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Cardiovascular Sonography: The Painful Art of Scanning

Marti L. McCulloch, RDCS*
Tianrong Xie, M.D.†
David B. Adams, RDCS‡

*Cardiovascular Consultant
Houston, Texas

†Researcher, University of Texas Medical Branch
Galveston, Texas

‡Cardiac Sonographer, Duke University
Raleigh, North Carolina

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Lesson Objectives

Upon completion of this lesson, the reader should be able to:

1. Discuss the prevalence of musculoskeletal injuries (MSIs) within the field of cardiovascular ultrasound.
2. Identify causes or risk factors of MSIs associated with cardiovascular scanning.
3. Discuss ergonomic methods for prevention of MSIs.
4. Describe the biological response of tissue to loading conditions.
5. Explain the importance of addressing and reassessing painful scanning techniques.
6. Discuss prevention and the critical role of the sonographer.
7. Explain three factors that influence work-related injuries.
8. List common work-related injuries in sonography and describe possible methods of prevention.
9. Discuss the importance of a safe scanning environment.
10. Discuss the current epidemic of MSI in cardiovascular ultrasound.

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Cardiovascular Sonography: The Painful Art of Scanning

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Does Performing Ultrasound Involve an Inherent Risk of Musculoskeletal Injury?

A review of the literature suggests an associated risk of injury in occupational fields that perform repetitive movements, static/awkward postures, and/or constant pressure or stress on specific muscles. One of the earliest articles mentioning occupational risk of injury dates back to a 1713 Latin text, by Bernardino Ramazzini, who wrote *De Morbis Artificum Diatriba* (English translation: Diseases of Workers). The author begins with: "I now wish to turn to workers in whom certain morbid affections gradually arise from some particular posture of the limbs or unnatural movements of the body called for while they work." He further elaborates on various occupations of the time that required repetitive motions and static postures which, if not remedied, could lead to life-altering disabilities. Ramazzini also had the foresight to recommend frequent rest and exercise as a method of preventing long-term disability.

As noted by Ramazzini's article, occupational hazards due to work-related stressors are not a new concept. In the past 30 years, multiple articles investigating the occupational dilemma have been published. The advent of research began with the rising cost of direct and indirect work-related injuries. For example, in 1997 the National Institute for Occupational Safety and Health (NIOSH) estimated an overall cost for workplace health and safety to be $11.26 trillion, with $418 billion in direct cost and $837 billion in

indirect costs. It is estimated that 30 to 40% of these costs represent musculoskeletal injuries (MSI).

The purpose of this article is to determine the prevalence of injury within the field of cardiovascular ultrasound, identify the causes, and examine methods of prevention. Our hope is to raise MSI awareness, suggest preventive measures, and reduce the risk of injury.

Survey

Methods and Distribution

A survey was developed to assess the relative musculoskeletal condition of cardiovascular sonographers. Fourteen questions relating to demographics, ergonomics, and workloads were asked (Appendix). In addition, the type of medical treatment sought, if any, and the rate of success was included in the survey. The demographics included name, age, height, and weight. Only anonymous cumulative data was used to analyze the responses to the survey. Questions pertaining to ergonomic data asked about the scanning hand, which side the patient was imaged from, and the type of table or bed used. Several questions regarding workload were asked to better understand the level of work intensity. These included the amount of workload, type of scanning (other than cardiac), years of scanning, and average studies per day. The intensity of workload included average time per study, total hours per day actually scanning, and amount of rest between studies. Respondents were asked to mark the location of pain with respect to level of discomfort on a schematic drawing. The level of discomfort was classified as minor, major, or disabling for 20 specific muscular areas.

The survey was distributed to subscribers of *Cardiac Ultrasound Today, Pediatric Ultrasound Today,* and *Vascular Ultrasound Today* in the fall of 2001, with a request that recipients distribute copies to other sonographers in their institutions. A December 15, 2001, deadline for returning completed survey forms was given. Completed surveys were either faxed or mailed back for analysis. The surveys were categorized according to discomfort in relation to workload and ergonomic factors.

Survey Results

A total of 295 responses to the survey were received (mean age, 42.9±8.4). Figure 1A shows the number of years of scanning reported, with 64% of respondents scanning more than 10 years and 37% scanning fewer than 10 years. Figure 1B shows the mean age ±SD related to years of scanning. Cardiac sonographers represent-

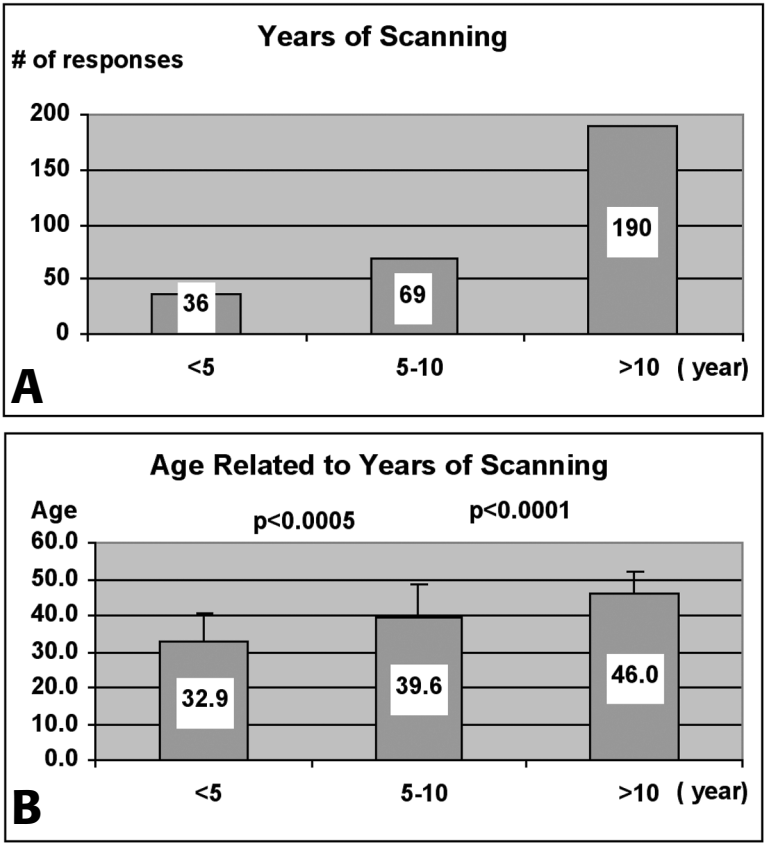


Figure 1. A: Years of scanning. Note the high percentage (64%) of sonographers scanning more than 10 years, with 37% scanning less than 10 years. B: Mean age related to years of scanning.

ed 75% (221) of the survey respondents. The type of scanning and the corresponding percentages showed that many sonographers scan in multiple specialties (Table 1).

Of the 295 responses, 82.0% (242) reported some level of discomfort (minor, major or disabling), with 67% (162) of the total reporting major or disabling discomfort (Figure 2).

Medical treatment was sought by 48% (142), including 54% (131/242) who had discomfort and 20% (11/53) of individuals with no complaints of discomfort (it is assumed that treatment lead to recovery from discomfort). Of the 131 from the discomfort group receiving treatment, 56% (74) considered it successful and 43% (57) did not perceive treatment as helpful.

Table 1
Type of Scanning and Corresponding Percentages

Type of Scanning	Total #	Percentage
Abdominal	55	19
Cardiac	221	75
General	32	11
Ob-Gyn	34	12
Transcranial	19	6
Vascular	106	36
Adult	129	44
Pediatric	66	22

Workload intensity was divided into three categories based on the number of studies per day (< 5, 6 to 8, > 9) and the number of minutes per study (< 30 minutes, > 30 minutes). Only three respondents reported studies > 60 minutes, and they were therefore eliminated from the analysis. No discomfort, minor discomfort, major discomfort, and disabling discomfort were then charted with respect to workload intensity.

Survey respondents who performed five or fewer studies per day had a higher percentage of major and disabling discomfort with a scanning time > 30 minutes than did those with a scanning time < 30 minutes. Minor discomfort was higher in those who reported scanning times > 30 minutes (Figure 3). However, there were no statistically significant differences between the two groups.

In the group that averaged 6 to 8 studies per day, major and

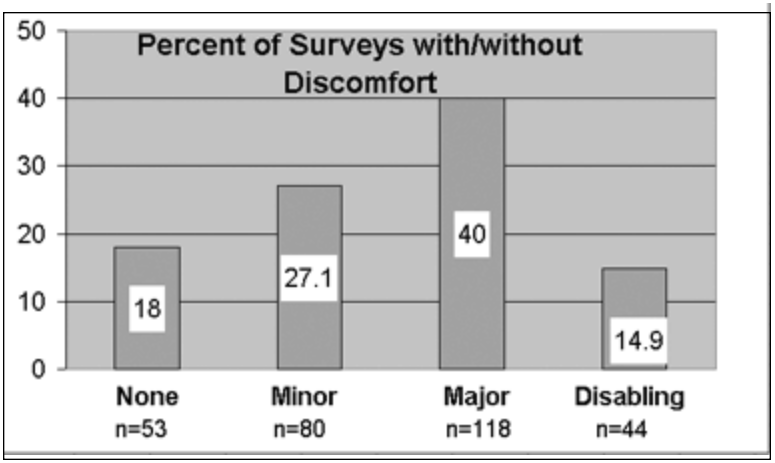


Figure 2. Levels of discomfort reported by survey respondents. Only 18% reported no discomfort.

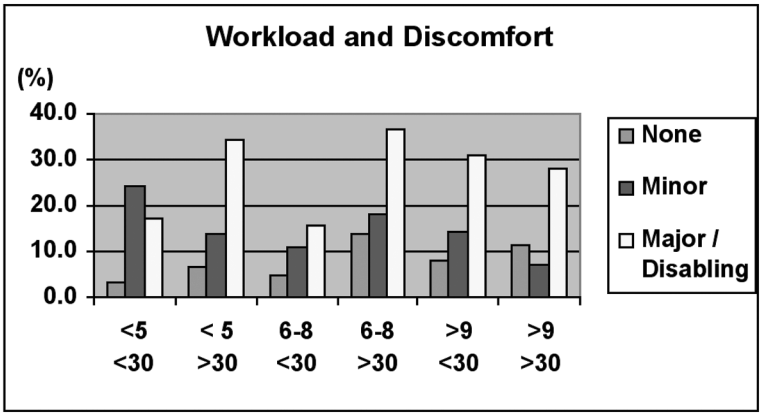


Figure 3. Level of discomfort related to workload intensity and number of studies performed per day.

disabling discomfort was significantly higher in those who reported scanning times > 30 minutes than in those whose scanning times were < 30 minutes. There was no statistically significant difference in respondents who reported minor discomfort (Figure 3).

In the group that scanned > 9 studies per day, the percentage of respondents with discomfort was slightly low in those who reported scanning times > 30 minutes, although there were no statistically significant differences when compared to those who reported scanning times < 30 minutes (Figure 3).

A majority of respondents, 64% (190/295), have been scanning for more than 10 years, which correlated with a higher mean age group (46±6.2). 23% (69) of respondents, with a mean age of 39.6+9.0 years, have been scanning 5 to 10 years. Only 12% (36) have scanned for less than 5 years, and this group had a much younger mean age of 32.9±7.8 years (Figure 1B).

Of the 105 respondents who reported less than 10 years of scanning, 81% (85) had some level of discomfort and 49% (52) had major or disabling discomfort (Figure 4A). Of the 190 respondents who reported scanning more than 10 years, 83% (157) had some level of discomfort with a higher major or disabling discomfort of 57.9% (110/190) (Figure 4B). Interestingly, when those scanning over 10 years were compared with those who had less than 10 years based on workload intensity, no significant differences were found between the two groups, except those who reported less than 10 years of scanning with < 30 minutes per study and more than 9 studies per day had significantly higher minor discomfort that those who reported more than 10 years of scanning with same workload in-

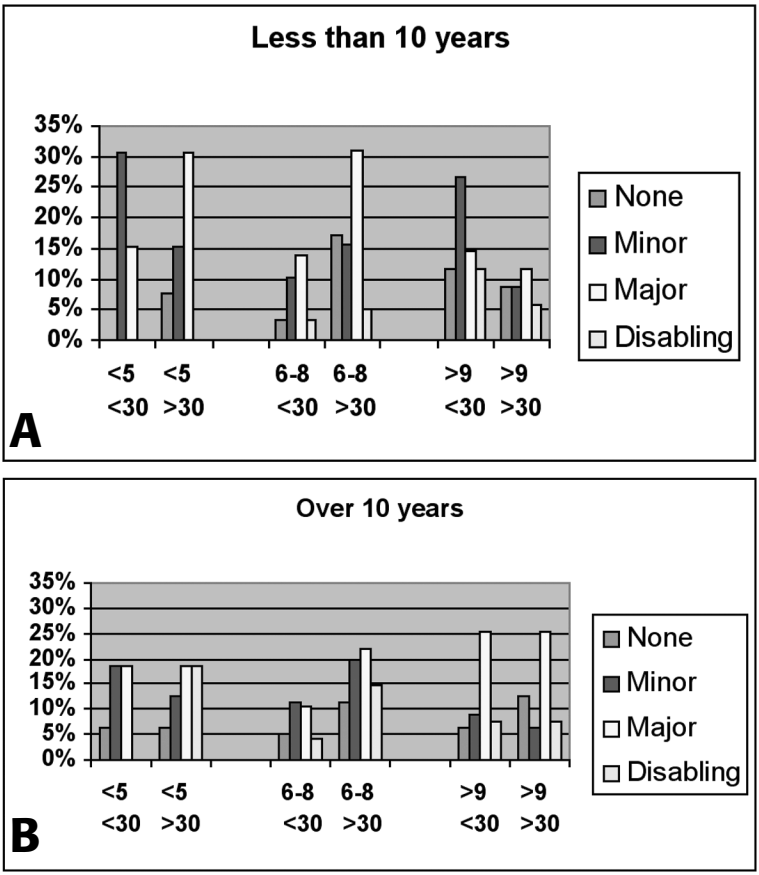


Figure 4. A: Workload intensity related to discomfort in sonographers scanning less than 10 years. A total of 81% had some level of discomfort, of which 49% had major or disabling discomfort. B: Workload intensity related to discomfort in sonographers scanning more than 10 years. A total of 83% had some level of discomfort, of which 58% was major or disabling discomfort.

tensity.

Analyses of left-handed, right-handed, and ambidexterous scanning were compared: 43% (128) use the left hand to scan, 41% (120) use the right hand, and 16% (47) use both hands to scan. Of the 128 left-handed scanners, 16% (21) had no discomfort, 32.0% (41) had minor discomfort, 38% (48) had major discomfort, and 14% (18) had disabling discomfort. Of the 120 right-handed scanners, 18% (22) had no discomfort, 25% (30) had minor discomfort, 44% (53) had major discomfort, and 13% (15) had disabling discomfort. Of the 47 people who scan with both hands, 21% (10) had no discom-

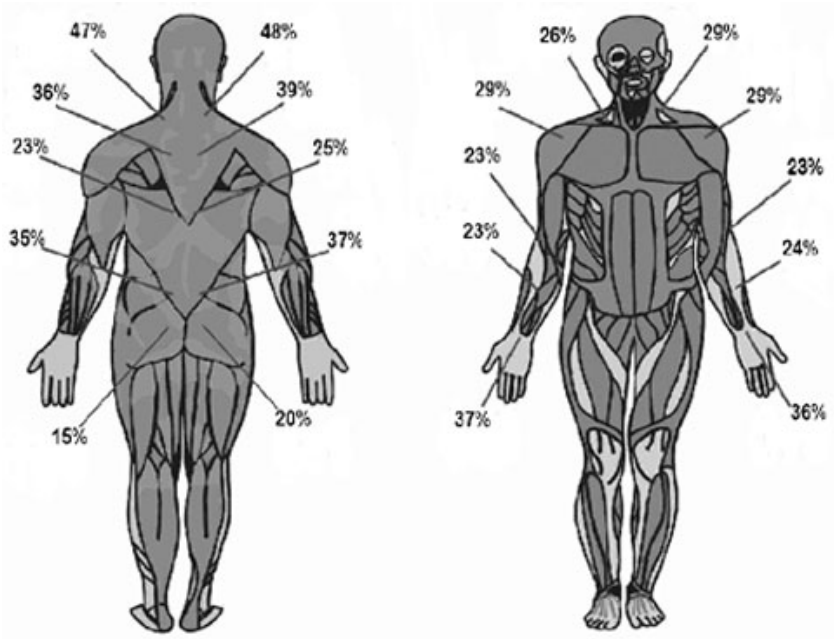


Figure 5. Left and right anatomical sites, with some level of discomfort reported by survey respondents. Note that reports of pain on the left and right sides show little difference in the percentage of occurrence.

fort, 19% (9) had minor discomfort, 36% (17) had major discomfort, and 24% (11) had disabling discomfort. There were no statistically significant differences in the comparisons among left-handed, right-handed, and both-hands scanners with and without different levels of discomfort. Percentages of discomfort at different locations are shown in Figure 5.

Discussion

This survey demonstrates an 82% prevalence of musculoskeletal discomfort within a select group of cardiovascular sonographers. The percentage may appear overwhelmingly high, yet it correlates with previous studies. Smith et al., who performed a similar survey in 1997, found "80% of their respondents reported musculoskeletal pain." In addition, the Society of Diagnostic Medical Sonographers (SDMS) survey results, reported during an Occupational Safety and Health Administration (OSHA) hearing concerning ergonomics, found that 80% of sonographers are scanning in pain. In a 1993 survey for the analysis of carpal tunnel syndrome (associated with cardiac sonography) by Vanderpool et al., slightly lower results

were reported, with 63% of the total having experienced symptoms of carpal tunnel syndrome. However, the response rate for Vanderpool et al. was low (47%) and could be a limiting factor to the percentage experiencing symptoms.

This study showed that when the total number of studies done per day increases, so does the prevalence of musculoskeletal discomfort. When we couple the number of studies performed daily with the length of time per study, the ratio increases even further. Vanderpool et al. reported a similar correlation, stating, "72% with pain reported performing more than a 100 scans per month."

Further correlation is present outside of the United States. Magnavita et al. surveyed the entire Ultrasound Section of the Italian Society of Radiology and the Italian Society of Ultrasound in Obstetric and Gynecology. Of the 2670 total survey respondents, 74% (2041) reported scanning in pain/discomfort. The authors concluded that both groups (American sonographers and Italian sonologists) suffer similar "cumulative trauma disorder."

Interestingly, even though there is an ongoing debate regarding right-handed versus left-handed scanning techniques, this study showed very little difference between the two types of scanning in regard to discomfort (Figure 5). In fact, there was a fair representation of both scanning techniques: 128 respondents scanned left-handed, 120 scanned right-handed, and 47 scanned ambidextrous. If a correlation between injury and type of scanning technique were present, it would have been detected. In contrast to popular belief, there is no correlation, rather, an uncanny similarity in discomfort between both the left and right side of the musculoskeletal system (Figure 5).

Limitations

More survey responses with a wider variety of sonographers may have yielded different outcomes with respect to discomfort. Granted, it may be that individuals with current musculoskeletal problems are more likely to respond to a survey that deals with a personal issue; this would account for the high number of sonographers responding with pain symptoms. Another limitation, noted by Craig, is that cardiovascular sonographers often "go portable" with systems weighing in excess of 300 to 400 pounds. This observation was correlated with data from Smith et al. and should have been part of the workload portion of this survey. Portable examinations often involve not only transporting the machine, but also moving furniture and scanning in twisted (spine) positions.

Furthermore, pain is the leading indicator of musculoskeletal in-

juries and is very difficult to diagnose because of the subjective nature of pain itself. Only the injured party can relate the level of discomfort associated with pain, thereby making the clinical diagnosis of discomfort very difficult to determine. As a result, Schierhout et al. suggested a tendency for discrepancies with qualitative self-reporting questionnaires.

Risk and Prevention

Mechanism of Injury

Work-related injuries result from minuscule cumulative traumas to human tissues. Scientific research verifies tissue breakdown due to loading conditions, but there is no specific threshold that can be considered safe for all individuals because the biological makeup of each person differs considerably. In addition, it is the combination of biological and biomechanical factors that influence the breakdown of tissues. Depending on the individual, specific loads can be adapted to or tolerated, but will eventually fail if constantly overloaded without sufficient rest or recovery. Another source of muscle fatigue and potential injury can occur with very low levels of muscle contraction when maintained for long durations, a technique often used during cardiac studies. As a result, many sonographers have more than one area of discomfort.

Origin of Injury

Three factors influence work-related injuries: biological makeup, external stressors, and work environment.

Biological Makeup. Biological makeup is dependent on individual factors such as age, height, weight, and level of fitness. Although age and height are predetermined, weight and level of fitness can often be improved. Currently, there is conflicting data available regarding whether exercise and fitness play a positive role in prevention, as exercise has been attributed to musculoskeletal disorders. However, athletes exercise and train for specific sports in order to reduce the risk of injuries and the same methodology can be applied to cardiovascular sonography. While condition training for safe scanning is a novel concept, no one with immediate discomfort should begin an exercise program without first consulting a physician.

Exercise and stretching programs have been developed for sonographers to help strengthen the torso and upper extremities. A wealth of information regarding appropriate exercises for sonographers is posted on the Society of Diagnostic Medical Sonography (SDMS) website under “Work Zone” (sdms.org) and in the Novem-

ber/December 2001 issue of the Journal for Diagnostic Medical Sonographers from author Cathy Jakes.

Recently, wellness programs have become a popular practice in the work place. A well-balanced program provides useful and informative instruction for employees regarding overall well-being. Typically, meetings are held monthly or bi-monthly with a focus on musculoskeletal safety and prevention, exercises, and the importance of stretching. Depending on the facility, wellness programs can be developed in house or contracted out. It should be noted that wellness programs are more successful when there is positive support and reinforcement by administrators.

External Stressors. External stressors involve exertional force, posture, and contact or static stress. The first line of defense must be the sonographer. Musculoskeletal pain, like chest pain, is an indicator that something is wrong. Enduring or ignoring pain perpetuates an injury. Sonographers must be taught how to prevent potential injuries (Figures 6–10). Injuries associated with external stress involve low back pain, upper back/neck pain, shoulder pain, tendonitis, epicondylitis, and carpal tunnel syndrome (CTS) or nerve compression. Figure 6 shows five examples of potential injuries associated with scanning incorrectly. Each example includes a description of the causes as well as methods for prevention. In addition, Table 2 provides a basic definition of these injuries along with common causes and typical prevention and/or treatment.

Low Back Pain. Lower back pain is commonly caused by muscle strain from poor, awkward, or static postures and can be prevented by assuring correct posture alignment and reducing the duration of static posture by relaxing or taking small breaks.

Upper Back and Neck Pain. Upper back and neck injuries also result from repetitive strain on muscles and ligaments due to poor, awkward, or static posture. Prevention involves making adjustments to the monitor and patient while maintaining a comfortable resting position for the arms and shoulders.

Shoulder Pain. Shoulder disorders arise from joint instability caused by abduction (arm extended out away from the torso) > 20° and repetitive, excessive, or static force. In order to avoid shoulder joint instability, position the patient close to the edge of the bed; this will narrow the reaching area and reduce arm abduction (arm close to torso) to < 20°. In addition, both the patient table and the ultrasound keyboard should be adjusted to allow an optimal 90° angle for the elbow.

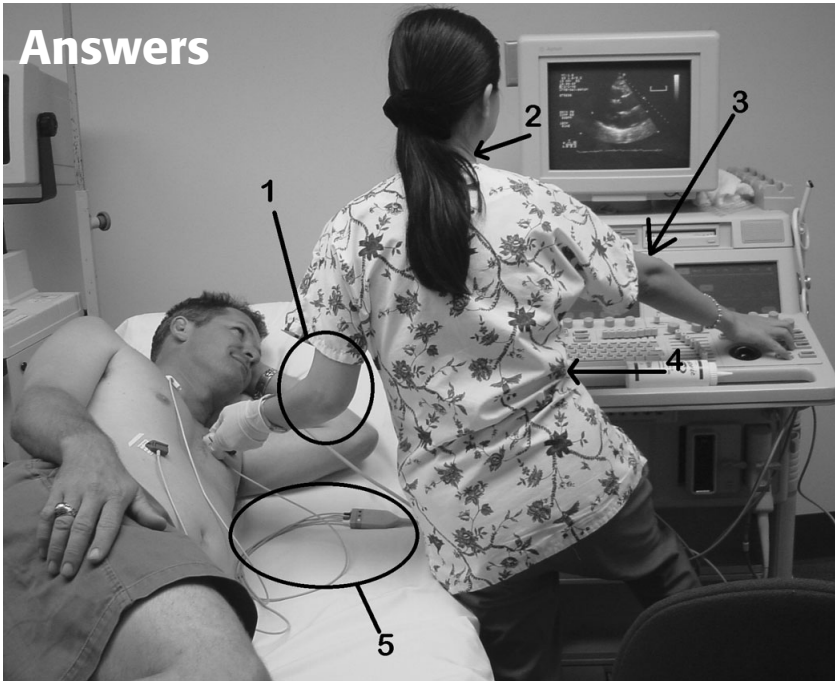
Tendonitis. Tendonitis is an overuse or repetitive force injury

Continued on page 89

Table 2
Common Injuries with Associated Definitions, Causes, and Prevention/Teatment

Common Injury	Definition	Causes	Prevention/Treatment
Low back pain	Pain in the spine or muscles of the lower back	Muscle strain due to poor/ awkward or static posture	• Correct posture alignment • Decrease duration of static posture
Upper back/neck pain	Pain in upper back radiating to clavicle and neck	Repetitive strain on muscles and ligaments due to static or poor/awkward posture	• Adjust monitor • Adjust patient • Avoid neck strain
Shoulder pain	Instability of joint due to trauma or injury from degeneration of muscle, tendons, and ligaments	> 20° abduction, repetitive excessive or static force, lack of support	• Adjust patient and equipment • Decrease abduction to ≤ 20° • Rest arm • Allow 90° angle for elbow
Tendonitis	Inflammation of a tendon that reduces a smooth gliding effect	Overuse or repetitive force	• Rest • Alternate scanning hand
Epicondylitis	Inflammation of the muscles of the forearm, or tendons near origin of the humerus	Repetitive twisting of the forearm or wrist with force	• Rest the elbow when flexion and extension is painful
CTS/nerve compression	Pain, tingling, burning, numbness in the hand and fingers	Compression of the median nerve due to awkward wrist angle	• Rest • Wrist flexion/extension • Wrist splinting • Steroid injection to reduce swelling • Surgery

Figure 6. What's wrong with this picture? Look for five errors in positioning that can lead to injury. Answers are discussed on pages 84–85.



Answers: What's wrong with this picture?

1. The left arm is extended (abducted) > 20° without support. As a result, shoulder pain may occur. In order to prevent an injury:
   - Move the patient closer to the edge of the bed. This will allow the left arm to be closer to the torso.
   - Raise the bed so the height provides a 90° angle for the elbow and allows the arm to rest down on the bed.
2. The patient and the machine are too far away from one another. This leads the sonographer to strain her upper back and neck in a static and awkward manner in order to see the monitor. To prevent an injury:
   - Adjust the machine and the monitor closer to the bed.
   - Move the patient closer to the edge of the bed.
   - Try to position the monitor directly in front of the sonographer.
3. The right arm is extended straight out (> 20°) and the wrist is in an awkward position in an attempt to reach the knobs of the ultrasound machine. Increased static strain on the right shoulder, elbow, and wrist could lead to shoulder pain, epicondylitis, and carpal tunnel syndrome. To prevent an injury:
   - Adjust the machine at an angle so the knobs are closer to the sonographer.

- Put the elbow at a 90° angle.
- Position the wrist in a straightforward manner.

4. The torso is in a poor and compromised position in order to reach both the patient and the ultrasound system. Muscle strain due to poor posture can injure the lower, mid, and upper back. To avoid an injury:
   - Move the patient closer to the edge of the bed (toward the machine).
   - Place the machine closer to the patient.
   - Constantly be aware of poor posture and straighten the torso.
5. There is approximately a foot of space between the sonographer and the patient and a foot of space between the bed and the sonographer's elbow. This leads to poor static posture, abduction > 20°, and lack of support for the left arm. Possible injuries include low back, upper back, and neck pain, shoulder pain, tendonitis, epicondylitis, and CTS. To prevent these injuries:
   - Move the patient closer to the edge of the bed.
   - Raise the bed up to the level of the elbow so the arm can rest on the bed.
   - Adjust the machine and the monitor closer to the patient and in front of the sonographer.

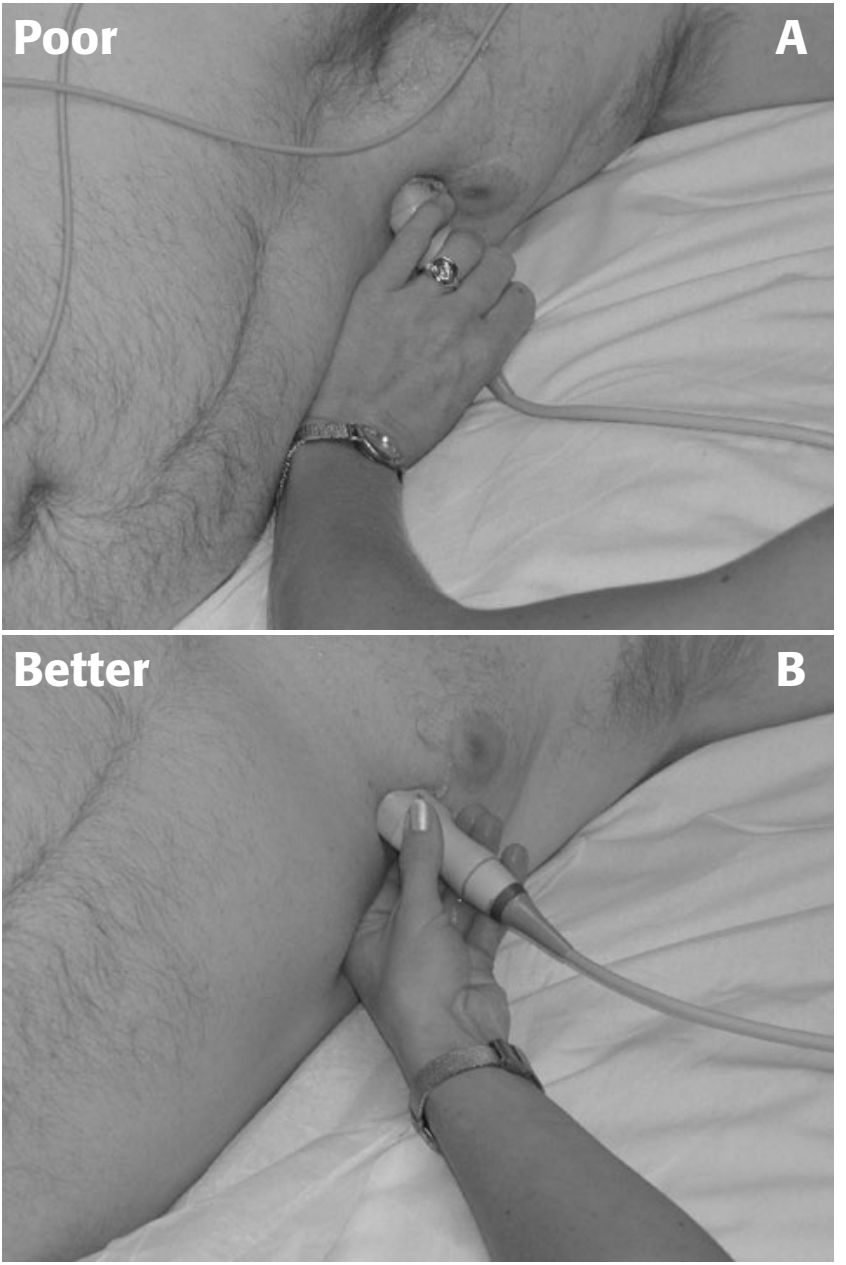


Figure 7. A: The wrist is extended and can cause compression of the median nerve due to the awkward angle. This can cause CTS. B: Injury can be avoided by: (1) straightening the wrist, (2) frequent rest, (3) intermittent flexion (flexed downward) and extension (flexed upward).

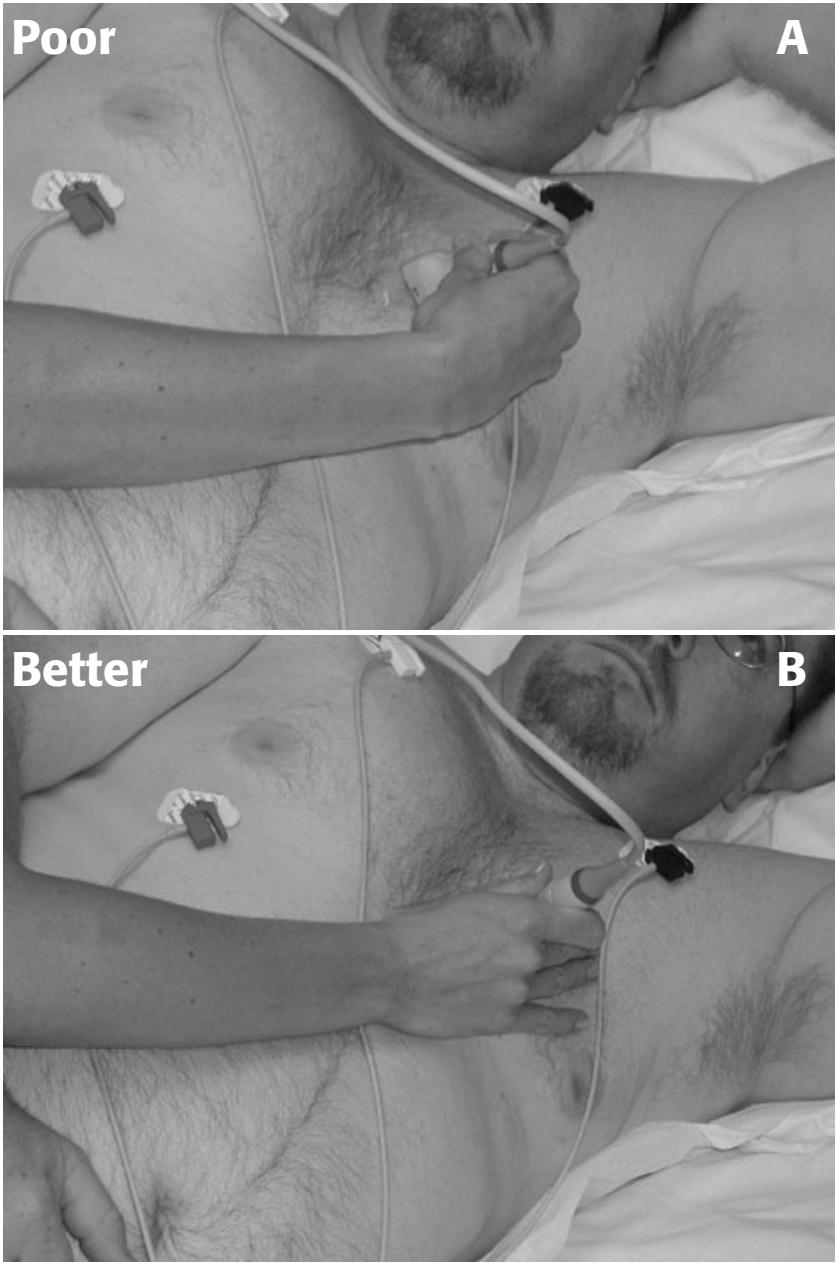


Figure 8. A: The wrist is flexed and can cause compression of the median nerve due to the awkward angle. This can cause CTS. B: Injury can be avoided by: (1) straightening the wrist, (2) frequent rest, (3) intermittent flexion (flexed downward) and extension (flexed upward).

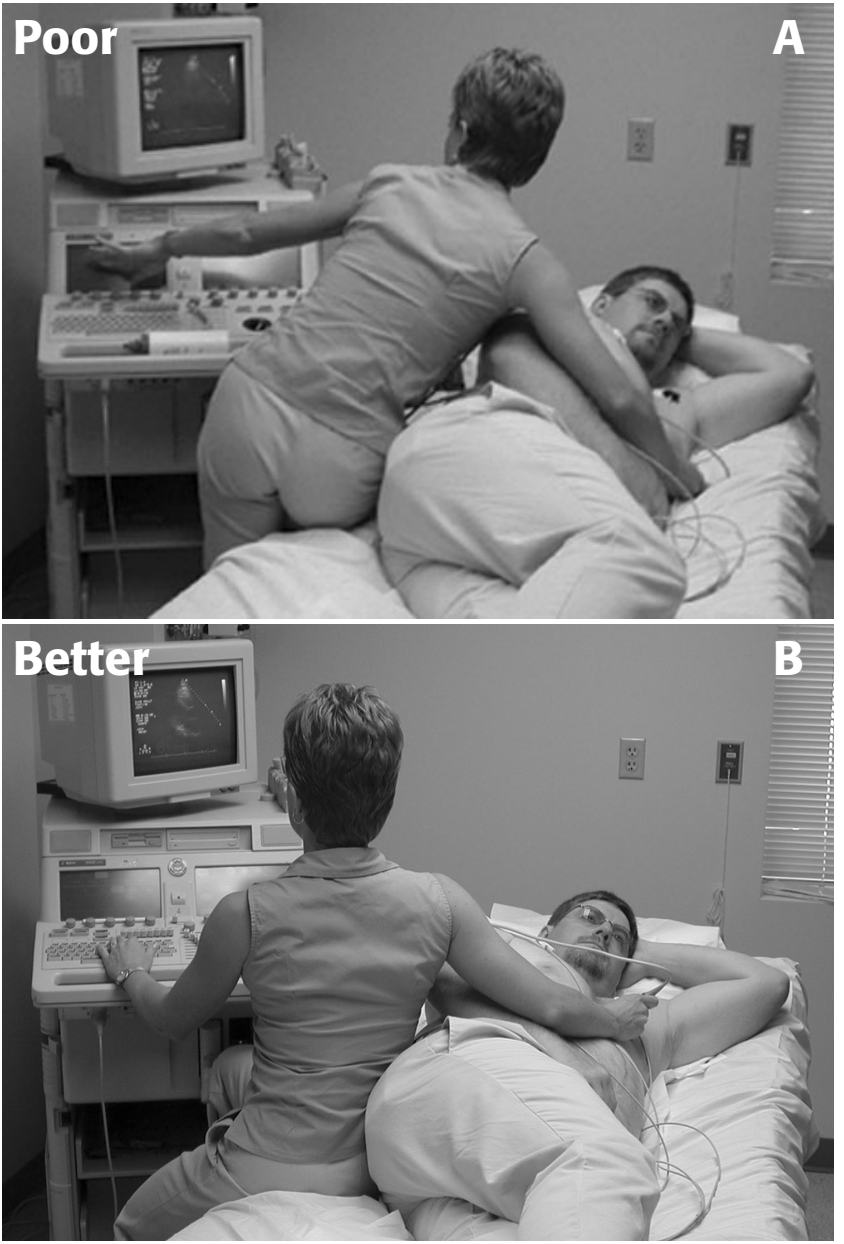


Figure 9. A: Notice the sonographer's poor torso posture due to reaching for an image with the right scanning hand. This increases strain on the lower back, upper back, and neck. In addition, the left arm is stretched out in an awkward position in order to reach the system control buttons. B: Minor adjustments to the patient, equipment, and scanning technique can often provide safe and comfortable scanning positions.

Table 3
Ergonomic Resources for Occupational Injury

Description	Website
Sonography exercises	sdms.org/msi/exercise.asp
Ergonomic services, educational tools, publications, and support material	soundergonomics.com
Primer for workplace evaluations of MSI	www.cdc.gov/niosh/ephome2.html
Adjustable chairs, tables, and tools	www.ergostoreonline.com

that causes inflammation of the tendon (typically in the forearm). Its occurrence can be reduced by rest and/or by alternating the scanning hand.

Epicondylitis. Inflammation of the muscles and tendon near the elbow area is called *epicondylitis,* which is produced by repetitive twisting of the forearm or wrist with force. Prevention of epicondylitis can be obtained with comfortable scanning and by resting the elbow when flexion and extension is painful.

Carpal Tunnel Syndrome and/or Nerve Compression. Carpal tunnel syndrome (CTS) is a nerve compression disorder that can occur in either the scanning hand or in the alternate hand used to manipulate the knobs and keyboard of the ultrasound system. CTS is commonly the result of awkward wrist angles, as shown in Figures 7A and 8A. Correction of the inappropriate angles is shown in Figures 7B and 8B. Signs and symptoms of CTS include pain, tingling, and burning or numbness in the hand and fingers due to compression of the median nerve as a result of repetitive force and/or awkward angles of the wrist. Prevention of CTS involves frequent rest or breaks with flexion (wrist turned downward) and extension (wrist turned upward) of the wrist. Treatment of CTS includes wrist splinting (to avoid awkward angles), steroid injection (to reduce swelling), and surgery.

However, once an injury occurs or surgery is performed, the probability of re-injury increases, which is why prevention is extremely critical. In general, cardiovascular sonographers need to scan in comfort. Minor adjustments in scanning technique, equipment placement, and patient position can often produce comfortable scanning positions, thereby reducing the risk of injury (Figure 9). If a task is painful, stop and reassess the situation. Use any tools (arm rests and wedges) or assist devices (pharmaceutical contrast) available, and always make the patient work with you whenever possible. A variety of risk prevention ergonomic tools are available to help reduce additional external stress. Some of these

include chairs with foot-rests, tables with dropouts, and flexible ultrasound equipment. For further information regarding ergonomic resources, please review the websites listed in Table 3.

Editor's Comments: The proper equipment to allow for proper posture and joint alignment is essential. Suitable chairs and scanning tables, with height adjustability and flexible features for specific needs (foot rests, Fowler positioning, drop sections for apical scanning and sonographer entry for right-handed scanning) have been available for several years now. The ultrasound unit manufacturers are finally starting to respond to sonographer input by designing more user-friendly platforms with adjustable keyboards, monitors, redesigned probes, and control areas. Height adjustability and side-to-side movement of these workstations will allow more flexibility in positioning not only the patient, but also the sonographer. —Debra Fulps, RDCS

Work Environment. Because of the repetitive nature of cardiac scanning, scheduling and task rotation can play an important role in prevention. Depending on the work setting (i.e., clinic, hospital, or mobile), there may be opportunities for cross-training sonographers to vary the studies performed daily and to increase task rotation. For example, many hospitals perform regular echoes, portable echoes, exercise stress echoes, pharmaceutical stress echoes, and transesophageal echoes. Rotating daily assignments among sonographers will improve variation and reduce the repetitiveness of specific studies. Changing from pharmaceutical stress echoes to transesophageal echoes creates a vast difference in external stressors and body mechanics.

Moreover, the workplace is responsible for providing a safe scanning environment with adjustable ergonomic equipment and a reasonable schedule. A reasonable schedule includes variation as well as enough time for the sonographer to properly set up a safe scanning environment. Time constraints become an important issue as Medicare reimbursement declines and the studies per sonographer increases. Although the scanning environment can be well controlled within the echo lab or clinic, there is definitely a higher risk associated with portable echoes. Scans on patients who cannot be transported (critically ill, chemotherapy, and orthopedic) and emergency studies (emergency department, cath lab, and operating room) are commonly performed at the patient's bedside. When attempting to perform a bedside scan, the sonographer must often overcome many obstacles. Hospital equipment (e.g., ventilators, bed side rails, and pumps) and reclining chairs are typical obstructions when trying to position the ultrasound system near the patient. However, the sonographer should never try to save time by "quickly" scanning a patient in an uncomfortable position (Figure

Figure 10. A: When trying to perform bedside echoes quickly, the sonographer is often at risk for injury. Notice the extreme posture and arm reach due to the bed height and machine position. B: Often, simply finding a chair so as to scan in the seated position can improve sonographer position and scanning technique.

10A). Maneuvering hospital equipment, adjusting the bed height, and finding a comfortable chair (Figure 10B) may not necessarily save time in regard to the study, but rather, it will indirectly save hospital dollars by preventing potential sonographer injuries.

A key element to successfully identifying causes and implementing solutions starts with administrative support.

Editor's Comments: This is an important point for the administrator's role in prevention of MSI. Sonographers should communicate their needs with their supervisor, or if necessary ask Employee Health or Risk Management to intervene. Many sonographers who hide their symptoms from superiors out of fear for their jobs should be aware that an experienced sonographer is a valuable commodity, not easily replaced in today's job market. It is too late to change the course of these repetitive strain injuries when a surgeon gives you the dire news that your scanning career is over. A wise administrator will provide the proper environment for employee safety. —DF

Conclusions

A significant prevalence of musculoskeletal injuries occurs among cardiovascular sonographers, both nationally and internationally. According to this study and current studies in the literature, this outcome has become an epidemic, which may eventually be chronic among cardiovascular sonographers. There must be an emphasis on safety and prevention throughout the ultrasound field. Reducing musculoskeletal injuries has to start in the ultrasound schools, by educating new sonographers about the potential dangers related to scanning. Risk prevention and safe scanning techniques need to be an integral part of daily laboratory operations. Systematic evaluation of workplace ergonomics can often be the initial step in reducing MSIs. By determining the problem, the solution can be gained simply by altering the cause of the problem. Some examples include the number of studies per day, amount of time per scan, and scanning position. This study as well as others should encourage staff sonographers, managers, and administrators to address this serious issue.

Editor's Comments: This dilemma was unheard of one or two decades ago, when most of those suffering now were being trained. Educating students is an optimal tool, and a plan that can not only enhance and prolong their scanning careers, but also help to reduce the overall cost of health care by reducing lost productivity and worker's compensation costs. —DF

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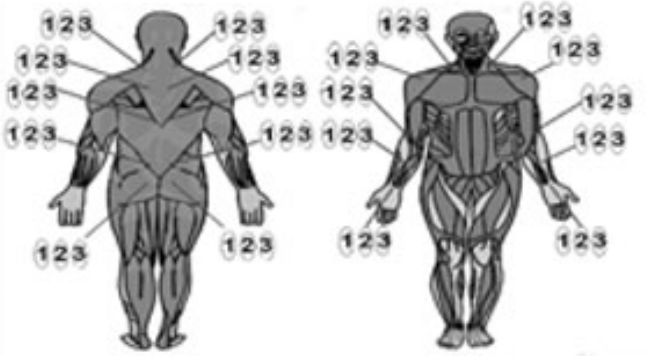
Musculoskeletal Injury Survey

The purpose of this survey is to provide analytical information for publication in a peer-reviewed journal. All surveys will be kept confidential and only cumulative anonymous data will be published. Please give copies of this form to your co-workers for their participation in the survey. Please check all of the boxes that apply to you as an individual.

1. Age: _____
   Height: _____
   Weight: _____
2. Type of scanning:
   - ☐ Abdominal
   - ☐ Cardiac
   - ☐ General
   - ☐ Ob-Gyn
   - ☐ Transcranial
   - ☐ Vascular
   - ☐ Adult
   - ☐ Pediatric
3. Years of scanning:
   - ☐ < 5
   - ☐ 5 to 10
   - ☐ > 10
4. Average number of studies per day:
   - ☐ < 5
   - ☐ 6 to 8
   - ☐ > 9
5. Average scan time (minutes):
   - ☐ < 30
   - ☐ 30 to 60
   - ☐ < 60
6. Total hours/day actual scanning: _____
7. Amount of time between studies: _____
8. Scanning hand:
   - ☐ Right
   - ☐ Left
9. Ergonomic table:
   - ☐ Yes
   - ☐ No
10. Scan from patient's:
    - ☐ Left
    - ☐ Right
11. Have you ever sought medical attention for injuries due to performing ultrasound?
    - ☐ Yes
    - ☐ No
12. If YES, what was the treatment?
    - ☐ Rest
    - ☐ Physical therapy
    - ☐ Medication
    - ☐ Career change
13. Were the treatment results successful?
    - ☐ Yes
    - ☐ No
14. Name: _____

Please Mark All Areas of Discomfort

1: Minor 2: Major 3: Disabling



Please mail or fax your completed survey by December 15, 2001, to:

MSI Survey Results, Chrestomathic Press, Inc., P.O. Box 15215, Hattiesburg, MS 39404-5215

Fax: 601-582-3354

Appendix A. Survey form.

Number 5, Volume 8

Poststudy Questions

Choose the one correct answer to each of the following 10 questions. Mark your answers on the answer card and mail it to the publisher for scoring. ***Be sure to use the card labeled as Number 5, Volume 8.***

1. **According to this study, the percentage of sonographers scanning with some level of discomfort is:**
   - ☐ A. 62%.
   - ☐ B. 72%.
   - ☐ C. 82%.
   - ☐ D. 92%.

2. **The causes associated with musculoskeletal injuries include all the following EXCEPT:**
   - ☐ A. Repetitive movements.
   - ☐ B. Frequent rest.
   - ☐ C. Static postures.
   - ☐ D. Muscle strain.

3. **The three main factors that influence work-related injuries include all the following EXCEPT:**
   - ☐ A. Biomechanical tissue.
   - ☐ B. Biological makeup.
   - ☐ C. External stressors.
   - ☐ D. Work environment.

4. **In order to prevent musculoskeletal injuries in cardiovascular sonographers, the first line of defense needs to be the:**
   - ☐ A. Administrator.
   - ☐ B. Equipment.
   - ☐ C. Medical director.
   - ☐ D. Sonographer.

5. **Specific loads can be adapted to or tolerated, but will eventually fail if constantly overloaded without sufficient:**
   - ☐ A. Strength and conditioning.
   - ☐ B. Rest and recovery.
   - ☐ C. Exercise and training.
   - ☐ D. Nutrition and hydration.

Continued on next page

6. **Shoulder pain results from instability of the shoulder joint and can be caused by all the following EXCEPT:**
   - ☐ A. Abduction > 20°.
   - ☐ B. Excessive force.
   - ☐ C. Arm support.
   - ☐ D. Static force.

7. **Inflammation of a tendon that reduces a smooth gliding effect refers to:**
   - ☐ A. Shoulder pain.
   - ☐ B. Nerve compression.
   - ☐ C. Tendonitis.
   - ☐ D. Epicondylitis.

8. **Symptoms associated with carpal tunnel syndrome (CTS) include all the following EXCEPT:**
   - ☐ A. Clammy.
   - ☐ B. Pain.
   - ☐ C. Tingling.
   - ☐ D. Burning.

9. **Ergonomic tools that help reduce additional external stress include all the following EXCEPT:**
   - ☐ A. Administrative support.
   - ☐ B. Adjustable chairs.
   - ☐ C. Flexible machines.
   - ☐ D. Tables with dropouts.

10. **The incidence of musculoskeletal injuries in cardiovascular ultrasound has become:**
    - ☐ A. Tolerable.
    - ☐ B. Epidemic.
    - ☐ C. Acceptable.
    - ☐ D. Chaotic.