ORIGINAL ARTICLE

Hearing Amplification and Quality of Life with Bone Anchored Hearing Aid (BAHA) in Turkish Population

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Objective: To evaluate patient satisfaction and quality of life with the bone-anchored hearing aid (BAHA) in Turkish population.

Patients and methods: Twenty adult patients who had conductive or mixed hearing loss were included. Two of 20 patients could not use BAHA due to cosmetic and social reasons. Age ranged from 16-60 years. Pre and postoperative audiological assessment included pure tone and speech audiometry and free field audiometric evaluation. Satisfaction and quality of life evaluations were performed by using The International Outcome Inventory for Hearing Aids (IO-IHA).

Results: The surgical procedure did not cause any significant changes in the residual air and bone conduction thresholds ($p>0.05$). The free field hearing thresholds in all frequencies significantly improved after BAHA application ($p<0.05$). Maximum functional gain was observed at 1000 Hz, minimum functional gain was observed at 250 Hz. In sound proof and acoustic environments where the signal to noise ratio was 10, speech discrimination scores improved significantly with BAHA ($p<0.05$). The "total" mean IOIHA score with BAHA was 30.44±3.73 (ranged from 22 to 35). Total satisfaction rate with BAHA was 86.97 %.

Conclusions: BAHA application possesses almost no risk in terms of loss of the residual hearing. It facilitates hearing amplification significantly in various types hearing losses. It seems that patient satisfaction rate is high and quality of life is increased with BAHA in our population.

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Introduction

Hearing amplification through bone can be performed by using either a bone conduction hearing aid (BCHA) or bone anchored hearing aid (BAHA). The former method is applicable in conductive or mixed hearing losses when air-conduction hearing aids cannot be provided successfuly or when surgery is not considered to be a better option[1]. The most important problems in BCHA are instabilization on the mastoid bone and attenuation of acoustic transmission by skin and subcutaneus soft tissues[2]. BAHA is also a bone conduction hearing aid with percutaneus transmission of sound vibrations to the skull. BAHA provides better hearing, preferable sound quality and better speech discrimination in silent and noisy backgrounds than conventional bone conduction device acting by the simple contact of a vibrator against the skin[3,4].

BAHA is advocated in conductive or mixed hearing losses due to choronic otitis media, otosclerosis, congenital malformations of external and middle ear and in patients who can not use conventional hearing aids for various reasons[5,6]. Since BAHA overcomes the shadowing effect in unilateral hearing loss; indication of BAHA has been extended to unilateral profound hearing loss or total deafness recently[7].

BAHA includes a speech processor and a titanium fixture. The titanium fixture is implanted into the mastoid bone of the skull. The speech processor is

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attached to the fixture by means of an abutment. Recently, improvements in BAHA software have facilitated digital adjustment of the device, thus is possible to perform frequency specific amplification and feedback cancellation [8,9].

The International Outcome Inventory for Hearing Aids (IOI-HA) was developed for assessment of rehabilitative planning to assess the usefulness of the fitted hearing aid in patients' daily life [10]. The effectiveness of the hearing aid measured by IOI-HA inventory has seven items targeting a different domain of satisfaction. It can also be used to evaluate individual performance with an hearing aid [11].

In this study, we aimed to evaluate satisfaction and quality of life of Turkish patients who had BAHA application.

Materials and Methods

This study was performed in accordance with the principles of the Declaration of Helsinki and approval for this study was granted by the local ethical committee, also written informed consent was obtained from the patients and controls tested in this study.

Between 2002 and 2012 years, 20 adult patients with conductive or mixed hearing losses had BAHA applications. Their ages ranged from 18 to 80 years (mean, 41.2 ± 15.2 years). All patients had one or multiple surgeries for chronic otitis media (COM) prior to BAHA application.

Postoperatively, the first fitting was performed one month after surgery. In the follow up period, the adjustments were made by taking into consideration the compression rates, gain and gain off according to feedbacks received from the patients. The adjustments were made by using Cochlear Baha Fitting Software 2.0 (Cochlear, Gothenburg, Swedish) or manually. The patients were followed up for at least six months after surgery.

All evaluations were performed in a sound proof room according to international standards. Pre and postoperative audiological assessments included the evaluations of pure tone, speech audiometry and free field audiometry, and IOI-HA data. The pure tone air conduction and free field audiometric evaluations were performed in the frequency range of 250 to 8000 Hz. The bone conduction evaluations was performed in the frequency range of 500 to 4000 Hz. Speech discrimination was assessed in quiet and noise (Signal to noise ratio: 10 dB) in the free field with BAHA. Free field audiometric evaluation was performed by masking the contralateral ear ; a loudspeaker placed 1 meter in front of the patient presented the tone and speech stimuli.

The Turkish version of International Outcome Inventory for Hearing Aids (IOI-HA) was used for the evaluation of patients' satisfaction[12], which consisted of seven questions measuring the following domains; daily use (USE), benefit (BEN), residual activity limitations (RAL), satisfaction (SAT), residual participation restrictions (RPR), impact on others (IoO) and quality of life (QoL). There were five options in response to each question, the minimum score of each question was one point, maximum was five points. The highest possible score was 35 points whereas the lowest possible score was 7.

Statistical Package for Social Sciences 15 for Windows (SPSS Inc, Chicago, USA) was used for the statistical analysis, and paired-t or Mann Whitney U tests were applied to compare dependent and independent samples, respectively.

Results

Two of 20 patients could not use BAHA due to cosmetic and social reasons, therefore, calculations were made according to remaining 18 patients.

The surgical procedure did not cause any significant changes in the residual air and bone conduction thresholds ($p>0.05$) (Table I and II) . The free field hearing thresholds in all frequencies significantly improved after BAHA application ($p<0.05$) (Table III)

Maximum functional gain was observed at 1000 Hz, minimum functional gain was observed at 250 Hz. The functional gains were 25.83 dB, 28.06 dB, 36.94 dB, 32.22 dB, 30.55 dB, 27.50 dB in the frequency range of 250-6000 Hz, respectively (Table IV). In sound proof and acoustic environments where the signal to noise ratio was 10, speech discrimination scores improved significantly with BAHA ($p<0.05$) (Table V).

The "total" mean IOIHA score with BAHA was 30.44±3.73 (ranged from 22 to 35). Total satisfaction rate with BAHA was 86.97 %. (Table VI).

Discussion

There are a number of methods which have been used for hearing restoration. However, patient compliance is

Table 1. Preop-postop air conduction threshold

Frequencies	Preoperative	Postoperative	P value
	Mean±SD	Mean±SD	
250 Hz	66.67±15.24	64.72±12.89	0.484
500 Hz	64.44±14.94	64.17±14.48	0.918
1000 Hz	62.78±17.25	64.17±14.88	0.692
2000 Hz	63.33±21.21	64.17±18.09	0.839
4000 Hz	72.22±22.57	70.83±24.81	0.745
6000 Hz	80.56±25.55	80.00±25.38	0.894

Table 2. Preop-postop bone conduction threshold

Frequencies	Preoperative	Postoperative	P value
	Mean±SD	Mean±SD	
500 Hz	21.39±14.73	20.56±13.16	0.604
1000 Hz	23.61±16.25	24.44±14.13	0.755
2000 Hz	32.50±19.87	32.78±19.57	0.913
4000 Hz	42.78±28.14	37.78±28.86	0.155

Table 3. Freefield hearing thresholds without and with BAHA

Frequencies	Without BAHA	With BAHA	P value
	Mean±SD	Mean±SD	
250 Hz	56.94	31.11	<0.001
500 Hz	59.17	26.67	<0.001
1000 Hz	60.00	23.05	<0.001
2000 Hz	53.89	21.67	<0.001
4000 Hz	65.83	35.28	<0.001
6000 Hz	69.72	42.22	<0.001

Table 4. Functional gains of BAHA

Frequencies	Functional Gain
	Mean±SD
250 Hz	25.83±11.54
500 Hz	28.06±13.41
1000 Hz	36.94±12.26
2000 Hz	32.22±18.25
4000 Hz	30.55±13.49
6000 Hz	27.50±10.04

also important in addition to achieving audiologically acceptable amplification. Stimulation of the inner ear by-passing the external and middle ear structures is one of the options used in the management of hearing loss, and BAHA is one of the bone anchored hearing aids used for this purpose.

In our study, 10% (2 of 20) of the patients could not use BAHA, and the abutments were removed despite the facts that the patients' were informed preoperatively and also had proper hearing amplifications postoperatively. This negative attitude might be attributable to some phychological factors such as "feeling of disabled" rather than cosmetic and social factors.

It is known that BAHA is a safe procedure in terms of preservation of the residual hearing, because no surgical intervention is made in the external or middle ear. Likewise, none of our patients had a significant change in their hearing thresholds after the operation. Significant improvement in the free field hearing thresholds in all frequencies were observed; and the functional gains were 25.83 dB, 28.06 dB, 36.94 dB, 32.22 dB, 30.55 dB, 27.50 dB in the frequency range of 250-6000 Hz,proved that BAHA is effective fort the hearing amplification of conductive or mixed hearing losses due to COM.

In addition to functional gains, it would also be important to know attitudes of the patients against BAHA in this

Table 5. Unaided and BAHA speech discrimination scores

Speech discrimination	Unaided	BAHA	P value
	Mean±SD	Mean±SD	
quiet (%)	69.11±18.40	80.33±13.16	0.000
Noise S/G: 10 dB (%)	58.22±21.62	64.89±20.83	0.010

Table 6. IOI-HA results

IO-IHA	With BAHA
	n (%)
1. Think about how much you used your present hearing aid(s) over the past two weeks. On an average day, how many hours did you use the hearing aid(s)? (DURATION OF USE)	
(1) none	
(2) less than 1 hours a day	
(3) 1 to 4 hours a day	2 (11.1)
(4) 4 to 8 hours a day	
(5) more than 8 hours a day	16 (88.9)
2. Think about the situation where you most wanted to hear better, before you got your present hearing aid(s). Over the past two weeks, how much has the hearing aid helped in that situation? (BENEFIT)	
(1) Helped not at all	
(2) Helped slightly	
(3) Helped moderately	3 (16.7)
(4) Helped quite a lot	4 (22.2)
(5) Helped very much	11 (61.1)
3 Think again about the situation where you most wanted to hear better. When you use your present hearing aid(s), how much difficulty do you STILL have in that situation? (RESIDUAL LIMITATION IN ACTIVITY)	
(1) Very much difficulty	1 (5.6)
(2) Quite a lot of difficulty	
(3) Moderate difficulty	5 (27.8)
(4) Slight difficulty	9 (50)
(5) No difficulty	3 (16.7)
4. Considering everything, do you think your present hearing aid(s) is worth the trouble? (SATISFACTİON)	
(1) Not at all worth it	
(2) Slightly worth it	
(3) Moderately worth it	1 (5.6)
(4) Quite alot worth it	5 (27.8)
(5) Very much worth it	12 (66.7)
5. Over the past two weeks, with your present hearing aid(s), how much have your hearing difficulties affected the things you can do? (RESIDUAL PARTICIPATION RESTRİCTION)	
(1) Affected very much	
(2) Affected quite a lot	
(3) Affected moderately	4 (22.2)
(4) Affected slightly	7 (38.9)
(5) Affected not at all	7 (38.9)
6. Over the past two weeks, with your present hearing aid(s), how much do you think other people were bothered by your hearing difficulties? (IMPACT ON OTHERS)	
(1) Bothered very much	
(2) Bothered quite a lot	
(3) Bothered moderately	1 (5.6)
(4) Bothered slightly	10 (55.6)
(5) Bothered not at all	7 (38.9)
7. Considering everything, how much has your present hearing aid(s) changed your enjoyment of life? (QUALITY OF LIFE)	
(1)Worse	
(2) No change	
(3) Slightly better	4 (22.2)
(4) Quite a lot better	5 (27.8)
(5) Very much better	9 (50)

country. The mean IOI-HA score was approximately 30 (maximum 35), and total satisfaction rate of the patients was around 87%. In addition, almost 89% of the patients used their device more than 8 hours a day. It was reported previously that BAHA is used more than 8 hours a day similar to the previous studies [13, 14] showing that the long daily use of the device suggested patient satisfaction.

Approximately 22% of our patients benefited from BAHA quite a lot while 61% benefited very much from it, similar to the findings previously [13]. The rate of patients in our study, who answered none to our question about residual limitation in activity was 16.7%. In the study of Maarten et al , the rate of patients who answered the same question about residual limitation in activity was 27.6% in the 18 to 40 years of age; 34.4% in 41 to 60 years of age and 28.2% in the group over 60 years of age [13] which reported relatively higher rates than ours.

It was reported that the rate of very much satisfaction was 72.4% in 18 to 40 years of age, 54.7% in 41 to 60 years of age, and 45.2% over 60 years of age, suggesting that the rate of satisfaction decreases with age [13]. Our study differs from the former study in that the satisfaction level of the patients over 60 years of age was very much although there were only two patients in this category. The rates of other parameters of IOI-HA were similar to the rates reported previously [9,14].

In the study of Badran et al, 7% stated that there were no changes in the quality of life [14]. According to the study of Maarten et al , this rate was 3.4% for patients aged from 18 to 40 years, 1.6% from 41 to 60 years, and 5.1% over 60 years of age [13]. None of the patients in our study stated negative change s in their quality of life, which is better than the reports in the literature. It was reported that the quality of life increased significantly in 71 to 80% of patients after BAHA application for the conductive hearing loss [9,15], which is similar to the rates observed in our patients.

In conclusion, BAHA application possesses almost no risk in terms of loss of the residual hearing; it facilitates hearing amplification significantly in various types of hearing losses. It seems that patient satisfaction rate is high and quality of life is increased with BAHA in our population.

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