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Effect of Pneumatic Power Tool Use on Nerve Conduction Velocity Across the Wrist

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ABSTRACT

The purpose of this study was to determine if the use of pneumatic power tools altered electrophysiologic properties of the median and ulnar nerves at the wrist during the work shift. Sensory nerve conduction velocities were measured in hands of workers before work and then at 2-hour intervals during the workday. Ten workers exposed to pneumatic power tool use and 10 workers not exposed to intensive hand activity were evaluated. The conduction velocities slowed significantly across the wrist in the median and ulnar nerves among workers using pneumatic tools but not among control workers. This investigation demonstrated that short-term exposure to highly intensive hand tasks causes significant slowing in nerve conduction velocity across the wrist. © 2005 Wiley Periodicals, Inc.

1. INTRODUCTION

Musculoskeletal and neurovascular disorders of the upper extremity are common problems in all occupational settings. Work tasks that are characterized by forceful exertions, high repetition, awkward postures, and vibration have been associated with several upper limb disorders such as carpal tunnel syndrome (CTS), hand–wrist tendonitis, and hand–arm vibration syndrome (National Institute for Occupational Safety and Health [NIOSH], 1997). Workers employed in heavy manufacturing as well as the construction trades often use heavy-duty pneumatic power tools with exposure to high forces, vibration, awkward postures, and repetition. Recently, we (Rosecrance, Cook, Anton, & Merlino, 2002) reported that as the number of hours of hand tool use increased so did the prevalence of CTS among construction workers. Although work tasks in the construction industry are varied, they have been characterized as having high peak hand forces, periodic repetitive motions, and awkward postures (Silverstein, Welp, Nelson, & Kalat, 1998). In heavy industry, researchers have recently quantified excessive exposure to vibration, high peak muscle loading, high levels of hand repetition, and extreme postures of the upper limb among

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foundry workers using pneumatic power tools to remove excessive metal from castings (Armstrong et al., 2002).

Comprehensive knowledge of the pathogenesis and etiologic factors related to occupational disorders of the distal upper limb are lacking (Moore, 2002). There are relatively few studies investigating the short-term effects of exposure to hand intensive work tasks on the electrophysiological changes in the upper limb. Using a prospective study design, Kearns and associates (Kearns, Gresch, Weichel, Eby, & Pallapothu, 2000), reported that within as little as 2 months after beginning jobs in a pork processing plant, workers exposed to hand intensive tasks developed prolongation of the median motor and sensory latencies within the carpal tunnel. Significant slowing of median nerve function over a 2-month period of hand and wrist intensive tasks suggests a rapid development of progressive neurophysiologic dysfunction. Other researchers have demonstrated transient neurophysiologic changes of the median nerve within the carpal tunnel resulting from short-term provocation maneuvers such as extreme wrist flexion for periods of 5 to 10 minutes (Clifford & Israels, 1994; Rosecrance, Cook, & Bingham, 1997). It is possible that highly intensive hand tasks performed in occupational settings produces a similar provocation to the median and or ulnar nerves within an 8-hour work shift. Investigating neurophysiologic changes across the wrist during work tasks may provide additional insight into the pathogenesis of disorders such as CTS and further explain the association between occupational activities and specific peripheral neurovascular disorders. The purpose of this study was to determine if the use of pneumatic power tools altered electrophysiological properties of the median and ulnar nerves across the wrist during the work shift. Nerve function was assessed among foundry workers exposed to pneumatic power tool use and compared to a control group of foundry workers that performed light intensity hand–wrist tasks.

2. METHODS

2.1. Tools

This study was conducted in the finishing department of a large metallurgic foundry in the Midwestern United States. The foundry produced heavy castings (up to 100 kg) for use as weights on tractors and other heavy equipment. As a result of the casting process, excess material formed where molds were joined and at points where molten metal entered the mold cavity. As part of the finishing operation, this excess material was removed by workers using pneumatic power tools. During the majority of the finishing operation, workers performed grinding tasks as castings moved slowly but continuously along a conveyor. Alternately, castings were taken off the main conveyor to a work cell where workers removed excess material. The primary pneumatic tool used by workers in the finishing area included rotational cup grinders, in-line hammers, and pencil grinders. Approximately 75% of the work involved the use of a two-handled cup grinder that weighed approximately 8 kg (Figure 1). The use of pneumatic grinding tools exposes workers to repetitive motions, forceful gripping, frequent deviations in wrist positions, and vibrations through both hands (Armstrong et al., 2002). Grinding tools are also commonly used in the construction industry for grinding metal piping, stone, and concrete mortar.

2.2. Participants

Twenty employees of the foundry participated in this study. The exposed group consisted of 10 experienced "finishing grinders" that used two-handed cup grinders and

Figure 1 Two-handle cup grinder used by finishing grinders.

in-line hammers 75% and 25% of the shift, respectively. The control group included 10 nonproduction workers from the same facility. Their daily tasks involved occasional computer work, various office tasks, inspecting equipment, and attending meetings. No formal task analysis was performed on the nonproduction control group. However, workers in the control group did provide the authors with a descriptive log of their work activities for every 2 hours of their work shift.

All participants were informed of the procedures and purpose of the research study. Participation was voluntary and all subjects agreeing to participate gave informed consent as required and outlined by the University Institutional Review Board on Research of Human Subjects. The subjects were paid their normal hourly wage during the testing. The participants were informed of their right to withdraw from the study at any time. All participants were informed that the information obtained from the study would be kept confidential and not accessible to their employer.

2.3. Procedures

Participants completed a survey consisting of demographic data, work history, medical history, and a history of any upper extremity injuries or symptoms. After completing the survey, standardized nerve conduction studies (American Academy of Environmental Medicine [AAEM], 1993) were performed to both hands with a Cadwell 5200A nerve conduction stimulator (Cadwell Laboratories, Inc., Kennewick, WA). An orthodromic, midpalmar 8-cm sensory latency was recorded across the wrist for the left and right median and ulnar nerves. For median nerve recordings, the active recording electrode was positioned 2 cm proximal to the distal wrist crease and superficial to the course of the median nerve. Percutaneous electrostimulation was performed in the mid-palm with the bipolar stimulator in line along the third metacarpal and the cathode positioned 8 cm distal to the active recording electrode. An 8-cm orthodromic, ulnar sensory latency was also recorded, with the stimulator placed over the ulnar aspect of the palm, and the recording electrode superficial to the ulnar nerve and proximal to the wrist crease. The ground electrode was placed on the dorsum of the hand between the stimulating and recording electrodes. The sensory latency was defined as the time interval between the stimulus artifact and the peak of the negative aspect of the action potential. Sensory nerve conduction velocities were then calculated for the median and ulnar nerves based on an 8-cm distance.

Hand temperature was monitored during each testing session by a surface thermistor (TH-8 Thermalert, Physitemp Instruments, Inc., Clifton, NJ) taped to the palmar aspect of the hand between the thumb and index finger. Nerve conduction velocities were normalized to a standard hand temperature of 34°C.

Nerve conduction studies were performed on the subjects at the beginning of their work shift and every 2 hours after that, for four tests (0 h, 2 h, 4 h, 6 h) per subject. Subjects were tested approximately 5 to 10 minutes after leaving their workstations. Identical nerve conduction study procedures were followed during each testing session for the median and ulnar nerves of both hands. All subjects took one 15-minute rest break and a 30-minute lunch break during the 6-hour investigation.

Utilizing the Strain Index (Moore & Garg, 1995), the grinding job task was analyzed for risk of distal upper extremity disorders. Each of the authors of this study performed an assessment of the grinding task utilizing the Strain Index and derived a consensus Stain Index score. All finishing grinders were videotaped throughout the workday by the investigators.

2.4. Data Analysis

Means and standard deviations, or frequencies were calculated for the demographic and work-related variables for all of the subjects (SAS 8.0 for Windows, SAS Institute, Inc., Cary, NC; NCSS 2000, NCSS, Kaysville, UT). Two-sample *t* tests were used to contrast these factors between the two groups. The primary study factors were two groups (finishing grinders and control subjects), and four measurement times (0, 2, 4, and 6 hours of work). Each hand and nerve combination was evaluated individually by a split-plot, repeated measures analysis of variance. The analyses consisted of testing the main effects of group and time, the simple effect of group at each measurement time, and the simple effect of time for each group separately. Preplanned comparisons were performed to detect differences in nerve conduction velocity from 0 hours of work to 6 hours within each group. Because normality could not be adequately assessed due to the small sample, each of the nerve and hand combinations was assigned an α level of 0.005 for the effects and comparisons. Sphericity of the covariance matrix was assessed by Mauchley's test statistic (Tabachnick & Fidell, 2001).

3. RESULTS

Twenty workers (10 finishing grinders and 10 control subjects) participated in the study. One of the control workers left work before the end of the study period, which prevented the collection of follow-up data. Thus, only nine control workers were used in the data analysis. Demographic data for the subjects is shown in Table 1. All subjects were male ranging in age from 25 to 51 years old, and ages were not significantly different between the groups. Control subjects weighed approximately 22 kg more than grinders ($p = 0.030$) and had a higher body mass index ($p = 0.053$). Work schedule variables were similar for the two groups, except the control group worked about 6 more hours per week ($p = 0.008$) than grinders. Subjects in both groups reported no known diabetes, rheumatoid arthritis, arm or neck pathology, hypothyroidism, or chronic illness. One subject in the control group reported previously diagnosed carpal tunnel syndrome.

The changes in nerve conduction velocity of the right median nerve over a 6-h time period in both groups are illustrated in Figure 2. As can be seen in Figure 2, the nerve conduction velocity decreased throughout the work shift for the finishing grinders but not for the control subjects. Although the interaction between group and time was not statistically significant ($p = 0.034$), it was close enough to assess the simple effects of time. The main effect of time (both groups combined) was significant ($p = 0.001$), but the group main effect was not significant ($p = 0.266$). Because the assumption of sphericity was violated for the main effect of time, a Box epsilon adjustment of the degrees of freedom was used to assess the main effect. The simple effects of time (Table 2) indicated that nerve conduction velocity (NCV) slowed (approximately 5 m/s) significantly over time for the grinders ($p < 0.001$), while the control workers did not show significant changes in NCV ($p = 0.309$). The preplanned comparison of changes in the final nerve conduction velocity measurement from the baseline was highly significant for the grinders ($p < 0.001$). For all nerve and hand combinations, the simple effects of group were

TABLE 1. Demographic Data of Finishing Grinders and Control Subjects

	Finishing grinders		Control subjects			
	Mean	*SD*	Mean	*SD*	*t*	*p*
Age	37.7	8.63	41.3	8.54	−0.92	0.3701
Weight (kg)	76.6	15.23	98.5	24.50	−2.37	0.0300
Height (m)	1.8	0.048	1.8	0.064	−1.11	0.2841
BMI (kg/m^2)	24.1	4.68	30.1	7.10	−2.09	0.0528
Months employed	46.0	67.11	56.0	43.10	−0.38	0.7077
Hours worked per week	40	0	45.6	5.83	−3.02	0.0077
Weeks worked per year	50.2	1.81	49.4	1.13	1.07	0.2977

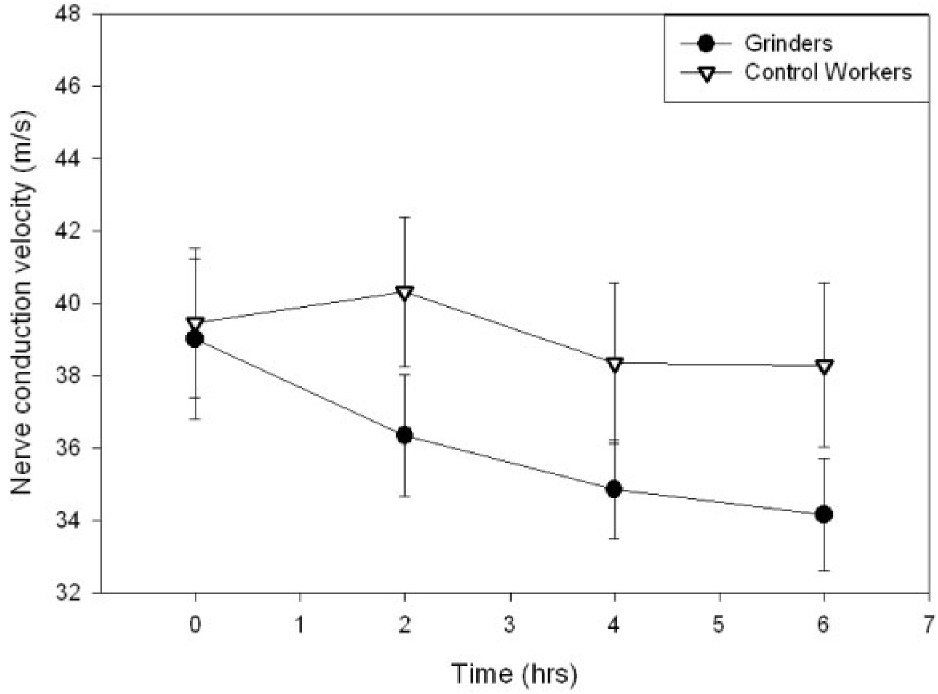

Figure 2 Right median nerve conduction velocities (m/s) before the start of the work shift and at 2-hour intervals during the work shift for the finishing grinders and for control workers.

TABLE 2. Mean (standard error) nerve conduction velocities of median and ulnar nerves across the wrist for finishing grinders and control workers at beginning of shift, and at 2, 4, and 6 hours into shift. Simple effect of time probability is reported as "Time p," and simple effect of group is "Group p."

Nerve	Group	0 h	2 h	4 h	6 h	Time p
Right median	Grinders	39.02 (2.22)	36.35 (1.69)	34.86 (1.36)	34.16 (1.56)	0.0002*
	Control workers	39.47 (2.07)	40.32 (2.07)	38.35 (2.22)	38.29 (2.27)	0.3087
	Group p	0.8841	0.1534	0.1885	0.1460	
Right ulnar	Grinders	44.26 (1.66)	40.98 (1.63)	39.18 (0.96)	39.21 (1.30)	0.0009*
	Control workers	42.14 (1.65)	43.61 (1.36)	40.61 (1.57)	41.93 (0.92)	0.2647
	Group p	0.3786	0.2480	0.4357	0.1117	
Left median	Grinders	39.60 (1.65)	38.20 (1.51)	38.25 (1.69)	36.19 (1.54)	0.0370
	Control workers	39.45 (2.86)	39.71 (2.31)	39.08 (2.92)	38.18 (2.63)	0.3414
	Group p	0.9638	0.5929	0.8082	0.5306	
Left ulnar	Grinders	43.07 (1.17)	40.93 (1.41)	41.24 (0.89)	38.26 (1.57)	0.0012*
	Control workers	41.38 (1.41)	43.04 (1.19)	41.48 (1.28)	41.17 (1.05)	0.0683
	Group p	0.3667	0.2755	0.8785	0.1498	

*Significant at adjusted $p < 0.005$.

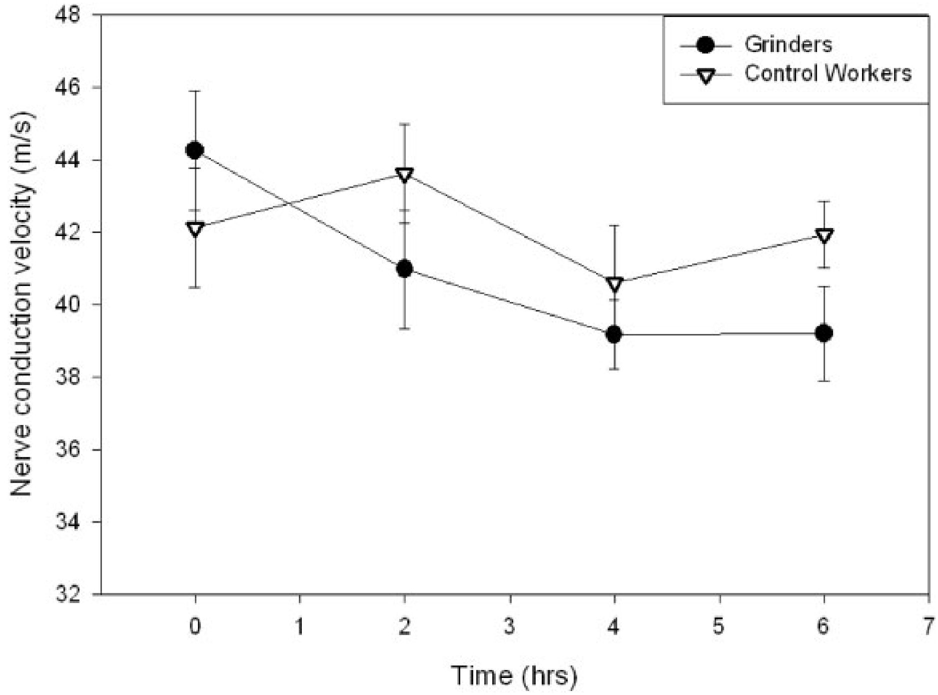

Figure 3 Right ulnar nerve conduction velocities (m/s) before the start of the work shift and at 2-hour intervals during the work shift for the finishing grinders and for control workers.

not significant at any of the measurement periods. However, statistical power was low for this test, possibly because of the limited available sample.

A similar pattern of decreased nerve conduction velocity in grinders was noted for the right ulnar nerve during the work shift (Figure 3). Interaction between groups and time again approached significance ($p = 0.029$). There were significant differences in the main effect of time ($p = 0.001$), with the grinders presenting lower values after 6 hours of work from the preplanned comparison ($p < 0.001$). The simple effect of time was highly significant for the grinders ($p < 0.001$). As with the nerve conduction velocity of the right median nerve, the nerve conduction velocity of the right ulnar nerve among control subjects did not significantly change over time.

There were no significant changes in nerve conduction velocity during the work shift for the left median nerve among the grinders or control subjects. Figure 4 illustrates small but nonsignificant decreases in left median nerve conduction velocity for both groups during the work shift. Although the main effect of time approached significance ($p = 0.029$, Box's adjustment), neither the effect of group ($p = 0.735$) or the interaction demonstrated significant differences ($p = 0.435$). The simple effect of time approached significance for the grinders ($p = 0.03$) but not for the control subjects ($p = 0.3$; Table 2).

The nerve conduction velocity of the left ulnar nerve slowed 4.8 m/s among grinders from the beginning to the end of the work shift (Figure 5), with the preplanned comparison highly significant ($p < 0.001$). The simple effect of time was significant for the left ulnar nerve conduction velocity among the grinders ($p = 0.001$). Although the nerve conduction velocity of the left ulnar nerve decreased over time and the simple effect of

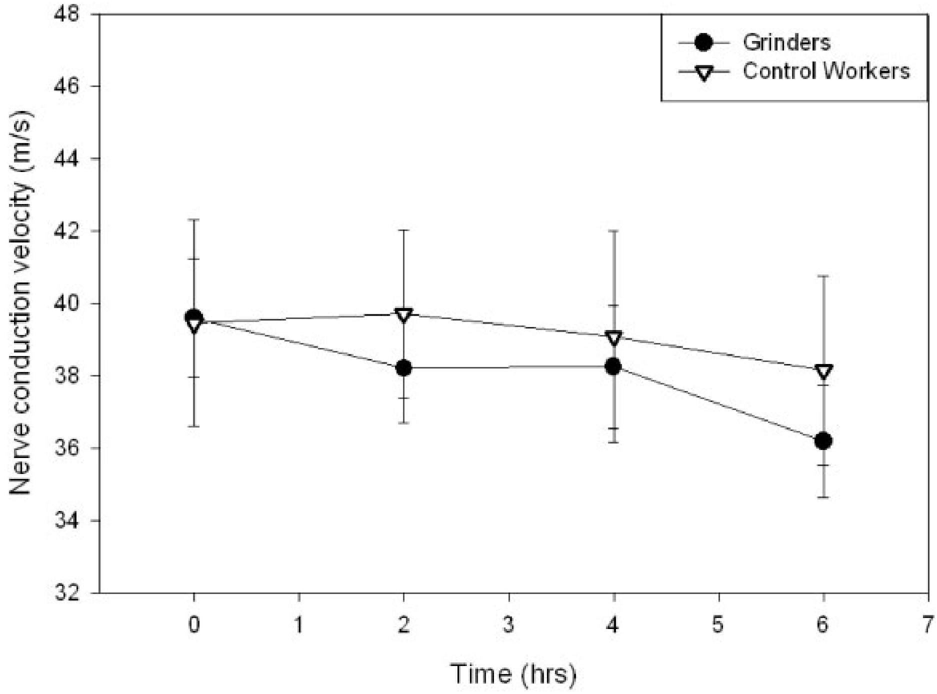

Figure 4 Left median nerve conduction velocities (m/s) before the start of the work shift and at 2-hour intervals during the work shift for the finishing grinders and for control workers.

time approached significance ($p = 0.068$) among the control workers, the preplanned comparison of the nerve conduction velocity before the shift and at 6 hours was not significant ($p = 0.777$). The p-value for the interaction effect was 0.005 and 0.002 for the main effect of time, while groups were again not significantly different ($p = 0.586$).

A Strain Index score of 27 was determined by consensus for the primary grinding task (the use of a cup grinder) performed on the day of the testing. The ratings for each task variable that determined the Strain Index score are presented in Table 3. A Strain Index score of 5 has been suggested as the upper limit of a safe job (Moore & Garg, 1995). Job

TABLE 3. Strain Index Rating and Score for the Task Involving a Two-Handled Cup Grinder

	Rating criteria	Rating	Multiplier
Intensity of exertion	Hard	3	6
Duration of exertion (% of cycle)	>80%	5	3
Efforts/minute	4–8	2	1
Hand/wrist posture	Fair	3	1.5
Speed of work	Fair	3	1
Duration per day	4–8 hours	4	1
Strain Index Score			27

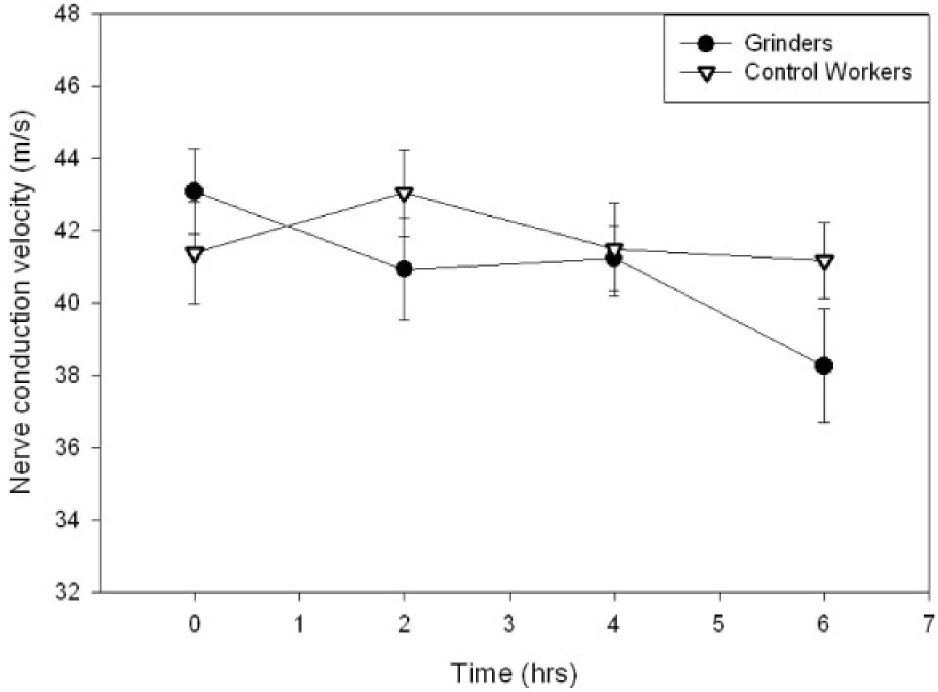

Figure 5 Left ulnar nerve conduction velocities (m/s) before the start of the work shift and at 2-hour intervals during the work shift for the finishing grinders and for control workers.

tasks rated greater than 5 on the Strain Index 5 have been associated with increased hand–wrist morbidity.

4. DISCUSSION

The results of this study demonstrated significant slowing of nerve conduction velocity in the median and ulnar nerves across the right wrist and in the ulnar nerves across the left wrist for workers performing highly intensive hand–wrist job tasks over a 6-h period. A control group of workers performing light intensity work from the same facility did not demonstrate any significant changes in the nerve conduction velocity in either hand–wrist during the work shift. This finding suggests that the slowing of the nerve conduction velocity across the wrists during the workday among the finishing grinders was most likely related to the hand-intensive tasks performed while using the pneumatic hand tools. Several occupational factors associated with pneumatic hand tool use may account for the reduction in nerve conduction velocity among the finishing grinders. A combination of factors including high-intensity forearm muscle forces, sustained awkward wrist postures, repetition, and hand–arm vibration may have led to reduction in conduction velocity of the median and ulnar nerves.

The exposure to external loads imposed on the hand and arm from the pneumatic tools was not quantitatively measured in this study. We did, however, use the semi-quantitative Strain Index proposed by Moore and Garg (1995) to estimate the potential risk of hand–wrist disorders associated with operating the two-handled cup grinder. Although other pneumatic tools such as inline hammers and pencil grinders were occasionally used by the finishing grinders, approximately 75% of the study period was spent using the two-handled cup grinder. The Strain Index is a rating of six task variables including intensity of exertion, duration of exertion, frequency of exertions, hand–wrist posture, speed of work, and duration per day. Each variable is assigned a numeric score based on one of five levels of task variables. The five scores are then multiplied yielding a measure of risk. We estimated the intensity of hand exertions as *hard* (Strain Index range of *light*, *somewhat hard*, *hard*, *very hard*, *near maximal*) which corresponds to approximately 30 to 49% of maximum voluntary contraction (MVC). Armstrong and colleagues (2002) recently quantified the exposure of foundry workers to physical stresses associated with using similar pneumatic tools to those used in the present study. They determined that finishing grinders were exposed to high peak muscle loading with peak muscle forces ranging between 16 and 53% MVC for the finger flexors and between 17 and 66% MVC for the wrist extensors. These forces are comparable to our estimates of exertion intensity using the Strain Index.

The significant decrease in conduction velocity for the right median and bilateral ulnar nerves during the grinding tasks may be similar to mild forms of nerve compression syndromes that are related to localized interference of microvascular function in the nerve. Although carpal tunnel syndrome is the most common nerve compression syndrome, the ulnar nerve at the wrist is also vulnerable to compression and referred to as Guyon's canal syndrome (Rempel, Dahlin, & Lundborg, 1999). Nerve compression syndromes usually occur at sites where the nerve passes through a narrow tunnel or canal formed by stiff tissue structures such as carpal bones and ligaments. The pathogenesis of compression neuropathies at the wrist are often the result of direct contact stress and or increased pressure within the confined tunnel where the nerve passes. Exposure at the wrist to non-neutral wrist postures and high-intensity tendon loading in proximity to the nerve is thought to result in biomechanical stresses that increase intracanal pressure causing subsequent intraneural ischemia (Moore, 2002). Prolonged and repeated episodes of intraneural ischemia are thought to lead to myelin degeneration of the nerve and subsequent symptoms of compression neuropathies and electrophysiologic test abnormalities such as decreases in never conduction velocity (Moore, 2002).

Forceful activity of the hand and wrist has been shown to experimentally increase pressure within the carpal tunnel. Smith, Sonstegard, & Andeson (1977) found that loading the second and third flexor digitorum profundus tendons of cadavers increased carpal tunnel pressure dramatically. Forceful isometric muscle contraction increased carpal tunnel pressure in subjects with CTS by three to six times that of resting pressure (Werner, Elmqvist, & Ohlin, 1983). Forceful finger activity, especially in extremes of wrist posture may cause direct pressure on the median nerve from the flexor tendons (Armstrong & Chaffin, 1979) or indirectly increase pressure on the flexor retinaculum (Smith et al., 1977; Szabo, Bay, Sharkey, & Gaut, 1994). Keir, Wells, Ranney, & Lavery (1997) reported increased carpal tunnel pressure in cadavers with loading of finger flexors in wrist flexion or ulnar deviation, which suggests that forceful gripping in these postures may be harmful, and agrees with findings on patients with CTS (Luchetti, Schoenhuber, & Nathan, 1998). Increased carpal tunnel pressure was also noted with loading of the palmaris longus in extension which may have the effect of indirectly reducing the cross-sectional area of the carpal tunnel (Cobb, Cooney, & An, 1995). Later studies with living subjects found carpal tunnel pressure around 30 mm/Hg with as little as 3 N (0.7 lb) of fingertip pressing (Rempel, Keir, Smutz, & Hargens, 1997), with still greater changes during a pinch grip (Keir, Bach & Rempel, 1998b). Simple finger activity has been shown to increase carpal tunnel pressure, especially use of the pinch grip (Ham, Kolkman, Heeres, den Boer, & Vierhout, 1996; Keir et al., 1998b; Smith et al., 1977). Pneumatic tool use such as that performed in the present study involved forceful gripping in awkward wrist postures.

Although posture was not directly measured in the current study, the hand–wrist posture of the grinders was rated as "fair" in the Strain Index. A "fair" rating for hand–wrist posture corresponds to non-neutral wrist postures during the grinding operations consisting of 26–40 degrees of wrist extension, 16–30 degrees of wrist flexion, and 16–20 degrees of ulnar deviation. Armstrong et al. (2002) reported medium to high levels of wrist flexion and extension among foundry workers during pneumatic tool use for grinding operations. There is evidence that both wrist flexion and extension increase carpal tunnel pressure (Keir, Bach, & Rempel, 1998a; Luchetti et al., 1998; Smith et al., 1977). The majority of studies suggest that the extremes of wrist flexion or extension lead to the largest increases in carpal tunnel pressure (Gelberman, Hergenroeder, Hargens, Lundborg, & Akeson, 1981; Szabo & Chidgey, 1989; Werner, Armstrong, Bir, & Aylard, 1997; Werner et al., 1983).

Hand–arm vibration is an exposure variable associated with upper limb disorders but is not included in the Strain Index. Grinding tasks like those in the present study expose workers to significant amounts of hand–arm vibration (Armstrong et al., 2002) and are associated with neurovascular changes (Kihlberg, Attebrant, Gemne, & Kjellberg, 1995). In laboratory studies of simulated foundry grinding tasks, single-handed grinders and in-line hammers produced average vibration levels of 3.3 m/s^2 of 11.8 m/s^2, respectively (Armstrong et al., 2002). ACGIH (American Conference of Governmental Industrial Hygienists) Worldwide (2003) has published threshold limit values (TLVs) for exposure to hand–arm (segmental) vibration. The TLV for hand–arm vibration exposure is 4 m/s^2 for the dominant frequency-weighted acceleration during an 8-h shift. It is likely that the two-handed cup grinders employed in the present study had greater average vibration levels than the smaller single-handed grinders described by Armstrong et al. (2002). The vibration exposure level measured for in-line hammers (11.8 m/s^2), similar to the tool used in the present study, is only acceptable under the ACGIH Worldwide (2003) TLV if used less than one hour during the work shift. The workers using pneumatic power tools in the present study used the in-line hammers 25% of the time during the 6-hour shift. Thus, hand–arm vibration was likely a primary factor contributing to the significant decrease in conduction velocity recorded in the median and ulnar nerves among the workers exposed to pneumatic tool use in the present study.

Significant decreases in sensory conduction velocity across the wrist for the median and ulnar nerve have been reported frequently among workers exposed to hand–arm vibration as compared with referents (Alaranta & Seppäläinen 1977; Hisanaga, 1981; Juntunen, Matikainen, Seeppäläinen, & Laine, 1983). The pathogenesis of vibration-induced neuropathies is not completely understood and it is difficult to determine the effects of vibration when tasks also involve exposure to high muscle forces, awkward postures, and repetition (Brammer & Pyykkö, 1987). Animal experiments have demonstrated that acute and isolated exposure to vibration induces epineurial edema (Lundborg et al., 1987). This edema is associated with increases in intraneural pressure which, in turn, leads to disturbances in the microcirculation and intraneural ischemia. Thus, vibration-induced neuropathies may mimic other compression neuropathies involving the median as well as the ulnar nerve in the hands of manual workers (Brammer & Pyykkö, 1987).

The changes in electrophysiology of the median and ulnar nerves of finishing grinders recorded in the present study are likely related to an induced intraneural ischemia from a combination of biomechanical stresses associated with the grinding task.

It is interesting to note that the nerve conduction velocity of the median nerve in the left hand of finishing grinders decreased from 39.60 m/s to 36.19 m/s from the start of the shift to 6 hours into the shift. This decrease of 3 m/s, however, was not statistically significant. Because the grinding task was essentially a bilateral activity, we expected significant decreases in nerve conduction velocity of both the right and left median nerves. Of the pneumatic tools used in the finishing area of a foundry, Armstrong et al. (2002) reported that the average right-hand electromyography activity exceeded that of the left hand by an average of 53%. The investigators associated the increased muscle activity in the right upper limb with the differential use of the extremities by subjects who were all right-handed. In the present study, 9 of the 10 grinders were right-handed. Although the primary finishing task involved a two-handed cup grinder, the workers may have used their dominant limb to a greater extent relative to the left limb. Reduced muscle activity in the left may have accounted for the nonsignificant changes in nerve conduction velocity of the median nerve in the left wrist. The small sample size in the present study may have also contributed to the lack of significance in changes in conduction velocity for the left median nerve.

5. CONCLUSIONS

The purpose of this study was to determine if the use of pneumatic power tools altered nerve conduction velocity of the median and ulnar nerves at the wrist during the work shift. Nerve function was assessed among foundry workers exposed to pneumatic power tool use and compared to a control group of foundry workers that performed light intensity hand–wrist tasks. Significant decreases in nerve conduction velocity were recorded in the median and ulnar nerves across the right wrist and in the ulnar nerve across the left wrist for workers performing highly intensive wrist–hand job tasks but not workers performing light intensity work over a 6-hour period. The finding suggests that the slowing of the nerve conduction velocity across the wrists during the workday was likely related to the hand-intensive tasks performed while using the pneumatic hand tools. A combination of high-intensity forearm muscle forces, sustained awkward wrist postures, repetition, and hand–arm vibration may be responsible for the reduction in nerve conduction velocity. Prolonged pneumatic power tool use may lead to upper limb neurovascular conditions such as carpal tunnel syndrome, Guyon's canal syndrome, and or hand–arm vibration syndrome. The results of this study emphasize the need to control the exposures that produce biomechanical or physiological stresses to the upper limb. Additional studies are needed to investigate the relative influence of the magnitude of exposure, the temporal pattern of biomechanical loading, and the duration of loading on the development of compression-related neuropathies.

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