ORIGINAL ARTICLE

Quality of Life in Patients Implanted With the BAHA Device Depending on the Aetiology

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KEYWORDS
Bone anchored hearing aid; Quality of life; Aetiology; Conductive hearing loss; Unilateral deafness; Tinnitus

Abstract
Introduction and objectives: To assess the improvement of quality of life in osseointegrated implanted patients, taking into account the indication as well as the use of the implant, and the presence of pre- and postoperative tinnitus.

Methods: Sixty-nine patients implanted between June 2004 and November 2010 were included. The average age of the patients was 40 years. The instruments used to quantify the change in quality of life were the Glasgow Benefit Inventory and a questionnaire including open questions, bone anchored hearing aid (BAHA) use, change in tinnitus and postoperative pain.

Results: The average total benefit score with the Glasgow Benefit Inventory was 38, and the general, social, and physical scores were 51, 15 and 7, respectively. There was no significant association between sex, age and bilaterality or unilaterality of the process with quality of life. Nevertheless, there were significantly better results in patients with conductive hearing loss than in those with unilateral deafness, and the results were positive although in both groups. The tinnitus rate went from 37.5 to 20.8% following BAHA, with this difference being significant.

Conclusions: Our results show that the use of BAHA is associated with a great improvement in quality of life for patients with conductive hearing loss, whereas indications in unilateral deafness have to be individually studied. Moreover, the study shows that BAHA has a positive effect upon tinnitus.

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CALIDAD DE VIDA DE PACIENTES IMPANTADOS CON EL DISPOSITIVO BAHA SEGÚN SU INDICACIÓN

Calidad de vida de pacientes implantados con el dispositivo BAHA según su indicación

Resumen
Introducción y objetivos: Cuantificar la mejoria en la calidad de vida en los pacientes osteointegrados, teniendo en consideración tanto la indicación del implant e como su uso y la presencia de acúfenos.

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Métodos: Este estudio incluye a 69 pacientes implantados entre junio de 2004 y noviembre de 2010. La edad media de los pacientes fue de 40 años. El instrumento empleado para la medición de la calidad de vida fue el Glasgow Benefit Inventory (GBI) y un cuestionario con preguntas abiertas, uso del BAHA, modificación del acúfenos y presencia o no de dolor.

Resultados: La puntuación media del GBI total fue de 38, y en las subescalas general, social y física: 51, 15 y 7 respectivamente. La media de horas al día de utilización fue de 11. No se encontró relación significativa entre el sexo, edad y bilateralidad o unilateralidad del proceso con la calidad de vida. En cambio se observaron diferencias significativas entre los pacientes con hipoacusia transmisiva y con cofosis unilateral, si bien en ambos grupos los resultados fueron positivos. La presencia de acúfenos disminuyó de un 37,5 a un 20,8%, siendo esta diferencia estadísticamente significativa.

Conclusiones: Nuestros resultados muestran que el uso del BAHA se asocia a una clara mejoria en la calidad de vida de los pacientes, menor en cofosis unilaterales, siendo necesario individualizar su indicación en este grupo. Asimismo muestran que el uso del BAHA tiene un efecto beneficioso sobre el acúfenos.

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Introduction and Objectives

The BAHA, bone anchored hearing aid, is an implantable osseointegrated device whose objective is to stimulate the cochlea by bone conduction. To install it, the small titanium implant is placed in the temporal bone, behind the ear lobe. The implant integrates with the bone and provides better audition, speech intelligibility in silence and in noise, sound quality and comfort than conventional bone conduction devices.1

The BAHA was originally designed to treat conductive hearing losses due to chronic otitis refractory to treatment with conventional hearing aids or to malformations of the middle or outer ear,2,3 not requiring the integrity of the ossicular chain.

Its indications have recently been extended to unilateral hearing impairment.4,5 These patients, in addition to hearing problems on the deaf side, often report difficulties in speech intelligibility in noise and in locating sounds.6 The BAHA avoids the shadow effect of the head, by catching the sound on the deaf side and conducting it by bone to the hearing side. In this way, the patients with implants perceive, in their healthy cochlea, 2 different auditory signals that simulate the physiological interaural difference.

Besides the fact that placement of the BAHA requires a surgical procedure and involves an economic cost for the system, various studies have revealed that interventions designed to improve hearing do not show any significant relationship between audiological results and quality of life results that would be expected. For this reason, such quality of life results are becoming more and more important.

The objectives of this study were to assess whether the BAHA improved the patients’ quality of life, if there were variations in the results depending on the indication for the BAHA or the hearing loss aetiology, and whether the use of the BAHA modified preoperative tinnitus.

Methods

The study covered 69 patients implanted between June 2004 and February 2011 in our centre. Of these, 58% were female and the mean age was 39.7±23 years, with a range from 8 to 76 years. Distributing the patients by age groups, 31% were younger than 30 years old; 41% were between 30 and 60; and 27% were older than 60 years old. The means for air and bone conduction for 500, 1000 and 2000 Hz frequencies are shown in Fig. 1.

Two of the patients, both for bilateral atresia of the external auditory canal, received bilateral implants.

The aetiology of the hearing losses is shown in Table 1. The instrument used to measure quality of life was the Glasgow Benefit Inventory (GBI), a specific questionnaire oriented towards the patient, designed to evaluate changes in post-surgical health. It consists of 18 questions that measure health changes in 3 fields (general, social and physical health), consequently having 3 subscales. Of the 18 questions, 12 are related to general health, 3 with physical and 3 with social health.

Each question has a score that ranges from 1 to 5 (1 being the worst result possible and 5 being the best, while 3 indicates lack of changes). The total score can therefore range between 18 and 90 points, although the numerical result is transformed into an average (that goes from −100 to +100). This makes it possible to compare results between

![Figure 1](https://example.com/figure1.png) Air and bone pathway means for 500, 1000 and 2000 Hz.
subgroups, as well as with other otorhinolaryngology procedures evaluated with the same scale. Positive scores, consequently, correspond to a response average greater than 3.

A questionnaire with 2 open questions was also used: ’’What is it that you like best about the BAHA?’’ and ’’What is it that you like least about the BAHA?’’. In addition, the patients were asked about their BAHA use (hours/day and days/week), pain with the BAHA (yes/no/sometimes) and whether they would recommend it to another person (yes/no).

The evaluation of postoperative tinnitus was carried out by a standard tinnitus questionnaire with 6 possible answers: I have never had tinnitus; the tinnitus disappeared after surgery; the tinnitus improved after surgery; tinnitus appeared after surgery; the tinnitus became worse after surgery; and the tinnitus was not modified by surgery.

Quantitative data were described by mean±standard deviation, and the qualitative data by frequencies and percentages.

Different groups (based on indication, age, sex, presence of tinnitus, pain and use) were compared on the scale for improvement in quality of life and its subscale using the Mann–Whitney U method. The role of hours of use (<8 h, >8 h) as a factor for confusion was analysed using the Chi-squared test.

All the statistical tests were considered bilateral and values were considered significant with a P=0.05. We used the programme SAS® 9.1 (SAS Institute) for the statistical analysis of the data.

### Results

Of the 69 patients implanted in our service and included in the study, 54 replied to the questionnaire (78%). The mean score on the general GBI scale was 38, while the scores on the general, social and physical subscales were 51, 15 and 7 respectively. The results of the general GBI and those based on hearing loss aetiology are summarised in Table 2.

The mean hours of BAHA use was 11 h, with 2 tendencies being observed in these patients: 72% of them used the device daily, with at least 8 h of use throughout the day; on the other hand, 28% had more erratic use, with less than 8 h a day on alternate days.

In response to the question on the presence of postoperative pain (of whatever degree), 22% answered affirmatively. Of these, only 1 patient reported pain, while the rest indicated slight discomfort.

From the 54 patients questioned, 22 presented tinnitus before surgery (41%) and 13 after surgery (24%), this difference being statistically significant (P=0.0022). Of these 22 patients, for 11 (50%), the tinnitus totally disappeared; for 3 (14%), it improved; and for 8 (36%), it continued the same. However, in 2 of the 32 patients that did not initially present tinnitus (6%), it appeared following the implantation of the BAHA.

### Table 1 Number of Patients by Aetiology.

<table>
<thead>
<tr>
<th>CHL or MHL</th>
<th>No. of patients</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHL or MHL</td>
<td>58</td>
<td>84</td>
</tr>
<tr>
<td>COM</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>Cholesteatotum COM</td>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td>Malformation</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>Surgery (paraganglioma)</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Otosclerosis</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Unilateral hearing loss</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery (neurinoma)</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Unknown</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Sudden deafness</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Degenerative cochlear pathology</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Traumatism</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>69</td>
<td>100</td>
</tr>
</tbody>
</table>

CHL, conduction hearing loss; COM, chronic otitis media; MHL, mixed hearing loss.

### Table 2 Glasgow Benefit Inventory Results in the Various Subscales for Each Aetiology.

<table>
<thead>
<tr>
<th>CHL or MHL</th>
<th>No.</th>
<th>Total score</th>
<th>General subscale</th>
<th>Social subscale</th>
<th>Physical subscale</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHL or MHL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM</td>
<td>17</td>
<td>47</td>
<td>63</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Cholesteatotum COM</td>
<td>15</td>
<td>32</td>
<td>43</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Malformation</td>
<td>10</td>
<td>41</td>
<td>55</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Surgery (paraganglioma)</td>
<td>2</td>
<td>44</td>
<td>53</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>Otosclerosis</td>
<td>1</td>
<td>44</td>
<td>75</td>
<td>0</td>
<td>−33</td>
</tr>
<tr>
<td>Subtotal</td>
<td>45</td>
<td>43</td>
<td>54</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Unilateral hearing loss</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery (neurinoma)</td>
<td>3</td>
<td>28</td>
<td>34</td>
<td>27</td>
<td>6</td>
</tr>
<tr>
<td>Unknown</td>
<td>2</td>
<td>22</td>
<td>27</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>Sudden deafness</td>
<td>2</td>
<td>30</td>
<td>42</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Degenerative cochlear pathology</td>
<td>2</td>
<td>18</td>
<td>27</td>
<td>16</td>
<td>−16</td>
</tr>
<tr>
<td>Traumatism</td>
<td>1</td>
<td>16</td>
<td>29</td>
<td>0</td>
<td>−16</td>
</tr>
<tr>
<td>Subtotal</td>
<td>10</td>
<td>24</td>
<td>32</td>
<td>18</td>
<td>−1</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>40</td>
<td>50</td>
<td>16</td>
<td>7</td>
</tr>
</tbody>
</table>

CHL, conduction hearing loss; COM, chronic otitis media; MHL, mixed hearing loss.
All of the 54 patients questioned would recommend the BAHA to other people. In answer to the question on what they liked about the BAHA, in first place (3%) was the possibility of hearing, followed by the improvement in communicating with other people (15%); while what was least pleasing was the noise or whistle that the device emitted (18%) and its excessive size (16%).

We did not find statistically significant differences in the GBI between the 2 sexes, except in the general subscale, in favour of the women (P=.057). Likewise, there were no differences among the 3 age subgroups (>30, 30–60, and >60 years) except for significantly better results in the social subscale for the youngest patients (P=.023).

In the different aetiologies, we did not observe significant differences in quality of life between them. However, when we compared the subgroup of patients implanted for conduction or mixed hearing loss with that of unilateral hearing loss, there were differences in both the total score (P=.016) and in the general subscale (P=.009), as is shown in Table 3.

Comparing the patients with unilateral hearing loss with those of bilateral did not yield any significant differences in quality of life or use. However, we did find a lower use in patients with 1 healthy ear.

**Discussion**

Our results clearly show that BAHA use is related to an improvement in quality of life, as is also noted in other studies.8-13

The mean total score in our study was 38, close to the results obtained in a similar study by Arunachalam et al.,9 in the 3 subscales. It is notable that the results are better in the general subscale than in the social and physical subscales in all the subgroups studied, being comparable to the results obtained by McLarnon.14

The favourable results obtained for the use of the BAHA, with 100% of the patients using the BAHA at least 6 h/day (mean: 11.8), are also comparable with those obtained by other authors. In addition, the fact that all of the patients would recommend using the BAHA to other people is very significant.

In general, no differences in quality of life were observed between sexes or age groups. The better results in the general subscale in women with respect to men are difficult to explain. The better results of the younger patients in the social subscale could be due to the social stigma involved with hearing loss, especially in adolescence and early adult years, presenting a clear improvement with respect to social relationships, in contrast to the elderly that have a more settled social life.

The presence of significant differences in the results for quality of life based on indication for the BAHA is explained by the fact that the way the BAHA works in these patients is very different. While the initial objective of the BAHA was to improve audition in patients conduction and mixed hearing losses, in patients with unilateral hearing loss what was sought was avoiding the head shadow effect and improving intelligibility, their auditory thresholds being similar. These results coincide with those obtained by Saroul et al.15 and Tringali et al.16 Nevertheless, the results are equally positive in this subgroup, demonstrating its usefulness, as Wazen et al.17 pointed out in their study.

In contrast, we did not find differences in quality of life between patients with bilateral and unilateral impairment, whatever the cause was. However, the bilateral patients used the device more regularly.

It should be pointed out that we did indeed find a significant difference between the patients that had tinnitus before and after surgery (41% and 24%; P=.05). This would be positively related to the data provided by the 2002 Holgers and Hakansson18 study. In it, based on masking therapy for patients with tinnitus, the possible benefit of a bone conduction sound stimulator was assessed for these patients. To do so, a bone conduction sound stimulator was placed in 8 patients previously implanted with a BAHA and who reported different degrees of tinnitus; afterwards, the researchers assessed the frequency of the patient’s tinnitus and the minimum decibels to achieve the masking through both bone and air conduction. Likewise, they carried out a subjective assessment of the improvement related to the use of the bone sound stimulator. The study concluded that the sound transmitted through the bone had the same potential for masking tinnitus as the sound transmitted through air. It also concluded that, in patients with conduction or mixed hearing loss, a mechanism to amplify the sound was needed in addition to the masking sound stimulus, which indicated that

**Table 3** Statistical Variations in Total Score and Subscales on the Glasgow Benefit Inventory Between the Conduction or Mixed Hearing Loss Subgroups VS Unilateral Hearing Loss.

<table>
<thead>
<tr>
<th></th>
<th>CHL or MHL</th>
<th>Unilateral hearing loss</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total score</td>
<td>40.7±18.6</td>
<td>24.1±17.7</td>
<td>.016</td>
</tr>
<tr>
<td>General subscale</td>
<td>55.2±25.1</td>
<td>32.3±22.1</td>
<td>.009</td>
</tr>
<tr>
<td>Social subscale</td>
<td>14±23.5</td>
<td>18.2±22.8</td>
<td>.489</td>
</tr>
<tr>
<td>Physical subscale</td>
<td>9.3±25.4</td>
<td>–1.6±14.4</td>
<td>.386</td>
</tr>
<tr>
<td>Percent greater than 8 h of use</td>
<td>77.3</td>
<td>50</td>
<td>.119</td>
</tr>
</tbody>
</table>

CHL, conduction hearing loss; MHL, mixed hearing loss.
a sound generator connected to the BAHA could be beneficial for some patients that already have it.

Conclusions

For the patients for whom the objective of therapeutic procedures is not to improve survival, as is the case of patients who receive operations to provide them with better hearing, the results in quality of life become essential, especially given that various studies have revealed that there is no significant relationship between audiological results and results of quality of life as would be expected.19,20 This fact emphasises the need to perform an evaluation not only of objective hearing measurements, but also of the quality of life perceived by the patient by means of questionnaires designed for this purpose. Our study shows a significant improvement in the quality of life of the patients that received a BAHA, information that is very useful when it is time to give preoperative advice to patients in daily clinical practice. Nonetheless, the indication for patients with unilateral impairment will have to be handled individually, with detailed information on the expectations.

Conflict of Interests

The authors have no conflicts of interest to declare.

References