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ANTERIOR COURSE OF THE SIGMOID SINUS AND USE OF A LIFT WITH THE BONEBRIDGE IMPLANT: CASE REPORT

Contributions:
A Study design/planning
B Data collection/entry
C Data analysis/statistics
D Data interpretation
E Preparation of manuscript
F Literature analysis/search
G Funds collection

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Abstract

Background: The Bonebridge bone conduction implant (BCI) is used in cases of conductive, mixed hearing loss and single-sided deafness. The system can be implanted in the mastoid process pre- or retrosigmoidally. Presigmoid placement tends to reduce the number of subsequent implantations. The use of new refinements – such as spacers called BCI lifts, which facilitate adjustment during surgery – broadens the applicability of Bonebridge to a larger group of patients.

Case report: This case study presents a 58-year-old female patient with bilateral chronic otitis media who had undergone several operations in the past and who qualified for a Bonebridge implant. During surgery, a lift for the lower screw of the bone-conduction floating mass transducer (BC-FMT) was used because of an anterior course of the sigmoid sinus. We analysed hearing results before and 3 months after the surgery. The results indicated stable bone conduction thresholds and improved hearing and speech recognition after implantation.

Conclusions: The Bonebridge system is an effective treatment for hearing loss caused by chronic otitis media in cases where classic otosurgery cannot be performed. Difficult conditions during surgery, as caused by an anterior sigmoid sinus, can limit the use of the Bonebridge. In such cases use of a lift can widen implantation options.

Key words: Bonebridge • bone conduction implant • anterior sigmoid sinus • BCI lifts

CURSO ANTERIOR DEL SENO SIGMOIDEO Y USO DE UN ELEVADOR (LIFT) CON EL IMPLANTE BONEBRIDGE: ESTUDIO DE UN CASO

Resumen

Antecedentes: el implante de conducción ósea Bonebridge (BCI) se utiliza en casos de pérdida auditiva conductiva, pérdida auditiva mixta y sordera unilateral. El sistema se puede implantar en la apófisis mastoide pre o retrosigmoidalmente. La colocación presigmoidea tiende a reducir el número de implantaciones posteriores. El uso de nuevos refinamientos, como los espaciadores llamados elevadores BCI, que facilitan el ajuste durante la cirugía, amplía la aplicabilidad de Bonebridge a un grupo más grande de pacientes.

Caso clínico: a continuación, se presenta el caso de una paciente de 58 años con otitis media crónica bilateral que se ha sometido a varias operaciones en el pasado y que es candidata para un implante Bonebridge. Durante la cirugía, se usó un elevador para el tornillo inferior del transductor de masa flotante para conducción ósea (BC-FMT) como consecuencia de una anteriorización del seno sigmoideo. Analizamos los resultados auditivos antes y 3 meses después de la cirugía. Los resultados indicaron unos umbrales de conducción ósea estables y mejoraron la audición y el reconocimiento del habla después de la implantación.

Conclusiones: El sistema Bonebridge es un tratamiento eficaz para la pérdida de audición causada por la otitis media crónica en los casos en que no se puede realizar la otocirugía clásica. Las condiciones difíciles durante la cirugía, como las causadas por un seno sigmoide anteriorizado, pueden limitar el uso de Bonebridge. En tales casos, el uso de un elevador puede ampliar las opciones de implantación.

Palabras clave: Bonebridge • implante de conducción ósea • seno sigmoideo anterior • elevaciones BCI

ПРЕДЛЕЖАНИЕ СИГМОВИДНОГО СИНУСА И ИСПОЛЬЗОВАНИЕ ПРОКЛАДОК В ИМПЛАНТАХ BONEBRIDGE - ОПИСАНИЕ СЛУЧАЯ

Аннотация

Вступление: Имплант костной проводимости Bonebridge (BCI) используется в случае частичной потери слуха кондуктивного или смешанного характера, а также при односторонней глухоте. Данная система вживляется в сосцевидный отросток перед или за сигмовидным синусом. Локализация перед синусом приводит к уменьшению числа возможных имплантаций. Внедрение новых инструментов, таких как распределительные прокладки «BCI lifts», которые позволяют во время операции расположить имплант соответствующим образом, позволяет расширить возможности использования импланта Bonebridge среди большей группы пациентов.

Описание случая: Представленный клинический случай описывает историю болезни 58-летней пациентки с хроническим воспалением среднего уха с обеих сторон, которой до этого было проведено несколько операций, и которая была направлена на операцию по вживлению импланта костной проводимости Bonebridge. Во время операции из-за предлежания сигмовидного синуса были использованы распределительные прокладки под нижний винт преобразователя BC-FMT. Проведен анализ полученных результатов слуха до операции и 3 месяца после. Полученные результаты подтверждают стабильность порогов слуха костной проводимости, улучшение слуха и понимания речи после имплантации.

Выводы: Система Bonebridge является эффективным способом лечения тугоухости, вызванной хроническим воспалением среднего уха в случаях, когда не могут быть применены методы классической отохирургии. Сложные условия во время операции, вызванные предлежанием сигмовидного синуса, могут ограничить использование системы Bonebridge. В таких случаях использование распределительных прокладок может расширить возможности использования имплантируемой системы.

Ключевые слова: Bonebridge • имплант костной проводимости • предлежание сигмовидного синуса • распределительные прокладки (BCI lifts).

PRZODUJĄCA ZATOKA ESOWATA I ZASTOSOWANIE PODKŁADEK DYSTANSUJĄCYCH DO IMPLANTU BONEBRIDGE – OPIS PRZYPADKU

Streszczenie

Wprowadzenie: Implant na przewodnictwo kostne typu Bonebridge stosowany jest w przypadku niedosłuchu o charakterze przewodzeniowym, mieszanym a także w jednostronnej głuchocie. System ten może być implantowany w wyrostku sutkowatym w lokalizacji przed lub za zatoką esowatą. Lokalizacja przedzatokowa może niekiedy ograniczać grono odbiorców tego urządzenia. Wprowadzenie nowych narzędzi, jakimi są podkładki dystansujące, pozwala na łatwiejsze dopasowanie części wewnętrznej podczas zabiegu operacyjnego i zastosowanie implantu typu Bonebridge w większej grupie pacjentów.

Opis przypadku: Opis przypadku klinicznego dotyczy 58-letniej pacjentki z przewlekłym zapaleniem ucha środkowego obustronnie, która przeszła kilka operacji w przeszłości i została zakwalifikowana do zabiegu wszczepienia implantu na przewodnictwo kostne typu Bonebridge. W trakcie zabiegu operacyjnego zastosowano podkładkę dystansującą pod dolną śrubę przetwornika BC-FMT z powodu przodowania zatoki esowatej. Dokonano analizy uzyskanych wyników słuchowych przed operacją oraz 3 miesiące po wszczepieniu urządzenia. Uzyskane wyniki potwierdzają stabilność progów słyszenia na drodze kostnej oraz poprawę słyszenia i rozumienia mowy po wszczepieniu systemu.

Wnioski: System Bonebridge to skuteczny sposób kompensowania niedosłuchu spowodowanego przewlekłym zapaleniem ucha środkowego w przypadkach, gdy nie można wykonać klasycznej otochirurgii. Trudne warunki podczas operacji, spowodowane przodującą zatoką esowatą, mogą ograniczać możliwości zastosowania systemu Bonebridge. W takich przypadkach użycie podkładek dystansujących może zwiększyć możliwość implantacji urządzenia.

Słowa kluczowe: Bonebridge • implant na przewodnictwo kostne • przodująca zatoka esowata • podkładki dystansujące

Introduction

The Bonebridge implant (Med-El, Innsbruck, Austria) is a system used to treat mixed, conductive hearing loss and single-sided deafness [1]. The device consists of two parts: internal, comprising a BC-FMT (bone conduction floating mass transducer) and a receiver coil with magnet and demodulator, and external, comprising sound processor held over the inner part by magnets [2]. The system is implanted

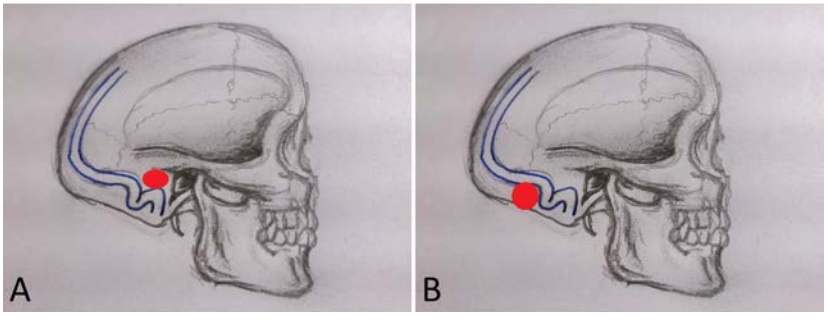

Figure 1. (A) Presigmoid placement of the BC-FMT; (B) retrosigmoid placement of the BC-FMT (own drawings)

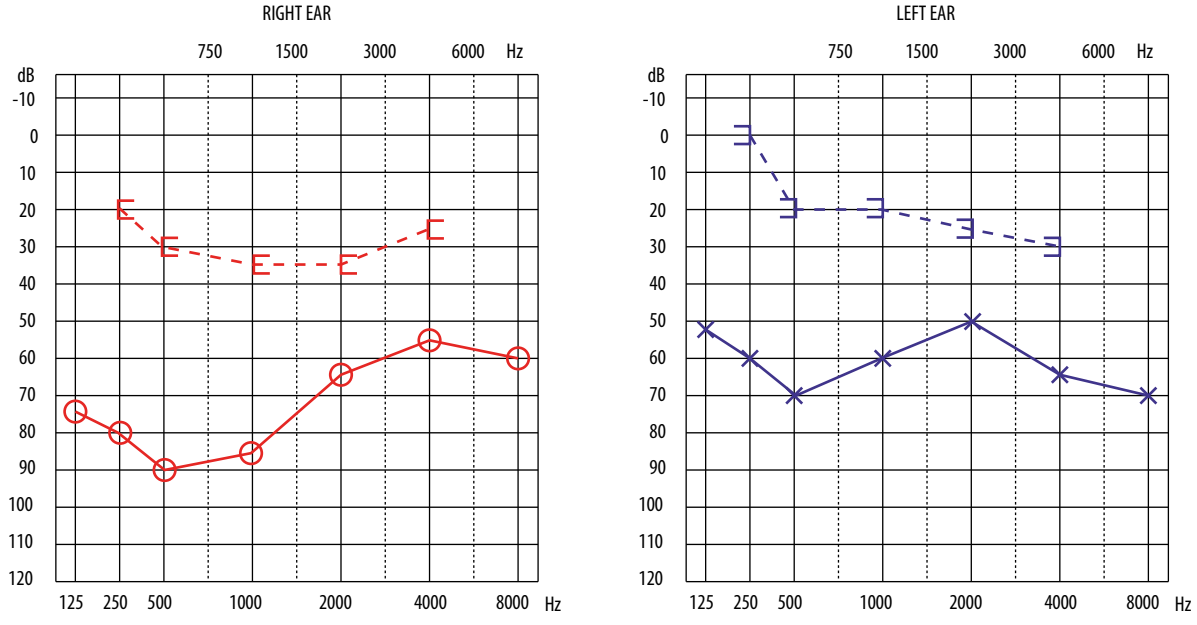

Figure 2. Pure tone audiometry before implantation of the Bonebridge system

pre- or retrosigmoidally. Sometimes an approach through the middle cranial fossa is used [3].

In the case of the Bonebridge, implantation using a presigmoid placement is generally preferred [1]. If the BC-FMT is placed retrosigmoidally, the meninges are exposed and the transducer can be in contact with them, sometimes even pressing against them [3] (Figure 1). The Bonebridge system has been used in clinical practice only since 2012 [4], and so long-term observations are unavailable, especially in cases where the safety of the transducer pressing upon the meninges is a concern. With presigmoid placement of the implant, the reference points are the sigmoid sinus, the middle cranial fossa dura, and the posterior wall of the external auditory canal.

In terms of everyday use the Bonebridge system is well received by patients. After implantation, the skin flaps are closed, providing low risk of skin complications. Patients assess the implanted area as more esthetic compared to percutaneous systems [4]. Nevertheless, the BC-FMT of the system is large and therefore the number of patients suited to presigmoid implantation is limited. The bone bed of the inner part of the BC-FMT requires a mastoid bone thicker than 8.7 mm and an antero–posterior dimension in excess of 15.8 mm [2]. During preparation of the bone bed, particular attention needs to be made to the placement with respect to the dura and the bony wall of the sigmoid sinus [5].

In addition to an anterior course of the sigmoid sinus, a decreased volume of mastoid due to congenital defects or prior radical operations can lead to serious limitations in how the Bonebridge system is implanted. However, thanks to the use of a lift (currently available in four sizes from 1 to 4 mm) and a procedure for rebuilding the posterior wall of the external auditory canal after radical surgery, options for Bonebridge implantation are now wider.

Case Presentation

This clinical case study reports the Bonebridge implantation of a 58-year-old woman with bilateral, mixed hearing loss. Analysis of the audiometric results was carried out with the consent (KB/07/2016) of the local bioethics committee. The patient's medical history listed bilateral chronic otitis media with cholesteatoma with recurrent draining ears for over 30 years. In the past, the patient had undergone myringo- and ossiculoplasty of the right ear and modified radical operation of the left ear, followed by two revisions of the left ear. During myringo- and ossiculoplasty of the right ear, a large quantity of adhesions were observed, presenting a high risk of no postsurgical hearing improvement. In addition, during revision surgery after a modified radical operation of the left ear, a total lack of auditory ossicles was observed, and as a result reconstruction was considered to be too risky. Due to the degree of hearing loss (Figure 2), stable bone conduction thresholds over the last few years, and no option to perform a classical surgical reconstruction, the recommendation to the patient was implantation of a bone conduction device. Audiological tests (free-field and speech audiometry) with a BC device on a softband showed that objective and subjective improvements in hearing could be obtained. A CT of the temporal bone was performed in order to show whether a bone conduction floating mass transducer (BC-FMT) could be implanted within the mastoid processes. On the right side it was found that if a bone conduction implant lift (BCI lift) of 3 mm was used, there was room for implantation of the transducer. On the left side, however, the anatomy made implantation of the device impossible. The patient therefore qualified for implantation of the Bonebridge device on the right side.

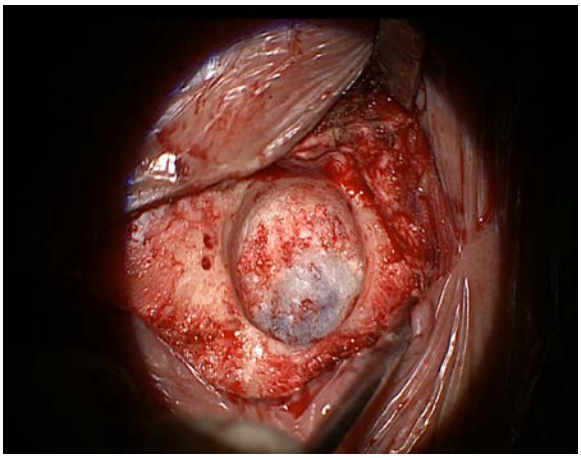

Figure 3. The light blue wall of the anterior sigmoid sinus is visible in the posterior lower quadrant of the created bone bed in this intraoperative picture of the right ear.

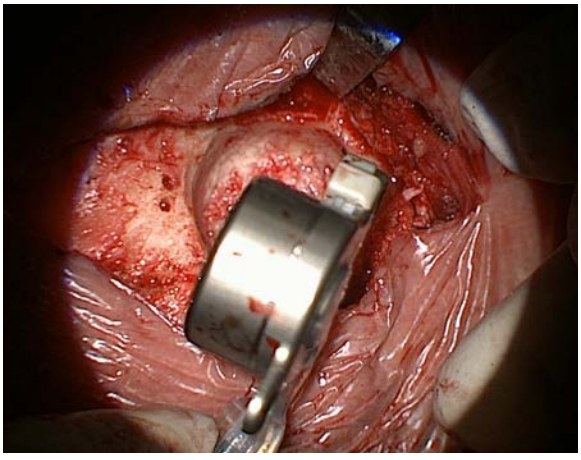

Figure 4. Placement of a 3 mm lift under the lower part of the BC-FMT

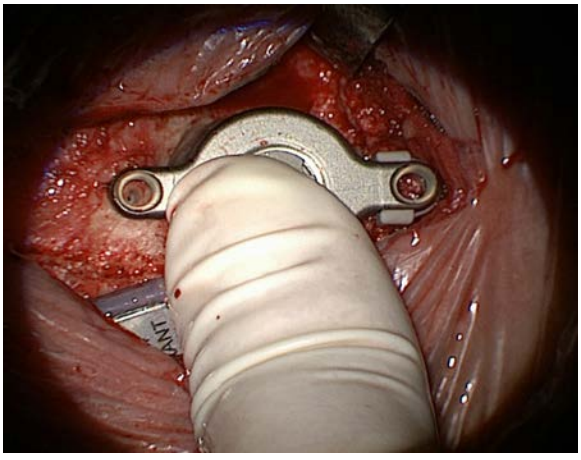

Figure 5. Fitting the transducer together with the BCI lift in the bone bed

During surgery, a right postauricular incision was made, subcutaneous tissues were dissected, the periosteum was elevated, and a bone bed matching the size of the transducer was prepared. During creation of the bone bed, the anterior sigmoid sinus could be observed through the bony wall (Figure 3). Two holes (1.4 mm in diameter) were then made using a 3.9 mm drill head. The implant was placed in the bed using a 3 mm lift under the lower part of the transducer (Figures 4, 5). It was attached by two screws of 2 mm diameter (upper part) and 2.4 mm (lower part) (Figure 6). Torque measurement gave a figure of 25 Ncm (Figure 7). The skin flap was of the correct thickness and it was closed in layers.

The postoperative period proceeded without complications. At the control visit 10 days after surgery, the stitches behind the right ear were removed and correct healing of the implant area was observed. The patient did not report any complaints. Four weeks after surgery, the external audio processor was fitted.

A control hearing test was performed 3 months after surgery. Pure tone audiometry showed stable air and bone conduction thresholds (Figure 8). Free-field audiometry performed with and without the device from 500 to 4000 Hz (Figure 9) showed a significant improvement in hearing sensitivity, and the average functional gain was 31 dB (calculated for 500, 1000, 2000, and 4000 Hz). The results of speech audiometry in the free field using monosyllabic word tests for speech signal intensities of 50, 60, and 70 dB SPL indicated an improvement in speech discrimination score of up to 70% in quiet; improvement in speech discrimination was also obtained at a signal-to-noise ratio of +10 dB (Figure 9).

Discussion

As indicated in the literature, the extent of the anterior course of the sigmoid sinus is often correlated with a low quantity of air in the mastoid process [6], which is affected, among other things, by chronic otitis media [7, 8]. Ichijo et al. [7] suggest that otitis media in childhood affects the development of the mastoid process and thus the course of the sigmoid sinus within it. There are several classifications of the extent of the anterior course of the sigmoid sinus [6, 9], and in temporal bone section preparations a relatively high percentage – over 57% – of anterior displacement of the sigmoid sinus has been reported [9].

In the case of the Bonebridge implant, displacement of the sigmoid sinus is a significant limitation in implanting it presigmoidally. Due to an anterior course of the sigmoid sinus, presigmoid placement of the Bonebridge can be limited or even impossible.

Techniques which facilitate presigmoid placement of the Bonebridge BC-FMT are available, e.g. maps of bone thickness or use of BCI lifts [10]. From our experience, the latter seems to be an additional tool that facilitates and sometimes even allows implantation that is otherwise impossible. At the moment, no studies are available on possible complications of the use of lifts, such as skin complications.

The use of BCI lifts during implantation of the Bonebridge system makes it possible to increase the number of potential recipients. Lifts provide additional help during surgery in cases where positioning of the transducer in the bone bed is difficult, as in the described case.

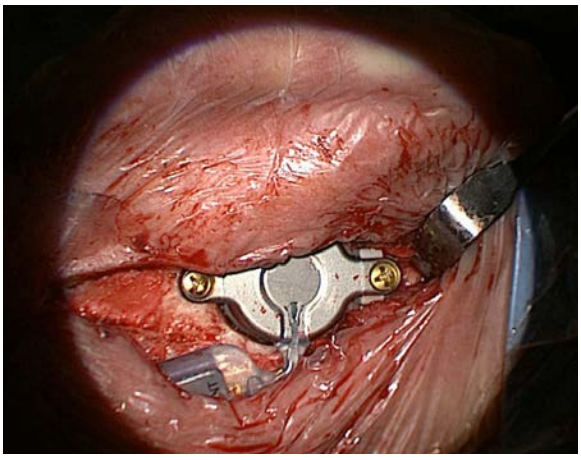

Figure 6. Condition after fixing the implant to the bone bed

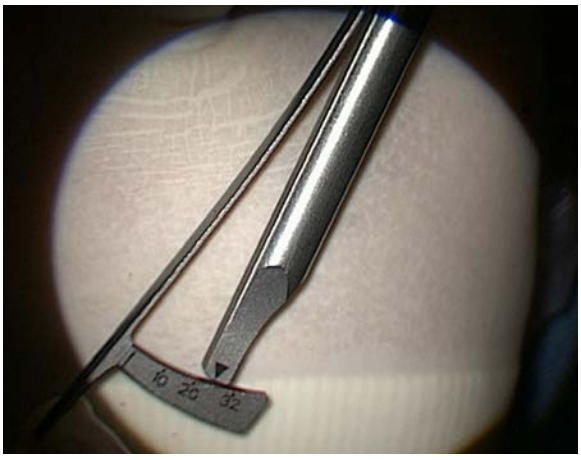

Figure 7. Checking the tightening torque of the fixing screws. A torque of 25 Ncm was measured under the lower part of the implant.

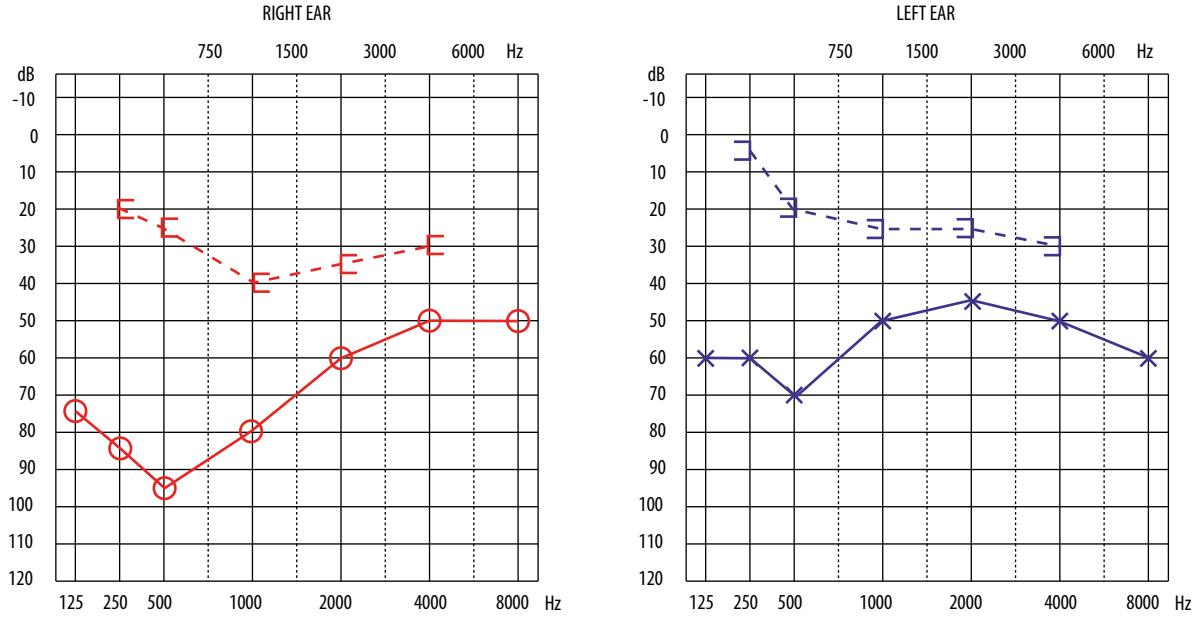

Figure 8. Results of pure tone audiometry 3 months after surgery

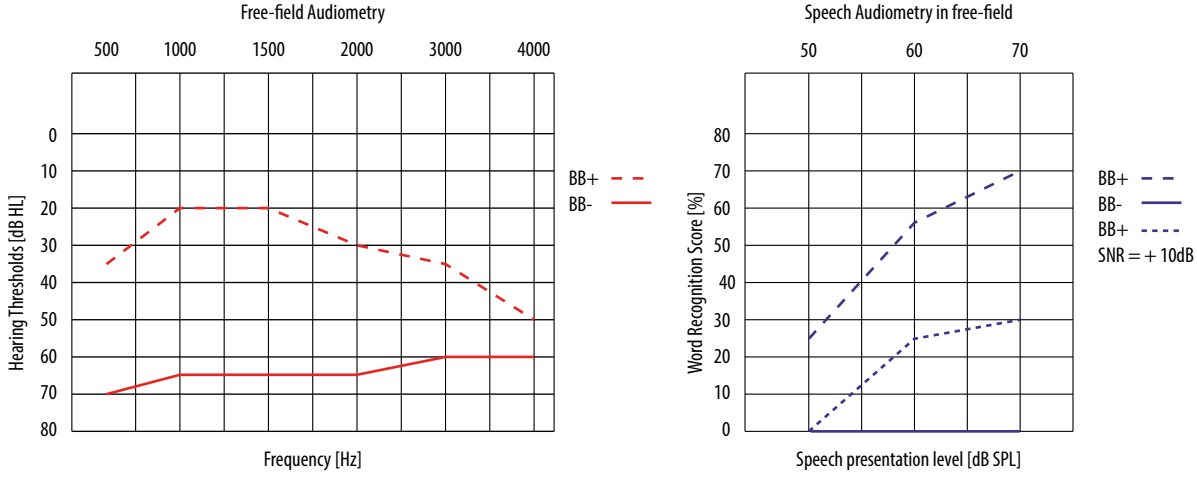

Figure 9. Results of free-field audiometry and speech audiometry 3 months after surgery

However, the use of lifts, especially those 3 or 4 mm thick, requires further observation, because it is possible that skin complications, associated with the formation of a bone step between the surface of the implant and the temporal bone, may occur.

Conclusions

Despite difficult intraoperative conditions, the Bonebridge system was implanted in the anterior sigmoid sinus using a BC lift. After surgery, audiological tests showed a successful outcome, demonstrating that difficult surgical conditions can be overcome.

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References

1. Skarżyński H, Szkiełkowska A, Olszewski Ł, Mrówka M, Porowski M, Fabijańska A, Skarżyński PH. Program stosowania implantów ucha środkowego i implantów zakotwiczonych w kości skroniowej na przewodnictwo kostne w leczeniu zaburzeń słuchu. Now Audiofonol, 2015; 4(1): 9–23.
2. Available at http://s3.medel.com/pdf/28178_40_BB%20Information%20for%20Surgeons.pdf (accessed 2019-01-02)
3. Huber A, Sim J, Xie Y, Chatzimichalis M, Ullrich O, Röösli C. The Bonebridge: preclinical evaluation of a new transcutaneously-activated bone anchored hearing device. *Hear Res*, July 2013, 93–99.
4. Sprinzl G, Wolf-Magele A. The Bonebridge bone conduction hearing implant: indication criteria, surgery and a systematic review of the literature. Clin Otolaryngol, 2016; 41(2): 131–43.
5. Sprinzl G, Lenarz T, Ernst A, Hagen R, Wolf-Magele A, Mojallal H, Todt I, Mlynski R, Wolframm M. First European multicenter results with a new transcutaneous bone conduction hearing implant system: short-term safety and efficacy. Otol Neurotol, 2013; 34(6): 1076–83.
6. Sun D, Lee D, Jang K, Park Y, Yeo S, Choi J, Lee S. A suggested new classification system for the anatomic variations of the sigmoid sinus: a preliminary study. Adv Otol, 2009; 5: (1) 1–5.
7. Ichijo H, Hosokawa M, Shinkawa H. The relationship between mastoid pneumatization and the position of the sigmoid sinus. Eur Arch Otorhinolaryngol, 1996; 253: 421–4.
8. Aslan A, Kobayashi T, Diop D, Balyan FR, Russo A, Taibah A. Anatomical relationship between position of the sigmoid sinus and regional mastoid pneumatization. Eur Arch Otorhinolaryngol, 1996; 253(8): 450–3.
9. Sarmiento PB, Eslait FG. Surgical classification of variations in the anatomy of sigmoid sinus. Otolaryngol Head Neck Surg, 2004; 131: 192–9.
10. Wimmer W, Gerber N, Guignard J, Dubach P, Kompis M, Weber S, Caversaccio M. Topographic bone thickness maps for Bonebridge implantations. Eur Arch Otorhinolaryngol, 2015; 272: 1651–8.