Efficacy of active noise cancelling headphones in patients undergoing ultrasonic scaling

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Efficacy of active noise cancelling headphones in patients undergoing ultrasonic scaling

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감사의 글

이 논문의 시작부터 완성되기까지 늘 따뜻한 배려와 큰 관심으로 지도해주신 최성호 교수님, 논문의 모든 과정에서 아낌없는 지원과 따뜻한 조언으로 저를 이끌어주신 김영택 교수님께 고개 숙여 감사드립니다. 그리고 논문을 심사해주시고, 논문을 완성할 수 있게 격려해주신 정의원 교수님, 이중석 교수님, 차재국 교수님, 백정원 교수님께 깊이 감사드립니다.

수련기간 동안 어려운 일이 있을 때 마다 함께 고민해주시고 늘 세심한 조언으로 가르침을 주신 이보아 교수님과 권혜인 교수님이 계셔서 4년동안 잘 견뎌낼 수 있었습니다. 감사합니다. 또한 다양한 전문 분야에서 치과의사로서의 시야를 넓혀주시는 일산병원 치과 모든 교수님께도 진심으로 감사드립니다.

의국 선배로서 항상 모범이 되어준 김병헌, 이성배, 박유선 선생님 그리고 부족한 저를 잘 따라준 정진호, 홍수빈, 문민 선생에게 고마운 마음을 전합니다. 그리고 수련기간동안 함께한 모든 의국 선생님들, 치위생사 선생님들에게도 감사드립니다.

마지막으로 낳아주시고 길러주신 부모님, 늘 옆에서 큰 힘이 되어준 아내 그리고 가족들에게 사랑을 담아 감사의 마음을 전합니다.

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Abstract

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Dental fear hinders patients from receiving appropriate dental treatment. In particular, the noise generated by high-speed air turbines and ultrasonic scalers can adversely affect patients. Many efforts have been made to reduce the discomfort caused by noise, but no methods are definitively recommended. The purpose of this study was to determine the efficacy of active noise cancelling (ANC) headphones in reducing the pain and discomfort associated with dental scaling.

Fifty-five patients requiring scaling and root planing, aged ≥19 years and showing no auditory problems, were included. Scaling was performed for the bilateral maxillary molars and premolars while patients wore headphones, with ANC turned either on or off. The degree of noise and pain reduction in the on and off conditions were surveyed using a visual analog scale (VAS). The Wilcoxon signed-rank test was performed to compare noise- and pain-related discomfort with ANC turned on and off.

The sample included 28 men and 27 women with a mean age of 45.45±13.12 years. The average noise-related discomfort score was 3.84±2.12 and 2.95±1.99 when noise cancelling was turned off and on, respectively, with a statistically significant difference ($P<0.05$). Similarly, the average pain-related discomfort score was 3.78±2.00 and 3.09±1.96 when noise cancelling was turned off and on, respectively, which was a statistically significant difference ($P<0.05$).

The use of ANC headphones seems to reduce the discomfort caused by noise and pain in patients undergoing scaling.

Keywords: Auditory Stimulation; Dental anxiety; Dental scaling; Noise

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I. Introduction

Dental anxiety, which presents an obstacle to receiving timely dental treatment [1-3], is a multidimensional and complex phenomenon affected by stimuli in the dental clinic, traumatic dental experiences, personality characteristics, and many other factors [4]. In particular, the stimuli in the dental clinic that can provoke dental anxiety include injections, the sight of needles, the sounds of dental instruments, the smell of the dental office, and several others [5,6].

Various noises are generated in the dental clinic. Sources of noise include high-speed handpieces, low-speed handpieces, dental suction, ultrasonic scalers, vibrators, mixing devices, and model trimmers [7]. Since these noises are by no means negligible, they can act as a potential hazard to the auditory system of both dental practitioners and patients [8-10]. In particular, sounds generated by high-speed air turbines and ultrasonic scalers can lead to dental fear [5,6,11-13]. This fear can make it difficult for patients to visit the dental clinic. Therefore, the noise generated during dental treatment may prevent patients from visiting the dental clinic.

Periodontal disease requires regular dental visits as it is an infectious disease caused by dental plaque and calculus, and it can recur if biofilms accumulate, even after treatment. Therefore, it is necessary to remove dental plaque and calculus regularly. Suomi et al. reported that thorough plaque control and scaling can reduce gingival inflammation, attachment loss, and tooth loss rates [14]. It has also been reported that patients with severe periodontal disease showed better treatment results if they continued regular recall programs, including dental scaling and root planing, after surgical treatment [15]. Therefore, it is possible that patients' hesitation to visit the dental clinic due to noise-related anxiety could worsen periodontal disease.

One of the most commonly used treatments to prevent periodontal disease is ultrasonic scaling, which constitutes the most effective method for removing dental plaque and calculus from the teeth [16,17]. Its mechanism is attributed mainly to the vibratory "chipping" action of the longitudinally oscillating scaling tip when the direction of motion is roughly parallel to the surface of the tooth [18,19]. Owing to this operating principle of the ultrasonic scaler, noise is generated when the scaler is turned on, and the noise is increased when the scaler contacts the teeth.

Water is used to relieve the heat generated during ultrasonic scaling, and for this purpose, dental suction (e.g., saliva ejectors or high-volume aspirators) is essential. Dental suction also creates noise as loud as scaling. Lee et al. reported that the noise of ultrasonic scalers alone was 58.0±3.36 dB(A), compared to 63.4±1.12 dB(A) when ultrasonic scalers and saliva ejectors were used, and 70.5±0.98 dB(A) when ultrasonic scalers and high-volume aspirators were used. Therefore, there was a significant difference in noise when an ultrasonic scaler was used alone versus coupling the ultrasonic scaler with suction [20]. Since dental suction cannot be omitted when scaling, these 2 sources of noise generated during scaling should always be considered together.

The noise generated during dental scaling through these pathways may cause dental anxiety [5,6,11-13]. Communication, brief relaxation, musical distraction, guided imagery, and even hypnotherapy have been tried to reduce dental anxiety [21]. In particular, in order to reduce the anxiety from noise generated during dental treatment, methods like listening to music or music therapy have been attempted [21,22]. The use of headphones has also been suggested to block dental noise, which is the fundamental cause of anxiety, sometimes with music [23-26]. However, each of these various methods has fundamentally struggled to block noise effectively, revealing its limitations. We then hypothesized that blocking noise better would reduce patients' anxiety more effectively.

We have focused on a technology called active noise cancelling (ANC) systems, which have been actively used commercially in recent years. Several studies have been conducted on noise reduction in dental treatment using ANC [23-25]. These studies have focused on the mechanical aspects of ANC systems to study how to block the noise of dental treatment, rather than analyzing the patient's discomfort with the noise. In addition, while research has primarily focused on reducing dental drilling sounds, few studies have investigated reducing noise generated by ultrasonic scaling. In particular, no clinical studies have attempted to determine how ANC systems affect patients.

The purpose of this study was to determine whether ANC affects noise and reduces the discomfort felt by patients during dental treatment, especially during ultrasonic scaling, and to evaluate its effectiveness.

II. Materials & Methods

1. Protocol registration and reporting

This study was conducted in accordance with the CONsolidated Standards of Reporting Trials (CONSORT) 2010 guideline. The protocol was reviewed and approved by the Institutional Review Board of National Health Insurance Service Ilsan Hospital (NHIMC 2020-09-018).

2. Patient enrollment

Patients were recruited at a dental clinic between December 2020 and August 2021. The inclusion and exclusion criteria are reported in Table 1. All patients received thorough explanations and had to complete a written informed consent form prior to enrollment in the trial. After the consent form was signed, the clinical trial began.

3. Sample size calculation

The required sample size was determined using the t-test with an effect size of 0.50, an alpha level of 0.05, and a statistical power of 95%. The required sample size was 47 patients, and 55 patients were therefore recruited to account for a potential dropout rate of 15%. The statistical power was calculated using G* Power 3.1 (University of Duesseldorf, Düsseldorf, Germany) [27].

4. Headphone manufacturer and group assignment

Two headphone devices with ANC systems from different manufacturers were used in this clinical trial. The rationale for using 2 different manufacturers' products was to confirm whether the effect of ANC on blocking the noise generated during dental scaling was consistent regardless of the manufacturer.

The patients were randomly assigned to 2 groups. Group 1 used Sony WH-1000XM4 wireless noise cancelling headphones (Sony, Tokyo, Japan) and group 2 used Bose Noise Headphones 700 (Bose, Framingham, MA, USA).

5. Random assignment

A random assignment function determined which company's headphones to use and when to turn on the ANC as follows:

Assignment to group 1 or 2 and the ANC on/off order were randomly determined using Microsoft Excel (Microsoft, Redmond, WA, USA); the randomized allocation was pre-designed and created before the start of the study. Finally, participants were allocated to each group in a 1:1 ratio, and the ANC on/off order was evenly distributed.

6. Blinding

During scaling, the patient was not informed of which company’s headphones were used. The side on which scaling was performed with the ANC function turned on was hidden.

7. Scaling instrument and dental unit chair

In all patients, scaling was performed using a Yoshida dental unit chair (EXCEED ef; Yoshida Dental Mfg. Co., Ltd, Tokyo, Japan). The ultrasonic scaling device used was the universal-handle Piezon EN-041/A (E.M.S. Electro Medical Systems S.A., Nyon, Switzerland). During scaling, the power setting was set to the lowest level.

8. Scaling procedure

The patients underwent scaling wearing headphones, while covered with a cotton cloth and provided dental suction on the left side of the mouth (Figure 1). First, ultrasonic scaling was performed in the mandibular teeth without headphones, which allowed patients to compare the degree of noise and pain in the presence or absence of headphones. Also, since the mandible is connected with the maxilla through the articular disk, it seemed that different results could be obtained from the maxilla. In this study, to examine the blocking ability of ANC, the comparison of both posterior teeth was conducted in only maxilla.

The right maxillary sextant, including the molars and premolars, was scaled, followed by the left maxillary sextant. Scaling was carried out with the ANC function turned on for 1 of the 2 sextants, and turned off for the other. The side at which the ANC was turned on or off was randomly assigned.

Finally, scaling of the maxillary anterior sextant was performed with headphones to reduce the inconvenience of attaching and detaching them, and scaling of the anterior sextant was performed after notifying patients that it was not included in the survey.

9. Questionnaire survey

After scaling, a questionnaire survey was conducted (Figure 2). The list of survey questions was as follows:

- Number of visits to the dental clinic.
- Feeling when visiting the dental clinic.
- Hesitation to visit the dental clinic. If so, what is the reason for this?
- Reasons for reluctance to visit the dental clinic (multiple choices).
- Discomfort score based on noise.

- Right maxillary sextant.
- Left maxillary sextant.
- Discomfort score based on pain.
- Right maxillary sextant.
- Left maxillary sextant.

The degree of noise and pain when the ANC was turned on and off was surveyed using a visual analog scale (VAS).

10. Statistical analysis

The study data were analyzed using SPSS version 22.0 (IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov test and Shapiro-Wilk test revealed that the data for noise-related discomfort reduction were not normally distributed. Therefore, the Wilcoxon signed-rank test was performed to compare noise- and pain-related discomfort when ANC was turned on and off.

A logistic regression model was used to analyze the factors affecting the reduction of noise-related discomfort when the ANC was turned on. The outcome was dichotomized according to whether ANC reduced or did not reduce noise-related discomfort or adverse effects. Age, the order in which ANC was turned on, previous discomfort due to dental noise, and the headphone manufacturer were considered independent variables.

Pearson correlation coefficients were used to analyze the correlation between the degree of noise reduction and the degree of pain reduction.

III. Results

In total, 55 patients who underwent ultrasonic scaling were randomized into group 1 (n=27) and group 2 (n=28). No participants dropped out. The CONSORT flow diagram with the enrollment characteristics and the number of patients in each phase of the study is presented in Figure 3. The mean age of the patients was 45.45±13.12 years. Patients' demographic characteristics and responses to the survey are presented in Table 2.

Of the 55 patients, 41 had visited the dental clinic more than 5 times. Moreover, 25 of the 55 patients said they were comfortable when they came to the dental clinic, 26 patients said they were worried, and 4 patients said they were nervous. Seventeen out of the 55 patients reported that they hesitated to visit the dental clinic. Patients who were hesitant to visit the dental clinic were divided into 3 groups: nine patients (17%) presented concern and anxiety, 4 patients (7%) reported having bad memories of dentistry, and 5 patients (9%) cited dental noise (Figure 4).

Figure 5 shows the responses to the multiple-choice question asking about reasons for reluctance to visit the dental clinic. Pain (n=34), noise from the dental drill (n=27), noise from the ultrasonic scaler (n=16), a long waiting time (n=8), smell (n=4), and noise from dental suction (n=4) were selected, respectively.

The most effective way to reduce dental noise was listening to music (22 patients, 40%), followed by headphones (18 patients, 33%), and conversation and explanation by the practitioner (8 patients, 14%). Seven patients (13%) answered that no method was effective (Figure 6).

The average noise-related discomfort score was 3.84±2.12 when noise cancelling was turned off and 2.95±1.99 when turned on. A statistically significant difference was found in all group 2 patients ($P<0.05$), but not in group 1 patients ($P>0.05$) (Table 3). The average pain-related discomfort score was 3.78±2.00 when noise cancelling was turned off and 3.09±1.96 when turned on, with a statistically significant difference in both groups ($P<0.05$) (Table 4).

In the logistic regression model, none of these variables had a statistically significant effect on noise reduction by ANC (Table 5).

In addition to the reduction in noise-related discomfort, the discomfort caused by pain also showed a significant reduction (Tables 3 and 4), and we examined whether the reduction of each type of discomfort affected the other. The Pearson correlation coefficient was 0.459, indicating a moderate correlation between the 2 types of discomfort reduction (Table 6).

IV. Discussion

In this study, noise-related discomfort was reduced when ANC was turned on. Since no studies have investigated how ANC and dental noise directly affect patients, this is considered a meaningful result. In addition, it is interesting that the pain felt by the patients was significantly reduced by wearing ANC headphones, which are supposed to affect hearing only. Another meaningful finding of this study is that the greater the noise generated during dental treatment, the greater the pain the patient may feel.

As initially expected in this study, ANC headphones did not completely eliminate noise generated during scaling. This is because the noise generated during scaling has a different transmission path than that of traffic noise or aircraft noise. There are 2 pathways through which noise is transmitted to the ears. The noise generated during scaling can be divided into air and bone conduction. Air conduction is a transmission pathway through which sound is recognized using the apparatus of the ear (pinna, ear canal, tympanic membrane, and ossicles), which amplifies and directs the sound. In contrast, bone conduction transmits sound in a way that allows the vibrations of skull bone to be transmitted to the inner ear [28-30].

In general, when the ear hears a sound through air conduction, the sound gathered on the ear canal hits the eardrum and vibrates the stapes footplate, which moves to the cochlea and leads to the brain through the auditory nerve. In contrast, bone conduction omits some parts of this process and vibrates the bones, which induces relative motion between the stapes footplate and the oval window of the cochlear fluids so that sound is transmitted directly to the cochlea [28,30,31]. Vibration applied to the teeth during scaling can be regarded as vibration in the skull bone [32], since the chipping action of the ultrasonic scaler, which involves vibration, causes both air-conducted and bone-conducted noise. Therefore, ANC could not block 100% of the noise generated during scaling.

As such, noise generated during dental scaling through these pathways causes anxiety and fear in patients, which can lead to dental avoidance [5,12,33,34]. Therefore, blocking noise will reduce dental anxiety and help patients receive timely dental treatment. The study began with an idea of how to help patients come to the dental clinic with a more comfortable mindset.

In this study, a noise cancelling device was used, and the effects of blocking noise generated during ultrasonic scaling on patient discomfort were analyzed. Noise cancelling can be classified into ANC and passive noise cancelling (PNC). PNC uses earplugs, earmuffs, or earcups to block unwanted noise. Headphones in which the ANC function is turned off can be regarded as PNC. Therefore, it was possible to observe differences between PNC and ANC.

ANC headphones are an efficient solution for reducing unwanted ambient noise. The principle of noise reduction of noise cancelling headphones is as follows: A microphone is placed outside the headphone to capture the noise signal. Adaptive algorithms are designed to analyze the waveform of the background noise. Then, based on the specific algorithm, a signal is generated that will either phase-shift or invert the polarity of the original signal. This inverted signal (in antiphase) is then amplified, and a transducer creates a sound wave directly proportional to the amplitude of the original waveform, creating destructive interference. This effectively reduces the volume of the perceivable noise [35,36].

In this study, noise-related discomfort was reduced when ANC was turned on. This indicates that applying ANC could block the noise generated during scaling better than applying PNC. The use of ANC reduces the absolute amount of noise, which seems to have led to a decrease in patients' discomfort. In addition, as the discomfort from noise decreased, the discomfort from pain decreased as well, even though ANC itself does not directly affect the pain that patients feel. Since patients with otolaryngological diseases, such as hyperacusis, who feel the noise itself as pain were excluded from the experiment, it is difficult to infer a direct association between noise reduction and pain reduction. However, the results of this study suggest that the overall pain felt by patients decreased.

Accordingly, we speculated that the degree of noise felt by the patient may be related to the degree of pain. Indeed, a previous study showed that the noise level and degree of pain were correlated [37]. In this study, the Pearson correlation coefficient was 0.459, suggesting a moderate correlation (Table 6). Therefore, the decrease in noise seems to have decreased the pain felt by the patient. Since ANC cannot directly reduce pain, a reasonable interpretation of this finding is that as the noise decreased, the discomfort or fear caused by the noise also decreased, and the pain felt by the patient was eventually also perceived as less intense. Indeed, it is not clear how much this reduction in discomfort by pain and noise can help patients visit the dental clinic. However, it is believed that a reduction in discomfort would have a positive effect on patients receiving dental treatment in a timely manner, since it may slightly lower the barrier to treatment.

In this study, we investigated whether specific factors such as the patient's age, headphone manufacturer, and order in which ANC was turned on affected the degree of reduction in discomfort due to noise. The reasons for considering the above factors were as follows. Because the frequency of hearing detection varies with age, it was necessary to see if age had an effect. Furthermore, the headphones made by different manufacturers might have different performance, and finally, whether ANC is turned on first or later may have a psychological effect. We conducted a logistic regression model analysis with these sub-factors as variables, and found that none of these variables in the logistic regression model had statistically significant effects on noise reduction by ANC (Table 5). The degree to which noise-induced discomfort decreased seemed to vary from individual to individual regardless of the above variables.

In addition, the reduction in noise-related discomfort in group 1 was not significant because 1 patient in group 1 felt more uncomfortable when the ANC function was turned on; this patient therefore provided an extreme score on the VAS. The patient responded that when the surrounding noise was blocked, the procedure was more uncomfortable because the patient’s attention was only focused on the scaling sound. In group 1, which consisted of 27 patients, this patient’s response with a large deviation caused statistical insignificance for the reduction of noise-related discomfort. However, statistically significant results were obtained when all 55 patients were analyzed.

According to our survey, more respondents generally reported that their discomfort decreased when using ANC headphones. Based on these results, it appears that ANC headphones are helpful when used clinically.

However, some patients reported discomfort when the ANC function was turned on, since all other ambient noises were blocked. This highlights bone conduction noise, which can make some patients more uncomfortable. As described previously, ANC can reduce the air conduction noise generated by the scaler and suction during scaling. However, bone conduction noise is difficult to block. Bone conduction noise directly vibrates the bones without passing through the eardrum, inducing relative motion between the stapes footplate and the oval window of the cochlear fluid so that the sound is transmitted directly to the cochlea. This sound transmission is a pathway that ANC cannot affect. Due to the remaining bone conduction noise, it is still not possible to provide 100% soundproofing to the patient during dental scaling.

Since ANC blocks other external sounds in addition to that of scaling, masking sounds disappear, allowing patients to focus more on the bone conduction noise, which may be uncomfortable for some patients based on our study findings.

While this study investigated how blocking noise alleviates discomfort, another study interestingly explored how adding noise could have the same effect. Suhara et al. [38] showed that discomfort was reduced by employing a control signal to mask multiple spectral peaks of the dental treatment sound. When scaling was accompanied by a pink sound or water running sound, patients' discomfort due to noise was significantly reduced

[38]. Since this study also found that discomfort was significantly reduced when noise was blocked by ANC, further studies are needed to investigate whether blocking noise with ANC or with pink sound is more effective.

One of the limitations of this study is that the practitioner knew when the ANC was on and off during scaling, which means that the practitioner was not completely blinded. The main purpose of this study was to evaluate the increase or decrease in discomfort caused by noise when the noise was blocked by ANC. Blinding of the practitioner was not considered necessary in this study design, because even if the practitioner knows when the ANC is on, he or she cannot adjust the noise volume of the ultrasonic scaler and dental suction. However, it is conceivable that a lack of blinding for the practitioner could affect pain. Although the practitioner did not intend to intervene, the lack of blinding for the practitioner could be considered a limitation in comparing pain.

Another limitation of this study is that if there was a difference in the severity of periodontal disease between both posterior regions of the maxilla, there might have been a difference in the depth of the scaling tip going into the periodontal pocket or the time taken for scaling. This could have affected the discomfort caused by noise or pain during scaling.

For a similar reason, the fact that the presence or absence of implants was not considered is also a limitation of this study. Because implants and teeth have different material properties, when the scaler generates noise through an oscillating action, the frequency range of the generated noise may be different. In addition, teeth and implants have differences in periodontal fiber placement, which can cause different degrees of pain during scaling [39,40]. Moreover, the presence or absence of endodontic treatment may also affect the degree of pain, because root canal-treated teeth have no cold perception, potentially reducing pain.

In addition, since the practitioner performed scaling in all patients based on the same clinical goal, the practitioner could not limit the time required for scaling or put the scaler tip into the periodontal pocket only to a certain depth. However, we tried to avoid significant differences in the time required for scaling by setting appropriate inclusion/exclusion criteria; specifically, we only recruited patients who had at least 3 teeth in each sextant of the dental arch and excluded patients with severe periodontitis.

In this study, we found that ANC significantly reduced the discomfort experienced by patients when undergoing scaling, but it could not be completely blocked. To further reduce the discomfort caused by noise generated during scaling, it is necessary to consider not only blocking noise, but also obtaining a masking effect by listening to music or other sounds. In addition, further research is needed on how to block bone conduction noise, which may have a complementary effect on blocking noise when used with ANC. Also, research about ANC through bone conduction headphones seems to be necessary for follow-up research.

V. Conclusion

The use of ANC headphones seemed to reduce the discomfort caused by noise and pain in patients undergoing scaling, which will help patients be slightly less afraid of treatment and visit the dental clinic in a timely manner. If patients can feel even a little less discomfort, it is believed that ANC headphones would be sufficiently helpful in clinical practice. Therefore, this study proposes to encourage patients to wear ANC headphones if they would like to do so during dental treatment. There is also a need for research on effective methods to better block the noise generated during dental treatment.

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Figure legends

Figure 1. Patient undergoing scaling with ANC headphones on.

Figure 2. Questionnaire survey.

Figure 3. The CONSORT Flow Diagram.

Figure 4. Reasons for hesitation to visit the dental clinic.

Figure 5. Reasons for reluctance to visit dental clinic (Multiple choice).

Figure 6. Efficacy of dental noise reduction methods.

Figures

Figure 1.

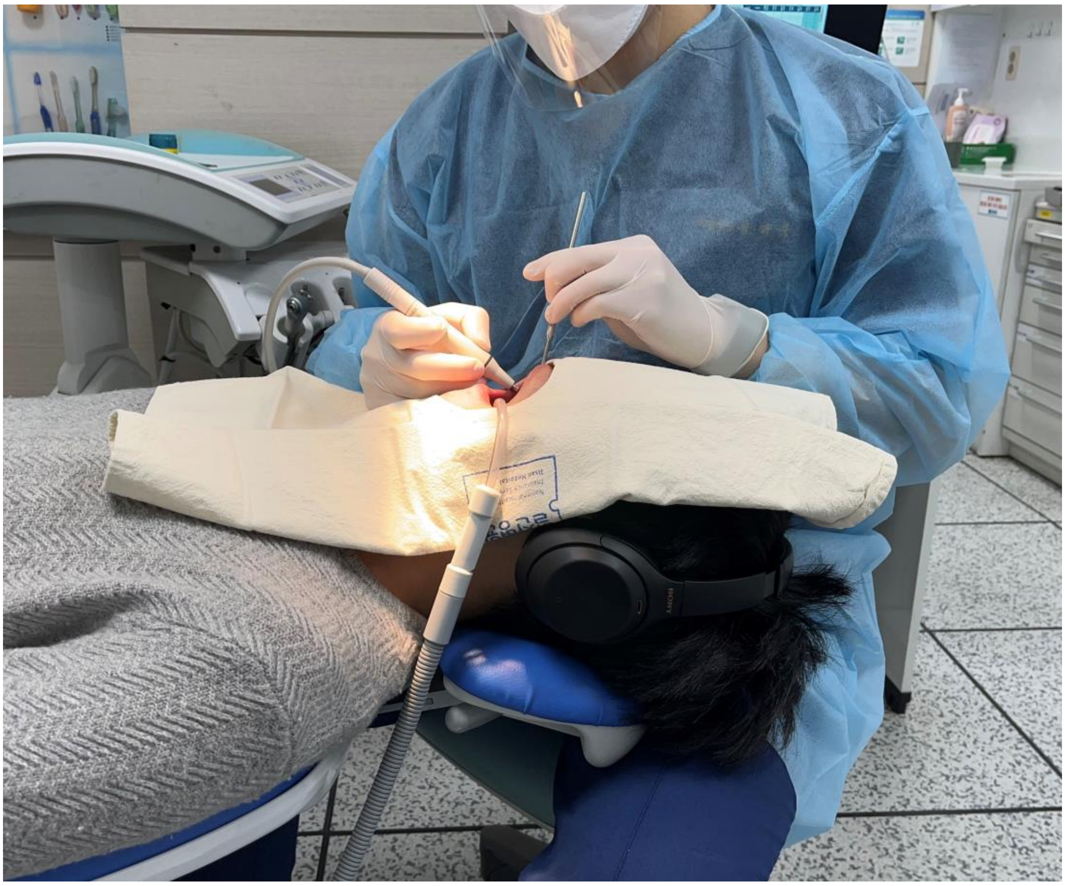


Figure 2.

설문지 V1.3

환자 고유식별번호 NC0101-101

1. 이번 치과 방문이 처음인가요?
a. 처음
b. 2~4번째
c. 5번 이상

2. 치과 방문시에 불편감이나 불안함을 느꼈나요?
a. 편안함
b. 초조함, 걱정
c. 불안함
d. 매우 불안함

3. 치과 내원을 주저한 적이 있습니까?
a. 예 (3-1번 문항으로)
b. 아니오 (4번 문항으로)

3-1. 치과 내원을 주저한 이유는 무엇인가요?
a. 걱정과 불안함으로 인해
b. 과거의 치과 경험이 안 좋아서
c. 치과 내 유발되는 소음으로 인해
d. 기타 ( )

4. 다음 내용 중 가장 불편하게 만드는 것은 무엇인가요? (중복 선택 가능)
a. 치과 드릴 소음
b. 치과 초음파 스케일러 소음
c. 치과 석션 소음
d. 치과 내 냄새
e. 대기실에서 긴 대기 시간
f. 치과 진료 시 통증

5. 치과 내 소음이 얼마나 신경이 쓰이시는가요? (0~10)
0: 신경쓰이지 않는다, 10: 치과의 소음으로 인해 치료받기 힘들다.

0 1 2 3 4 5 6 7 8 9 10

( )

6. 다음 중 어느 것이 가장 소음에 효과적인 것 같은가요?
a. 음악을 듣는 것
b. 헤드폰을 사용하는 것
c. 술자의 끊임없는 대화 시도 및 설명
d. 위 아무 것도 효과가 없다.

<오른쪽>

7. 스케일링 중 소음으로 인한 불편함 혹은 불안감은 어떠했나요? (0~10)
0: 전혀 불편하거나 불안하지 않았다. 10: 불편함과 불안으로 스케일링 시행이 어려웠다.

0 1 2 3 4 5 6 7 8 9 10

( )

8. 스케일링 중 통증 정도를 수치로 표현해주세요. (0~10)
0: 통증없음 10:상상할 수 있는 가장 심한 통증

0 1 2 3 4 5 6 7 8 9 10

( )

<왼쪽>

9. 스케일링 중 소음으로 인한 불편함 혹은 불안감은 어떠했나요? (0~10)
0: 전혀 불편하거나 불안하지 않았다. 10: 불편함과 불안으로 스케일링 시행이 어려웠다.

0 1 2 3 4 5 6 7 8 9 10

( )

10. 스케일링 중 통증 정도를 수치로 표현해주세요. (0~10)
0: 통증없음 10:상상할 수 있는 가장 심한 통증

0 1 2 3 4 5 6 7 8 9 10

( )

Figure 3.

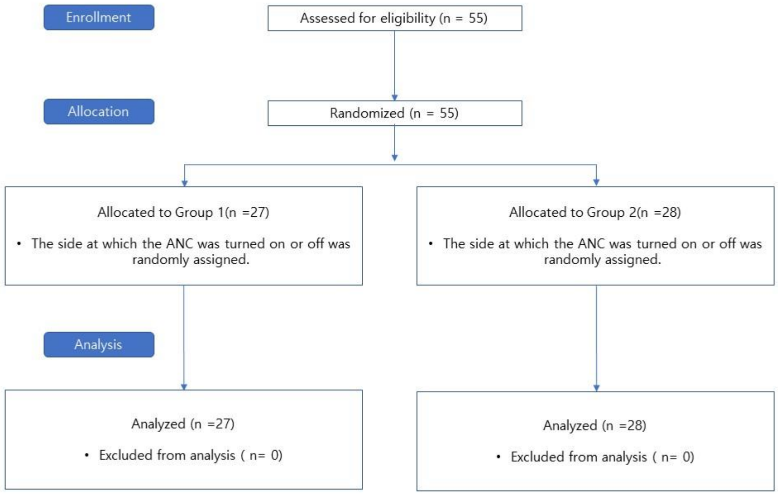

Enrollment
Assessed for eligibility (n = 55)
Allocation
Randomized (n = 55)
Allocated to Group 1(n =27)
• The side at which the ANC was turned on or off was randomly assigned.
Allocated to Group 2(n =28)
• The side at which the ANC was turned on or off was randomly assigned.
Analysis
Analyzed (n =27)
• Excluded from analysis (n= 0)
Analyzed (n =28)
• Excluded from analysis (n= 0)

Figure 4.

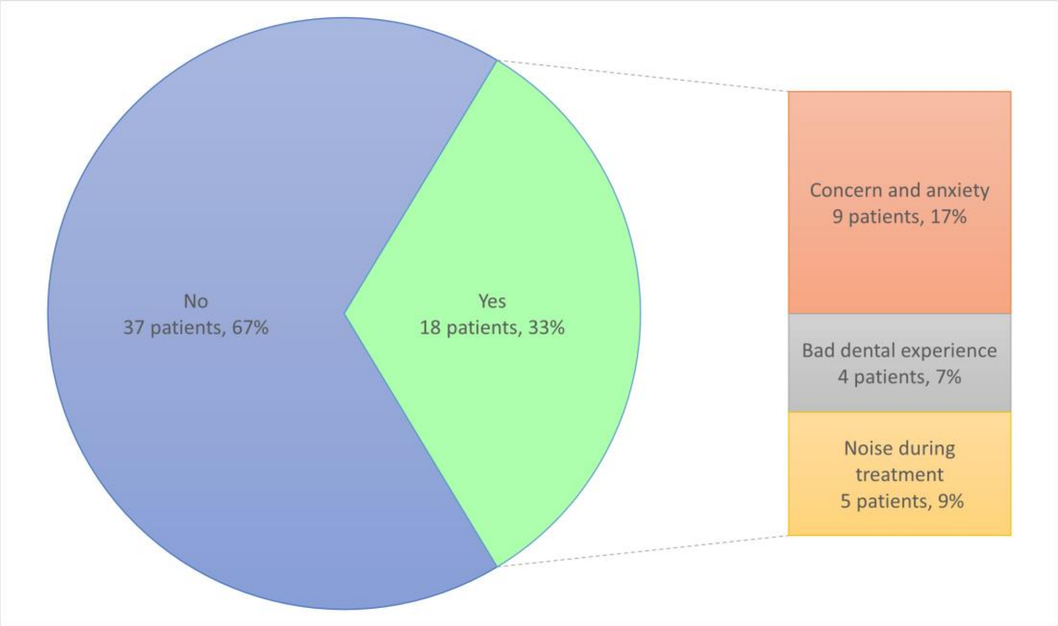

No
37 patients, 67%
Yes
18 patients, 33%
Concern and anxiety
9 patients, 17%
Bad dental experience
4 patients, 7%
Noise during
treatment
5 patients, 9%

Figure 5.

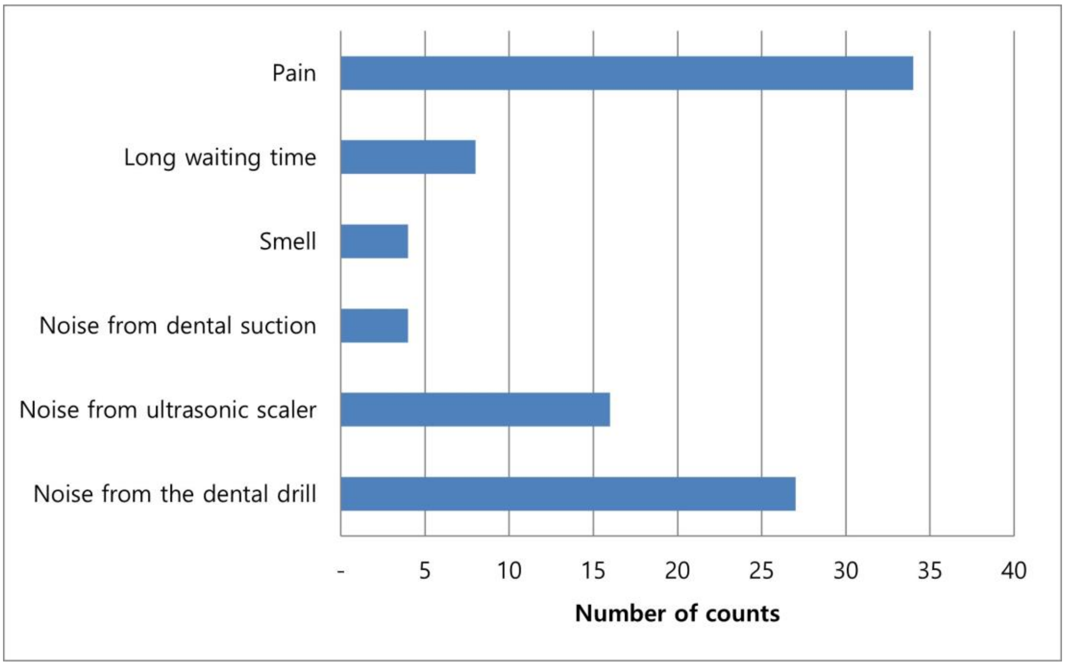
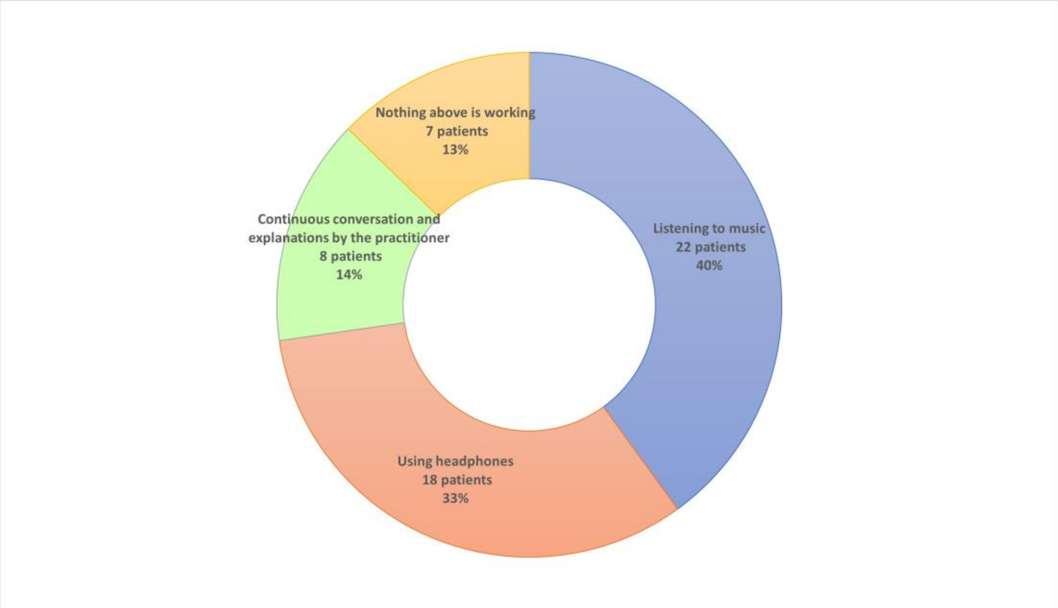

Pain
Long waiting time
Smell
Noise from dental suction
Noise from ultrasonic scaler
Noise from the dental drill
-
5
10
15
20
25
30
35
40
Number of counts

Figure 6.


Nothing above is working
7 patients
13%
Continuous conversation and
explanations by the practitioner
8 patients
14%
Listening to music
22 patients
40%
Using headphones
18 patients
33%

Tables

Table 1. Inclusion and exclusion criteria for patient enrollment

Inclusion criteria	Exclusion criteria
Patients requiring dental scaling and root planing	Patients who could not understand or refused informed consent
Patients 19 years of age or older	Patients younger than 19 years of age
Patients without hearing problems	Patients who have history of or are currently visiting otorhinolaryngology clinics owing to hearing problems
Patients with gingivitis or mild to moderate periodontitis	Patients with severe periodontitis requiring surgical periodontal treatment
Patients with at least three teeth each sextant of the dental arch, including premolars and molars	Patients with less than three teeth each sextant of the dental arch, including premolars and molars.
	Use of hearing aids

Table 2. Respondents' characteristics and answers to the survey

Characteristics	Group 1 (n=27)	Group 2 (n=28)	Total
Age, (yr)	45.81 ± 12.93	45.11 ± 13.54	45.45 ± 13.12
Sex, male/female	15/12	13/15	28/27
Number of visits to dental clinic			
First time	1	3	4
2 to 4 times	6	4	10
More than 5 times	20	21	41
Feeling when visiting dental clinic			
Comfortable	12	13	25
Nervous/Worried	12	14	26
Anxious	3	1	4
Hesitated to visit a dental clinic			
Yes	7	10	17
No	20	18	38

Table 3. Average discomfort score by noise (visual analog scale)

Groups	**Noise**			
	ANC off	**ANC on**	**Diff**	***P*-value**
Group 1	3.74 ± 1.99	3.11 ± 2.08	0.63 ± 1.90	0.098
Group 2	3.93 ± 2.28	2.79 ± 1.91	1.14 ± 1.76	0.004*
Total	3.84 ± 2.12	2.95 ± 1.99	0.89 ± 1.83	0.001*

* Statistically significant; $P<0.05$

ANC: active noise cancelling

Table 4. Average discomfort score by pain (visual analog scale)

Groups	Pain			
	ANC off	ANC on	Diff	*P*-value
Group 1	3.93 ± 2.34	3.33 ± 2.15	0.59 ± 1.05	0.010*
Group 2	3.64 ± 1.64	2.86 ± 1.76	0.79 ± 1.00	0.0004*
Total	3.78 ± 2.00	3.09 ± 1.96	0.69 ± 1.02	0.00002*

* Statistically significant; $P<0.05$

ANC: active noise cancelling

Table 5. Logistic regression model analyzing factors affecting the reduction of noise-related discomfort with ANC turned on

Variable		**Exp(B)**	**95% CI for B**		**Significance**
			Lower bound	**Upper bound**	
Age		0.988	0.947	1.030	0.564
Order of turning on ANC	First	1.380	0.449	4.239	0.574
	Later	1.000	-	-	-
Degree of discomfort due to dental noise		1.136	0.880	1.467	0.327
Corporation	Group 2	1.206	0.410	3.544	0.734
	Group 1	1.000	-	-	-
Constant		0.961			0.975
χ^2				1.617	
Hosmer-Lemeshow				7.860	

ANC: active noise cancelling, CI: confidence interval

Table 6. Pearson correlation coefficient for the association between the reduction in noise-related discomfort and the reduction in pain-related discomfort

Variable		**Reduction in noise-related discomfort**	**Reduction in pain-related discomfort**
Reduction in noise-related discomfort	Pearson's correlation	1	0.459**
	Sig. (two-tailed)		0.000
	N	55	55
Reduction in pain-related discomfort	Pearson's correlation	0.459**	1
	Sig. (two-tailed)	0.000	
	N	55	55

** Correlation is significant at the 0.01 level (two-tailed).

국문요약

초음파 스케일링을 받는 환자에서 Active noise cancelling 헤드폰 착용의 효능

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김 정 웅

치과에 대한 공포는 환자가 적절한 시점에 적절한 치과 치료를 받는 것을 방해한다. 특히, 고속 에어 터빈과 초음파 스케일러에서 발생하는 소음은 치과 치료를 받는 환자에게 불안과 공포를 유발할 수 있다. 그 동안 치과치료 중 발생하는 소음으로 인해 환자가 느끼는 불편함을 줄이기 위한 많은 노력이 있었지만, 확실한 방법은 없었다. 이 연구의 목적은 치과 스케일링으로 발생하는 소음 및 통증에 대한 불편함을 줄이는 데 있어 Active noise cancelling(ANC) 헤드폰의 효능을 확인하는 것이다.

스케일링과 치근 활택술이 필요한 19세 이상 및 청각에 문제가 없는 55명

의 환자를 대상으로 연구가 실시되었다. 환자가 헤드폰을 착용한 채로 상악 구치부에 대하여 스케일링을 실시했는데, 한쪽은 ANC를 켠 채로, 다른 한쪽은 ANC를 끈 채로 스케일링이 진행되었다. 스케일링 실시 후 설문을 통하여 ANC의 켜고 끔에 따른 소음 및 통증 감소 정도를 VAS(Visual Analog Scale)를 이용하여 조사하였다. ANC를 켰을 때와 껐을 때 소음 및 통증에 의한 불편감을 비교하기 위해 Wilcoxon 부호 순위 검정을 수행하였다.

연구 대상자는 28명의 남성과 27명의 여성으로 이루어졌고, 평균 연령은 45.45±13.12세였다.

소음에 대한 불편감에 대한 점수는 ANC를 껐을 때 3.84±2.12, ANC를 켰을 때 2.95±1.99로 통계적으로 유의미한 차이가 있었다 ($P<0.05$). 마찬가지로 통증에 대한 불편감에 대한 점수는 ANC를 껐을 때 3.78±2.00, ANC를 켰을 때 3.09±1.96으로 통계적으로 유의한 차이를 보였다 ($P<0.05$).

결론적으로 스케일링을 받는 환자에게 ANC 헤드폰을 착용시키면, 환자가 스케일링 중에 느끼는 소음과 통증에 의한 불편감을 감소시킬 수 있을 것으로 보인다.

핵심되는 말 : 소음; 스케일링; 청각 자극; 치과 불안