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Effect of Hand Held Vibrating Tools on Nerve Conduction Study in Dental Residents

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ABSTRACT

Background: Repetitive exposure to vibration has been shown to induce peripheral nerve dysfunction. Dentists are exposed to handheld vibrating tools in their daily clinical practice. Most of the studies are done in dentists who have symptoms such as paresthesia and numbness of the hands. Thus, we conducted the study to explore the effect of vibration on nerve conduction variables in apparently healthy asymptomatic dental residents.

Methods: This cross-sectional study enrolled 22 dental residents and age matched 22 medical residents as controls. Nerve conduction study was performed in median and ulnar nerves of both hands.

Results: Anthropometric and cardiorespiratory variables were comparable between the groups. There were no statistically significant differences between dental and medical residents in the sensory conduction variables (right median onset latency=2.05±0.27 vs 1.91±0.21, p value=0.07; right median amplitude =27.80±8.11 vs 29.55±7.04, p=0.45; right median conduction velocity = 59.54±7.05 vs 61.06±5.15, p= 0.42) and motor conduction variables (right median distal latency = 2.87±0.38 vs 2.87±0.38, p= 0.94; right median distal amplitude=10.71±2.19 vs 11.10±2.37, p=0.58; right median conduction velocity= 70.57±13.16 vs 68.53±7.73, p= 0.54) of median and ulnar nerves. Further, there was no significant difference between the dominant and non-dominant hands of dental residents.

Conclusions: Hand held vibration tools did not alter nerve conduction study parameters of dental residents.

Keywords: Dentists; nerve conduction study; vibration.

INTRODUCTION

Dentists are exposed to handheld vibrating tools in their daily clinical practice.[1] Numbness and tingling sensation are common symptoms.[2] Neurological disorders caused by vibration are peripheral neuropathy; mainly the sensory but may involve the motor nervous system. These disorders might affect the ability to fulfill the high precision demands of dentistry as they require extremely good finger mobility, strength and tactile sensitivity.[3]

Nerve conduction studies (NCS) provide objective and quantitative assessment of peripheral nerve functions. They are considered as the gold standard methods to assess peripheral nerve damage.[4] Previous studies reported significant changes in the nerve conduction variables of the subjects exposed to vibration including dentists.[5,6] However, most of the studies are investigated in symptomatic subjects.[7]

The purpose of the study is to assess the effect of vibration on nerve conduction variables in asymptomatic dental residents.

METHODS

The comparative cross-sectional study was conducted in Department of Basic and Clinical Physiology at B.P. Koirala Institute of Health Sciences, Nepal from 31st December 2016 to 31st December 2017. The ethical approval was obtained from the Institutional Review Committee (IRC). The procedure was fully explained and informed written consent was taken from all the subjects recruited for the study.

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The study group consisted of 22 apparently healthy asymptomatic dental residents (16 males and 6 females) having at least 10 months exposure to vibration with age ranging between 27-34 years. The sample size was calculated from the published data[4] using two mean formulas. Subjects who did not have clinical complaints such as tingling sensation and numbness were considered as apparently healthy. Subjects with major systemic illness, peripheral nerve trauma, fracture and dislocation of upper limb bones, cervical radiculopathy, and brachial plexopathy and under medications that alter nerve conduction variables were excluded from the study. The control group consisted of age-matched 22 healthy medical residents (18 males and 4 females) who were not exposed to vibration. Both groups were selected from B.P. Koirala Institute of Health Sciences. A detailed history and clinical examination were performed using standard proforma of all subjects involved in the study.

Anthropometric, cardiorespiratory and nerve conduction variables were studied. Nerve conductions study (NCS) was performed in Neurophysiology laboratory. The room temperature was maintained at 26±2 degree Celsius during recording. All data were analyzed statistically for comparison between the groups.

NCS of the bilateral median and ulnar nerves were recorded using Digital Nihon Kohden (NM420S_ H636, Japan) by belly-tendon montage. For each site of stimulation, proximal latency, distal latency, amplitude, nerve conduction velocity (NCV) and F- wave latency of compound muscle action potentials (CMAPs) were recorded.

Orthodromic method of stimulation was employed for testing the bilateral median and ulnar nerves using ring electrodes. For each site of stimulation, onset latency, amplitude and NCV of sensory nerve action potentials (SNAPs) were recorded.

The data was first entered into Microsoft Excel worksheet and then statistical analysis was done using SPSS 20.0 version. The data of anthropometric, cardiorespiratory and NCS variables were normally distributed. Independent sample t test was used to compare NCS between the groups. Paired t test was applied to compare NCS between dominant and non-dominant hands of dental residents. The p value <0.05 was considered statistically significant.

RESULTS

Dental residents were exposed to vibration, particularly high frequency ultrasonic scalers (50-60 kHz) and high speed micromotor (1000-10,000 rpm) and airotor (200,000 rpm) hand pieces in their daily clinical practice. The range of duration of vibration exposure in dental residents was between 2 to 6.5 years. The average daily exposure to vibration was 6 hours per day.

Anthropometric variables were comparable between dental and medical residents in terms of their age, weight, height, body mass index (BMI), upper limb length (ULL) and lower limb (LLL). Similarly, cardiorespiratory variables such as systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate (PR) and respiratory rate (RR) were comparable between the groups (Table 1).

Table 1. Comparison of anthropometric and cardiorespiratory variables between dental and medical residents.

Anthropometric variables	Dental residents (n=22); Mean ± SD	Medical residents (n=22); Mean ± SD	P value
Age (years)	30.09±1.57	29.27±1.61	0.10
Weight (Kg)	169.41±10.82	167.23±9.70	0.49
Height (m)	73.30±13.48	65.55±13.194	0.06
BMI (Kg/m²)	25.30±2.75	23.45±4.31	0.10
ULL (cm)	73.25±4.88	72.93±5.00	0.83
SBP(mmHg)	120±3.086	120.27±0.935	0.69
DBP(mmHg)	79.55±3.751	80±0.617	0.58
PR (bpm)	73.45±1.97	72.82±1.82	0.27
RR(breaths/min)	17.27±0.98	16.64±1.29	0.07

Sensory conduction variables of the bilateral median and ulnar nerves are presented in Table 2. There were no significant differences in the sensory conduction variables of median and ulnar nerves such as onset latency, amplitude and nerve conduction velocity (NCV) between the groups.

Table 2. Comparison of sensory conduction variables of median and ulnar nerves between dental and medical residents.

Variables	Dental residents (n=22); Mean ± SD	Medical residents (n=22); Mean ± SD	P value
RMOL (ms)	2.05±0.27	1.91±0.21	0.07
RMA (mv)	27.80±8.11	29.55±7.04	0.45
RMNCV (m/s)	59.54±7.05	61.06±5.15	0.42
LMOL (ms)	2.07±0.25	1.94±0.17	0.06
LMA (mv)	27.89±7.77	28.70±8.63	0.74
LMNCV (m/s)	58.81±6.32	59.96±4.97	0.51
RUOL (ms)	1.67±0.23	1.72±0.20	0.50
RUA (mv)	15.24±5.45	14.91±3.39	0.81

RUNCV (m/s)	62.16±5.28	60.51±5.77	0.33
LUOL (ms)	1.69±0.24	1.74±0.21	0.50
LUA (mv)	16.20±5.22	15.25±2.95	0.46
LUNCV (m/s)	61.86±6.93	59.42±6.58	0.24

RMOL: right median onset latency, RMA: right median amplitude, RMNCV: right median nerve conduction velocity, LMOL: left median onset latency, LMA: left median amplitude, LMNCV: left median nerve conduction velocity, RUOL: right ulnar onset latency, RUA: right ulnar amplitude, RUNCV: right ulnar nerve conduction velocity, LUOL: left ulnar onset latency, LUA: left ulnar amplitude, LUNCV: left ulnar nerve conduction velocity

Motor conduction variables of the bilateral median and ulnar nerves are presented in Table 3 and Table 4. There were no significant differences in the motor conduction variables of median and ulnar nerves such as proximal and distal latencies, amplitude, nerve conduction velocity and F-wave latency between the groups.

Table 3. Comparison of motor conduction variables of median nerve between dental and medical residents.

Variables	Dental residents (n=22); Mean ± SD	Medical residents (n=22); Mean ± SD	P value
RMDL (ms)	2.87±0.38	2.88±0.43	0.94
RMPL(ms)	6.75±0.69	6.61±0.66	0.49
RMDA (mv)	10.71±2.19	11.10±2.37	0.58
RMPA(mv)	9.91±2.24	10.13±2.41	0.76
RMNCV(m/s)	70.57±13.16	68.53±7.73	0.54
RMMinF(ms)	24.65±2.16	24.57±1.34	0.87
LMDL(ms)	2.89±0.34	2.95±0.22	0.50
LMPL(ms)	6.90±0.73	6.64±0.39	0.15
LMDA(mv)	11.40±2.58	11.80±2.40	0.60
LMPA(mv)	10.79±1.99	11.04±2.26	0.71
LMNCV(m/s)	67.75±9.88	69.03±6.17	0.61
LMMinF(ms)	24.55±2.34	24.42±1.81	0.84

RMDL: right median distal latency, RMPL: right median proximal latency, RMDA: right median distal amplitude, RMPA: right median proximal amplitude, RMNCV: right median nerve conduction velocity, RMMinF: right median minimum F-wave, LMDL: left median distal latency, LMPL: left median proximal latency, LMDA: left median distal amplitude, LMPA: left median proximal amplitude, LMNCV: left median nerve conduction velocity LMMinF: left median minimum F-wave

Table 4. Comparison of motor conduction variables of ulnar nerve between dental and medical residents.

Variables	Dental residents (n=22)	Medical residents (n=22)	P value
RUDL (ms)	2.15±0.38	2.35±0.50	0.15
RUPL(ms)	6.11±0.75	6.30±0.62	0.35
RUDA)mv)	7.70±1.17	7.67±1.81	0.95
RUPA(mv)	7.11±1.13	7.22±1.76	0.81
RUNCV(m/s)	72.92±9.40	68.33±7.93	0.09
RUMinF(ms)	25.34±2.72	25.80±1.20	0.47
LUDL(ms)	2.23±0.34	2.35±0.31	0.21
LUPL(ms)	6.20±0.74	6.35±0.74	0.52
LUDA(mv)	7.48±1.808	7.64±1.62	0.75
LUPA(mv)	7.03±1.68	7.25±1.52	0.65
LUNCV(m/s)	72.34±11.77	69.37±8.33	0.34
LUMinF(ms)	25.52±2.68	25.45±1.49	0.91

RUDL: right ulnar distal latency, RUPL: right ulnar proximal latency, RUDA: right ulnar distal amplitude, RUPA: right ulnar proximal amplitude, RUNCV: right ulnar nerve conduction velocity, RUNMinF: right ulnar minimum F-wave, LUNDL: left ulnar distal latency, LUNPL: left ulnar proximal latency, LUNDA: left ulnar distal amplitude, LUNPA: left ulnar proximal amplitude, LUNCV: left ulnar nerve conduction velocity, LUNMinF: left ulnar minimum F-wave

All dental residents were right handed except one. Both sensory and motor conduction variables of the median and ulnar nerves were comparable between dominant and non-dominant hands of dental residents (Table 5).

Table 5. Comparison of sensory and motor conduction variables of median and ulnar nerves between dominant and non-dominant hands of dental residents.

	Variables	Dental resident (n=22; Mean±SD)		P value
		Dominant hands	Non-dominant hands	
sensory	MOL (ms)	2.05±0.27	2.07±0.25	0.57
	MA (mv)	27.80±8.11	27.89±7.77	0.94
	MNCV (m/s)	59.54±7.05	58.81±6.32	0.45
Motor	MDL (ms)	2.87±0.38	2.89±0.34	0.74
	MPL (ms)	6.75±0.69	6.90±0.73	0.05
	MDA (mv)	10.71±2.19	11.40±2.58	0.20
	MPA (mv)	9.91±2.24	10.79±1.99	0.10
	MNCV (m/s)	70.57±13.16	67.75±9.88	0.10
	MMinF(ms)	24.65±2.16	24.55 ±2.34	0.78
sensory	UOL (ms)	1.67±0.23	1.69±0.24	0.55
	UA (mv)	15.24±5.45	16.20±5.22	0.39
	UNCV (m/s)	62.16±5.28	61.86±6.93	0.82

Motor	UDL (ms)	2.15±0.38	2.23±0.34	0.21
	UPL (ms)	6.11±0.75	6.20±0.74	0.25
	UDA (mv)	7.70±1.17	7.48±1.80	0.61
	UPA (mv)	7.11±1.13	7.03±1.68	0.84
	UNCV (m/s)	72.92±9.40	72.34±11.77	0.60
	UMinF(ms)	25.34±2.72	25.52±2.68	0.71

MOL: median onset latency, MNA: median amplitude, MNCV: median nerve conduction velocity, MDL: median distal latency, MPL: median proximal latency, MDA: median distal amplitude, MPA: median proximal amplitude, MMinF: median minimum F-wave, UOL: ulnar onset latency, UA: ulnar amplitude, UNCV: ulnar nerve conduction velocity, UDL: ulnar distal latency, UPL: ulnar proximal latency, UDA: ulnar distal amplitude, UPA: ulnar proximal amplitude, UMinF: ulnar minimum F-wave

DISCUSSION

Our study did not find any difference in sensory and motor conduction variables in comparison to asymptomatic medical residents. To our knowledge, we did not come across many studies reporting present findings in dental professions. Those studies available were also assessed mostly in symptomatic dentists.[7, 8]

Prolonged exposure to vibration has been associated with adverse effects on peripheral nerves.[9] However, the duration of exposure to vibration needed to produce neurological symptoms is not defined.[10] The latency period ranging from 6 weeks to 14 years makes it extremely difficult to predict the likely time of onset of the symptoms and their progression.[11] In the present study, the mean duration of exposure to hand-held vibrating tool in dental residents was between 2-6.5 years. However, Hjortsberg et al found normal sensory conduction velocity of the median nerve across the carpal tunnel in dental technicians who were exposed to vibration for average 27 years.[1] Likewise, Sanden et al found no significant differences in sensory and motor conduction studies of the median and ulnar nerves between vibration exposure and non-exposure groups.[12] However, the study group involved workers who manufactured pulp and paper machinery for 21 years.

Malchaire et al, in contrast demonstrated acute sensory impairment after an exposure of only 30 min to vibration, in which vibration perception thresholds increased and developed paresthesia and numbness.[13] Similarly, mild and moderate carpal tunnel syndrome was reported in dentists who had working experience between 1 to 10 years by Inbasekaran et al.[8] Likewise, Cherniack et al found decreased sensory conduction velocity of median nerve in dental hygienists experienced for at least more than 5 years.[6]

It is evident from the previous studies that duration of vibration exposure required to produce neurological symptoms is not clear. This considerable variation may be explained due to susceptibilities of different individuals to vibration and different physical characteristics of the vibration exposure.[14] In addition, other factors such as work technique and working environment should also be taken into consideration during the assessment of the vibration exposure to the hand-arm system. The handling of the tool is influenced by the muscle strength and experience of the worker. More vibration from the machine is absorbed in the hand-arm system if the handgrip is tighter because of better coupling. Therefore, tighter handgrip raises the probability of vibration harm.[15]

The dental residents in our study were right handed except one. The present study revealed no significant difference in sensory and motor conduction variables of the median and ulnar nerves between dominant and non-dominant hands of dental residents. In this regard, Sanden et al reported prolonged motor distal latency of median and ulnar nerves in only dominant hand of subjects exposed to vibration.[12] Borhan et al, in contrast found involvement of both dominant and non-dominant hands in dentists and dental students.[5]

These findings can be interpreted that, regardless of the type of instruments implied and the hand engaged, the pressure imposed on the non-dominant hand and fingers, and the position of the wrist and the palm during retraction of cheek and tongue may contribute to develop neurologic symptoms. Furthermore, the effect in the non-dominant hands of dentists may be due to firmly holding crowns, stabilization splints and removable orthodontic appliances with this hand, and by using vibrating tools during adjustments before installation.[5]

CONCLUSIONS

In our study, we did not find any significant differences in nerve conduction study between dental residents who were exposed to hand-held vibrating tools for 2 to 6.5 years and medical residents who were not exposed to vibration. This study can be further conducted on larger sample size with more long duration of exposure to vibration.

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