Arm and Neck Pain in Ultrasonographers

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Objective: The aim of this study was to evaluate the prevalence of upper-body-quadrant pain among ultrasonographers and to evaluate the association between individual ergonomics, musculoskeletal disorders, and occurrence of neck pain.

Method: A hundred and ten (N = 110) Belgian and Dutch male and female hospital ultrasonographers were consecutively enrolled in the study. Data on work-related ergonomic and musculoskeletal disorders were collected with an electronic inquiry, including questions regarding ergonomics (position of the screen, high-low table, and ergonomic chair), symptoms (neck pain, upper-limb pain), and work-related factors (consecutive working hours a day, average working hours a week).

Results: Subjects with the screen on their left had significantly more neck pain (odds ratio [OR] = 3.6, p = .0286). Depending on the workspace, high-low tables increased the chance of developing neck pain (OR = 12.9, p = .0246). A screen at eye level caused less neck pain (OR = .22, p = .0610). Employees with a fixed working space were less susceptible to arm pain (OR = 0.13, p = .0058). The prevalence of arm pain was significantly higher for the vascular department compared to radiology, urology, and gynecology departments (OR = 9.2, p = .0278).

Conclusions: Regarding prevention of upper-limb pain in ultrasonograph, more attention should be paid to the work environment and more specialty to the ultrasound workstation layout. Primary ergonomic prevention could provide a painless work situation for the ultrasonographer.

Application: Further research on the ergonomic conditions of ultrasonography is necessary to develop ergonomic solutions in the work environment that will help to alleviate neck and arm pain.

Keywords: ergonomics, musculoskeletal disorders, neck pain

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INTRODUCTION

In modern medicine, ultrasonography is an important medical diagnostic tool thanks to its noninvasive and radiation-free character. Different medical subdisciplines, such as radiology, abdominal surgery, vascular surgery, cardiology, and gynecology, use this technique frequently.

The high prevalence of (low-back pain and) neck pain is causing serious public health problems in Western industrialized countries (Côté et al., 2008; Freburger et al., 2009), with an estimated 12-month prevalence of back pain of 44.4% and 28% neck pain in the Netherlands (Picavet & Schouten, 2003). This finding is common among the working population as well. Neck pain has unfavorable consequences for the individual worker in terms of pain and disability (Côté et al., 2008; Henschke et al., 2008) but is also a burden for society and companies in terms of costs due to medical health care consumption, work absenteeism, and loss of productivity at work (Dagenais, Caro, & Haldeman, 2008; Lambeek, van Tulder, Anema, Swinkels, & van Mechelen, 2010). Considering this impact, there is an obvious need for effective preventive strategies.

Personal experience teaches us that ultrasonographers, the people who work with ultrasound machines, are more predisposed to develop neck complaints, potentially in combination with (radiating) pain in the upper limb. However, epidemiologic data about this medical problem are not yet available.

The objective of the present study was to investigate the prevalence, severity, and impact of neck pain caused by working with the ultrasound machine in different medical subdisciplines by means of an electronic inquiry. This study could be the base for further scientific investigation.

Based on our data, we hope to be able to develop custom ergonomic recommendations to reduce the prevalence of neck pain in the ultrasonographers.

METHOD

The data for this study were obtained through an electronic inquiry regarding the ergonomic work environment and health complaints among Belgian and Dutch ultrasonographers. The self-administered electronic inquiry incorporated three parts:

- Demographic data: Self-reported age (years), gender, institution, medical department, years working as an ultrasonographer.
- Ergonomic data: Average number of hours per week working with an ultrasound machine, consecutive working hours a day, permanent workplace, high-low table, ergonomic chair, position of the machine compared to own sitting position, position of the screen compared to own sitting position, height of the screen, and maneuverability of the screen.
- Musculoskeletal data: Neck and arm pain (present and past), location of arm pain, evolution of the pain throughout the workday, relation between work and pain.

A hundred and ten male and female ultrasonographers working in a hospital setting were randomly recruited by e-mail to take part in the study, regardless of their musculoskeletal complaints. An electronic link was placed on the website of the Dutch/Belgian Association for Noninvasive Vascular Diagnosis (http://www.vnivd.nl).

Description of the Ultrasonographer Task

Cardiac department. A standard echocardiogram is also known as a transthoracic echocardiogram. Images are obtained using an ultrasound probe and ultrasound gel. In this case, the echocardiography transducer (or probe) is placed on the chest wall (or thorax) of the subject, and images are taken through the chest wall. Different views are made: parasternal, apical, subcostal, and suprasternal. This is a noninvasive assessment of the overall health of the heart. The technician can assess a patient's heart valves and degree of heart muscle contraction (an indicator of the ejection fraction). The images are displayed on a monitor and are recorded by digital techniques (see Figure 1).

Figure 1. Cardiac department.

To obtain the best image quality, the room needs to be darkened. The subject undresses his or her upper body and lies in left lateral decubitis position with his or her left arm next to the head. Electrodes are connected on the chest of the subject to monitor the heart rate of the patient.

Vascular department: Examination of various veins. In a standard examination of the various veins, the patient is standing on an adjustable high-low table. The investigator sits behind the patient and holds with his or her right hand the duplex probe. He or she uses the left hand for (a) manipulating or typing on the duplex machine, (b) taking ultrasound gel, and (c) compressing the calf of the lower extremity. The examiner always turns his or her head left, toward the duplex machine; meanwhile, his or her right arm is in the opposite direction, compressing the lower limb with the probe. The examiner scans the whole limb, from hip to toe (see Figure 2).

Statistical Methods

All analyses were performed in SPSS 20.0 with a two-sided significance level of 5%. Separate

Figure 2. Vascular department: Examination of various veins.

analyses were performed to answer our different research questions. Note that in our descriptive statistics, we reported categorical variables (such as handedness) as numbers and percentages and continuous variables as means and standard deviations.

Age was the only continuous variable in the study and was normally distributed. Therefore, an unpaired *t* test was used to compare age across different groups: with and without pain.

For the comparison of categorical variables, a chi-square test was used if the numbers were large enough; otherwise, a Fisher exact test was performed.

Finally, we used multiple logistic regression models to identify predictors of arm and neck pain using a backward stepwise selection procedure. The initial models included gender, age, medical department (cardiology, vascular surgery, or other), more than 10 years working as an ultrasonographer (yes or no), more than 10 hr working per week with an ultrasound machine (yes or no), more than 2 hr working consecutively per day (yes or no), permanent workplace (yes or no), high-low table (yes or no, depending on workplace), ergonomic chair (yes or no), position of machine (left, right, or in front), position of screen (left, right, or in front), height of screen (eye level, higher, or lower), and maneuverable screen (yes or no).

RESULTS

Descriptive Information on the Study Population

Of the 110 ultrasonographers included in the analysis, 70 (63.63%) were women. The mean age of the study population was 43 (*SD* = 8.81) years, and 94 of them (85.45%) were right-handed. Of the interviewees, 25.69% were working at the Antwerp University Hospital.

Forty-four (or 39.99%) of the ultrasonographers worked or were working in the cardiology department, 40 (36.36%) worked or were working in the vascular surgery department, 15 (13.63%) worked or were working in the radiology department, 6 (5.45%) worked or were working in the urology department, and 4 (3.63%) worked or were working in the gynecology department.

The inquiry also surveyed the ultrasound experience of our population. Twenty-eight participants (25.45%) had up to 5 years of experience, 26 (23.63%) had 5 to 10 years of experience, 27 (24.54%) had 10 to 15 years of experience, 15 (13.63%) had 15 to 20 years of experience, and 14 (12.73%) had more than 20 years of experience.

Besides the experience, the inquiry also surveyed workload of the participants. Eighteen participants (16.36%) worked 0 to 10 hr a week with an ultrasound machine, 36 (32.73%) between 10 and 20 hr, 36 (32.73%) between 20 and 30 hr, 19 (17.27%) between 30 and 40 hr, and 1 participant (0.90%) worked more than 40 hr a week with an ultrasound machine.

Looking at the consecutive hours working with an ultrasound machine, we found that 19 participants (17.27%) never worked more than 1 consecutive hour, 4 (3.63%) worked 1 to 2 consecutive hours, 38 (34.54%) worked 3 to 4 consecutive hours, 13 (11.81%) worked 4 to 5 consecutive hours, and 34 (30.90%) worked more than 5 consecutive hours with an ultrasound machine. One participant did not answer this question.

To get a better understanding of the work environment of the participants, several questions about ergonomics were included in the inquiry.

Sixty-six participants (59.99%) had a fixed workplace. Seventy-nine participants (71.81%) used a height-adjustable table for taking ultrasounds, 19 (17.27%) did not have a height-adjustable table, and 12 (10.91%) sometimes used a height-adjustable table depending on the workplace.

The inquiry also surveyed the use of a height-adjustable chair by the ultrasonographers.

Seventy-two participants (65.45%) used a height-adjustable chair.

We also surveyed the positioning of the ultrasound machine itself and the positioning of the screen. Thirty-two participants (29.08%) had the ultrasound machine positioned to their left, 11 (10%) to their right, and 67 (60.90%) had the machine positioned right in front of them. Looking at the positioning of the examiner's head during the ultrasound examination, we found that 59 participants (53.64%) looked straight ahead, 49 (44.55%) turned their head to the left to look at the screen, and 2 (1.80%) turned their head to the right. Eighty-four participants (76.36%) had the screen at eye level, 20 (18.18%) looked up to the screen, and 2 (1.82%) looked down to the screen. Four participants did not answer this question.

We verified whether it was possible for the ultrasonographer to adjust the position of the screen. Ninety-one participants (82.72%) had an adjustable screen, and 19 (17.27%) had a fixed screen position.

The last question concerning ergonomics surveyed which hand was used by the examiner. Ninety-seven participants (88.17%) worked right-handed, 4 (3.63%) worked left-handed, and 7 (6.36%) worked ambidextrously. Two participants did not answer this question.

Importantly, we questioned the ultrasonographers about their physical problems. Fifty-four participants (49.08%) had physical problems at the time of the inquiry, including 34 participants (30.90%) with neck pain and 27 (24.54%) with arm pain. Taking into account physical problems that occurred in the past, we came to a total of 65 participants (59.08%) with neck pain and 73 participants (66.36%) with arm pain now or in the past. The total number of participants with neck and/or arm pain now or in the past was 89 (80.90%).

Subsequently, we asked the participants with arm pain now or in the past to specify the location of the pain in the arm. Fifty-four participants (49.08%) had pain in the shoulder, 52 (47.27%) had pain in the upper arm, 28 (25.45%) had pain in the wrist, 15 (13.63%) had pain in the elbow, 15 (13.63%) had pain in the hand, 10 (9.09%) had pain in the lower arm.

Of those participants with arm and/or neck pain, 49 (44.54%) noticed an increase of the pain during work, 30 (27.27%) had no increase, 8 (7.27%) did not know, and 2 did not answer the question. Sixty-one participants (55.45%) thought the arm and/or neck pain to be related to their work situation, 13 (11.82%) thought there was no relation, 12 (10.91%) did not know if there was any relation, and 3 did not answer the question.

Of all participants with physical problems, 44 (39.99%) had received a treatment. Forty-nine participants (44.54%) knew of coworkers with the same problem, 13 (11.81%) did not know of coworkers with the same problem, 23 (20.90%) had no idea about this, and 4 did not answer this question.

Fourteen participants (12.72%) also had experienced the same pain level in a nonworking environment, 34 (30.90%) had less pain, 39 (35.45%) had no pain when not working, and 2 did not answer this question. Forty-three participants (39.08%) indicated other activities that induced the same pain, 39 (35.45%) did not know such activities, and 7 did not answer this question.

Of all participants, 27 (24.54%) thought that the subject of this inquiry was being treated during trainings and in congresses, 62 (56.35%) thought there was no attention to it, 18 (16.36%) had no idea, and 3 did not answer this question. Seventy-three (66.35%) participants wished to take part in any future investigation related to this subject.

A multivariate logistic regression model was used to study the relationship between pain and the use of an ultrasound machine. Odds ratios and corresponding 95% confidence intervals are reported. The multivariate logistic regression model for arm and neck pain are presented in Tables 1 and 2.

DISCUSSION

This study was conducted to determine the prevalence of neck and arm pain in ultrasonographers.

The following findings are discussed.

- Subjects with the screen on their left report significantly more neck pain (Figure 3).

When performing work with the hands and fingers, the muscles in the neck/shoulder region must act as stabilizers.

TABLE 1: Neck Pain

		Multiple Logistic Regression	
Variable	Response	OR [95% CI]	*p* Value
Adjustable examination table	Yes + depends on work location vs. no	4.0 [1.2, 12.9]	.0196
Screen at the left	Yes vs. no	3.1 [1.3, 7.3]	.0117
Screen at eye level	Yes vs. no	0.32 [0.09, 1.07]	.0647

Note. OR = odds ratio; CI = confidence interval.

TABLE 2: Arm Pain

		Multiple Logistic Regression	
Variable	Response	OR [95% CI]	*p* Value
Left-/right-handed	Left-handed vs. right-handed	0.18 [0.05, 0.65]	.0087
Hours/day ≤ 2	≤2 vs. >2	3.8 [1.3, 11.7]	.0165
Fixed working space	Yes vs. no	0.28 [0.10, 0.79]	.0155
Department	Cardiology vs. others (radiology, gynecology, urology)	1.46 [0.46, 4.60]	.5229
	Vascular surgery vs. others	4.3 [1.3, 14.9]	.0198
	Cardiology vs. vascular surgery	0.34 [0.10, 1.08]	.0666

Note. OR = odds ratio; CI = confidence interval.

Static contraction of the trapezius and other shoulder muscles is needed to keep the arms at right angles, a necessary posture when using the keyboard. This contraction is accentuated when there is also rotation or bending of the neck when the computer screen is placed to the side of the worker. The recommended position is in front of the worker (Cagnie, Danneels, Van Tiggelen, De Loose, & Cambier, 2007).

Continuous rotation of the neck throughout the working day causes neck pain. It should be analyzed what the impact is on different structures located in the neck area and which anatomic structures are the root cause of the pain development. In addition, the effect of head rotation, combined with the position of the arm, on the development of a specific complaint pattern in the upper quadrant should be monitored.

In our population, only 2 people (1.82%) worked with the screen on their right side. The number was too small to be considered in our statistical analysis.

- A screen at eye level causes less neck pain (Figure 3).

In the reported literature, there is consensus that poor ergonomic conditions at workstations contribute to musculoskeletal symptoms in office workers (Ariens, Bongers, Hoogendoorn, van der Wal, & van Mechelen, 2002; Gerr, Monteilh, & Marcus, 2006; IJmker et al., 2007). Studies have shown that holding the neck in a bent posture and working in the same posture for prolonged periods of time were significantly associated with neck pain in office workers (Dagenais et al., 2008). Ranasinghe et al. (2011) suggest that modification of incorrect postures at work and improvements in the ergonomic designs of workstations could be important not only as a primary preventive strategy but also as a secondary preventive strategy in those with symptoms. Ariens et al. (2001) found a trend for a positive relation between neck flexion and neck pain, although not significant, suggesting an increased risk of neck pain for those who spent a large percentage of the working time with their neck at a minimum of 20° of flexion.

- Depending on the workspace, high-low tables increase the chance of developing neck pain (Figure 3).

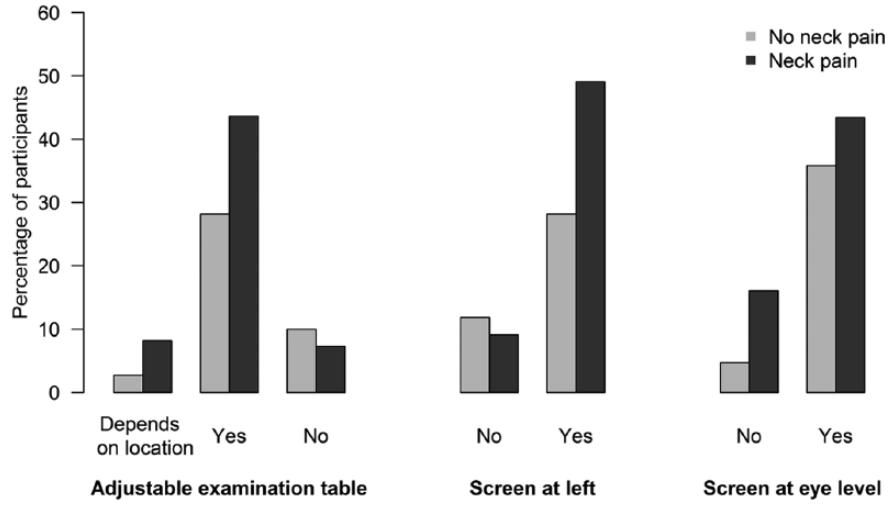

Figure 3. Percentage of participants with and without neck pain.

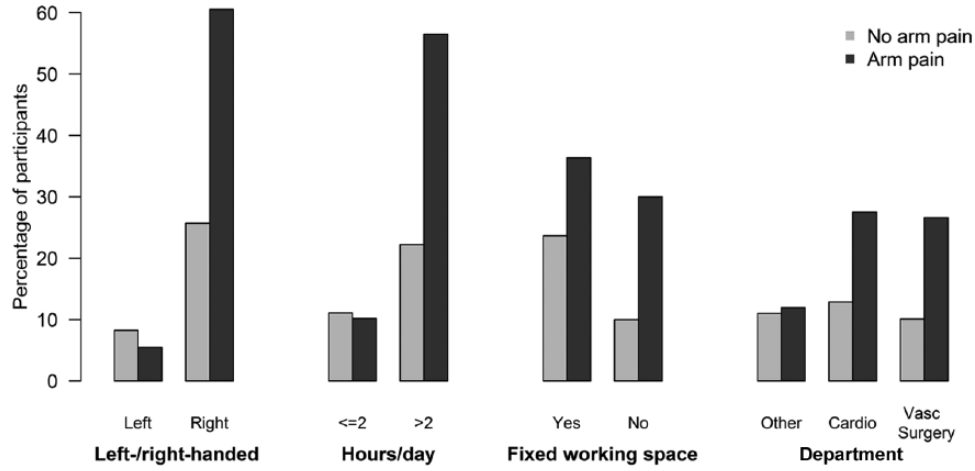

Figure 4. Percentage of participants with and without arm pain.

- Left-handed people suffer significantly less arm pain than right-handed people. In our study population, we found 15 left-handed people (13.76%), of whom only 4 (3.70%) held the ultrasound probe with their left hand (Figure 4).
- Employees with a fixed working space report less arm pain (Figure 4).

When people use ergonomic furniture, we expect that they adjust their table to the correct height so the chance of arm or/and neck pain will reduced.

Poor ergonomic understanding is a significant predictor of complaints in the neck, forearm, and hand regions. Implementation of a worksite ergonomics program is known to be effective in reducing work-related complaints in the workforce (Cole et al., 2006).

The height of standard tables has been designed with respect to the average length of humans. Use or nonuse of a height-adjustable table possibly has a negative impact on various structures in the upper quadrant. Further research is needed to determine which anatomic struc-

tures might be affected by this design and how to assess the ideal individual working height for health care staff. Given these findings, every staff member performing ultrasound scans should complete a thorough training.

- Ultrasonographers with less than 10 years of working experience report less arm pain than those who have more than 10 years of experience.

However, this effect was found to be marginally significant. Cagnie et al. (2007) also found a trend for a positive relation between years of working experience and arm pain. The increase with age can be explained by the increasing degenerative changes of the cervical spine with age (Cagnie et al., 2007).

- The prevalence of arm pain was significantly higher in the vascular department compared to the radiology, urology, and gynecology departments (Figure 4).

Further research will have to clarify to what extent the working conditions, such as position of the screen or subject, may differ in the departments mentioned. There might be significant differences in working methods between the various departments, which might explain why the vascular department staff seems to be more susceptible to complaints than others. A detailed job analysis with posture and force assessment may be useful in future studies.

Given the results of our study, authors of further research should consider several aspects of the workspace of ultrasonographers.

First, a more ergonomic approach to the ultrasound machine configuration may be appropriate. Since most ultrasonographers have their own workplace, separating the screen and the keyboard from the machine is advisable. This separation can result in more individualized configurations.

Second, we should reconsider the position of the ultrasonographer. It is possible to identify some individual parameters by which we can set up an appropriate and individualized ultrasound configuration. The sitting height of each person is an individual parameter. It is possible to calculate this height for every ultrasonographer. Depending on the sitting height, we can search for the ideal table height. We should also encourage examiners to shift their position more often. The current technology allows us to remember the position of our car seats. Why not do the same for the ultrasonographer's seat?

Finally, we should also reconsider the position of the patient. It is possible to redesign the examination table in a more ergonomic way so the ultrasonographer can work in more ergonomic conditions. This redesign varies with the different medical subdisciplines. The working conditions in the cardiology department are not the same as in the radiology or vascular department.

CONCLUSIONS

This study reveals that arm and neck pain are a significant health issue among ultrasonographers. Further research into work environment as it relates to ergonomics may help improve these issues.

KEY POINTS

- Ultrasonographers are more predisposed to develop neck complaints, potentially in combination with (radiating) pain in the upper limb. Primary ergonomic prevention could help the ultrasonographer to work without pain during his or her medical tasks.

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