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Abstract

Work related musculoskeletal disorders (WRMSDs) are a common cause of pain and sickness absence for ultrasound practitioners. This article aims to provide background information about factors increasing the chance of developing WRMSDs and potential ways to reduce risk. Factors influencing ultrasound professionals' likelihood of developing WRMSDs include poor posture, repetitive movements, transducer pressure and poor grip, stress, workload, limited support or sense of control and other psychosocial factors. The impact of these risk factors on the health and well-being of ultrasound practitioners can be reduced by following recommendations published by professional bodies and the Health and Safety Executive. Ultrasound practitioners should remember that optimising the examination should not be at the detriment of their health. Some hints and tips to reduce the chance of developing WRMSDs are provided.

Introduction:

Work related musculoskeletal disorders are a common cause of pain amongst sonographers, with research suggesting that between 80 – 90.5% of sonographers are scanning in pain. [1, 2] WRMSD can lead to pain, sickness absence, surgical procedures and in some cases long term disability or career ending injury.[3, 4,] Brown[5] observed sonographers scanning and noticed wrists at "*fairly grotesque angles away from the neutral*" and concluded that the "*human arm*" is unsuited to ultrasound scanning. However at the present time it is a human arm that performs the examination and ultrasound practitioners need to consider ways to reduce the chance of injury, when undertaking this task. The causes of WRMSD are multifactorial,[6] so it is important to consider factors other than simply ergonomics.

Common causes of WRMSD in ultrasound practitioners include [1,4,6 - 9]

- Poor and/or static posture
- Repetitive movements
- Transducer grip pressure and the use of force
- Psychosocial factors
- Workload management issues

Common symptoms of WRMSD include aches and pains, stiffness in the joint, pins and needles sensation, tingling and/or a burning sensation.[4,7] Some people

will see evidence of an injury, with physical signs of swelling and/or warmth in the region, whilst others may not. Initially pain may be transient and improve when not scanning. If no action is taken the injury could progress and pain becomes more frequent, eventually leading to a chronic injury, when constant pain can be experienced, in addition to weakness, reduced movement and potentially an inability to carry out every-day tasks.[3,10]

Not all ultrasound practitioners are affected by WRMSD, as suggested by the figures quoted in previous studies.[1,2] A small study, which surveyed 22 sonographers who reported themselves as unaffected by WRMSD[11], found no strong evidence of factors that help prevention, although it was suggested that job satisfaction and increased general well-being may be linked. It should be noted that even in this small sample, 5 (23%) had experienced some "temporary problems" in the past and how they overcame these problems could be relevant to ultrasound practitioners.[11] Research has found that WRMSD amongst sonographers was more likely to be unreported and undiagnosed for a variety of reasons, including concerns for their job or a presumption that experiencing pain is a normal part of ultrasound practice. [1,4]

This article aims to highlight some of the associated risk factors for developing WRMSD and suggest ways to monitor and reduce risk. Whilst there are some flaws in the methodology of many studies into WRMSD, due to factors such as

small sample sizes, self-selecting populations, difficulties with standardisation of responses, the aim is to provide guidance on areas that have been indicated, within the literature, as possibly helping to reduce the chance of developing or exacerbating WRMSD, to ensure a long and health career in ultrasound.

Ergonomics:

Ergonomics is the study of human factors affecting the worker, with a focus on observing how people interact with the environment they work in and adapting the workplace to the worker, their abilities and limitations.[12] For ultrasound practitioners this involves assessing the working practices and positions adopted during the scan and determining ways to reduce risk of injury for each operator and each type of examination. Current evidence suggests that most departments have moveable chairs and couches,[1] these should be utilised well by the operator. If a movable couch is not available, it would be advisable to submit a business case and quote the work of Baker[13] who suggests that it is more cost effective to purchase a couch than pay for a potential compensation claim and associated costs. As an ultrasound practitioner it is important to spend a few moments at the beginning of each examination optimising the position of the equipment and patient, to ensure a good posture can be achieved to reduce strain. Forrester,[14] in a small study interviewing nine osteopaths who had involvement in occupational health cases, suggests that

good ergonomic practice can reduce or prevent injury. The room should be of an adequate size, to enable safe working practices, [8] with lighting that does not cause glare on the monitor and heating that is appropriate for the working conditions.[7, 8,]

Shoulder:

Arm abduction can lead to reduced blood flow to the shoulder and increased risk of injury. [7, 15, 16] Research evidence suggests that the shoulder is a common site for injury, [1, 3] thus when scanning it is recommended that arm abduction should be less than 30º.[13, 16] The patient should be as close to the ultrasound practitioner as possible, to reduce arm abduction (figure 1). The non-scanning arm can also sustain injury from overextending to reach the machine controls.[13] To reduce overextending of the non-scanning arm, the machine should be close to the operator and controls within easy reach. If this is not possible, a foot pedal or voice recognition controls could be utilised. In some cases, when scanning patients who are in their beds an additional person to operate the controls, would allow the operator to scan from the other side of the bed, which could alleviate excessive stretching. It has been suggested that supporting the shoulder or forearm could also reduce the potential for injury.[13]

The forearm should be horizontal to the floor[15] allowing the shoulder to remain in a neutral position, both when scanning and when operating the keyboard. To

allow for the optimal elbow position, the couch needs to be moved to an appropriate position, depending on the type of examination and patient habitus. Figure 2 demonstrates the effect of scanning, on posture, with the couch too high and too low.

Neck:

The neck is another common site for injury, [7, 15] with Evans et al [1] finding 65.8% of ultrasound practitioners suffering from neck pain or discomfort. The ultrasound monitor needs to be adjustable and at a level to ensure that there is no neck extension. Ideally the neck should be flexed slightly to approximately 15 – 20^{o}.[13] When observing people in practice, it is common to see practitioners tilt their head to visualise the image, particularly when looking at fine structures e.g. when assessing fetal lips with the fetal head in the horizontal position or stretching their neck into unnatural positions when sharing the monitor with the patient. Ideally the machine should be directly facing the operator and for obstetric cases a “slave monitor” should be used to allow the parents to see the scan, without the need for turning the monitor towards them. [8, 13, 15]

Back:

Twisting of the body can lead to back pain and injury. [7 13] Again, having the machine parallel to the couch reduces the need for twisting. [6] Altering the couch height or adapting techniques for example standing or sitting, with both feet

placed firmly in front of the operator can reduce the need to twist.[7, 8, 15] Also bringing the patient closer will reduce the need to rotate the spine[15] (figure 1). Literature has suggested that short stature can increase the risk of WRMSD, [4] which may be due to the need to over extend when scanning.

Hand, wrist and fingers:

Wrist flexion and extension should be minimised during the scan. [7] When turning from longitudinal to transverse, the transducer should be rotated in the hand, rather than turning the wrist (figure 3). Hypermobility has been suggested as a contributing factor for musculoskeletal injury in some people. [14, 17] Hypermobility is common and is evident when someone is supple, with a wide range of joint movements, often due to laxity in the ligaments.[18] Joint hypermobility syndrome can be associated with back and neck pain, tendon injuries, muscular and joint pain and stiffness,[18] which can also be found in WRMSD, which could make it difficult to differentiate WRMSD from hypermobility syndrome. Additional care is needed to reduce the range of movements used, if ultrasound practitioners are hypermobile.

Transducer grip and pressure:

The optimal transducer grip is a power grip / palmar grip rather than a pinch grip, to distribute the weight of the transducer evenly across the whole hand.[6, 7] During a study looking at teaching ergonomics and when teaching student

sonographers, a range of different grips have been observed, many of which include some element of pinching the transducer, demonstrating white knuckles, or tucking one or two finders behind the transducer[19] (figure 4). The ideal power grip is demonstrated in figure 5, with all fingers and the palm of the hand used to manipulate the transducer.

Equally important, when considering ergonomics and transducer grip, is grip pressure. Anecdotally trainees are often told to push harder or grip the transducer more tightly by clinical colleagues. This was also highlighted by Gibbs and Young. [20] One factor that respondents suggested aggravated symptoms of WRMSD, in a study of 2963 ultrasound practitioners, was transducer pressure. [1] Ideally the transducer should be held using a light grip with no or minimal pressure applied to the patient.[15, 21] A study by Toomey et al[22,] whilst not specifically assessing ergonomic issues, found very little difference in compression of adipose tissue between half and full transducer force, which might suggest that pressing the transducer at maximum force would not affect tissue compression enough to improve image quality. Some smaller transducers can lead to increased force being applied by the operator, so careful review of transducers and the effect on grip should be undertaken when purchasing new equipment.[21] Wearing textured gloves can assist when gripping the transducer, if the gloves are the appropriate size. [9, 23]

Other factors:

Patient obesity is becoming a common issue that ultrasound practitioners find challenging both clinically, when trying to obtain diagnostic images[24] and physically, when scanning patients with increased body mass index (BMI). [8 25] Obesity is on the increase[24] and in 2011 the Royal College of Obstetricians and Gynaecologists[26] suggested that approximately 1 in 5 pregnant women were obese, with a BMI of ≥ 30. It is important to ensure that limited pressure is placed on the transducer, as pushing can increase transducer grip, which may lead to injury[25]. Techniques that can be used to reduce the risk of muscle injury when scanning obese patients include optimising the equipment, using lower frequency and a range of factors such as harmonics, compound imaging or trying transvaginal scanning, where appropriate.[24] Lifting the panniculus (subcutaneous tissue in the lower abdomen) or scanning from above or to the side of the panniculus[24] can help, as can decubitus scanning or the use of the Sims position, where the patient is almost prone and scanning is from the flank, to reduce the depth of tissue for the sound to penetrate.[27] Limitations of the examination need to be highlighted in the report and a sensitive explanation provided to the patient.[24] Removing the probe from the patient and having micro-breaks during the examination can also help reduce strain. [4]

Ergonomics is not only important for scanning, but also to the use of personal computers (PCs), particularly for ultrasound professionals who type their own reports.[8] The set-up of the PC needs to be optimised to reduce risks, as typing utilises similar muscle groups to those used when scanning.[4] Figure 6 suggests the optimal positioning of the upper limbs when scanning, using the ultrasound controls and a PC.

Workload management:

One of the common causes of WRMSD is repetitive movements and actions leading to micro-trauma.[28] Some examinations are highlighted as more challenging in relation to ergonomics, these included transvaginal scans,[13] portable examinations,[4, 6,13] venous reflux scans[13] and scanning obese patients.[6,8] Many studies were conducted before the widespread implementation of nuchal translucency scanning or community based ultrasound services, which may be less well designed ergonomically for ultrasound practice. It would be interesting to determine whether these would feature in future research findings. When planning work lists for ultrasound practitioners, one method of reducing the risk of injury through repetitive movements is to have mixed lists with a variety of examinations, thus varying the movements that the ultrasound practitioners make throughout the day. [4,6,9] This also relies on the operator adjusting the equipment for each examination,

to optimise their position in relation to the patient and ultrasound machine. Engaging staff in the discussions about workload management can improve morale and general sense of wellbeing [8,29] and improve compliance with workplace safety.[30]

When planning lists there are guidelines suggesting the minimum scan time for each type of examination. [31,32] Adherence to these guidelines could help staff feel supported in their workplace and potentially reduce the chance of staff developing WRMSD.

Regular breaks:

Rest periods are seen as essential by many authors. [4,6,8,9,14] Managers need to ensure that in addition to varying the workload during the day, they factor in time for breaks, to allow the muscles and tendons time to recover. Ultrasound practitioners need to use these breaks wisely to ensure a change from the working environment[9] and undertake activities that utilise different muscles, for example walking or gentle exercise, as exercise can increase the flow of blood to the joints. [4,14] Micro-breaks are equally important during the working day,[4,9] providing muscle recovery time. [21,33] Taking the probe off the patient and relaxing the hand, whist measuring a structure is enough to give the joints a short rest.

When considering extended days, overtime or additional shifts in other units ultrasound practitioners need to consider the impact this may have on their physical well-being and managers should assess the risks carefully. [6,8]

Risk assessment:

In any work environment risk assessments should be performed. Additional assessments are required if an area is assigned a “yes” in the Health and Safety Executive (HSE) risk filter assessment for upper limb disorders. [30] As most ultrasound scanning roles will be assigned “yes” in at least one of these categories a full risk assessment is needed to determine the “likelihood and severity of risk” and ways to reduce risk [30] (page 16). Monnington et al[8] found that most risk assessments were insufficient for assessing the risks to ultrasound practitioners, with few making recommendations to reduce risk. The sites that used professional staff, such as occupational health, ergonomists, back care specialists, within the risk assessment process, demonstrated more thorough risk reduction strategies.[8] There is no specific detail about how often risk assessments should be carried out[34], although they should be “up to date” and are required when changes are made to processes, equipment, staff or following reported accident or injury.

Images of the body, to encourage “body mapping”, have been suggested to help monitor on-going areas of concern within departments.[35] The use of

different coloured pens or stickers to highlight areas of the body affected by different types of pain, for example aches and pains, shooting pains, continuing pain that persists when away from the scan department, can identify trends within a department.[35] Monitoring can demonstrate improvements or worsening of individual or departmental pain following intervention, changes to equipment or working practices, but can also encourage staff to engage in discussion about common issues and potential solutions.[21,35] Again no specific guidance is given to frequency of assessments, however 6 to 12 monthly might be appropriate.

Ergonomics education for existing and new staff is important, to ensure that staff are aware of best practice guidelines, ways to reduce risk to themselves and others, how to report and monitor pain and injury to ensure a long and healthy career.[9]

Psychosocial factors:

Stress is an important contributing factor in many cases of chronic WRMSD, [6-10, 14] which may be caused by work related and / or personal issues. [10] Of the nine osteopaths in the study by Forrester[14] all had found stress to be a contributing factor in chronic cases of WRMSD in their clients. A meta-analysis evaluating the link between job satisfaction and health[29] found that poor job satisfaction had a strong influence on “burnout” (mental or physical exhaustion often caused

by stress, possibly leading to negativity, poor performance and illness)[36] in particular, but also on possible increased rates of anxiety, depression and lower levels of self-esteem. This correlates with the study of sonographers who were unaffected by WRMSD, which found that a positive outlook, job satisfaction, control over the workload and equipment selection were commonly referred to by respondents.[11] Workers attitudes and beliefs can also impact on their risk of WRMSD.[10] Are you the type of person that will go to great lengths to achieve the perfect image, despite aches and pains? Would you continue working in pain to avoid “letting down” your colleagues? Do you put too much pressure on yourself? The HSE[30] highlights an example of an employee missing their breaks because of excessive workload demands, as a psychosocial issue impacting on the well-being of a worker. Poor sense of control over workloads, lack of support from senior management and reduced job satisfaction have all been suggested as possible factors associated with the development of WRMSD.[6] Ultrasound practitioners should have an awareness of any early physical signs of injury or overuse, acting on these and reporting issues as soon as possible,[21] as early identification and treatment can improve outcomes.[37]

Ever increasing workloads and target driven working practices are possible causes of increased stress amongst ultrasound practitioners. In the workplace, stress can be reduced by supportive management and ensuring ultrasound

practitioners feel able to report any injuries at an early stage.[4, 6] If you are a manager, how do you support your staff? You could be part of the problem if you do not provide a supportive environment and consider staff safety as an important part of the role. Staff would benefit from having more control over their working environment and workload.[10] The HSE[30] recommend engaging with all staff when planning to address risk factors and workload management.

Physical exercise:

It has been shown that women and those with a short stature or lower weight are more prone to injury.[4] Whilst there is nothing that can be done to change general physical attributes, building up muscle strength can reduce the risk of injury. [4,9,21,23,37] Exercise has also been shown to reduce stress and improve self-esteem.[21, 37] Exercise which improves the supply of blood to the joints has been suggested as a way to help manage injuries, such as swimming which is less likely to aggravate an existing injury, in association with gentle stretching. [14, 30] Following rehabilitation, stretching and strength building exercises are often suggested.

Pilates is recommended to strengthen and improve core stability and participating in physical activities has been suggested as a way of promoting a healthy lifestyle and reducing the risk of WRMSD[14, 37]. The use of the Alexander

technique has also been investigated for sonographers, to help improve body awareness and posture. [8, 20]

A warm up, using dynamic exercises, before starting the scanning list can warm muscles, as used before any form of workout. Research evidence suggests possible benefits from stretching between patients. [4,38, 39] A number of stretching exercises can be found at http://www.hse.gov.uk/research/rrpdf/rr743.pdf . [33]

Conclusion:

WRMSDs are a risk to the health and well-being of the ultrasound workforce. There are many factors involved in the reduction or ideally the prevention of WRMSD for ultrasound practitioners, including ergonomic issues, workload management, psychosocial factors, physical factors and general fitness levels. This article has highlighted some of the methods that could be used to reduce risk and allow staff to work together to improve working practices (figure 7). Ultrasound practitioners have to take responsibility for their own health and practice in a safe effective manner, whilst managers have a duty of care to provide a supportive environment for practitioners to work in, report any risks or injuries at an early stage and receive support to overcome issues relating to adverse working practices. A safe working environment can only be achieved by engagement with all stakeholders, including senior managers, ultrasound managers, ultrasound practitioners, students, educators, occupational health

and equipment manufacturers. It is essential that all staff have a good awareness of current best practice guidelines and health and safety executive advice, as this can be used to support business cases for additional equipment, staffing and changes to working practice.

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Figure 1: Demonstrates how moving the patient closer to the operator can reduce arm abduction and spine rotation

Figure 2: the effect of poor couch positioning on the back and shoulder

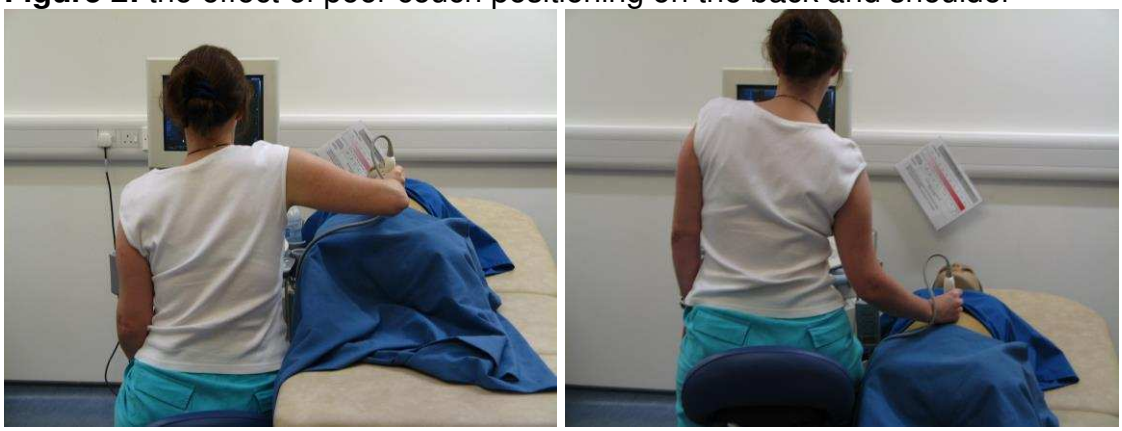

Figure 3: Poor wrist positioning when turning the transducer into transverse section by rotating the wrist, rather than the transducer

Figure 4: How not to hold the transducer (note the fingers tucked behind the transducer, the wrist angle and white knuckles)

Figure 5: Demonstration of the power grip

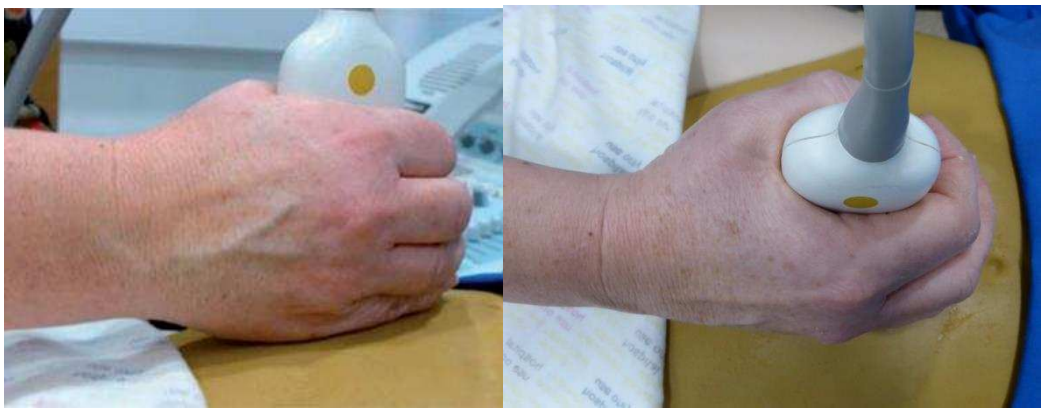

Figure 6: The optimal position for different areas of the body.[6,13]

Body part	Optimal position	Worst position
Neck	Flexed	Extended
Forearm	Horizontal to couch	$<60^0$ or $>100^0$
Arm abduction	$<30^0$	$>30^0$
Hand radial deviation	$<15^0$	$>15^0$
Hand ulna deviation	$<25^0$	$>25^0$
Wrist flexion / extension	$<15^0$	$>15^0$
Shoulder posterior extension	Vertical at the side of the body	Any posterior extension, worse if $>20^0$
Shoulder anterior extension	Vertical at the side of the body	$>60^0$

Figure 7: Summary of advice

Advice:

- Take time. Think about the set-up of the room before placing the probe on the patient
- Work with other ultrasound practitioners for a session, to observe their posture and advise each other how to make improvements to reduce risk
- Ensure that students are observed for ergonomics early in their career, before they can develop bad habits
- Undertake regular risk assessments and body mapping exercises to highlight issues
- Consider having a named person responsible for ergonomics within the department, to provide advice and ensure monitoring is taking place
- Be mindful of your body. Encourage early reporting of symptoms. Access to occupational health or fast track physiotherapy
- Get fit, stay fit. Build your upper body strength
- Warm up, using dynamic exercises, before starting the scanning list
- Don't push when scanning, wear textured gloves of the correct size, use aids where necessary to support the shoulder and arm
- Follow the ABARA principle (as best as reasonably achievable)
- Perform stretching exercises between patients and at the end of the list
- Keep up to date with current guidelines and advice. Use this to support business cases for funding, changes to practice, staffing.