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Effect of the sound of dental equipment on dental anxiety and noise control techniques

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ABSTRACT

The dental office environment subjects both patients and dental professionals to the noises associated with dental equipment. The sound of the dental drill, for example, usually causes some discomfort and anxiety. Fear and anxiety due to these noises are among the major reasons why patients avoid dental visits. It is important that these fears are addressed and patients are encouraged to seek the oral healthcare treatment they need. Long-term exposure to these noises also puts dental professionals themselves at high risk of hearing loss. It is unclear about the psychological influence of the sound of dental equipment on dental anxiety. This paper presents a questionnaire survey previously conducted by the authors to study the effects of the sound of dental equipment on people's perceptions and dental anxiety levels and discusses solutions to the problem by means of passive and active noise control technologies or a combination of both of them.

INTRODUCTION

Some people fear from seeking a dental treatment because they feel stressed when they are examined by a dentist or a dental hygienist. Dental anxiety and phobia are common. In fact, most dental procedure is not painful under anaesthesia. Studies have indicated that as many as 75% of US adults experience some degree of dental fear from mild to severe [1, 2, 3]. The fear/anxiety of dentistry and of receiving dental care has significant impact on daily oral health. This is a serious problem to both patients and dental care provided. This also raises questions on what aspects of the dental setting may have the potential to cause dental anxiety or fear. Considerably a large number of investigations [4, 5, 6, 7, 8, 9, 10, 11] have been sought to investigate the potential anxiety-provoking stimuli present in the dental setting. However, few have focused on the anxiety-provoking impact of dental equipment, including the high-speed air-turbine (dental drill) and the ultrasonic dental scaler. The psychological influence of the sound of dental equipment remains unclear, especially in terms of the effect of the dental drill on willingness to seek dental treatment. Nowadays people are more concerned about indoor acoustical environment, as it is related to public health [12], comfort [13] and productivity [14]. As a result of this concern, a large number of investigations have been sought to study indoor noise problem [15, 16, 17]. The effect of the sound of dental equipment on dental anxiety is of concern as it affects oral health, which in turn has an impact on public health. Since dental anxiety is closely related to one's past experience in dental clinics, the purpose of this study

was to investigate the effects of the sound of dental equipment on people's perceptions and dental anxiety levels using a questionnaire survey.

METHODS

Questionnaire survey

A convenience sample was selected for this survey. Two hundred and thirty dental students at the University of Hong Kong were invited to participate, and 230 gender and age-matched non-dental students were recruited from other universities in Hong Kong. The students completed a four-part questionnaire themselves. The questionnaire was used to examine the effects of the sound of a dental drill on people's perceptions and assess the relationship between that sound and dental anxiety. Details of the questionnaire can be referred to the research paper of Wong et al [12, 18].

Statistical analysis

Data were coded and analysed using the software package SPSS for Windows 17.0 (SPSS Inc., Chicago, IL, USA). The SPSS is a widely used program for statistical analysis in social science. It is also used by researchers in the fields of health, engineering, built environments and other fields.

RESULTS

Fifty percent of both the dental and non-dental students were male, and the age range was from 17 to 24 years. There was no statistically difference for gender and age between the dental and non-dental students ($P > 0.05$). Based on the hierarchy of the mean capacities and standard deviations for the 73 anxiety-provoking stimuli and the percentage of participants who rated each stimulus as extremely anxiety provoking (capacity 4) for the non-dental students and the dental students, it was found that among the total of 73 stimuli examined, the sound of these two items of dental equipment (dental drill and dental scaler) provoked a relatively high level of dental anxiety. In addition, the non-dental students regarded the sound of dental equipment as more anxiety-provoking than did the dental students and that a higher percentage of non-dental students rated the sound of dental equipment as extremely anxiety-provoking. The details can be found in the published papers of the authors [12].

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Dental anxiety and the dental anxiety-provoking factors

Table 1 shows the differences between dental and non-dental students in the scores for the five dental anxiety-provoking factors (sound, smell, taste, sight and feeling), the Dental Anxiety Question (DAQ) [19], and the Dental Anxiety Scale (DAS) [20]. The mean capacities of the five anxiety-provoking factors among the non-dental students were all significantly higher than those among the dental students ($P < 0.001$). Significant differences in DAQ ($P < 0.01$) and DAS ($P < 0.001$) scores were also found between the dental and non-dental students. These results show that the non-dental students had a statistically higher level of dental anxiety when measured by the DAQ and the DAS and a greater capacity to become anxious on hearing the sound of dental equipment in comparison with the dental students. A stepwise regression

analysis was adopted to evaluate the relative influence of the anxiety-provoking factors on dental and non-dental students. The DAS score was selected as the dependent variable and the five anxiety-provoking factors were chosen as the independent variables. The results of the stepwise regression analysis are shown in Tables 2 and 3. A statistically significant model was obtained, and when “feeling” and “sound” were input into the model, significant P-values ($P < 0.001$) were obtained for non-dental students. The standardized betas showed that the “feeling” factor contributed principally to dental trait anxiety and that the “sound” factor had a secondary influence on dental trait anxiety. In addition, dental trait anxiety was also affected by the “dental/non-dental” property. The value of R^2 indicated that 94.0% of the variance in the DAS score was explained by the regression model. However, for dental students, only “feeling” entered the statistically significant model ($P < 0.001$). This means that the fear of the sound of dental equipment has a significant influence on dental anxiety among non-dental students, but not on dental students.

Table 1: Mean (SD) scores for dental anxiety-provoking factors, DAQ, and DAS between the dental and non-dental students

	Non-dental students	Dental students
Sound***	2.57 (0.94)	2.07 (0.86)
Smell***	2.22 (0.97)	1.70 (0.78)
Taste***	2.24 (0.91)	1.88 (0.85)
Sight***	2.03 (0.71)	1.70 (0.80)
Feeling***	2.58 (0.97)	2.18 (0.91)
DAQ**	2.14 (0.86)	1.87 (0.72)
DAS***	9.74 (3.79)	8.04 (2.43)

Mann-Whitney test

** $P < 0.01$, *** $P < 0.001$

Table 2: Results of stepwise regression analysis with DAS as the dependent variable for the non-dental students

Variable	β	Standardized- β	P
Feeling	3.431	0.693	0.000
Sound	1.122	0.284	0.000

$R^2 = 0.940$, $F = 1700.854$ ($P < 0.001$)

Excluded independent variables: smell, sight, taste

Table 3: Results of stepwise regression analysis with DAS as the dependent variable for the dental students

Variable	β	Standardized- β	P
Feeling	4.451	0.963	0.000

$R^2 = 0.927$, $F = 2918.780$ ($P < 0.001$)

Excluded independent variables: smell, sight, taste, sound

To help people address fears and encourage them to seek the oral healthcare treatment they need, techniques for noise control have been employed, including the passive and active noise control technics or a combination of them. Conventional methods for noise control at sources include the application of muffles, good maintenance of handpieces, and keeping compressors away from the work place [21]. Noise disturbance can also be reduced by using sound-damping materials in the dental offices and laboratories, e.g. sound absorbing material walls, resilient floors and sound proof acoustical ceiling [22]. These passive noise control methods are quite efficient at higher frequencies, however, the performance is significantly degraded for low-medium frequency noises, where the dental equipment usually produces large and annoying noises [23]. Moreover, passive methods usually prevent an efficient communication between patients and dental professionals. To protect dental professionals from possible hearing loss at an early stage, annual hearing tests are suggested to be taken,

especially by those at the beginning of the professional career which would function as a reference point for assessing possible later changes in the ear [24].

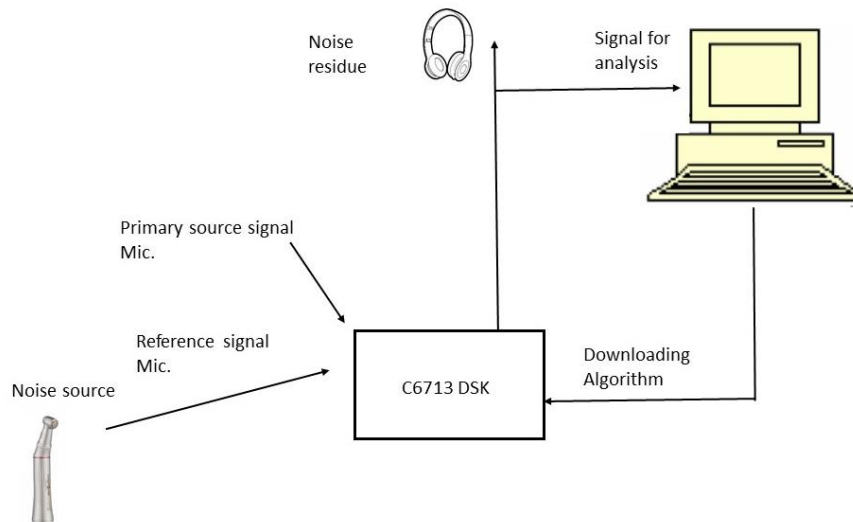


Figure 1: A diagram of an ANC system that allows good patient-dentist communication

By the help of engineers, a headphone-type system that protects patients from anxiety while allowing good patient-dentist communication has been designed. This device is quite efficient in cancelling out noises of the dental equipment and ending patients' anxiety. Compared with passive methods, active noise control (ANC) offers more flexibility in controlling lower-medium frequency noises [25]. The adaptive filtering algorithms [26] are first employed to reduce the noise from dental drill in references [27]. This pioneer work is then extended to a more robust adaptive algorithm, namely the normalized least mean squares (NLMS) algorithm [28], and is implemented on the Texas Instruments TMS320C6713 DSK Digital Signal Processor (DSP). Since conventional ANC applications consider noise frequencies at a maximum of 1.5 kHz while dental drills may produce frequency ranging from 1.5 kHz to 12 kHz, Rotter et. al. then justify an approach for dealing with dental noises using digital technologies at higher frequencies. To better control noises emitted by dental drills, a comparative study of drills from a range of manufacturers is carried out. Then, a method for dental drill noise reduction that uses a combination of ANC, passive noise control and adaptive filter is proposed [29], where the most widely-used filtered-x LMS (FxLMS) algorithm [30] is employed for the ANC systems. A study on noise control for other handpieces in the frequency range from 2.5 kHz to 11 kHz is further carried out. Finally, a headphone-type system that reduces patient's discomfort and protect them from anxiety while allowing good patient-dentist communication is designed in [31], a diagram of which has been shown in Fig. 1.

CONCLUSIONS

A survey was performed to investigate the effects of the sound of dental equipment on people's perceptions and dental anxiety levels. The convenience sample for the survey comprised 230 dental students and 230 gender and age matched non-dental university students. It was found that among the five anxiety-provoking factors examined (sound, smell, taste, sight, and feeling), the sound of dental equipment has a great influence on dental anxiety among non-dental students. The further analysis and the complete study can be found in the papers of the authors [12, 18].

Methods that release the patient's anxiety during the dental treatment have been discussed. ANC controllers that employ adaptive filtering algorithms are introduced, which provides new

methods to increase the comfort for both dentists and dental professionals during oral treatment.

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