The noise of dental instruments evaluated at sound pressure level

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Abstract

The noise of dentists' workplace and dental instruments would be measured in this study. Besides, the sound pressure level of the noise of dental instruments and the outpatient department would be transferred into hearing level and then be compared and analyzed. The results of survey for the feeling of dentists would also be analyzed. Based on the results, the intensity of noise at the chairside laboratory was larger than that at the outpatient department by 16 dB to 30 dB. The maximum noise was 86 dBSPL and 70 dBSPL at the chairside laboratory and at the outpatient department, respectively. As for the frequency distribution, the range of frequency of noise at the chairside laboratory distributed at lower frequency (240 Hz to 372 Hz) or hyper frequency (13156 Hz to 19874 Hz). The range of frequency of noise at the outpatient department centered at 1404 Hz to 9356 Hz. The noise at the outpatient department is still under the hearing damage risk criteria but the noise will affect the spoken communication of patients and dentists. For noise at the chairside laboratory, it has violated the 80 dB of the hearing damage risk criterion, the hearing loss of dentists will be happened if staying in the chairside laboratory over 8 hours.

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1. Background and objective

Infectious diseases and musculoskeletal pain are common occupational diseases for dentists. Although the dentists can make a diagnosis more conveniently by the great advance of dental instruments, the noise of dental instruments will became an important problem.

Based on previous study, the background noise by clinical room was around 75 dB SPL. The background noise by chairside laboratory with tooth model producing and large-scale instruments was around 100 dB SPL [1, 2], even noisier than that by petrochemical factory [3]. However, whether the dentists would suffer from the risk of noise-induced hearing loss at their workplace or not was lack of discussion on previous study. Even some study indicated that the dentists would not suffer from the risk of noise-induced hearing loss at their workplace

Human hearing would be influenced by the frequency of noise [7, 8]. The hearing level of human would be different due to different frequency of noise. The frequency that human could hear ranges from 20 Hz to 20000 Hz. However, the frequency that human could hear most sensitively ranges from 1000 Hz to 2000 Hz [9]. Some noise at similar sound pressure level transferred into the hearing level would be more different due to different frequency. The hearing level for listeners would be different because some noise at ultra-high frequency was over the frequency range that human could hear. Nonetheless, the hearing level by dentists would be different due to the noise of different kinds of dental instruments which would make dentists nervous and hypertensive and then result in low quality of diagnosis when working. So far the issue has not been discussed by relative study.

Thus, the noise of workplace for general dentists and the noise of working dental instruments would be measured this study. The noise of workplace would be analyzed by sound intensity and frequency in order to obtain the real noise of workplace for dentists. Additionally, the sound pressure level measured by the noise of dental instruments and by the environment noise of general dental outpatient department would be transferred to the hearing level and then be analyzed. Finally, the noise by which kind of dental instruments that would most affect the quality of working for dentists would be understood by the survey of dentists.

2. Materials and methods

2-1 The noise of dental instruments measurement system

The NI (National Instruments) PXI 1042, the acquisition card PXI 4461 PXI 4462 and two microphones G. R. A.S (Type 46AE) were utilized to record the noise of dental instruments in this study. The recording program would be made by DAQ toolbox of LabView, and the spectrum program utilized to analyze the noise of dental instruments would be made by Matlab.

2-2 Microphones calibration

The microphones were calibrated by the sound calibrator (B&K 4231) before the

measurement. The frequency used for the calibration was 1000 Hz and the sound pressure was 94 dB SPL. The microphones would be adjusted if the frequency and the intensity of sound were not 1000 Hz and 94 dB SPL, respectively.

2-3 The noise of dental instruments measurement

The general dental outpatient departmentoutpatient department and the chairside laboratory at Chun Gung Memorial Hospital were the measurement places in this study. Before the experiment, the background noise of the outpatient department and the chairside laboratory was measured for 10 minutes and the results would be the reference for the analysis of the spectrum noise of dental instruments and sound pressure.

The measurement was divided into two portions: the outpatient department and the chairside laboratory. The background noise and the common used dental instruments noise were measured at the two workplaces, respectively. 7 common used instruments, saliva ejectors of dental chair (Kavosun 1415), ultrasonic scaling handpiec, low speed rotary, curette hand instrument (Universal Hu-Friedy), crown removal (Anthogyr), mallet automatic (Kavo corona flex 2005) and conical flame (Kavo EWL 4966 K9), were utilized for the measurement at the outpatient department. 4 common used instruments, vibrator (GS vibroboy SL), ultrasonics (Hwashin Power sonic 420), air blow gun (KWI) and vacuum forming machine (Keystone industries 101), were utilized for the measurement at the chairside laboratory. During the two experiments, the dentist would stand at the place where the instruments were working. One microphone was set at the ear of the dentist and beside each common used dental instrument, respectively. The discussion of the noise of dental instruments by the outpatient department and by the chairside laboratory evaluated at sound pressure level and hearing level by dentists were the main purpose of this study. Therefore, the sound recorded by the microphone set at the ear of the dentist would be analyzed, whereas the sound recorded by the microphone set beside each common used dental instrument would merely be the reference for the spectrum noise of dental instruments.

The spectrum noise of dental instruments was programmed by Sound & Vibration tool kit of LabView in this study. The recording program was made by DAQ toolkit. The sound was recorded by microphone at the interval of 0.5 second. The data of sound pressure obtained by microphone were saved as the point data in the specific folder. The spot spectrum would be also shown on the interface at the same time. The sample rate acquired in the recording file was 44100 Hz times/second. The recording file was divided into the specific folder at the interval of 10 seconds.

2-4 The analysis of dental instrument noise

Based on previous study, the frequency of noise by different dental instruments would vary greatly. The frequency was distributed between 250 Hz and 20000 Hz and the sound intensity was between 60 dBA and 100 dBA. The recording file obtained from dental

instruments would be exported by the form of point data and then be imported to program by matlab. The point data of background noise was also imported. The sound pressure of dental instrument noise that higher than the background noise by 50 dBSPL would be the criterion used for judging the noise that was the background noise or the dental instrument noise. The range of human hearing would be the criterion used for frequency analysis. The frequency was acquired between 20 Hz and 20000 Hz by the interval of 2 Hz that could shown the results of dental instrument noise by the highest sound pressure level acquired at 120 dBSPL.

3 Results

3.1 Background noise

Based on the comparison of the noise at the outpatient department and the chairside laboratory, the largest sound intensity of noise at the outpatient department was 40 dBSPL and the peak frequency was 564 Hz when the saliva ejectors, ultrasonic scaling handpiec, low speed rotary, curette hand instrument, crown removal, mallet automatic and conical flame were turned off. The largest sound intensity of noise at the chairside laboratory was 33 dBSPL and the peak frequency was 1620 Hz when the vibrator, ultrasonics, air blow gun and vacuum forming machine were turned off. However, the sound intensity of noise at the chairside laboratory would rise from 33 dBSPLto 74 dBSPL when all the dental instruments were turned on.

3.2 The noise of dental instruments

3.2.1 The general outpatient department

The dental instruments at the outpatient department were the saliva ejectors, ultrasonic scaling handpiec, low speed rotary, curette hand instrument, crown removal, mallet automatic and conical flame. The main frequency and the largest sound intensity of noise measurement were shown in table 1. Based on the results, the sound intensity of noise by the ultrasonic scaling handpiece was the largest and the sound pressure level was 70 dBSPL. The sound intensity of noise by the mallet automatic was the smallest and the sound pressure level was 41 dBSPL. The frequency of dental instrument noise distributed between 1500 Hz and 9500 Hz.

3.2.2 The chairside laboratory

The dental instruments at the chairside laboratory were vibrator, ultrasonics, air blow gun and vacuum forming machine. The main frequency and the largest sound intensity of noise measurement were shown in table 2. Based on the results, the sound intensity of noise by the vibrator was the largest and the sound pressure level was 86 dBSPL. The sound intensity of noise by the air blow gun was the smallest and the sound pressure level was 72 dBSPL. The frequency of dental instrument noise distributed between 250 Hz and 20000 Hz.

4. Discussion

Based on the results, the sound intensity of background noise was larger and the main frequency of noise was lower at the outpatient department than that at the chairside laboratory when the all dental instruments were turned off. However, the sound intensity of background noise was much larger at the chairside laboratory than that at the outpatient department when the all dental instruments were turned on. The sound intensity of noise at the chairside laboratory was larger than that at the outpatient department by 16 to 30 dB. The largest sound intensity at the chairside laboratory and at the outpatient department reached to 86 dBSPL and 70 dBSPL, respectively. The frequency of noise at the chairside laboratory distributed at lower frequency (240 Hz to 372 Hz) or hyper frequency (13156 Hz to 19874 Hz), whereas the frequency of noise at the outpatient department centered at 1404 Hz to 9356 Hz.

Based on the measurement, the noise of dental instruments at the outpatient department would quite differ. The noise of ultrasonic scaling handpiece evaluated at sound pressure level and hearing level which were the largest were 70 dB SPL, respectively. The noise of mallet automatic evaluated at sound pressure level and hearing level which were the smallest were 41 dB SPL, respectively. The difference of noise between the largest and the smallest instruments was the sound pressure level which was 29 dB.

The difference among the noise of dental instruments at the chairside laboratory would be small. The noise of vibrator evaluated at sound pressure level and hearing level which were the largest were 86 dB SPL, respectively. The noise of air blow gun evaluated at sound pressure level which were the smallest were 72 dB SPL.

5. Conclusion

The volume of noise at dentists' workplace instead of the noise of dental instruments was evaluated and discussed in previous study [6]. The sound intensity of noise by dental instruments was discussed and analyzed by sound pressure level and hearing level in this study. Besides, the hearing level of dentists would be compared after interviewing.

Based on the intensity of sound pressure level, the sound intensity of noise was 86 dBSPL at the chairside laboratory which was larger than that at the outpatient department. As for the frequency distribution, the frequency of noise at the chairside laboratory distribute at lower frequency or at hyper frequency. The frequency of noise at the outpatient department centered at middle and high frequency. The noise at the outpatient department is still under the hearing damage risk criteria but the noise will affect the spoken communication of patients and dentists. For noise at the chairside laboratory, it's violated the 80 dB of the hearing damage risk criterion, the hearing loss of dentists will be happened if staying in the chairside laboratory over 8 hours.

6.References

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Table 1 The noise of dental instruments at the outpatient departmentoutpatient department

Instruments	Frequency(Hz)	Intensity(dBSPL)
Saliva ejectors	1404	54
Ultrasonic scaling handpiec	3420	70
Low speed rotary	1954	65
Curette hand instrument	5898	48
Crown removal	9356	41
Mallet automatic	7920	57
Conical flame	9220	62

Table 2 The noise of dental instruments at the chairside laboratory

Instruments	Frequency(Hz)	Intensity(dBSPL)
Vibrator	240	86
Ultrasonics	19874	80
Air blow gun	13156	72
Vacuum forming machine	372	75