes to complete a given task, thus improving productivity.[25,26]

Figure 18. **A** and **B**, Deviation of the wrist, which is especially high risk when using force. The shoulder is also abducted and the forearms unsupported.

A

B

Figure 19. The left arm is unsupported, and the cable is around the neck of the cardiac sonographer.

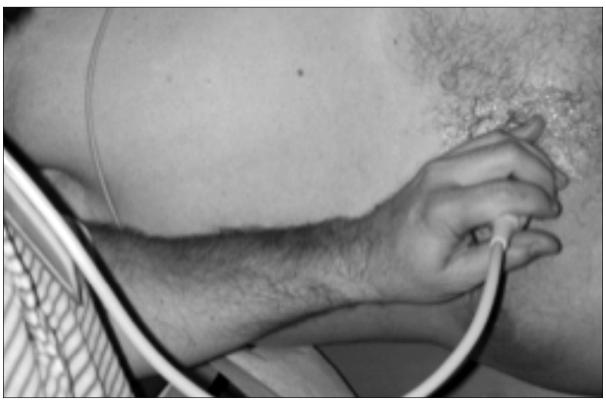


Figure 20. The right arm is supported and the cable is trapped in a cable brace. The vascular sonographer is looking directly at the monitor.

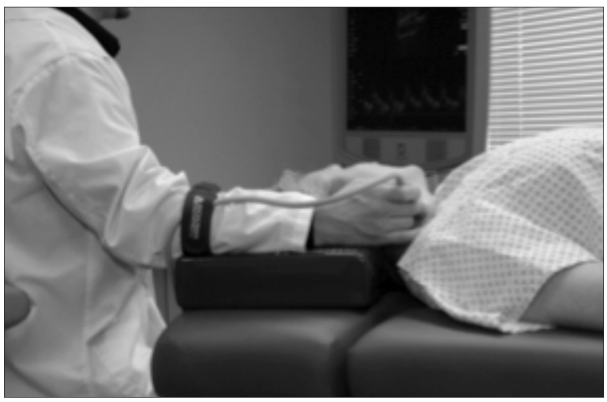


Figure 21. **A** and **B**, Good postural alignment and equipment positioning. The monitor is the correct height in both images; the chair and table are also correct with the sonographer's elbow at 90°. The shoulder is less than 30° abducted. The sonographer's feet are supported on the ring of the chair. The chair back is supporting the sonographer. Both sonographers' shoulders are not abducted; their necks and trunks are not twisted. **A**, Reproduced with permission from Philips Healthcare. **B**, Reproduced with permission from Siemens Medical Solutions (Mountain View, CA).

A

B

Conclusions

The causes of work-related musculoskeletal injuries among sonographers are multifactorial and, thus, require multiple methods to decrease the risk. An ergonomic workstation plays a major role in mitigating these injuries, but changing sonographers' work practices is the key to successfully reducing injuries. Sonographers must take the time to optimize the ergonomic features of the workstation equipment, and they must make changes in those work postures that cause pain. Examples of good postural alignment and equipment positioning are shown in Figure 21.

Alternate between sitting and standing during an examination. Remember to readjust the examination table and the monitor height whenever you change your position. Throughout the examination, take a few seconds to relax your upper extremities. Avoid prolonged static postures at the extreme range of a joint's capacity. Choose seating that promotes subtle movement.

The ergonomic features of your examination room equipment are only as good as your willingness to use them. The key to the effectiveness of these features is changing your work postures so that you maintain neutral postures for the majority of each examination. Comfortable work postures can make any ultrasound workstation ergonomic, reduce injury risk, increase worker comfort, and impact the quality of patient care.

Prolonged static postures prevent the normal perfusion of muscles and tendons. Muscle contractions and relaxations facilitate the flow of oxygen-carrying blood into soft tissues and allow for the removal of wastes. Computerization of the workplace has removed the need for us to move to perform our work tasks.[19]

Understanding the importance of optimal body mechanics and how to maintain neutral postures will enable sonographers to reduce the risk factors associated with their profession.[4,18] Even with the most advanced equipment, an ergonomic workstation is only as effective as the person using it.

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