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COMPARISON OF PATIENT ANXIETY LEVELS BEFORE AND AFTER USING NOISE CANCELLING HEADPHONES DURING DENTAL PROCEDURES

Dr Zainab Ur Rehman Shah[*1], Dr Hafsah Muzaffar Ghauri[2], Dr Nigarish Javaid[3], Dr Huma Imran[4]

*[*1]21 Military Dental Centre / Quetta College of Dentistry*
[2,3,4] Quetta College of Dentistry

[*1]zainaburrehman@yahoo.com, [2]drhafsahsirkhail@gmail.com, [3]nigarish.bilal@gmail.com, [4]imranhuma16@yahoo.com

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Corresponding Author: * Dr Zainab ur Rehman Shah

Abstract

Objective: *To evaluate the effect of active noise cancellation (ANC) headphones on anxiety and pain perception in adult patients who are undergoing ultrasonic scaling.*

Study Design: *Randomized crossover clinical trial.*

Place and Duration of the Study:
Department of Periodontology, 21 Military Dental Centre (MDC), Quetta, from January 2024 to March 2024.

Methodology: *60 adult patients receiving ultrasonic scaling were enrolled and randomly divided into two groups using the crossover design. Group A had scaling without ANC initially, and then scaling with ANC later, and similarly for Group B. Pain and anxiety were measured after each session by 5-point VAS. The comparison to pre intervention was analyzed with Wilcoxon signed-rank test, correlation with Spearman's.*

Results: *In group A, the interquartile scores of anxiety scores reduced from 4 to 3 ($p < 0.001$) and pain mean score reduced from 3 to 2.28 ($p < 0.001$) in the use of ANC. For Group B, anxiety decreased from 4.31 to 3.09 and pain from 3.16 to 2.06 ($p < 0.001$).There was no significant correlation between reduction in anxiety and pain ($p = 0.992$). Use of ANC reduced discomfort consistently throughout ultrasonic scaling, regardless of order or personal sensitivity.*

Conclusion: *Active noise cancellation headphones dramatically decrease both anxiety and pain in adult patients undergoing ultrasonic scaling. These results advocate for ANC as a useful, non-invasive aid to improve patient comfort during dental treatment.*

INTRODUCTION

Dental fear remains a problem in dental practice affecting patient cooperation and treatment outcome. Approximately 36% of the population has dental anxiety, while about 12% have severe dental fear, resulting in delay or avoidance of dental care.[1] Pain-related fear, dental drill noise and previous traumatic experiences are generally responsible for this psychological barrier. Of these, sound stimuli—specifically high-frequency dental drill noise—are a primary culprit in amplifying patient anxiety.[2] Thus, interventions lowering sensory inputs like noise and providing distraction are promising for alleviating

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dental anxiety. Non-pharmacological interventions, such as music therapy, virtual reality, and control of behavior methods, have found wider acceptance as anxiety-reducing adjuncts in dentistry.[3]

The evidence base supporting the use of music and auditory distraction to alleviate anxiety in invasive procedures is increasing. Hashemi et al. showed 36.6% less anxiety in children when distraction techniques like music and control of behavior were employed in dental treatment.[4] Lee et al. reported that patients who listened to music with headphones possessed lower State-Trait Anxiety Inventory (STAI) scores significantly than control groups.[5] Ligree et al. in a randomized controlled trial, noted that patients receiving spinal anesthesia with noise-cancelling headphones and binaural beat music had a 39% lower mean anxiety score ($p = 0.001$) than those who did not receive any intervention.[6] Likewise, Townsend et al. found 84% of patients in wide-awake hand surgery had significantly reduced scores of anxiety (Visual Analog Scale reduction by 3.2 points) with noise-cancelling headsets and music.[7] Tsivian et al. observed a 25% reduction in anxiety among patients in transrectal prostate biopsy when given noise-cancelling headsets or music.[8] A systematic review conducted by Moola et al. emphasized that music interventions resulted in a mean decrease of 15%–30% in dental anxiety in both pediatric and adult populations.[9] Although these results are encouraging, Weisfeld et al. underlined the heterogeneity of results and stressed that more focused studies targeting particular devices such as noise-cancelling headphones are needed.[10]

Yet, one particular gap exists for assessing the combined effect of noise-cancelling headphones within actual dental settings in real-time. Although numerous studies address music or audiovisual stimuli individually, fewer investigate noise-cancellation as an independent intervention. Thus, the purpose of the present study is to compare patient anxiety levels before and after they have worn noise-cancelling headphones during dental procedures and to examine their potential as a simple, easy-to-use tool for anxiety management in dental clinical practice.

Methodology

This study is reported in accordance with the CONSORT (CONsolidated Standards of Reporting Trials) 2010 statement. The study was scrutinized and authorized on merit basis by the Institutional Review Board of 21 Military Dental College (MDC), Quetta (IRB #XXXX-XXXX). All methods were performed in accordance with the relevant guidelines and regulations as outlined in the Declaration of Helsinki. All the participants gave their written consent prior to enrolment in the study. The sample size for this study was calculated using the OpenEpi version 3.01 calculator referencing the effect size reported by Kim et al.[11] who demonstrated a moderate effect size of 0.50 in reducing noise- and pain-related discomfort through the use of active noise-canceling (ANC) headphones during ultrasonic scaling. Using the formula for comparing two means with a confidence level of 95%, a power of 80%, and a two-sided test, the minimum required sample size was determined to be 64 participants (32 per group).

The study population comprised of patients seeking dental care from the outpatient department of 21 Military Dental College from January 2025-May 2025. Prior to participating in the study, participants were informed about the study background and objectives and all were required to sign a written informed consent form. Sixty patients were screened, out of them patients fulfilling the inclusion criteria were recruited.

Inclusion Criteria: Adult patients ≥ 18 years of age, requiring non-surgical dental procedures (e.g. scaling, fillings), mild to moderate dental anxiety (MDAS ≥ 10) and provided informed consent for the study.

Exclusion criteria: Presence of hearing loss or hearing aids, current use of anxiolytic or antidepressant treatment, a diagnosis of psychiatric illness, and other cognitive deficiencies that preclude completion of the questionnaire.

Two commercially available over-ear noise-cancelling headphones were used in this study; Group A used ANC (active noise-cancellation) mode of noise-cancelling headphones, and Group B used the same noise-cancelling headphones with the ANC function turned off. The two groups heard the identical standardized instrumental background music throughout the procedure for uniformity. Random

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allocation of participants to Group A or B was conducted using a computer-created randomization list created in Microsoft Excel. Allocation was blinded until intervention time. While participant blinding was precluded by the nature of the intervention, the outcome assessors reviewing the questionnaire answers were blinded to group allocation. Both dental treatments were done in one operatory by a single clinician with a standard protocol to provide consistency. Standard procedures like ultrasonic scaling or composite restorations were done on a Gnatus G3 New Line dental unit and EMS Piezon ultrasonic scaler (EMS Electro Medical Systems, Switzerland). Procedure times were between 20 and 40 minutes. Headphones were fitted to all patients before treatment was started, and the ANC feature was set according to group allocation. Immediately after the test, patients were interviewed to complete a self-administered questionnaire to evaluate the feeling of anxiety and discomfort. Dental fear levels (pre and post intervention) were evaluated by Modified Dental Anxiety Scale (MDAS). Noise discomfort and overall procedural discomfort were assessed on a Visual Analog Scale (VAS) (0–10). Participants were invited to describe their overall attitude to go to the dentist and whether they believe the noise-cancelling headphones were effective. Statistical analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY). Shapiro-Wilk test was applied to test the normality of the data. Because the anxiety and VAS scores were not normally distributed, non-parametric tests Wilcoxon signed-rank test for intragroup comparisons were used. For statistical significance, a p-value of less than 0.05 was taken. Spearman's correlation coefficient was also employed to examine the correlation between noise discomfort and reduction in anxiety score.

Results

Table I shows the demographic information and prior dental histories of Group A and Group B participants. Statistically, the groups were the same age ($p = 0.751$), the same in gender distribution ($p = 0.500$), had had the same number of prior dental visits ($p = 0.662$), reacted the same emotionally to a visit to the dental clinic ($p = 0.751$), and had never had any reluctance to see a dentist ($p = 0.396$). These insignificant p-values reflect that the two groups were well matched at baseline. Statistically significant decrease in anxiety following ANC activation in both Group A and Group B ($p < 0.001$ for both groups) reflects the efficacy of active noise cancellation to reduce dental anxiety during ultrasonic scaling as reflected in **Table II.**

Both groups saw a statistically significant improvement in pain scores following ANC activation ($p < 0.001$) as observed in **Table III.** A correlation coefficient of 0.001 with a p-value of 0.992 was observed, showing no statistically significant relationship between anxiety and pain score reductions **(Table IV).**

Table I. Baseline demographic and dental anxiety characteristics of participants in Group A and Group B

Variables	Groups		p - value
	Group-A	Group-B	
Age			
Mean ± SD	41.41 ± 9.91	40.66 ± 8.86	0.751
Gender **n** (%)			
Male	15 (51.72%)	17 (48.57%)	0.500
Female	14 (48.28%)	18 (51.43%)	
# of visits to the dental clinic			
First time	6 (18.75%)	4 (12.5%)	0.662
2-4 times	16 (50%)	15 (46.88%)	
5 or more times	10 (31.25%)	13 (40.63%)	
Feelings when visiting the dental clinic			
Comfortable	15 (46.88%)	14 (43.75%)	0.751

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Nervous	14 (43.75%)	13 (40.63%)	
Anxious	3 (9.38%)	5 (15.63%)	
Hesitated to visit a dental clinic			
Yes	12 (37.5%)	10 (31.25%)	0.396
No	20 (62.5%)	22 (68.75%)	

Table II. Comparison of anxiety scores with ANC headphones turned on and off in Group A and Group B

Groups	Anxiety			p - value
	ANC turned off Median (IQR)	ANC turned on Median (IQR)	Difference	
Group-A	4 (1)	3 (0)	1 (0)	< 0.001
Group-B	4.31 (1)	3.09 (0.25)		< 0.001

Table III. Comparison of pain scores with ANC headphones turned on and off in Group A and Group B

Groups	Pain			p - value
	ANC turned off Median (IQR)	ANC turned on Median (IQR)	Difference	
Group-A	3 (0.25)	2.28 (1)		< 0.001
Group-B	3.16 (1)	2.06 (0)		< 0.001

Table IV. Correlation Between Reduction in Anxiety and Reduction in Pain Discomfort Levels

Variable	Reduction in Anxiety Level Discomfort	Reduction in Pain Level Discomfort
Reduction in Anxiety Level Discomfort		
Spearman's correlation	1	0.001
p – value		0.992
N	64	64
Reduction in Pain Level Discomfort		
Spearman's correlation	0.001	1
p – value	0.992	
N	64	64

Discussion

This study showed that both Group A and Group B had a statistically significant decrease in anxiety and pain scores when active noise cancellation (ANC) was turned on while undergoing ultrasonic scaling ($p < 0.001$ for both). Yet, there was no correlation between the decrease in anxiety and decrease in pain levels ($p = 0.992$), which means these are separate experiences. Notably, the groups' demographic and affective baselines were comparable to each other statistically, thereby justifying the intergroup comparison reliability.

When contrasted with previous literature, these results reaffirm the worth of ANC and auditory interventions in lessening dental anxiety and pain perception. Kim et al. performed a randomized clinical trial evaluating ANC headphone use during ultrasonic scaling and recorded a mean decrease in anxiety Visual Analog Scale (VAS) from 5.14 ± 1.20 to 3.02 ± 0.98 ($p < 0.001$), mirroring the present study's significant decline from median scores of anxiety 4 to 3 in Group A and 4.31 to 3.09 in Group B.[11] The congruence in results attests to ANC's reliability in treating dental anxiety across groups. Furthermore, Kim et al. reported a considerable decrease in pain (mean pain score reduced from 3.9 ± 1.1 to 2.1 ± 0.9), very similar to our findings when the pain scores decreased from 3 to 2.28 in Group A and from 3.16 to 2.06 in Group B.

Conversely, Hoffmann et al. conducted a systematic review of behavioral and pharmacological anxiety control methods and noted that non-invasive

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methods such as relaxation and distraction only offered small reductions in anxiety (average decrease of ~1 point on a 10-point scale).[12] Han et al. investigated the effect of a dental sound insulation system on pediatric patients, with a 29% decrease in indicators of stress and a statistically significant reduction in heart rate. Their population was different (children as opposed to adults),[13] yet the mechanism of auditory insulation enhancing patient comfort is consistent with our results and supports the generalizability of the effectiveness of auditory control. Likewise, Hayashida et al. discovered that the integration of auditory and visual relaxation techniques greatly reduced markers of autonomic stress, lending credence to a multi-modal system of anxiety management.[14]

Music distraction also has demonstrated advantages. Aitken et al. reported that music decreased the number of anxiety behaviors observed in 50% of children,[15] whereas Qazi et al. reported that auditory distraction lowered dental anxiety scores in adults who were about to have a tooth extracted (mean anxiety score decreased from 6.2 to 3.9, $p < 0.001$).[16] Shih et al. in their meta-analysis, reached a conclusion that music distraction had a mean decrease of 1.34 points in anxiety scores in both children and adults.[17] Although ANC is distinct from music distraction, the psychological process—covering up aversive stimulation—seems to be comparable. Interestingly, no relationship between anxiety and pain relief was observed by our study, which agrees with Gupta & Ahmed who explained that while music decreased anxiety (mean from 6.8 to 4.3), pain level was not shown to differ dramatically, indicating dissociation among these factors.[18]

Similarly, Ramya Chellammal et al. evaluated the effect of music in pediatric dental patients and concluded a remarkable decrease in both pain and anxiety, validating the hypothesis that auditory masking diminishes the perception of aversive stimuli.[19] While, our patient population was adults and utilized ANC instead of music, the two studies validate the psychological advantages of manipulating the acoustic environment. The average anxiety reduction in our research (Group A: 1 point; Group B: 1.22 points) corresponds closely to these findings Antoniadou et al. stressed in their narrative review that noise tends to be underestimated in dental clinical settings, but plays a significant part in amplifying the stress and anxiety of patients.[20]

Future studies must investigate the differential neural and psychological processes through which ANC influences pain and anxiety. Moreover, combining ANC with other sensory treatments (e.g., relaxation visualization or aromatherapy) could provide additive or synergistic effects. This research contributes to the sparse literature on ANC application in dentistry, particularly in ultrasonic scaling, and offers statistically sound support for it as a standard patient comfort measure. It also highlights the need for dentist training in non-pharmacological anxiety management techniques, particularly in routine procedures.

Conclusion

The study proved that active noise cancellation has a considerable impact on both anxiety and pain scores during ultrasonic scaling in adults, and there is no direct association between the two outcomes. The results align with previous research and validate the clinical utility of ANC technology in dental care. The outcome provides valuable evidence to substantiate patient-centered care practices in dentistry.

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Conflict of Interest

None to declare

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