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NOISE AND VIBRATION EXPOSURES TO DENTAL HYGIENISTS

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Introduction

The association of hand paresthesias and auditory damage to exposures of high-frequency sound and vibration from dental instrumentation remains unclear. Auditory threshold studies have shown dental practitioners to have significant hearing loss at 3 kHz, 4 kHz, and 6 kHz [1,2]. Experienced hygienists were observed to have elevated Vibration Perception Thresholds (VPTs) at the FAII mechanoreceptors[3] even though daily vibration exposures are below the limit value of the ISO 5349-based European Union Directive[4]. These studies suggest that years of high-frequency exposures may lead to symptoms of Hand-Arm Vibration Syndrome (HAVS) and hearing loss. This paper explores these exposure-response relationships using data from questionnaires, vibrotactile testing, and laboratory measurements of high-frequency dental instruments.

Methods

Two populations of dental hygienists (hygiene students (n=66), and experienced hygienists (n=94) with at least five years of experience) were recruited to investigate the relationships between multiple exposures and symptoms, as well as the early onset of symptoms in previously unexposed students[3]. Job information was obtained by questionnaire and vibrotactile perception thresholds were measured for the FAII (125 Hz), FAI (32 Hz), and SAI (4 Hz) mechanoreceptors on both hands using a tactometer. (Auditory thresholds were not collected.) The most commonly used vibratory dental instruments were identified from the questionnaire data and the weighted and un-weighted 1/3 octave band frequency spectra of sound and vibration up to 63 kHz were measured using a 1/4-inch free-field microphone (4939, B&K, Denmark) coupled with an ultra high-frequency Scanning Laser Vibrometer (PSV-300, Polytec GmbH, Germany). Instruments were operated without load (i.e., no tip contact) at recommended operating pressures and were evaluated using two mounting positions (tool base and typical grip position) using a simulated pinch grip with a similar biodynamic response to a human three-finger grip for grip forces between 30 and 45 N [3].

Results and Discussion

Table 1: Questionnaire Results[3]

	STUDENTS (n=66, 98.5% Female)	EXPERIENCED (n=94, 97.9% Female)
Age (SD)	26.1 (6.4)	45.5 (8.8)
Years in Practice (SD)	3.0 (4.3)	21.8 (8.3)
Vibration Exposure (years (SD))	1.0 (1.9)	17.1 (8.7)
Manual Tool Use (hours/week (SD))	5.2 (5.5)	12.0 (7.3)
Vibratory Tool Use (hours/week (SD))	3.0 (3.9)	5.1 (5.4)
Est. Lifetime Ave. Weekly Vib. Exp. (hrs*1000 (SD))	0.3 (0.6)	10.8 (11.5)
Presence of Musculoskeletal Pain (number (%))	27 (40.9)	81 (86.7)
Presence of Carpal Tunnel Syndrome (number (%))	3 (4.6)	17 (18.1)
Use of Hearing Protection (number (%))	2 (3.0)	2 (2.1)

Questionnaire results (Table 1) showed significant differences between mean age, years in practice, and self-reported vibration exposures. Experienced hygienists were shown to be four times more likely to suffer from musculoskeletal pain and carpal tunnel

syndrome and only four hygienists (two students and two experienced) reported the use of hearing protection. Average VPTs (Table 2) for the FAII mechanoreceptors of the third and fifth digits of both hands were observed to be slightly higher for the experienced hygienists, while FAI and SAI results showed no differences and there was no association with age for any of the threshold measurements. The sound and vibration levels of the dental instruments varied and the spectra indicated small differences in frequency components between mounting conditions. Table 3 shows the measured unweighted and weighed total band powers for the SPL and the VL. While the weighted results suggest minimal effects on health, the unweighted results, self-reported exposures, and VPTs suggest that accumulated exposures over time may cause musculoskeletal discomfort, HAVS, and possibly hearing loss.

Table 2: Average Vibration Perception Threshold Results[3] in dB (re $1x10^{-6}$ m/s^2)

HAND AND DIGIT	MECHNORECEPTOR	STUDENTS	EXPERIENCED
Dominant Hand, 3rd Digit	FAII – 125 Hz	103.0 (7.5)	107.0 (8.8)
(Median Nerve)	FAI – 32 Hz	102.7 (6.8)	104.4 (6.3)
	SAI – 4 Hz	83.4 (4.5)	83.6 (5.1)
Dominant Hand, 5th Digit	FAII – 125 Hz	100.6 (6.2)	104.3 (8.8)
(Ulnar Nerve)	FAI – 32 Hz	104.0 (5.7)	104.5 (11.8)
	SAI – 4 Hz	83.8 (3.6)	84.2 (4.5)
Non-Dominant Hand, 3rd Digit	FAII – 125 Hz	101.3 (7.8)	105.2 (9.0)
(Median Nerve)	FAI – 32 Hz	102.5 (6.0)	103.8 (6.5)
	SAI – 4 Hz	83.3 (4.3)	83.2 (4.8)
Non-Dominant Hand, 5th Digit	FAII – 125 Hz	98.9 (5.5)	103.2 (9.3)
(Ulnar Nerve)	FAI – 32 Hz	102.9 (7.2)	104.2 (7.2)
	SAI – 4 Hz	83.4 (4.0)	84.6 (5.1)

Table 3: Sound Pressure Level (SPL) and Vibration Level (VL) Measurements

TYPE	MODEL	MOUNT	OP. FREQ.	SPL (re $2x10^{-5}$ Pa)		VL (re $1x10^{-6}$ m/s^2)	
			(kHz)	dB	dB(A)	dB	dB(Weighted)
Rotary Polisher	5k	GRIP	4.4	69.2	65.9	169.2	97.6
	RDH	GRIP	4.4	77.4	72.5	168.7	98.1
	Hygiene	GRIP	5.0	72.7	68.9	171.8	101.0
	Titan	GRIP	4.6	70.2	67.7	165.9	94.9
Sonic Scaler	Quixonic	BASE	6.5	73.8	73.0	199.0	46.4
		GRIP	6.5	77.6	77.2	198.7	46.1
	Pirouette	BASE	6.3	80.2	75.4	176.4	51.9
		GRIP	6.3	81.8	79.7	171.4	54.2
Ultrasonic Scaler	Cavitron	BASE	29.0	102.0	75.6	192.3	78.3
		GRIP	29.0	99.6	75.2	198.0	76.6
	Advantage	BASE	27.8	99.3	48.5	201.4	83.0
		GRIP	27.8	94.7	46.9	197.2	65.1

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