



The prevalence and causes of MSI amongst sonographers

Becky Morton, Penny Delf*

University of Portsmouth, Centre for Radiography Education, James Watson Building, King Richard I Road, Portsmouth, PO1 2DF, UK

Received 1 February 2006; accepted 20 July 2006
Available online 30 March 2007

KEYWORDS

Musculoskeletal
injury (MSI);
Sonographer

Abstract The concept for this article came from the observation of sonographers at work and by reviewing the literature; it aims to consider the prevalence and causes of musculoskeletal injuries amongst sonographers.

Emerging themes were analysed using the comparison of study results to verify and validate findings. Several important themes were identified in the literature: symptoms, prevalence and causes of musculoskeletal injury (MSI) among sonographers.

The prevalence of MSI is apparently high; the average from the literature being 81%. However, many sonographers have not been diagnosed with musculoskeletal injuries, seeing their pain and discomfort as part of their job. Many areas of a sonographers' job have been reported as being possible causes of MSI. Posture, equipment, increased workload, and lack of breaks are just a few causes which are explored below.

Crown Copyright © 2007 Published by Elsevier Ltd on behalf of The College of Radiographers. All rights reserved.

Introduction

What is musculoskeletal injury?

Musculoskeletal injury (MSI) is a generic term used to describe many conditions, which affect the tendons and muscles in the body¹ and can be caused by "thousands of repetitive, forceful or awkward movements".² There is a common misconception that MSI only affects the upper extremities and neck, however, this is not true as

back pain, which is associated with MSI, is one of the major health problems in industrial countries, affecting 80–90% of the population at some time during their lives.³ Other terms, such as, cumulative trauma disorder, repetitive motion injury, repetitive strain injury, overuse syndrome and work-related musculoskeletal disorders, have also been used to describe musculoskeletal injury.⁴

Similarly, in the early stages, musculoskeletal injury can be confused with muscle fatigue, with several symptoms and factors common to both.¹ However, musculoskeletal injury takes much longer to recover from, whereas muscle fatigue usually stops soon after ceasing the activity that has caused the pain.

* Corresponding author. Tel.: +44 2392 845389.
E-mail address: penny.delf@port.ac.uk (P. Delf).

How does MSI relate to sonographers?

Musculoskeletal injuries and work-related musculoskeletal disorders, are well documented amongst many groups of workers but, until recently, were not recognized as affecting sonographers.⁴

Research has identified the prevalence and possibility of MSI amongst sonographers.⁵ A study carried out on behalf of the Society of Radiographers in 1997, found that 71% of all radiographers experienced pain and discomfort they believed to be associated with their work,⁶ whilst a larger study in 2000 found 70% of radiographers and 79% of sonographers to have MSI related problems.¹

With the latter group, the main risk factors appeared to be related to the poor work postures and sustained muscle exertions involved during an ultrasound examination, exacerbated by poor equipment design and job organization factors.⁷ It could be that despite sonographers experiencing some problems, they had not been related specifically to their work activities. But, if one takes into account changes in equipment and associated working practices, these may have been aggravating factors.

Old B-scanner arms were attached to the ultrasound unit making sonographer positioning more stable and naturally aligned, limiting dramatic body movements. The sonographer did not support the weight of the transducer and its electrical cord, while leaning across a patient to achieve an image,⁸ as is the case nowadays. Current scanner designs and practices necessitate the operator gripping the transducer in their scanning hand and support the electrical cable during an examination. Although this allows for a wider and freer range of movements to be performed, it does lead to more awkward postures being sustained for long periods of time. This was confirmed by another report which identified that the application of "sustained pressure on the transducer; abduction of the shoulder; sustained twisting of the neck and trunk; and repetitive twisting of the neck and trunk"⁹ did aggravate musculoskeletal symptoms.

Methodology

A literature review was considered an appropriate tool for investigating the topic of musculoskeletal injuries amongst sonographers because the issue of MSI affecting sonographers is a new development, therefore current research is available on the topic. Only recently has the idea of sonographers suffering from MSI as a result of their work been raised, although it has long been a recognized occupational hazard for radiographers.

This literature review was approached with the expectation of finding a limited range of specialized information related directly to MSI amongst sonographers, and a large amount of general literature on musculoskeletal disorders, posture and ergonomics. A good supply of general definitions, treatments, etc. of musculoskeletal disorders were found and the library catalogue aided information sought on ergonomics of the workplace, musculoskeletal disorders and how to manage and prevent problems in these areas. Internet searches yielded informative websites and online articles on the topic, whilst more specialised information relating to MSI in sonographers was located in health professional journals.

Data analysis

In order to identify the main themes presented in the literature it is important to immerse the researcher in the literature, reading and absorbing all information. Themes running throughout the literature were perceived to be:

- Causes and risk factors of MSI among sonographers
- The prevalence of MSI among sonographers (e.g. research statistics)
- Symptoms experienced and common areas of pain
- Implications for current practice
- Recommendations for future practice

Within each theme, sub-categories were recognized so separate sections could explore individual areas, amalgamating all information into one coherent and succinct paper.

This review compares the results of studies focused on sonographers and the potential hazards of their occupation. It falls into the category of a focused survey, where research is "focused on a particular demographic group, i.e. occupation".¹⁰

Emerging themes

Symptoms of MSI

Common symptomatic areas

Collated results from the studies showed that sonographers frequently suffered from pain in more than one anatomical area at a time. Ninety-three percent reported at least one episode of one or more symptoms, with 77.5% having recurring symptoms.⁴ Common sites of pain include: neck, shoulder, upper back, middle back, lower back, upper arm, forearm, wrist, hand/fingers, elbow, legs.^{11,12} Table 1 shows the results of three studies of prevalence of symptoms in each anatomical area for comparison.

Although the results across the three studies tended to agree on the prevalence associated with each anatomical site (neck and shoulder pain being the most common problem areas) there were some anomalies such as the incidence of lower back symptoms. This difference could be due to the samples being of different sizes, locations and separated by several years.

Table 1 Table of anatomical areas affected by pain and discomfort

	Miles ¹¹ (%)	Pike et al. ¹² (%)	Necas ¹³ (%)
Neck	66	73	76
Upper back	45	60	53
Middle back	29	40	
Lower back	48	65	46
Shoulder	67	73	66
Upper arm	34	38	
Forearm	29	35	33
Wrist	47	65	61
Hands/fingers	43	60	47
Elbow	32		33

Types of symptoms

There is a long list of types of symptoms experienced by MSI sufferers. The symptoms can be classed as tendon disorders or nerve disorders:

Patients with tendon disorders often present with local pain, tenderness to touch, and decreased range of motion, whereas those with nerve disorders also complain of tingling, numbness, clumsiness, and weakness in the area innervated by the affected nerve.¹³

Symptoms range in severity from aching and fatigue that subside with overnight rest, to constant pain that impacts work and leisure activities and may be career ending.¹⁴

The most common type of pain suffered appeared to be aching with reports of percentages being between 91 and 95%.^{4,11} Muscle and joint pain was also recorded as problematic accounting for 73% of problems,⁴ although other frequent symptoms included tingling, numbness and finger pain.¹⁵

Resulting conditions

Injuries associated with MSI in sonographers could be classified as: nerve entrapment syndromes, e.g. carpal tunnel syndromes; tendon related disorders, e.g. tendonitis; muscular disorders and joint capsular disorders, e.g. bursitis.¹³ The most common diagnosis was identified as tendonitis, closely followed by bursitis and non-specific musculoskeletal injury.^{12,16,17}

Prevalence of MSI

The prevalence of MSI among sonographers

It is important to establish the difference between suffering from pain and discomfort associated with work, and actually being diagnosed with MSI. It has been found that the literature presents the prevalence of pain and discomfort among sonographers rather than the prevalence of the sonographer population with an MSI diagnosis. This may be due to a willingness of sonographers to answer questionnaires anonymously about their symptoms but not to officially report pain and discomfort to Occupational Health or to seek medical advice as pain is commonly misconceived as part of the job.¹⁸

Discussion of findings

Table 2 shows that the prevalence of pain and discomfort among sonographers is high. The findings range from 63% to 98.7%, which is extremely high.

It can be seen that prevalence rises gradually over time, which could be related to an increased workload in recent years as well as the change in equipment design. The location of the study appears to have no affect on the findings as the prevalence in all countries is high. Scanning technique may differ from country to country, but the occupation of the sonographer calls for the same skills and practices in all countries.

Those that were identified as receiving a diagnosis by the literature were low. This may be due to a low reporting rate, or due to misdiagnosis by general practitioners and Occupational Health. Several studies describe how respondents were not initially diagnosed with work-related problems or

Table 2 The prevalence of pain and discomfort amongst sonographers

Year	Author (country)	Prevalence (%)
1993	Vanderpool (USA)	63
1996	Necas (USA)	66
1997	Wihlidal (USA)	88.5
1997	Pike (USA)	81
1998	Gregory (AUS)	77.8
1999	Gregory (AUS)	95.4
1999	Magnavita (UK)	80
2001	Feather (UK)	98.7
2001	Chapman-Jones (UK)	80
2001	Baker (USA)	81
2002	Grant (UK)	75
2002	Ransom (UK)	96.4
2005	David (USA)	81
2005	Miles (UK)	85
n.d.	Sound Ergonomics	84

were referred to the wrong department. When findings were normal, they were often told it was "all in their mind".¹

From the findings it can be concluded that the prevalence of MSI symptoms among sonographers is high, with an apparent mean of 81%. Therefore it can be assumed that sonographers in the UK and other countries are currently scanning in pain due to the causes outlined in the next section. An astonishing 20% of careers are reported to have ended because of musculoskeletal injuries affecting the working and social lives of sonographers,^{2,18-20}

Currently, the incidence of diagnosis is low compared to the prevalence of symptoms. The reporting of pain thought to be linked to working practices needs to be encouraged and promoted as not being an acceptable part of the job. Once this stigma is overcome, it is predicted that the prevalence of MSI diagnoses will rapidly increase in the future unless preventative measures are taken.

Causes of MSI

Biomechanical factors

For the duration of the examination the sonographer must hold a transducer in one hand and apply pressure to keep the transducer in contact with the patient's body, or risk losing the image.¹⁶ The sonographer may keep the transducer relatively still or may move it in repeated arcs over the area of the body being investigated.

The posture adopted by the sonographer is one of many biomechanical factors which may cause MSI. Inefficient scanning postures, frequent repetitive motions, exertions of excess force whilst performing these motions, wrist flexion, or deviation, faulty workspace and equipment design are all biomechanical factors.

Poor equipment design is an important contributing factor. Static height couches, chair design and the keyboard and monitor height are ergonomic factors which may induce MSI symptoms.² Respondents to one survey suggested they had to work with unadjustable examination beds and chairs and "had difficulty in reaching equipment controls".⁷ This implies that accessory sonographic equipment has not been ergonomically designed.

New processing technology has reduced the time spent developing images, thus reducing time between patients. Due to this and an ever increasing workload, the literature revealed that many sonographers did not feel they had time to adjust the layout of equipment, if it is adjustable, to suit the dimensions of each patient.¹¹

Similarly with expanding roles, many sonographers report on the images they produce, yet often there is insufficient space to do this in comfort.⁴ It is also noteworthy to highlight that methods used to carry out the reporting task, such as writing, typing or recording a verbal report, often use the same muscle groups as scanning,¹ so the sonographer is never truly at rest.

Work organisation

Inadequate rest periods can be another significant factor. Various studies found that over two-thirds of symptomatic respondents (61–86%) had less than three 10-minute breaks a day.^{12,13}

This, exacerbated by advances in technology, has reduced the time between patients²² and when combined with longer working hours, begins to indicate there is probably insufficient time for muscles to recover^{1,4,16} during the course of the working day.

Types of work activities

Several working patterns have already been highlighted. Repetitive motion, forceful exertions or strain when pushing into a patient's abdomen or compressing leg veins, awkward postures or unnatural positions (commonly from reaching over patients during bedside exams), uncomfortable positioning of limbs (such as flexion, extension or deviation of the hand) frequent reaching above shoulder level, all add to a fairly hectic and strenuous work activity. This, in combination with the growing length of the working day, is thought to contribute collectively towards the development of MSI.^{4,11,12,14}

Individual physical factors

Individual physical factors may have an input into MSI development, although no correlation between MSI symptoms and age were found. The majority of sonographers in the UK are aged 40 or under (51%)¹ making it unlikely that many of the reported injuries could be explained by natural degeneration.

Male sonographers tended to experience fewer MSI symptoms than their female counterparts. This may be due to the fact that ultrasound is largely a female dominated occupation and therefore there were less male respondents in each study with the exception of a study conducted in 1999.¹⁵

Height and weight are two physical factors which may put individuals at risk. One study¹⁶ found that respondents with symptoms were slightly shorter in stature than those without symptoms. Possibly these symptomatic individuals did not adjust the workstation to suit their height, but it should be recognised that those of a shorter stature would need to adapt their working practices, perhaps leaning further across a patient and holding a more extended position to reach the patient's far side, compared to a taller colleague. Similarly, those sonographers who were slightly lighter in weight tended to experience more problems than their heavier counterparts.

Therefore, the height, weight and gender of a sonographer and their prevalence to MSI could be pertinent, with male sonographers, because of their tendency to be taller and heavier than women, less likely to develop MSI symptoms.

The physical fitness of the individual is another factor which should be considered. The impression formed from the literature and recommendations gathered, indicated that regular physical activity was associated with a reduction in the prevalence of musculoskeletal complaints. Certainly it is evident that undertaking regular activity to strengthen various muscle groups may help counteract the effects of those muscles used during normal scanning activity and may even help prevent MSI symptoms.¹⁵

Recommendations

The unanimous recommendation from this review was prevention, with the only way to combat MSI, to prevent it starting. Yet prevention of MSI is "multifactoral",¹⁴ involving sonographers, departmental managers, and equipment manufacturers. However, before preventative measures can be instituted in sonography, it is necessary to carry out additional research into the epidemiology and aetiology of MSI to pinpoint the precise ergonomic hazards of sonography.^{13,16}

Job design

MSI is caused, or aggravated, by long sustained or short intensive periods of repetitive movements.²⁰ To overcome this, various job design control measures can help reduce the risks. These may include limiting repetitive examinations on session lists, or allowing the rotation of staff during sessions, limiting overtime and encouraging mini-breaks to reduce muscle fatigue and allow muscle recovery.²⁰

The latter is an important issue and research^{1,11,21} has shown that sonographers do not take sufficient breaks to allow a complete change in activity, or to be able to adjust equipment between each patient.⁶ Respondents reported working under extreme pressure, with too many patients to scan to enable them to take satisfactory breaks.⁸ A reduction in numbers of patients per list to facilitate sonographers' legal entitlements to breaks and ensuring sufficient staff are available for breaks away from workstations is recommended.¹¹

Changing work practice to allow more frequent breaks to be taken, along with encouraging a variety of examinations on patient lists should allow muscles sufficient recovery time and help prevent the development of MSI. Linked in with this is the recommendation to undertake regular physical activity.¹⁵ During breaks from scanning, sonographers could carry out simple exercises to strengthen muscles used during scanning, or to give those muscles a complete rest from activity, for example, lifting light weights to strengthen the upper arms and wrists, or performing stretches to release tension in muscles throughout the body.¹⁵

Risk assessments

It is also recommended that risk assessments are "an essential part of the process of identifying risks to

employees".¹ To carry out suitable and sufficient risk assessments into the ergonomics and process of ultrasound scanning should be mandatory and carried out at regular intervals.¹¹ Without this, it is extremely difficult to pinpoint the risks, and therefore almost impossible to do anything to rectify the problems.

Where assessments show that there are ergonomic problems, steps should be taken to counter them, such as adjustable chairs and tables, positioning of patient and monitor and sufficient room to produce a report.^{1,7} This may lead to increased manufacturer involvement, as they reconsider the design of the equipment in order to benefit the user.

In addition, a pro-active attitude from department managers towards risk assessment may encourage sonographers to report symptoms to them in order for treatment or a change to their workstation to help prevent symptoms from worsening; managers will be seen as being more involved and will take their concerns seriously rather than dismissing them as "part of the job".¹⁸

Ultrasound equipment

The majority of the literature suggested the need for all equipment to be ergonomically suitable.^{4,19,22} This overwhelmingly pinpoints a recommendation which needs to be implemented.

This responsibility lies not only with the sonographer, but with the department manager and the equipment manufacturers too. Grant (2002) and Sound Ergonomics (n.d.) both lay responsibility with the department manager to order and supply ergonomically designed equipment, as well as carrying out risk assessments. Sonographers should be encouraged to work cooperatively with manufacturers to facilitate design of more ergonomically desirable equipment,¹⁶ actively participating in the selection of equipment.¹⁴ If the correct ergonomic equipment is supplied, then sonographers can improve their posture during scanning, helping to prevent the onset of MSI.

Education

Education of sonographers and managers in raising awareness, risk prevention, correct use and adjustment of equipment and self-care may be required.^{11,20} This could be managed through the delivery of training programmes to all sonographers, detailing health and safety regulations, ergonomics of equipment and manual handling.

Conclusions

The first conclusion that can be made is that the prevalence of MSI, nationally and globally, is higher than initially expected. The average prevalence found from the results in the literature is 81%, increasing over the years, but remaining high since 1997. It is surprising that, even after research has been carried out in this area and subsequent recommendations been made, no action has been taken to reduce the prevalence of MSI among sonographers nationally. There is evidence that changes are being made departmentally.²⁰ This proactive attitude towards implementing change needs to be recognized by larger organisations with more influence.

Many different causes of MSI were brought to light by the literature, all of which may or may not play a role in the development of MSI. The literature reviewed gave no definitive answer as to what factors cause MSI; only identified strong possibilities and areas that have been criticised by sonographers. This is an area where further research is needed to say which possible causes play a definite role in causing MSI and how strongly they may encourage the development of MSI.

In conclusion, the best way to lower the prevalence of MSI is prevention. Major issues, such as workstation ergonomics and the good habit of correct posture may take time to implement and will need careful planning, but smaller changes to work organisation and the working practice of sonographers, in the short term, will make a significant difference. Increasing the frequency of breaks throughout the day to relax the muscles used during scanning is important. Performing strengthening exercises and stretches during those breaks would also help. Varying the examinations on the scanning lists is another recommendation which may help sonographers almost immediately.

Lastly, raising awareness of MSI and how to prevent it through staff meetings and educational posters would be simple to implement. This will teach sonographers to adjust their workstations to suit their own needs between patients and how to use equipment safely. It may also encourage them to report any problems they are experiencing.

References

1. Ransom E. The causes of musculoskeletal injury amongst sonographers in the UK. The Society of Radiographers Publications; 2002.
2. Chapman-Jones D. Musculoskeletal injury: is it a problem for sonographers? *Synergy* April 2001:7–11.
3. Frymoyer and Gordon. New perspectives on low back pain. American Academy of Orthopaedic Surgeons; 1989.
4. Grant H. WRULD amongst sonographers: a survey. *Synergy* June 2002:7–11.
5. Arrowsmith I. Why do radiographers suffer work-related upper limb disorders? *Synergy* March 2001:6–9.
6. Ransom E. Does RSI affect radiographers? Society of Radiographers. *Synergy* August 1997:10–1.
7. Feather C. WMSD: an occupational hazard for sonographers? *Synergy* October 2001:10–13.
8. Allied Health. B-scanner images; 2005. <http://www.ob-ultrasound.net/> [accessed 4 January 2006].
9. Murphy C, Russo A. An update on ergonomic issues in sonography. Employee Health and Safety Services. *Health Care Benefit Trust* 2000.
10. Needham J. Research in practice: "making a difference."; 2000. http://www.pginfo.uhi.ac.uk/types_of_lit_review.htm [accessed 15 November 2006].
11. Miles J. Work related upper limb disorders in sonographers. *Synergy* 2005:6–11.
12. Pike I, Russo A, Berkowitz J, Baker J, Lessoway VA. The prevalence of musculoskeletal disorders among diagnostic medical sonographers. *J Diagn Med Sonogr* 1997;13:219–27.
13. Necas M. Musculoskeletal symptomology and repetitive strain injuries in diagnostic medical sonographers: a pilot study in Washington and Oregon. *J Diagn Med Sonogr* 1996;12:266–73.
14. Sound Ergonomics. Sonographer occupational musculoskeletal disorders: what are they and how can they be prevented? n.d. <http://www.soundergonomics.com/pdf/Biodes.pdf>.

15. Magnavita N, Bevilacqua L, Mirk P, Fileni A, Castellino N. Work-related musculoskeletal complaints in sonologists. *J Occup Environ Med* 1999;41:981–8.
16. Wihlidal LM, Kumar S. An injury profile of practicing diagnostic medical sonographers in Alberta. *Int J Ind Ergon* 1997;19: 205–16.
17. Gregory V. Occupational health and safety update: report on the results of the Australian sonography survey on the prevalence of musculoskeletal disorders among sonographers. *Sound Effects* 1999;42–3.
18. David S. Importance of sonographers reporting work-related MSI: a qualitative view. *J Diagn Med Sonogr* 2005; 21:234–7.
19. Baker J., Joan Baker's testimony for OSHA proposed ergonomic injury worksite rules; 2001. <http://www.sdms.org/msi/osh.asp> [accessed 14 December 2005].
20. Kilbourn P. Reducing the health risk to sonographers. *Synergy* March 2004:13–8.
21. Vanderpool HE, Friis EA, Smith BS, Harms KL. Prevalence of carpal tunnel syndrome and other work-related musculoskeletal problems in cardiac sonographers. *J Occup Med* 1993;35: 604–10.
22. Kroemer K, Kroemer H, Kroemer-Elbert K. *Ergonomics — how to design for ease and efficiency*. 2nd ed. London: Prentice Hall; 2001.

Further reading

1. Cooper HM. The structure of knowledge synthesis. *Knowledge Society* 1988;1:104–26.
2. Gregory V. Musculoskeletal injuries: an occupational health and safety issue in sonography. *Sound Effects* 1998:2–5.
3. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sorensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon* 1987;18:233–7.
4. Massey A. Methodological triangulation, or how to get lost without being found out. *Stud Educ Ethnogr* 1999;2:183–97.
5. Taylor D. The literature review: a few tips on conducting it; 2005. <http://www.utoronto.ca/writing/litrev.html> [accessed 1 October 2005].