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Original Research Article

A comparative study between audiological and speech outcomes of non-implantable wearing options for BAHA in the pediatric population

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ABSTRACT

Background: The aim of the study was to determine the audiological benefit of the current BAHAs sound processor worn on a SoundArc and to compare it to the known Softband in terms of soundField hearing thresholds and speech understanding in patients who have purely conductive, mixed, or SSD hearing loss.
Methods: A cross-sectional study looking at children with conductive, mixed, or SSD hearing loss who are not candidates for middle ear surgery, canalplasty, or standard hearing aids. At the baseline visit, pure-tone audiograms were obtained, including masked/unmasked air- and bone conduction thresholds with speech recognition scores.
Results: After two weeks of using programmed processors with Softband and SoundArc, all children were examined. The threshold for aided pure-tone audiometry was tested twice through each of the two transmission paths. The aided pure-tone audiometry threshold demonstrated a statistically significant improvement in PTA. The mean air-conduction thresholds for frequencies (0.5 to 4 kHz) were 63 dB, while the aided mean thresholds with the device (with Softband and SoundArc) was 35 dB. When compared to the unaided scenario, a statistically significant improvement of 98 percent (SoundArc) to 96 percent (Softband) was found at 65 dBSPL. There were no statistically significant differences between any of the ensembles (p=0.261).
Conclusions: The results of our study suggest that subjects with conductive, mixed, or single-sided deafness hearing loss aided with BAHA sound processor worn on SoundArc or on a Softband can cause a significant improvement in terms of soundfield hearing threshold and speech understanding when compared to unaided conditions.

Keywords: Comparative, Audiological, Speech, Non-implantable, Wearing, BAHA

INTRODUCTION

According to the degree and type of hearing loss, various auditory rehabilitation methods could be utilized, i.e.; conventional hearing aids, bone conduction hearing implants (BCHIs), middle ear implant, and cochlear implant.

Among them, BCHIs is a well-established treatment option for children with conductive or mixed hearing loss (MHL), which could not be corrected with middle ear surgery, canalplasty, or conventional hearing aids.[1] Furthermore, BCHIs is used in individuals with single-sided deafness (SSD) to transmit sound via bone conduction to the contralateral side with normal hearing.[2] The BAHA system uses an Osseo integrated titanium implant to transport sound to the inner ear directly through the skull, bypassing the skin and subcutaneous tissues' impedance.

The device's audiological benefits have been extensively documented, and it is frequently utilized.[3-6] Nonetheless, there are at least two drawbacks: the requirement for surgery and the skin-piercing abutment, which can lead to infections around the implant.[7,8] Several transcutaneous systems, such as the BAHA Attract® (Cochlear Inc., Mölnlycke, Sweden).[12] The Bonebridge system (MED-EL, GmbH, Innsbruck, Austria), the SophonoTM system (Medtronic, Inc., Fridley, Minnesota, USA), or the bone conduction implant (BCI, not yet commercially available), have been developed in response to the latter of these two issues.[13-15] While the skin above the implant in these transcutaneous devices eventually heals ,surgical intervention is still required, particularly in young children, but also in a growing population of older children, adolescents, and even adults. There is a demand for solutions that allow users to profit from the benefits of a BAHS without having to undergo surgery.

There were primarily two nonsurgical options for using BAHAs sound processors until recently: Headbands and Softbands.[16] Headbands are made up of a diadem-like steel spring to which a disc with a BAHS processor connector is attached. Headbands are frequently used for temporary preoperative trials, but they are also occasionally used permanently. Softbands are elastic bands worn around the head and are most frequently used in young children.[16]

There are two major drawbacks to using these non-implantable wearing solutions. The first is skin sound attenuation, which rises with high frequencies and reaches around 15 dB at 3000 Hz.[16] As a result, non-implantable hearing aids are virtually exclusively available to children with normal or near-normal cochlear functioning, such as children with purely conductive hearing loss.

The aesthetic attractiveness is the second disadvantage. The prominence of Headbands and Softbands, in our experience, discourages their use in older children, who become self-conscious, as well as adults.

A new method of wearing BAHS sound processors that does not require surgery has recently become available. It is a flexible titanium bow that goes behind the head instead of around it. A disk supporting the sound processor is mounted to the side of the device, like the Headband and Softband.

From a clinical standpoint, a significant concern in this context is whether adopting the new wearing option compromises the audiologic performance of the BAHS sound processor. This hasn't been investigated yet, as far as we know. With this work, we want to begin to close this gap.

The primary goal of this study was to determine the audiological benefit of a current BAHS sound processor worn on a SoundArc in terms of soundfield hearing thresholds, speech understanding in quiet in children who have purely conductive hearing loss, as this is the group that will most likely benefit from the new option.

The second aim of the study was to compare the audiological benefit with the Softband, as this is the most frequently used solution, which is already available today.

METHODS

A cross sectional study was carried out at King Abdulaziz University Hospital in Jeddah, Saudi Arabia from the period of February 2021 to February 2022. The study was conducted on all the subjects within the age group of 5 to 18 years old with conductive, mixed or Single Sided

Deafness hearing loss who are not candidates for middle ear surgery, canalplasty, or standard hearing aids that were reported to the Otorhinolaryngology or Audiology clinic. The patients with air bone gap hearing loss more than 20 dBnHL were not included in the study. Statistical analyses were performed using the SPSS software version 25 (IBM Corp., Armonk, NY, USA). p value<0.05 were considered to indicate statistical significance. Descriptive statistics (median, mean, and standard deviation) were calculated for all variables.

All the subjects' guardians had given their informed consent prior to inclusion in the study. At the baseline visit, pure-tone audiograms, including masked/unmasked air- and bone conduction thresholds with speech recognition scores were obtained. After a two-week experiment, each patient had an aided free field hearing threshold measurement with a BAHA sound processor on the Softband and SoundArc. Subjects were seated 1 meter away from a loudspeaker positioned at 0° azimuth in a sound-treated room.

Unrestricted area at the frequency range 250-4000 Hz in octave intervals, warble tone thresholds were computed using the BAHA processor using the behavioral map and loudness level that would be utilized in speech perception testing. An Interacoustic audiometer (Clinical audiometer AC40) that has been calibrated to acceptable standards produced these clear tones (ANSI 1969). Thresholds were measured in 5-dB increments using a regular clinical modified method of limits, in which subjects were asked to identify hearing a sound by clicking a button, raising a hand, or, in the case of younger children, by conditioned play audiometry.

A speech discrimination test of monosyllabic words was conducted in a quiet setting with low distractions for subjects utilizing devices based on behavioral maps. Before continuing, the patient should first understand the instructions (often with the use of visual clues). A list of monosyllabic words was shown to the patients, who were asked to discriminate and repeat the words.

After that, it was proceeded with a list of 25 words. Correct and erroneous responses were given 1 and 0 points, respectively. The right response is the correct repeat of the term. The percent of correct responses is computed by multiplying the number of correct responses by the total number of stimuli recorded on the assessment sheet.

RESULTS

In this study, hearing performance outcomes, and patient satisfaction ratings in 32 pediatric patients with conductive, mixed, and SSD hearing loss were assessed which showed that the mean age of the participants was 12.13±3.95 with an age ranging from 7 to 18 years. Three quarters (75%) were males; the most common cause of hearing loss was microtia (62%). Sixteen of the patients had MHL, twelve had CHL, and four patients with (SSD). Twelve patients used the processor on the right side, eight patients on the left side, and twelve patients received bilateral processors.

After two weeks of using programmed processors with Softband and SoundArc, all children were examined. The threshold for aided pure-tone audiometry was tested twice through each of the two transmission paths: first with the BAHA Softband and again with the SoundArc. When compared to the unaided condition, the aided pure-tone audiometry threshold demonstrated a statistically significant improvement in PTA (mean of 500, 1,000, 2,000, and 4,000 Hz). The mean air-conduction thresholds for frequencies (0.5 to 4 kHz) were 63 dB unaided with BAHA (Table 2). Table 3 shows the aided with BAHA mean thresholds with the device (with Softband and SoundArc) as a frequency-specific threshold was 35 dB. At all frequencies (p=0.05), there was no statistically significant difference between the two wearing options (Softband or SoundArc). Before BAHA, the average SDS was 63.25±11.86. When compared to the unaided scenario, statistically extremely significant improvements of 98 percent (SoundArc) to 96 percent (Softband) are found at 65 dBSPL. There were no statistically significant differences between any of the outfits (p=0.261).

Table 1: Distribution of the demographic data and clinical characteristics of the studied cases (n=32).

Characters	N	%
Gender		
Male	24	75
Female	8	25
Age (years) mean±SD	12.13±3.95	
Cause		
SSD	4	12.5
Microtia	20	62.5
Chronic ear discharge	8	25.0
Side		
Right	12	37.5
Left	8	25.0
Bilateral	12	37.5
Type of hearing		
Mixed	16	50.0
Conductive	12	37.5
Sensorineural	4	12.5

Table 2: Mean and SD of unaided at different values of frequencies.

Unaided	Mean±SD	Median
250	68.13±28.86	75.0
500	65.63±33.21	65.0
1000	60.0±29.10	65.0
2000	63.13±30.98	65.0
4000	60.0±29.66	65.0
Total	63.38±29.80	67.50

Table 3: Difference between aided Softband and SoundArc.

Differences	Aided with Softband (n=32)	Aided with SoundArc (n=32)	Paired t-test	P value
250				
Min-max	15.0-55.0	20.0-55.0	0.808	0.432
Mean±SD	40.0±12.65	38.75±12.58		
500				
Min-max	15.0-45.0	10.0-40.0	1.000	0.333
Mean±SD	33.13±8.92	31.88±8.92		
1000				
Min-max	15.0-40.0	10.0-50.0	1.000	0.333
Mean±SD	28.75±8.06	30.0±11.25		
2000				
Min-max	15.0-40.0	20.0-50.0	0.808	0.432
Mean±SD	31.25±8.85	32.50±10.0		
4000				
Min-max	15.0-80.0	10.0-70.0	1.031	0.319
Mean±SD	44.38±19.05	42.50±17.32		
Total	35.50±13.26	35.13±12.95		

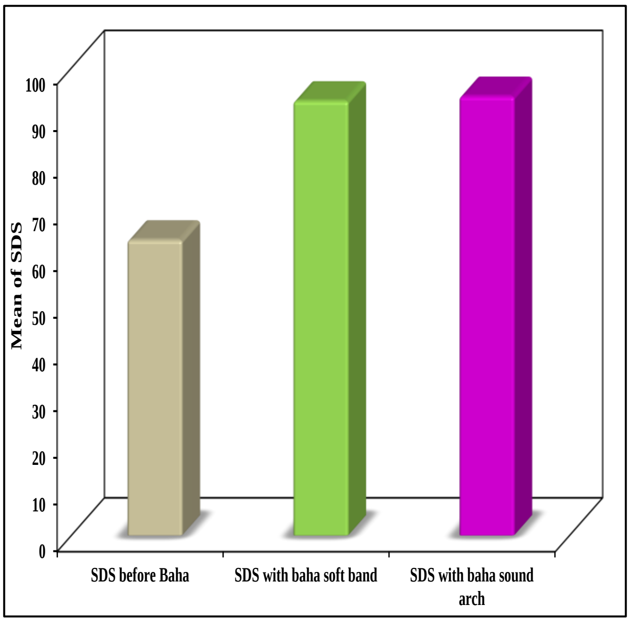

Figure 1: Comparing the standard deviation of the results.

DISCUSSION

Due to the recent development and use of many types of bone conduction hearing aids, a comparative evaluation of the numerous non-surgical solutions is necessary. The right selection of devices, considering the child's hearing level/type, characteristics, and personal demands are essential for successful auditory rehabilitation. The authors of this study compared the audiological and speech outcomes and attempted to link them to the compliance of the various types of non-surgical BAHAs sound processor alternatives. When compared to unaided hearing, the results of the study showed statistically significant improvements in hearing performance. SoundArc and Softband have no statistically significant differences. No processors have been removed, indicating that the device is effective for the medical/audiological indications examined.

Hearing threshold measurements in the free field with a device show significant improvement at all frequencies. The most significant improvement is in the essential speech frequency. The performance diminishes gradually around 4,000 Hz, as expected, due to soft tissue attenuation, which is known to primarily influence high frequencies, according to the literature.[12,16] It is expected that boosting the gain at high frequencies in the programming software will increase aided high-frequency thresholds. When we compared the SDS with and without the device, we found that the gadget resulted in a statistically significant improvement. There was no discernible difference between the BAHA Headband and the BAHA test band. The same was observed in previous studies.[17]

Upon conducting a literature review we have found an article under the title of "Speech understanding and sound localization with a new non-implantable wearing option for BAHA" that has parallel results in which the subjects using BAHAs with a SoundArc have a significant improvement in hearing performance and speech understanding compared to unaided conditions. As well as no significant differences between BAHA SoundArc and Softband.[18]

The study limitation were that the results were presented from a single institution in Jeddah, and the results cannot be generalized. Nevertheless, this research provides data about the audiological and speech outcomes of non-implantable wearing options for BAHA in the pediatric population in Saudi Arabia.

CONCLUSION

All patients were assessed after two weeks of utilizing programmed processors with Softband and SoundArc. The threshold for aided pure-tone audiometry was tested twice, once with the BAHA Softband and once with the SoundArc, through each of the two transmission channels. The aided pure-tone audiometry threshold showed a statistically significant reduction in PTA, and the mean air-conduction thresholds for frequencies (0.5 to 4 kHz) were 63 dB unaided with BAHA, compared to 35 dB aided with the device (Softband and SoundArc). There was no statistically significant difference between the two wearing alternatives (Softband vs. SoundArc). The average SDS before BAHA was 63.25±11.86. At 65 dBSPL, statistically significant improvements of 98 percent (SoundArc) to 96 percent (Softband) were obtained when compared to the unaided condition. No statistically significant differences were found between any of the ensembles (p=0.261).

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Ethical approval: The study was approved by the Institutional Ethics Committee

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