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Possible Associations between Scan Quality and Pain during Ultrasound Scanning: Results from the Society for Vascular Ultrasound 2009 Survey on Ergonomics

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ABSTRACT *Background*.—**Pain might act as a distraction while the operator performs ultrasound imaging. It is not clear whether perceived pain while scanning is associated with scan quality.**

Materials and Methods.—**An internet-based survey was conducted during the months of April to June 2009 for members of the Society for Vascular Ultrasound (SVU). Survey questions included questions evaluating demographics, work load, practice milieu, and level of imaging experience. The level of pain experienced while performing scans in the last month before the survey was evaluated on a pain scale of 0 to 10 and the possibility that scan quality might have been affected (0 no effect, 1, possibly and 2, definitely). Comparisons were made with the use of analysis of variance and multivariable logistic regression.**

Results.—**We evaluated the responses of 640 SVU members for a response rate of 14.4%. Most sonographers surveyed were in the 50 years or older age category (n = 296; 46.6%) and had an average of 21 or more years of imaging experience (n = 257; 41%). We found that scan quality was inversely associated with the level of experienced pain ($p < 0.0016$) and positively associated with transducer time: as pain and transducer time increased, scan quality decreased taking into consideration age, gender, and experience.**

Conclusion.—**Our data suggest that pain while scanning and sonographer perception that quality of the examination is affected are strongly associated. Further analyses of the survey data and the development of appropriate analytical tools are needed to investigate possible causal links.**

Introduction

Work-related musculoskeletal disorder (WRMSD) is a major cause of loss productivity in the work force. Recent surveys have also indicated that medical professionals such as nurses and radiologic technologists experience a high prevalence of pain while performing their duties.[1,2]

In addition to obvious losses in overall productivity, it appears that performance might be decreased when an individual continues to work despite the presence of pain. For example, typists or computer terminal operators are prone to make more errors while working in pain or an uncomfortable position.[3–5] There is also an indication that medical error rates might increase in health care professionals either as the result of pain or excessive work hours.[6,7]

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In the United States, ultrasound imaging is mostly performed by trained and certified sonographers. In the performance of their functions, sonographers deliver a very specialized medical service akin to a targeted physical examination. Possible effects of pain during ultrasound studies might result in a tendency to shorten the examination or, more likely, increase the distraction of the sonographer and possibly lead to decreased quality of the examination. It is also not clear whether pain is linked to specific scanning factors such as time taken to perform an examination. We investigated these possible associations in a survey of vascular sonographers conducted with the aid of a web-based survey instrument.

Materials and Methods

A WRMSD survey was conducted of the Society for Vascular Ultrasound (SVU) members via the online survey tool, Survey Monkey, from July 13 through October 9, 2009. The survey link was e-mailed electronically to a distribution list of vascular sonographers generated by SVU. There was successful delivery of the survey link to 4,472 e-mail addresses.

All answers were anonymous; however, the responders were given the opportunity to report their e-mail address. The responders were asked to clink on a link in the e-mail, which directed them to a multiple-choice survey with 33 questions. Each of the questions had multiple choice answers, and the respondent selected the most appropriate choice electronically by clicking a box on the computer screen with a mouse. The respondent was not forced to make a selection if he or she chose not to do so. The selected responses were captured by Survey Monkey and stored in a database and transferred to an Excel spread sheet.

This survey used some questions previously used by either the Society of Diagnostic Medical Sonographers (SDMS) or Sound Ergonomics, LLC to allow for cross sectional data evaluation of prevalent occupational injury, working conditions, types and number of examinations performed. The survey included questions dealing with age of the operator, gender, number of years of experience, and current work hours. Specific questions dealing with pain were added to previously used survey instruments to determine the presence of pain and the likelihood of an effect on the quality of the ultrasound examination:

1. "In the last 2 years do you feel that scan quality was decreased by performing a large number of scans each day?
2. "In the last month at work, please grade the WORST level of pain you experienced while scanning on a scale of 0 to 10 with 0 being no pain whatsoever, and 10 the worst pain you ever experienced."
3. "In the last month at work, please grade the AVERAGE level of pain you experienced while scanning on a scale of 0 to 10 with 0 being no pain whatsoever, and 10 the worst pain you ever experienced."

This survey was an attempt to collect pertinent data for presentation to the Occupational Safety and Health Organization in Washington, DC, July 28, 2009, and minutes/results of this meeting have been made available at NewsWave from the SDMS, and in the e-Spectrum online newsletter from the SVU. At the time of the Occupational Safety and Health Organization presentation, 504 completed surveys were available.

Statistical analyses were performed with the aid of a statistical analysis program (JMP 7.0.1; SAS Institute Inc., Cary, NC). Chi-square was used to evaluate ordinal variables, *t*-tests for continuous variable(s), and multivariable logistic regression analyses were used to evaluate association between survey variables and perceived scan quality.

Results

Of a possible total of 4,472 surveys, 644 (14.4%) were completed during an interval of 87 days. The age distribution and years of experience of the respondents are shown as Figures 1 and 2. Of the total respondents, 23.4% were men (147/628), 21% (149/631) of respondents estimated that transducer time per examination was less than 20 minutes, and 73% (454/622) had an 8-hour work day. Pain was experienced while scanning by 83.2% (525/631). The mean of the average pain (for a pain scale of 0 to 10) experienced over the last month was 3.08 ± 2.04, and the worst pain 4.94 ± 2.64.

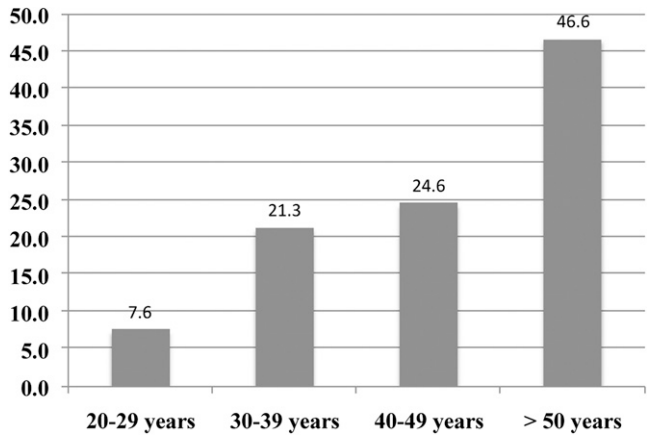

Figure 1

Age distribution of responders to the SVU 2009 Ergonomics survey. The y-axis is the percentage of total responders within the categories shown on the x-axis.

We evaluated the key variables that might be associated with the perception of pain during ultrasound examinations (Table 1). Years of experience, gender (women more than men) and decrease in scan quality were associated with perceived pain while performing the examination. The pain scale values, both average pain and worst pain experienced, were also significantly associated.

Factors that were associated with scan quality are shown in Table 2. Experience of more than 3 years, increased transducer time, and discomfort/pain while

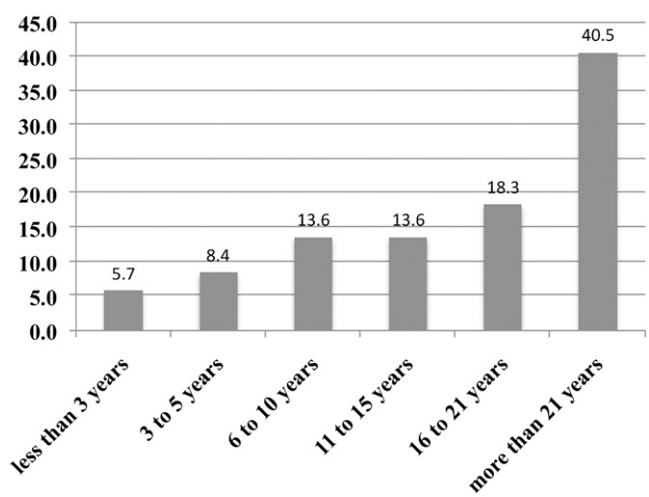

Figure 2

Distribution of years of experience with ultrasound imaging of responders to the SVU 2009 Ergonomics survey. The y-axis is the percentage of total responders within the categories shown on the x-axis.

Table 1

Bivariate Associations of Key Responses with the Presence of Any Pain/Discomfort While Scanning

Variable	*p* Value	Observation
Age	0.99	Overall 83.35% (522/627)
Years of experience	0.07	Overall 83.23% (521/626) but apparent cut point above 3 years or more
Years of experience 3 years or less vs. 4 years or more	0.003*	For 3 years or less experience 63.9% (n = 36) For 4 years or more experience 84.4% (n = 590)
Gender	0.03*	Female > Males, $p = 0.02$ 85.1% vs. 77.2%
Transducer time/study	0.57	
Transducer time >20 minutes/study	0.84	Cut-point seen on exploratory analysis from Table 2
Work shifts (8/10/12 hours)	0.15	
Scan quality No effect/possible/definite	<0.0001*	No effect: 78.4% with discomfort Possible effect: 87.3% with discomfort Definite effect: 94.6% with discomfort
Scan quality No effect/some effect	<0.0001*	No effect: 78.4% with discomfort Some effect: 90.3% with discomfort
Average pain in last month (scale 0–10)	<0.0001*	No discomfort: 0.62 ± 0.19 (n = 89) Some discomfort: 3.53 ± 0.08 (n = 493)
Worst pain in last month (scale 0–10)	<0.0001*	No discomfort: 1.09 ± 0.23 (n = 87) Some discomfort: 5.61 ± 0.94 (n = 496)

*Significant difference.

scanning were all associated with a perception of decreased scan quality.

Results of a multivariable logistic regression model are shown in Table 3. Adjusting for age and gender, transducer time and pain while scanning were the two key variables associated with a decrease in scan quality (area under the receiver operating curve of 0.62).

Discussion

We have found that 83% of sonographers participating in this survey experienced pain while they performed imaging scans. We also note that scan quality was significantly associated with perceived pain while scanning and increased transducer time.

We note a low participation rate of our survey (14%) as compared with other large surveys,[1] where the response rate of health professionals, nurses, and X-ray technologists varied between 58% and 65%. However, the overall prevalence of symptoms during scanning is in the same order of magnitude because 76% reported prevalence of back pain in nurses and X-ray technologists.

There is also a possible limitation of using self-reported pain as a measurement of WRMSD. This issue has been addressed as a possible methodological limitation as compared with the determination of true physical findings either by physical examination or other diagnostic tests.[8] However, the poor sensitivity and specificity of the physical examination or physical findings in WRMSDs has been an argument for the adoption of self-administered questionnaires.[9–11]

Another limitation is the nature of the instrument and the questions that were selected in our survey. A survey, by its nature, can only ascertain a certain aspect of a physical or psychological state. We have opted to evaluate possible associations between scan quality and perceived pain. Major potential confounders include age, gender, years of experience, and transducer time during the examination. Age can play a role because continued exposure to an ergonomically challenging situation can cause pain with duration of exposure. We did not observe such an association. It is possible that the relatively old age of our respondents as compared with other surveys on health professional might have masked such an effect.

Experience as measured by numbers of years at work was noted to have some associations with pain and discomfort while scanning. However, this took place relatively soon after starting employment, at 3 to 4 years in our survey. Time of the examination estimated by time holding the transducer is a major confounder for two reasons. Duration of holding the transducer can in itself cause pain because of unfavorable ergonomics. However, prolonged transducer time might also indicate that the examinations are more complex and inherently more likely to be "difficult" and generate poor quality examinations. It is interesting to note that both these effects are independently associated with scan quality in the multivariable logistic regression model.

Limitations of this study include the possibility that an atypical subset of all sonographers responded to the survey and that this could have biased the results. However, the consistency in the responses suggests that the associations among scan quality, pain, and

Table 2

*Bivariate Associations of Possible Risk Factors and Outcome Variable of Possible Effect on Scan Quality**

Variable	*p* Value	Comment
Age	0.70	
Gender	0.95	
Years of experience	0.11	
Experience >3 years	0.04*	More experienced sonographers see an effect on scan quality
Work shifts (8/10/12 hours)	0.259	
Transducer time per patient (overall)	0.039*	
Transducer time greater than 20 minutes vs. 20 minutes or less	0.0010*	47.8% who scan less than 20 minutes perceive an effect of scan time 63.2% who scan >20 minutes perceive an effect on scan quality
Any discomfort while scanning	<0.0001*	
Average pain in last month (0–10)	0.0007*	
Worst pain in last month (0–10)	<0.0001*	

*Effect on scan quality has been summarized as a categorical variable with two levels: none and possible/definite.

Table 3

Multivariable Logistic Regression Analysis with "Effect on Scan Quality" as the Outcome

Variable	*p* Value
Age	0.48
Gender	0.53
Experience (>3 years)	0.09
Longer work shift	0.08
Transducer time >20 minutes	0.0003*
Discomfort/pain while scanning	0.0005*

*Significant difference.

transducer time might apply to the more general population of sonographers. Another possible bias is the prevalence of pain could be overestimated because individuals in pain are more likely to have responded. However, our results are consistent with published series examining with prevalence of back pain in nurses[1,9,12] and radiologic technologists.[1,2] If anything, the relatively older age range of our respondents favors the possibility that continued scanning over the years has lead to some form of WRMSD.

Contrary to previous studies, we did not focus on distinguishing specific sites or types of pain/discomfort.[1,12] Our goal was rather to study the overall effect of pain as a possible distraction that could ultimately affect scan quality and possibly lead to medical errors. The latter possibility has been suggested in studies looking at nursing error rates. A major limitation is the overall accuracy of a question that asks an individual to estimate whether or not scan quality was affected. There is a normal resistance to report quality issues because they can ultimately lead to medical errors. However despite this reticence, medical error self-reporting seems to match up with objective case reviews in health professionals. We were not able to objectively evaluate scan quality using only our survey instrument. This remains the major limitation of our survey. Further work is required to evaluate the possibility of a causal linkage between perceived pain, scan quality and the possibility of medical errors.

We conclude that pain experienced while performing a vascular ultrasound examination is associated with a perceived decrease in scan quality. Given the independent association of transducer time while scanning and pain while scanning, this finding needs further investigation.

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