

Original Article

# The Relationship Between Auditory Performances and Satisfaction of Unilateral Bone-Anchored Hearing in Conductive and Mixed Hearing Loss

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**BACKGROUND:** The aim of this study is to investigate the device and non-device auditory performance results of patients with unilateral bone-anchored hearing aid.

**METHODS:** Device and non-device free field hearing thresholds, speech discrimination, and sentence discrimination scores were evaluated. Shortened profile of the benefit from the hearing instrument (Abbreviated Profile of Hearing Aid Benefit) was used.

**RESULTS:** A total of 17 patients participated in the study. The mean age was  $37.9 \pm 17.1$  years. There was a statistically significant difference between the Abbreviated Profile of Hearing Aid Benefit satisfaction questionnaire and total scores, Background Noise (BN), Reverberation (RV) subscales according to device status ( $P < .05$ ). No significant difference was found between the Abbreviated Profile of Hearing Aid Benefit total score result of the group divided by the hearing aid threshold ( $P > .05$ ). No significant difference was found between the Abbreviated Profile of Hearing Aid Benefit total score result of the group divided by the threshold without a hearing aid ( $P > .05$ ).

**CONCLUSION:** Bone-implanted hearing aids are effective and reliable amplification methods in patients with conductive and mixed hearing loss. Positive results of patient satisfaction and evaluation inventories were obtained from this study.

**KEYWORDS:** Bone-anchored hearing aid (BAHA), hearing loss, satisfaction, APHAB survey.

## INTRODUCTION

Hearing loss decreases the quality of life by creating a negative effect on the social, academic, psychological, and similar areas of individuals.<sup>1</sup> As a solution, amplification applications suitable for the type of hearing loss are recommended for patients whose results cannot be obtained with medical or surgical methods. These amplification applications are hearing aids, middle ear, cochlear or bone-anchored implants, and some auxiliary apparatus. Usually, the first preferred amplification application is airway hearing aids. Rehabilitation with conventional airway hearing aids is the first preferred method, especially in sensorineural hearing loss. In some conductive and mixed hearing losses that cannot be resolved by surgical or medical treatment, the use of conventional airway hearing aids cannot be used because it causes complications. Amplification with a bone conduction hearing aid is recommended for this patient group.<sup>2</sup>

With the studies and new technologies, significant developments have been recorded in bone-anchored hearing aid (BAHA) surgery today. In addition to percutaneous models placed directly on the bone, magnetic transcutaneous models have also been used to reduce esthetic concerns.<sup>3</sup> This rehabilitation method is widely used today, and the number of users is increasing day by day. Studies have shown that patients using BAHA are more satisfied with a device than without a device.<sup>4</sup> Many studies have stated that BAHA has audiological benefits and affects the quality of life considerably.<sup>5</sup>

The aim of this study is to investigate the relationship between device satisfaction and auditory performance results of unilateral BAHA users with and without devices.

## MATERIAL AND METHODS

The research was carried out among the patients who underwent unilateral BAHA surgery in Ege University Medicine School Department of Otolaryngology who were suitable according to the research conditions. Data were collected between February 2018 and June 2018. Ethics committee approval was received for the study in Ege University (February 20, 2018; 86991637-302.14.01, 18-2.1/50). The sample of the study consisted of volunteers aged 9-65 years, who regularly used unilateral BAHA for at least 3 months. The patients who used BAHA as a contralateral routing device were excluded. Users who did not use their device regularly for at least 3 months, those who did not have the ability to respond to the questionnaires reliably, those who filled in the questionnaires incompletely, those whose retrospective data required for the study could not be reached, and those whose written consent could not be obtained were excluded from the study. The specific language sentence tests (SLST) with or without devices, the speech discrimination (SD) scores, and the free field (FF) thresholds of the patients were measured at 4 frequencies (500, 1000, 2000, and 4000 Hz). Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire form were applied to the patients to measure device satisfaction. The Turkish validity and reliability of the APHAB questionnaire was performed by Ceylan<sup>6</sup> in 2012.<sup>6</sup> The questions were classified as RC, AV, EC, and BN subscales, and the global APHAB score was evaluated as the difference between the groups with and without the device, by averaging the 6 items of each subscale. Hearing performance and satisfaction survey results of the patients were compared according to the median of their thresholds with and without devices.

## Statistical Analysis

The results were analyzed using the Statistical Package for Social Sciences version 22.0 (IBM SPSS Corp.; Armonk, NY, USA) package program. Normality assumption, one of the prerequisites of parametric tests, was checked with the Shapiro-Wilk test. To test whether there was a significant difference between the means in normally distributed measurements, a *t*-test was used for repeated measurements, and Wilcoxon and Mann-Whitney *U* test was used for non-normally distributed measurements. Type I error level was kept at .05 level.

## RESULTS

Seventeen volunteers, who applied unilateral BAHA and used it regularly for at least 3 months, participated in the study. Ten (59%) of the patients were female and 7 (41%) were male. The mean age is  $37.9 \pm 17.1$ . Ten of them use the device in the right ear, and 7 use it in the left ear. Among the volunteers who were treated with BAHA included in

**Table 1.** Demographic Characteristics, Etiology, Implant Side, and Model of the Patients with Bone-Anchored Hearing Aid (n = 17)

Sociodemographic Characteristics	Number	Percentage
Gender		
Male	7	41
Female	10	59
Age (year)	Mean $\pm$ SD: $37.9 \pm 17.1$ Min: 12, Max: 65	
Implant side		
Right	10	59
Left	7	41
Etiology		
Atresia	6	35
Stenosis	2	12
COM	9	53
Model		
Connect	3	18
Attract	14	82

COM, chronic otitis media.

the study, 6 of them had external ear canal atresia (35%), 2 of them had external ear canal stenosis (12%), and 9 of them had chronic otitis media (53%). All of the participants were Cochlear® BAHA users (Table 1).

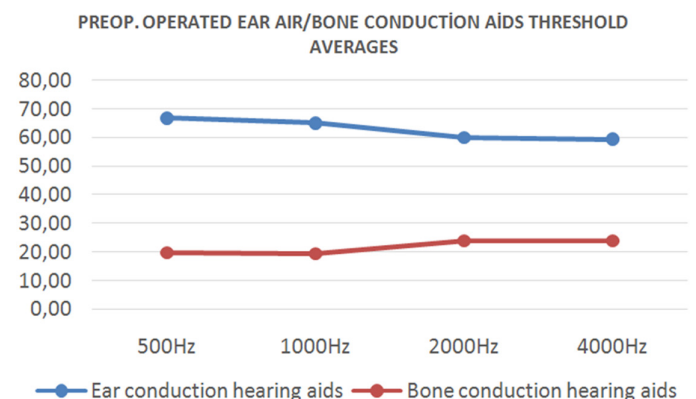
## Audiological Results

The mean preoperative air and bone conduction thresholds of the operated ear of the patients are given in Figure 1. A significant difference was found when the means of FF thresholds with and without device were compared in 4 frequencies ( $P < .05$ ) (Table 2).

A significant difference was found between the mean percentages of the patients' SD and SLST test scores with/without device ( $P < .05$ ) (Table 3).

## Comparison of Abbreviated Profile of Hearing Aid Benefit Questionnaire Total Score Results and Average Values

A significant difference was found between the total score results of the APHAB questionnaire with the device and the total score of



**Figure 1.** Preoperative operated ear air/bone conduction aids threshold averages.

## MAIN POINTS

- Patients using BAHA have higher satisfaction with the device than those without the device.
- Very efficient results are obtained from bone-anchored hearing aids both in hearing thresholds and in understanding speech.
- Satisfaction with hearing aid in patients using BAHA is very important for patients.

**Table 2.** With Device and Without Device FF Threshold in all Frequencies, Separately Average of 0.5-1-2-4 kHz

Measurement	n	Without Device Med (dB)	With Device Med (dB)	P
500 Hz	17	67.6	36.1	<.5
1000 Hz	17	66.4	30.2	<.5
2000 Hz	17	60.2	29.1	<.5
4000 Hz	17	61.1	41.1	<.5

**Table 3.** Comparison of Mean Percentages of SD and SLST Test Scores With/Without Device

Measurement	With Device	Without Device	P
SD score	87.3	24.7	<.05
SLST score	67.6	36.2	<.05

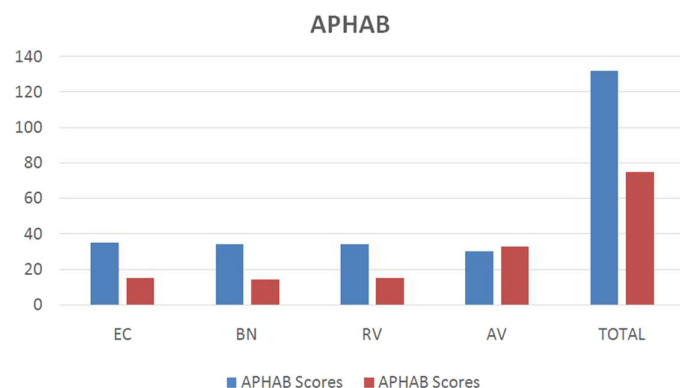
SD, speech discrimination; SLST, specific language sentence tests.

the APHAB questionnaire without the device ( $P < .05$ ). A *t*-test was performed for related samples to see if there was a significant difference between the averages of the APHAB questionnaire total score results. A significant difference was found between the total score results of the APHAB questionnaire with device EC, BN, RV subscale and the total score results of the EC, BN, RV subscale of the non-device APHAB questionnaire. ( $P < .05$ ). However, no significant difference was found between the total score results of the APHAB questionnaire AV subscale with devices and the total score results of the APHAB questionnaire AV subscale without devices ( $P > .05$ ) (Table 4, Figure 2).

**Table 4.** Comparison of Total APHAB and APHAB Subscales Scores With/Without Device

Measurement	With Device	Without Device	P
APHAB (EC) score	35.0	14.8	<.05
APHAB (BN) score	33.7	14.5	<.05
APHAB (RV) score	33.6	14.7	<.05
APHAB (AV) score	29.8	33.3	>.05
Total APHAB score	132.2	75.1	<.05

APHAB, Abbreviated Profile of Hearing Aid Benefit; EC, Ease of Communication (EC), Reverberation (RV), Background Noise (BN), Aversiveness (AV)

**Figure 2.** Abbreviated Profile of Hearing Aid Benefit score results with and without device.**Table 5.** Comparison of Hearing Performance and Satisfaction Survey Results

Group	n	U	P
With device	35 dB HL ≤	9	33.5
	35 dB HL >	8	
Without device	63.7 dB HL ≤	9	26.0
	63.7 dB HL >	8	

### Comparison of Hearing Performance and Satisfaction Survey Results

The patients were divided into 2 groups of 17 according to the median of the FF thresholds averages with and without the device at 500, 1000, 2000, and 4000 Hz. No statistically significant difference was found between the APHAB total score results of the group, which was divided into 2 groups as 35 dB above and below according to the FF thresholds mean with the device, and 63.7 dB above and below the mean FF thresholds without the device ( $P > .05$ ) (Table 5).

### DISCUSSION

Bone-implanted hearing aids are effective and reliable amplification methods in patients with conductive and mixed hearing loss. It is at least as important as choosing the appropriate device to reveal the problems that the patient using a hearing aid may experience with their device in daily life and to provide counseling. Many studies have stated that BAHA has audiological benefits and affects the quality of life considerably.<sup>5</sup>

It is thought that objective or subjective hearing tests used for auditory gain and performance evaluations in individuals with hearing loss do not fully reflect the positive or negative situations that patients encounter in daily life. For this reason, various questionnaires were designed to evaluate the effect of hearing loss on quality of life. One of these questionnaires is APHAB, which is used quite frequently. In 2012, the Turkish validation study of APHAB was carried out and its Turkish version was created. In the APHAB-TR questionnaire, it was stated that the subscales EC, RV, and BN realistically show the benefit provided at the international level; however, the compliance score in the AV subscale may not reflect the benefit in general.<sup>6</sup> Cox and Alexander<sup>7</sup> stated that this may be due to the maximum gain from the device and that more research is needed on this subgroup. In this study, similar results were obtained in Turkish and in the original version. The AV score results were not statistically significant ( $P > .05$ ).

In a study on APHAB, Hoover et al<sup>8</sup> reported that patients were positively affected in their daily lives by providing ease of communication even one month after they started using the device.

Yue et al<sup>9</sup> reported that the scores of all EC, RV, and BN subscales were high in their study of 15 patients who underwent BAHA due to bilateral aural atresia. In addition, during the application of the questionnaire, patients reported that they were able to communicate quite easily when they were equipped with a device. During the questionnaire administration in this study, patients gave feedback on communication comfort similar to that of Yue et al. Yue et al<sup>10</sup> also evaluated the satisfaction of patients who underwent BAHA due to conductive and mixed hearing loss with the APHAB questionnaire in their study and stated that patients benefited from all subgroups of

the questionnaire, especially speaking in noise and understanding spoken words.

Dumper et al,<sup>4</sup> on the other hand, investigated device satisfaction with the APHAB questionnaire in 50 BAHA-using patients with varying degrees of hearing loss and obtained positive results. Satisfaction can be affected by many variables. In this study, etiology of hearing loss is not the same. Also, there were 2 types of BAHA (Attract and Connect). Although there are some differences in the etiology and device of BAHA, a statistically significant result was found between the total scores of the APHAB questionnaire for bone-anchored hearing aid users with and without a device; in this study,  $P < .05$ .

When BAHA was first used, it was preferred to be used in conductive hearing losses, but over time, the devices were strengthened and started to be used in mixed hearing losses.<sup>10</sup> One of the main conditions for a patient to benefit from a bone-conduction hearing aid is good cochlear function. The mean bone conduction hearing of the patients participating in this study was 23.8 dB. The contribution of BAHA to hearing is assessed by the change in pure tone hearing thresholds measured preoperatively. Bance et al<sup>11</sup> stated in their study that the best results were obtained with BAHA at 1000 and 2000 Hz. In addition, Agterberg et al<sup>12</sup> reported in their study that hearing thresholds increased at high frequencies after BAHA surgery, but this increase was not statistically significant. They stated that this situation is related to the interference arising from direct and cross-excitation and that it may be related to the fact that this interference is more effective at high frequencies. In a study conducted in 2018, it was reported that an average of 5-25 dB functional gain was obtained with BAHA.<sup>13</sup> In this study, the functional gain was obtained on average 5-17 dB, while the best results were obtained at 4000 Hz.

Dotú et al<sup>14</sup> evaluated the SD scores of the patients who underwent BAHA and obtained significant results. When the mean values of the bone anchored hearing aid with and without the device at 65 dB were compared in the patients included in this study, statistically significant results were obtained in the SD scores ( $P < .05$ ) and it was found that these findings were compatible with the literature. In addition, significant results were found in the sentence discrimination scores made at the same intensity ( $P < .05$ ).

Satisfaction with hearing aid in patients using BAHA is very important for patients. Considering the factors affecting device satisfaction, functional hearing gain seems to be the most important factor, but we can talk about many parameters that affect the perception of satisfaction. For this reason, when considering the level of satisfaction with the device, factors such as the patient's age, psychological state, presence of additional disease, the method of application of the device used (implantable or non-implantable), sociocultural level as well as the audiological values should be taken into consideration. In this study, the group was divided into 2 according to the median of the FFA averages with and without the device, and an evaluation was made between the audiological results and satisfaction to evaluate the device satisfaction of the group according to audiological results, too. However, there was no difference in satisfaction between the groups with better and worse audiological values in the groups with and without the device. The main limitation of the study is the small number of patients.

Very efficient results are obtained from bone-anchored hearing aids both in hearing thresholds and in understanding speech. Patients using BAHA have higher satisfaction with the device than those without the device. The hearing quality and communication of patients who have not benefited from bone conduction or airway conventional hearing aids and therefore have undergone BAHA application increase in their daily lives.

**Ethics Committee Approval:** This study was approved by Ethics Committee of Ege University (Approval No: 86991637-302.14.01, 18-2.1/50, Date: February 20, 2018).

**Informed Consent:** Written informed consent was obtained from the patients who agreed to take part in the study.

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**Declaration of Interests:** The authors have no conflict of interest to declare.

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