Using Ultrasound to Assess First Year Sonography Students for Wrist Injury

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Diagnostic Medical Ultrasound

Abstract

Various studies have reported that 80-90% of diagnostic medical sonographers who work in the United States of America report they are scanning with musculoskeletal pain. One of the most common work related injuries incurred by sonographers is carpal tunnel syndrome which results from extrinsic compression on the median nerve within the carpal tunnel. While many studies have been conducted on sonographers to see if they experience pain while scanning, none have hypothesized how soon after entering the workforce will new sonographers begin to manifest signs of a repetitive injury. The purpose of this study was to discover if first year ultrasound students would develop signs of swelling or injury of the median indicating carpal tunnel syndrome. Using the diagnostic criteria of measuring the cross-sectional area of the median nerve within the carpal tunnel, a group of first year sonography students were evaluated. Because the participants were not performing ultrasound scans as frequently during their first year a dramatic increase in the cross-sectional area of the median nerve within the carpal tunnel was not expected.

Background

Work related musculoskeletal disorders (WRMSD) are injuries that are over time due to frequent muscle use, repetitive motion, held muscle strain, and a lack of appropriate recovery time.[2] Sonographer may develop WRMSD due to scanning an increasing number of obese patients who require sonographers to exert great pressure through their scanning arm to obtain quality images or due to improper scanning technique. These motions can affect the nerves by compressing them and they affect the muscles and tendons by causing fatigue, and restricting blood flow reducing function.[2] One example of WRMSD that sonographers often develop is carpal tunnel syndrome (CTS) which is a condition resulting from extrinsic compression on the median nerve within the carpal tunnel.[3]

Materials and Methods

During this study, the wrists of each subject was scanned using ultrasound to examine the median nerves of each subject. A base line scan was done at the beginning of the semester starting in late January 23 through February 20 of 2012. The second scan was done in April 2012. The main goal of each scan was to identify the median nerve as it enters the carpal tunnel proximally and leaves it distally. The dimensions of the median nerve were taken at each location which included the width, height, and cross-sectional area, see figures 1 and 2. Both the left and the right wrists of each subject were scanned for additional comparison. Based upon prior research, the following measurements were used as criteria for diagnosing CTS: a cross-sectional area of the median nerve of greater than 0.13 cm^2 at the proximal entrance and greater than 0.11 cm^2 at the distal entrance.

Ultrasound was chosen as the imaging modality in this study because it has been proven effective at imaging the wrist. In recent years, several studies have shown ultrasound to be reliable and accurate in diagnosing carpal tunnel syndrome.[4,5,6] Scanning the wrist with ultrasound is easy because there are no obstacles in the way to obstruct the view. When examining the nerves within the wrist, the volar or palm side of the hand should be imaged. The carpal tunnel is located in between the carpal bones of the hand on the deep side, the flexor retinaculum on the superficial side, the radial artery and vein laterally, and the ulnar artery and vein medially.[3] The following structures are found within the carpal tunnel: 8 flexor digitorum tendons, the flexor pollicis longis, and the median nerve.[3] The median nerve is located superficially and slightly medially. The nerve is superficial at the proximal end of the tunnel, then dives deeper into the wrist as it traverses the tunnel.

Sample Population

The sample population for this study included 18 first year sonography students. Of the subjects , there were 3 males and 15 females. The ages of the subjects ranged from 20 to 30 and all appeared to be in good health. A young population was chosen because they did not have as much time performing ultrasound scans as group of professional sonographers would have. As sonographers have a high rate of developing musculoskeletal injuries like CTS, the median nerves of first year sonography students would be evaluated to see if show any signs increasing in size due to improper scanning techniques. A bigger sample size of 30 would have been more desirable but logistically more time consuming.

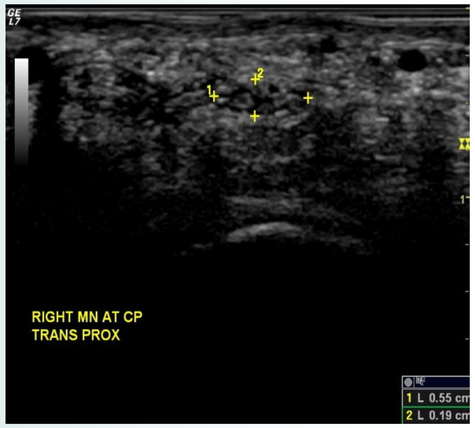

Figure 1. Transverse image of the carpal tunnel at the proximal inlet in the right hand with calipers measuring the median nerve width and height.

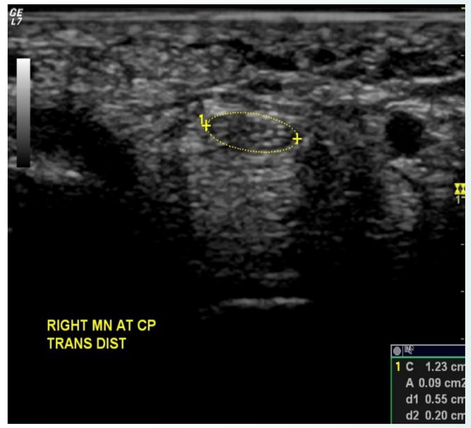

Figure 2. Transverse image of the median nerve at the distal out let of the carpal tunnel in the right hand of the same subject with the calipers measuring the circumference and cross-sectional area.

Results from the first scan obtained in January and February of 2012

PROXIMAL RIGHT MEDIAN NERVE				PROXIMAL LEFT MEDIAN NERVE			
Identifier	Width (cm)	Height (cm)	Area (cm²)	Identifier	Width (cm)	Height (cm)	Area (cm²)
MN01	0.56	16	0.07	MN01	0.50	0.18	0.07
MN02	0.53	0.20	0.09	MN02	0.49	0.13	0.07
MN03	0.51	0.30	0.08	MN03	0.42	0.29	0.08
MN04	0.53	0.19	0.07	MN04	0.72	0.25	0.12
MN05	0.52	0.16	0.06	MN05	0.60	0.18	0.08
MN06	0.70	0.16	0.11	MN06	0.67	0.19	0.09
MN07	0.51	0.20	0.07	MN07	0.54	0.17	0.07
MN08	0.54	0.13	0.06	MN08	0.65	0.16	0.09
MN09	0.52	0.22	0.09	MN09	0.49	0.22	0.08
MN10	0.54	0.17	0.08	MN10	0.57	0.19	0.09
MN11	0.49	0.24	0.09	MN11	0.54	0.12	0.07
MN12	0.57	0.18	0.08	MN12	0.44	0.16	0.06
MN13	0.62	0.17	0.08	MN13	0.63	0.16	0.09
MN14	0.66	0.17	0.11	MN14	0.62	0.16	0.09
MN15	0.55	0.19	0.09	MN15	0.51	0.16	0.07
MN16	0.71	0.17	0.10	MN16	0.62	0.18	0.10
MN17	0.50	0.14	0.08	MN17	0.52	0.17	0.08
MN18	0.71	0.16	0.12	MN18	0.62	0.24	0.12
Averages:	**0.57**	**0.18**	**0.09**	Averages:	**0.56**	**0.18**	**0.08**

DISTAL RIGHT MEDIAN NERVE				DISTAL LEFT MEDIAN NERVE			
Identifier	Width (cm)	Height (cm)	Area (cm²)	Identifier	Width (cm)	Height (cm)	Area (cm²)
MN01	0.66	0.19	0.09	MN01	0.39	0.23	0.07
MN02	0.48	0.26	0.08	MN02	0.57	0.17	0.08
MN03	0.44	0.30	0.09	MN03	0.45	0.17	0.06
MN04	0.46	0.26	0.08	MN04	0.75	0.26	0.17
MN05	0.82	0.33	0.20	MN05	0.95	0.40	0.30
MN06	0.62	0.33	0.15	MN06	0.67	0.24	0.12
MN07	0.50	0.19	0.09	MN07	0.53	0.18	0.07
MN08	0.51	0.16	0.06	MN08	0.58	0.20	0.08
MN09	0.56	0.24	0.11	MN09	0.39	0.20	0.07
MN10	0.47	0.27	0.10	MN10	0.56	0.17	0.09
MN11	0.57	0.21	0.10	MN11	0.41	0.19	0.05
MN12	0.39	0.25	0.08	MN12	0.36	0.15	0.05
MN13	0.50	0.24	0.09	MN13	0.54	0.19	0.07
MN14	0.57	0.17	0.07	MN14	0.64	0.22	0.11
MN15	0.55	0.21	0.09	MN15	0.38	0.22	0.08
MN16	0.62	0.18	0.10	MN16	0.61	0.23	0.12
MN17	0.55	0.19	0.09	MN17	0.53	0.15	0.07
MN18	0.54	0.23	0.11	MN18	0.62	0.29	0.15
Averages:	**0.55**	**0.23**	**0.10**	Averages:	**0.55**	**0.21**	**0.10**

Figure 3. Table of measurements from the first round of scans. Measurements above the criteria for CTS are highlighted in yellow.

Results from the second scan obtained in April 2012

PROXIMAL RIGHT MEDIAN NERVE				PROXIMAL LEFT MEDIAN NERVE			
Identifier	Width (cm)	Height (cm)	Area (cm²)	Identifier	Width (cm)	Height (cm)	Area (cm²)
MN01	0.62	0.18	0.09	MN01	0.38	0.25	0.07
MN02	0.60	0.15	0.08	MN02	0.52	0.17	0.08
MN03	0.52	0.25	0.09	MN03	0.48	0.19	0.08
MN04	0.44	0.20	0.08	MN04	0.62	0.20	0.11
MN05	0.61	0.23	0.09	MN05	0.66	0.21	0.11
MN06	0.59	0.17	0.09	MN06	0.56	0.18	0.09
MN07	0.54	0.16	0.07	MN07	0.62	0.14	0.07
MN08	0.47	0.15	0.08	MN08	0.53	0.22	0.09
MN09	0.53	0.24	0.12	MN09	0.41	0.21	0.08
MN10	0.56	0.17	0.08	MN10	0.56	0.14	0.07
MN11	0.50	0.19	0.07	MN11	0.55	0.16	0.07
MN12	0.44	0.18	0.08	MN12	0.37	0.16	0.04
MN13	0.60	0.21	0.10	MN13	0.70	0.19	0.12
MN14	0.53	0.15	0.07	MN14	0.57	0.15	0.08
MN15	0.47	0.17	0.07	MN15	0.49	0.14	0.06
MN16	0.71	0.16	0.09	MN16	0.67	0.18	0.12
MN17	0.46	0.18	0.06	MN17	0.52	0.13	0.06
MN18	0.84	0.22	0.17	MN18	0.69	0.20	0.15
Averages:	**0.56**	**0.19**	**0.09**	Averages:	**0.55**	**0.18**	**0.09**

DISTAL RIGHT MEDIAN NERVE				DISTAL LEFT MEDIAN NERVE			
Identifier	Width (cm)	Height (cm)	Area (cm²)	Identifier	Width (cm)	Height (cm)	Area (cm²)
MN01	0.53	0.21	0.10	MN01	0.48	0.22	0.08
MN02	0.52	0.24	0.10	MN02	0.52	0.21	0.09
MN03	0.42	0.24	0.08	MN03	0.37	0.25	0.07
MN04	0.42	0.25	0.08	MN04	0.57	0.29	0.13
MN05	0.75	0.28	0.16	MN05	0.97	0.36	0.29
MN06	0.48	0.17	0.07	MN06	0.53	0.17	0.08
MN07	0.56	0.18	0.08	MN07	0.59	0.17	0.09
MN08	0.63	0.19	0.09	MN08	0.72	0.22	0.13
MN09	0.39	0.26	0.09	MN09	0.39	0.23	0.07
MN10	0.48	0.18	0.07	MN10	0.55	0.15	0.08
MN11	0.51	0.23	0.09	MN11	0.51	0.14	0.06
MN12	0.42	0.22	0.07	MN12	0.34	0.18	0.05
MN13	0.54	0.17	0.07	MN13	0.49	0.19	0.07
MN14	0.49	0.27	0.11	MN14	0.58	0.22	0.12
MN15	0.46	0.26	0.10	MN15	0.38	0.21	0.08
MN16	0.58	0.20	0.10	MN16	0.52	0.23	0.11
MN17	0.57	0.18	0.10	MN17	0.46	0.17	0.07
MN18	0.66	0.20	0.12	MN18	0.54	0.25	0.12
Averages:	**0.52**	**0.22**	**0.09**	Averages:	**0.53**	**0.21**	**0.10**

Figure 4. Table of measurements from the second round of scans. Measurements above the criteria for CTS are highlighted in yellow.

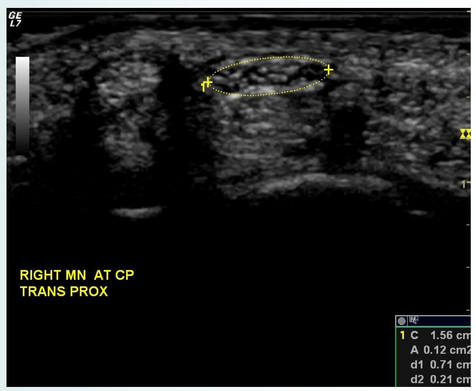

Figure 5. Image of the cross-sectional area of the right median nerve at the proximal inlet of subject MN18 obtained during the first round of scans.

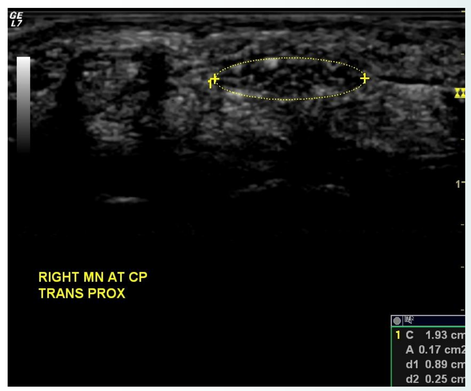

Figure 6. Image of the cross-sectional area of the right median nerve at the proximal inlet of subject MN18 obtained during the second round of scans.

Results

During the initial scan the average cross-sectional area of the median nerves were as follows: 0.09 cm^2 at the right proximal inlet, 0.08 cm^2 at the left proximal inlet, and 0.10 cm^2 for the right distal out let, and 0.10 cm^2 for the left distal outlet, see figure 3. The results of the second scan, performed 6 weeks later were: 0.09 cm^2 at the right proximal inlet, 0.09 cm^2 at the left proximal inlet, 0.09 cm^2 at the right distal outlet, and 0.10 cm^2 at the left distal outlet, see figure 4. In the first round of imaging, all carpal tunnel inlet measurements were less than 13 cm^2. However, at the distal outlet there were 6 measurements significantly greater than 0.10 cm^2, two on the right hand and 4 on the left; with only one subject (MN05) being affected bilaterally.

On the second scan, subject MN18 was above the threshold for CTS at all four locations. Once again subject MN05's distal measurements only were above 0.10 cm^2 while the proximal measurements were within normal limits. There were three additional measurements in the distal left wrist above this measurement as well.

When using both wrists, the average measurements of the cross-sectional area of the median nerves in the subjects did not change. This held true when averaging the areas of just the right and left wrists alone or when averaging all proximal and distal measurements separately. In fact many of the measurements of the cross-sectional area were smaller during the second scan than during the first scan. The measurements varied from +/- 0.04 cm^2. The measurement for MN06 at the right distal outlet decreased by 0.08 cm^2. As this is a rather large change in area, this finding was thrown out as being considered operator error. After allowing for error in scanning and throwing out the one exception, two measurements had shown to be reliably meeting the criteria of increasing in size over the course of the study. These were the proximal inlet of MN18 which increased in size by 0.05 cm^2 from 0.12 cm^2 to 0.17 cm^2 and the distal outlet of MN08 which also increased in by 0.05 cm^2 from 0.08 cm^2 to 0.13 cm^2.

Discussion

Only one of the 18 participants saw an increase in the measurement of the cross-sectional area of the carpal tunnel in their right hand which is the scanning hand which was only 6% of the sample size, see figures 5 and 6. There was one other wrist that was considered to have become significantly larger on the second scan but it was on the left wrist which was not the scanning hand. While the study does support the notion that ultrasound can detect changes in the area of the median nerve, it does not completely support the hypothesis that first year sonographers would manifest signs of CTS.

The main reason for this is that repetitive motion injuries like carpal tunnel syndrome take more time to develop. While the first year sonography students have spent much more time scanning in the lab, this increase has not been enough to show signs of CTS. One positive result is not enough to be considered proof of this theory. While this one student may be starting to show signs of CTS, the subject may have also had pre-existing inflammation of the median nerve.

The main limitation of this study was the length of time over which the study took place. Due to time constraints there was only a 6 week interval in between scans. The progression of CTS takes time and will not often be manifested in so short a time as this. Further research In this area in which more time was allowed in between scans may yield different results as it would allow the subjects to spend more time scanning and potentially more time to manifest signs of CTS.

References

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