BRIEF COMMUNICATION

Audiologic and Subjective Evaluation of Baha® Attract Device

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Abstract We included 9 patients implanted with Baha® Attract. All our patients were evaluated by free field tonal audiometry, free field verbal audiometry and free field verbal audiometry with background noise, all the tests were performed with and without the device. To evaluate the subjective component of the implantation, we used the Glasgow Benefit Inventory (GBI) and Abbreviated Profile of Hearing Aid Benefit (APHAB).

The auditory assessment with the device showed average auditory thresholds of 35.8 dB with improvements of 25.8 dB over the previous situation. Speech reception thresholds were 37 dB with Baha® Attract, showing improvements of 23 dB. Maximum discrimination thresholds showed an average gain of 60 dB with the device.

Baha® Attract achieves auditory improvements in patients for whom it is correctly indicated, with a consequent positive subjective evaluation. This study shows the attenuation effect in transcutaneous transmission, that prevents the device achieving greater improvements.

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PALABRAS CLAVE
Hipoacusia de transmisión; Ayudas auditivas; Transmisión ósea; Osteointegración; Audiometría

Valoración audiológica y subjetiva del dispositivo Baha® Attract

Resumen Se incluyeron en el estudio 9 pacientes implantados con el dispositivo Baha® Attract. A todos los pacientes se les realizó, con y sin el dispositivo, una audiometría tonal en campo libre, una audiometría verbal en campo libre, y una audiometría verbal con ruido de fondo, así como la aplicación de los cuestionarios Glasgow Benefit Inventory (GBI) y Abbreviated Profile of Hearing Aid Benefit (APHAB).


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Las valoraciones audiológicas con el dispositivo mostraron unos umbrales auditivos promedios de 35,8 dB, con ganancias medias de 25,8 dB. El umbral de recepción verbal promedio con el dispositivo se situó en 37 dB, mostrando una ganancia de 23 dB. Los resultados promedio del umbral de discriminación máxima fueron de 60 dB con el dispositivo.

El Baha® Attract logra alcanzar unas ganancias auditivas en los pacientes indicados correctamente, con una consiguiente valoración subjetiva positiva por parte de los pacientes, presentando no obstante un efecto atenuativo en su transmisión transcutánea, que le impide alcanzar mayores ganancias.

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Introduction

Osseointegrated hearing devices can be divided into two large groups: percutaneous and bone conduction through the skin, which in turn are divided into active and passive. The latter group includes the Baha® Attract (Bone Anchored Solutions AB, Cochlear Ltd., Göteborg, Sweden). In these types of devices the stimulus is transmitted through a system of magnetic couplings placed either side of the skin, one of which is anchored to the skull surface via an osseointegrated implant at the level of the temporal bone and the other on the skin of the same region to which the sound processor is connected. The soft tissue between each magnet has an attenuating effect on the sound signal that varies according to the thickness, width and characteristics of this tissue. This attenuation of the signal should limit the indications for Baha® Attract compared to its percutaneous counterpart. The Baha® Attract devices have more limited indications for conductive hearing loss (CHL) with bone conductions of up to 25–30 dB and single sided deafness (SSD). This system has less aesthetic impact than the percutaneous systems, the implant does not protrude through the scalp. The surgical procedure for placing the osseointegrated implant is very similar to that of its percutaneous counterpart, and similarly there are numerous variations in technique. The subcutaneous site where the osseointegrated implant and the subcutaneous magnetic coupling are to be placed is marked, and anterior to or posterior to this mark a C or S incision is made of the longitudinal length of the magnet. Along this incision, which should reach the periosteum in depth, a flap is made which should occasionally be honed in thickness to reduce any impedance that the tissue might cause between each of the system’s magnets. The implant is then placed on the marked area removing the periosteum, and then it is joined to the magnet.

Methods

We present a series of cases attended between 1 January 2014 and 30 November 2014 in our centre, where elective surgery for implantation of the Baha® Attract device was indicated and performed in 9 patients.

Figure 1 Graphic average audiometric results obtained by free field tonal audiometry. Baha: free field results with the device after correcting incidents; BC Direct: bone conduction via the Baha® Attract; AC: air conduction after fitting; BC: bone conduction after fitting.

The inclusion criteria for this study were that the patients should be over the age of 18 years, with a diagnosis of CHL – a bone conduction threshold lower than 30 dB was accepted as the limit—they had to have agreed to the surgical intervention and to be fitted with this hearing device.

All the patients were implanted, following the manufacturers’ recommendations; with the same type of osseointegrated implant, the same magnetic coupling system, and the same type of processor, the Baha® 3 BP100.

The patients were asked to complete two questionnaires, the Glasgow Benefit Inventory (GBI) and the Abbreviated Profile of Hearing Aid Benefit (APHAB) (Figs. 2 and 3), so that we could assess their subjective evaluation of their hearing device fitting and the beneficial effect of the intervention on their quality of life.

All the participants underwent hearing screening without the Baha® Attract, comprising pure tone audiometry (PTA), free-field PTA (FF), and verbal audiometry (VA); with
contralateral masking when appropriate. Subsequently, once the device had been implanted and after the initial programming was made, the same hearing tests were repeated, between 3 and 6 months after fitting the device.

At a second session, having assessed the initial results and made corrections where necessary, which we shall outline later, a second set of results was taken.

Finally VA was performed with background noise, following a signal-to-noise ratio (SNR) of SNR = 5 dB (the 5 dB signal less intense than the noise); of SNR = 0 dB (signal and noise at the same intensity); and of SNR = 10 dB (10 dB signal more intense than the noise). The background noise was always constant in this procedure: 65 dB.

The pure tone averages (PTA) for bone-conduction (BC) were 21.56 dB. The PTA for the free-field pure tone audiometry for air conduction was 61.6 dB.

In the initial phases, the PTA were obtained with the device in operation, measured by FF PTA with contralateral masking, and these were 47.6 dB, obtaining average gains of 14 dB with respect to free field without the device.

Once the incidents, which we shall mention later, were corrected and further programming made, the hearing thresholds of the operated ear were measured for a second time with the device. The second measurements obtained PTA for the FF PTA with the device in operation of 35.8 dB, substantially improving the results prior to the adjustments and programming, and average gains were obtained of 25.8 dB (Table 1 and Fig. 1).

With regard to our patients’ degree of speech intelligibility assessed by VA, the mean speech reception threshold

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**Figure 2** Absolute benefit in the Glasgow Benefit Inventory (GBI) with the Baha® Attract.

**Figure 3** Results in the Abbreviated Profile of Hearing Aid Benefit (APHAB) pre and post fitting with Baha® Attract. **AV**: aversion; **FC**: ease of communication; **BN**: background noise; **RV**: reverberation.

**Table 1** Average Numerical Audiometric Results Obtained by Free Field Tonal Audiometry.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>AC</th>
<th>BC</th>
<th>Baha</th>
<th>Gain</th>
<th>BC Direct</th>
<th>Baha Post</th>
<th>Gain*</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 Hz</td>
<td>58</td>
<td>14</td>
<td>48</td>
<td>10</td>
<td>16</td>
<td>37</td>
<td>21</td>
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<tr>
<td>500 Hz</td>
<td>60</td>
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<td>44</td>
<td>16</td>
<td>25</td>
<td>32</td>
<td>28</td>
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<tr>
<td>1000 Hz</td>
<td>64</td>
<td>22</td>
<td>43</td>
<td>21</td>
<td>24</td>
<td>30</td>
<td>34</td>
</tr>
<tr>
<td>2000 Hz</td>
<td>60</td>
<td>28</td>
<td>48</td>
<td>12</td>
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<td>35</td>
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<td>4000 Hz</td>
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<td>11</td>
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<td>ATT</td>
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<td>21.4</td>
<td>47.6</td>
<td>14</td>
<td>28</td>
<td>35.8</td>
<td>25.8</td>
</tr>
</tbody>
</table>

Baha: free-field results with the device; Baha Post: free-field results with the device after correction of incidents; **BC Direct**: bone conduction through the Baha® Attract; **Gain**: air conduction hearing gain of the device; **Gain***: hearing gain of the device after correction of air conduction incidents; **ATT**: average tonal thresholds; **AC**: air conduction after fitting; **BC**: bone conduction after fitting.

Values are expressed in decibels (dB).
(SRT) was 60 dB without the device and 37 dB with the Baha® Attract. With regard to the maximum discrimination threshold, the average results were 80 dB without the device, and 60 dB with the device.

Finally, with regard to VA with background noise, 45% of the verbal list was answered correctly for SNR -5 dB, 76% for SNR +0 dB and 91% for SNR +10 dB.

Seventy percent of the patients reported pain, stinging and itchingness in the area of the magnetic coupling in the first weeks after the surgical procedure. These were the only complications in our series of patients. These incidents disappeared in all the patients over a period of 2–8 weeks.

Discussion

In our study, once the hearing results had been obtained after the first programming, an average tonal gain of 14 dB was observed; lower than expected during the study design, since we started from an average air-bone gap of 40 dB. It was observed that the patients with moderate CHL, and therefore lower gaps, achieved better results, their tonal threshold with the device being closer to their bone conduction, while the patients with more severe CHL, and larger gaps, achieved lower gains.

Although it is true that in our paper we did not record the functional hearing status of the contralateral ear, we believe that this does not affect the outcomes since all the tests were performed with masking. We believe that this possibly confusing effect is mitigated, since we were chiefly interested in performing a monaural assessment of the device.

Possible incidents in undertaking and designing the study were assessed. It was concluded that the results obtained, lower than expected, might have been because the hearing assessment was performed early, since most of the patients had only been programmed 2 or 3 times and at very early stages. Therefore the processor might possibly not have reached its maximum performance and the patient might not have completely adapted to the device. Moreover, it was probable that the wrong type of processor had been selected for cases with severe CHL and with a larger gap, since according to the outcomes achieved, the BP100 processor was not powerful enough to reach the predicted thresholds, and the poorest outcomes were achieved in these cases.

The final outcomes obtained in our study showed gains both in hearing thresholds and in assessment of speech intelligibility, coinciding with other similar studies on the same device and other passive transcutaneous osseointegrated implants.3–7 Comparing studies on the same device, the outcomes of different studies such as those of Briggs et al.,5 show similar results to ours, in terms of assessment of the device by FF PTA. Our results after successive programming were slightly better, even so, both studies coincide in the conversational frequencies (500–3000 Hz) both showing gains close to 25 dB. Our initial outcomes can be compared to those of the study by Iseri et al.,7 the first study performed with this device. Their study’s and our initial outcomes showed similar hearing gains, around 19 dB, which could probably have been improved due to the need for successive programming and readjustments, as we demonstrate in our study.

Once the incidents had been identified, we attempted to resolve them as follows. First the patients were reassessed after a greater number of programming sessions, the FF PTA thresholds were repeated with contralateral masking, with and without the Baha® Attract device, obtaining results closer to those expected. Secondly, the BP100 processor was replaced with the BP110 or Power device in 2 patients who showed no or very low hearing gains. These devices have a more powerful output signal, obtaining hearing thresholds that were closer to their PTA bone conduction threshold.

The incidents that occurred in our study could be extrapolated to other passive transcutaneous models, due to their similarity in terms of mode of action, indications and outcomes.9

Although we did not make a comparison with percutaneous models, our experience and different studies10–12 suggest that the percutaneous devices achieve greater gains both in tonal thresholds and in speech intelligibility assessed by VA. This is possible due to their avoiding the attenuation effect of the signal caused by the soft tissue between the two components of the magnetic coupling system, which causes more marked reduction in transmission at higher frequencies. We believe that some of our cases required a more powerful processor because of this attenuating effect.

Conflict of Interests

The authors have no conflict of interest to declare.

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References