Bimodal hearing with OSIA® and BAHA® ATTRACT: advantageous or confusing? a clinical case.

Clinical Case

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Article received on July 31, 2024.
Accepted for publication on January 24, 2025.

Abstract

Malformations of the external ear, which may be associated with concomitant malformations of the middle ear, cause conductive hearing loss. When the malformation prevents auditory rehabilitation with conventional hearing aids, bone conduction devices are an effective option. These devices, which include the Baha® Attract and the Osia®, use bone vibration to directly stimulate the inner ear, thus bypassing the function of the external and middle ear. We present a clinical case of an adolescent with microtia and bilateral atresia of the external auditory canal, initially treated with the Baha® Attract and later with the Osia® on the contralateral ear. This work analyzes the differences between both devices and reflects on bilateral bone implantation.

Keywords: Ear malformations, microtia, bone conduction implant, percutaneous active implant, transcutaneous active implant

Introduction

Ear malformations are a cause of congenital hearing loss and must be identified early to initiate timely and appropriate rehabilitation. Understanding their embryogenesis is essential. The auricle develops from the first and second branchial arches, the external auditory canal (EAC) from the first branchial cleft, the middle ear from the first pharyngeal pouch, and the inner ear from the neuroectoderm via the otic vesicle. Consequently, malformations of the external and middle ear may occur simultaneously but are independent of inner ear abnormalities[1] .

Microtia has a prevalence of 1 in 10,000 births in Europe and is more common among Asian and Hispanic populations[2]. It is classified according to Hunter's classification (Table 1)[3]. EAC stenosis or atresia occurs in approximately 1 in 10,000–20,000 births and results from a defect in the recanalization

process of the EAC following its closure in the 8th week of gestation[4]. Similar to microtia, it is also more common in males than in females and typically presents unilaterally[5,6]. Bilateral external ear malformations may be associated with congenital syndromes such as Treacher–Collins, Nager, or CHARGE (Coloboma, Heart defects, Atresia choanae, growth Retardation, Genital abnormalities, and Ear abnormalities)[4].

Hearing rehabilitation options include non-implantable bone conduction devices (e.g., ADHEAR, Baha® Softband), bone conduction implants, and surgical reconstruction[4].

Bone conduction implants transmit sound vibrations directly to the inner ear, bypassing the external and middle ear structures. These devices can be categorized as follows:

1) Passive transcutaneous (e.g., Baha® Attract, Sophono®), where vibration occurs in the external processor and is transmitted through the skin to the implant.

2) Active percutaneous (e.g., Baha®, Ponto®), where the external processor is directly connected to an osseointegrated implant, providing simultaneous vibration.

3) Active transcutaneous (e.g., Osia®, Bonebridge™), where the external processor sends an electrical signal to a transducerplaced near the bone that produces vibration. In the Osia® system, the piezoelectric transducer requires osseointegration[7–9].

This study aimed to report a clinical case and analyze the differences between passive and active transcutaneous bone conduction implants.

Table 1
Hunter's classification

Degree of microtia	Description
1	All structures present, but malformed
2	Microtia, but with all the distinct structures
3	Small vertical appendix
4	Anotia

Materials and methods

This study describes a patient with ear malformations who received bilateral osseointegrated implants and a literature review conducted in PubMed using the Medical Subject Heading terms "Osia®" and "Baha® Attract."

Case report

The patient was an 11-year-old boy who was being followed up in the otorhinolaryngology clinic for grade 3 microtia (Figure 1) and bilateral EAC atresia with moderate conductive hearing loss (grade II) (Figures 2.1 and 2.2).

Computed tomography of the ears revealed agenesis of the EAC bone and cartilage, along with bilateral malformation of the malleus and incus. The inner ear was normal (Figure 3).

At 9 months of age, the patient received bilateral Baha® Softband devices, which yielded favorable audiometric results and facilitated normal language development.

At 7 years of age, a Baha® Attract was implanted in the right ear. At age 11, an Osia® OSI200 implant was placed in the left ear (Figures 4.1 and 4.2). Both surgeries were performed under general anesthesia, and

Figure 1
Type 3 microtia, Hunter's classification

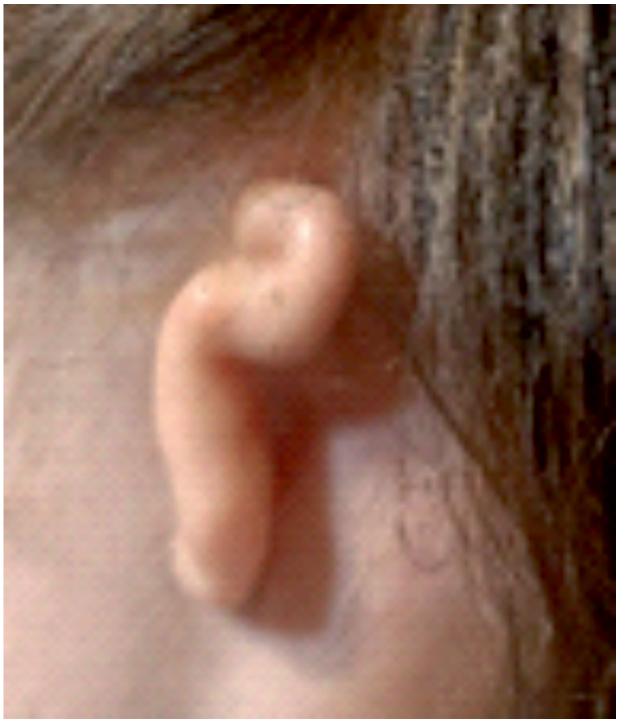


Figure 2.1
Pure-tone audiogram showing a pure-tone average (PTA) of 57.5 dB and air-bone gap of 57.5 dB

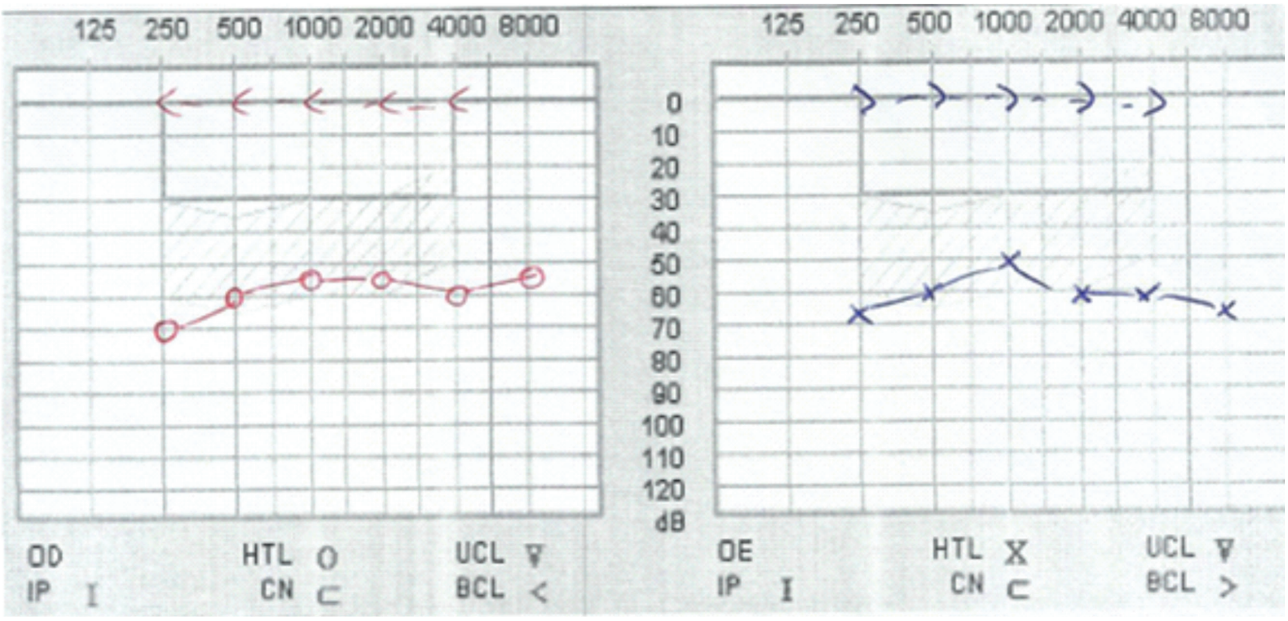
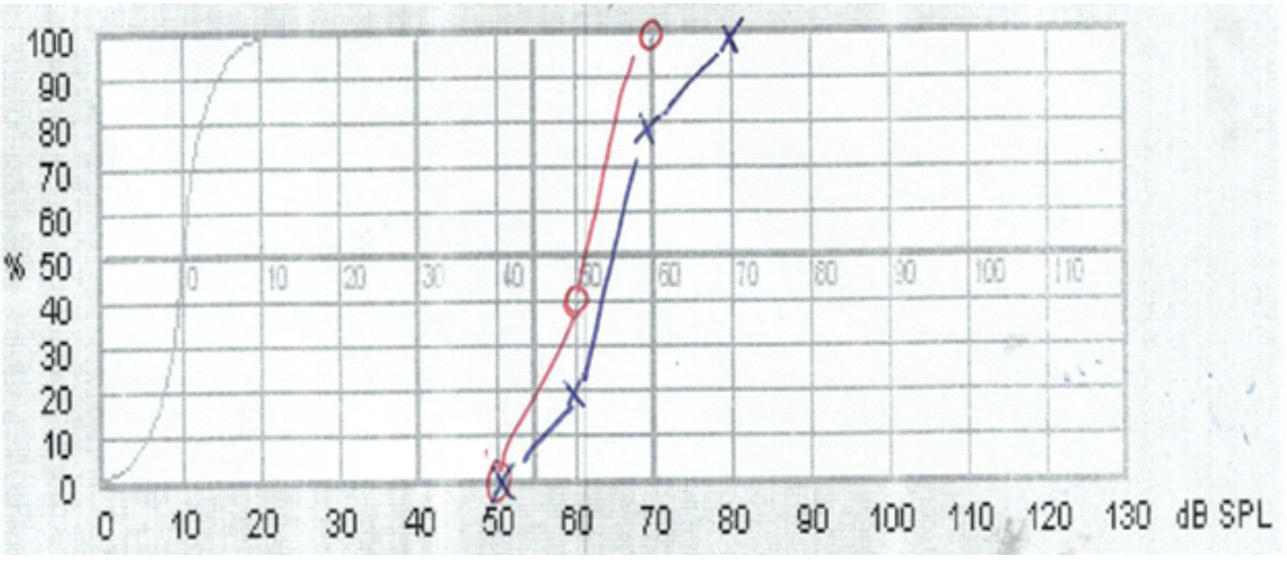


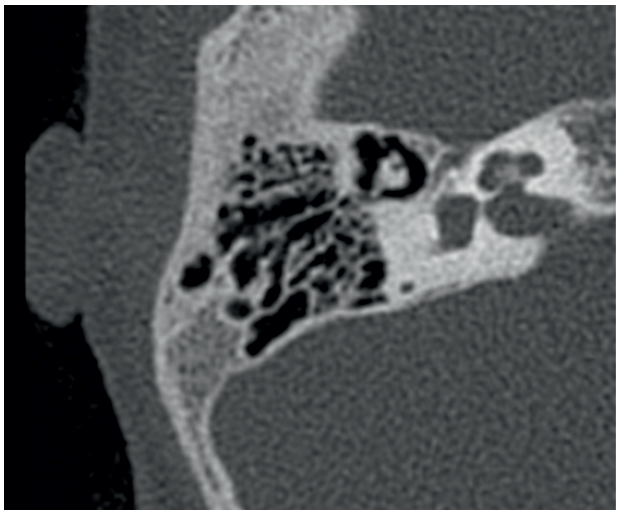
Figure 2.2
Speech audiogram demonstrating a speech reception threshold (SRT) of 60 dB and maximum speech intelligibility of 70–80 dB.



the patient received prophylactic antibiotic therapy. He was discharged the following day with analgesic medication, cefuroxime, and a compressive dressing, which was removed after 1 week. No perioperative complications were reported. In both cases, the processor was activated 8 weeks postoperatively to enable osseointegration.

Outcomes were assessed using audiometry and a questionnaire, with each device tested individually and in combination. In the free-field pure tone audiogram, the pure tone average (PTA) was similar with each implant (17.5 dB) (Figure 5). In the free-field speech audiogram, both the speech recognition threshold (SRT) and maximum intelligibility were slightly betterwith Osia®, both alone and in combination with the Baha® Attract (Figure 6). A speech audiogram in noise was also conducted, and the best results were

Figure 3
Axial computed tomography scan of the ear showing malformations of the external and middle ear



obtained when Osia® was used alone (Figure 7). The questionnaire used was the Portuguese version of the Speech, Spatial and Qualities of Hearing Scale (P-SSQ)[23]. The results are shown in Table 2. Speech understanding and sound quality were superior with Osia® alone, while spatial hearing was better when both devices were used concurrently.

Minor skin complications were noted with Baha® Attract, which improved with topical corticosteroids and reduced magnet strength. To date, no complications have been reported with Osia®. The patient continues using both devices simultaneously.

Discussion

According to the literature, hearing loss in EAC atresia typically ranges from 40 to 60 dB[5], as observed in this case. The patient was evaluated by a genetics team, and no associated syndromes were identified. Recanalization surgery was not performed due to a reported restenosis rate of approximately 40%[10]. The patient initially received the Baha® Attract, introduced by Cochlear® in 2013. Although a single device can stimulate both cochleae almost equally, since the transcranial attenuation of bone-conducted sound is minimal (10 dB), several studies have reported the advantages of binaural stimulation[11,12]. the favorable outcomes reported in the literature, Osia®, launched in 2019 by the same manufacturer, was subsequently chosen.

Indications

Both implants are indicated for cases of conductive/mixed hearing loss and unilateral sensorineural hearing loss when conventional hearing aids are not suitable or tolerated[13]. Some studies have suggested

Figure 4.1
Osia® (left ear)

Figure 4.2
Baha® attract (right ear)

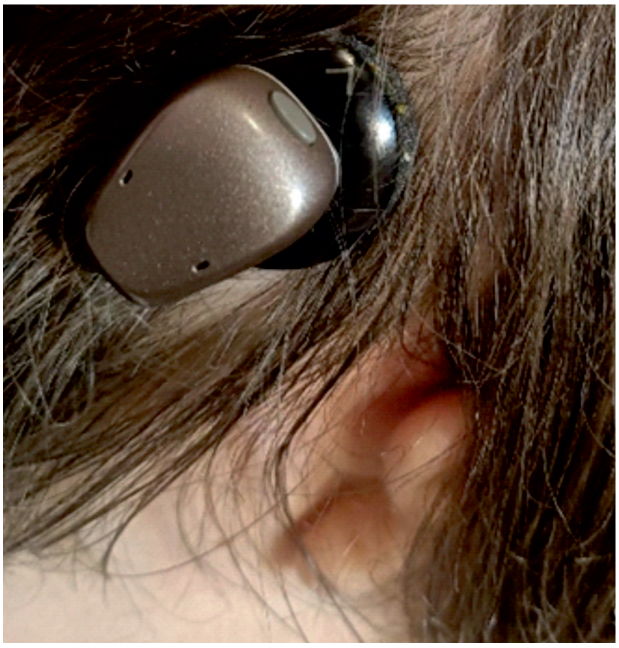


Figure 5
Pure tone audiogram with Baha® Attract (red) (PTA 17.5 dB), Osia® (blue) (PTA 17.5 dB), and Baha® Attract + Osia® (black) (PTA 20 dB)

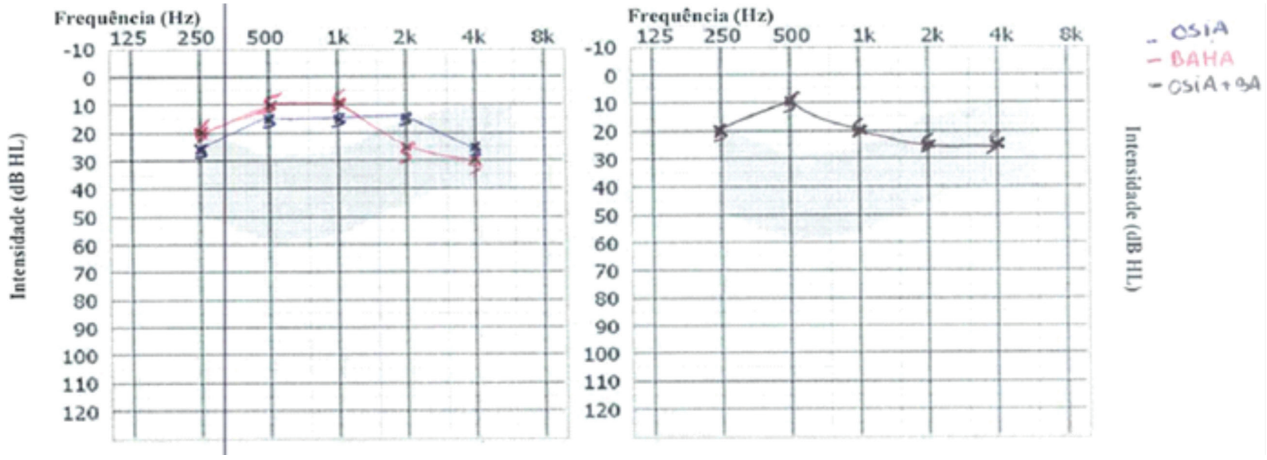


Figure 6
Speech audiogram with Baha® Attract (red) (SRT 25 dB, 100% maximum intelligibility at 40 dB), Osia® (blue) (SRT 20 dB, 100% maximum intelligibility at 30 dB), and Baha® Attract + Osia® (black) (SRT 20 dB, 100% maximum intelligibility at 30 dB)

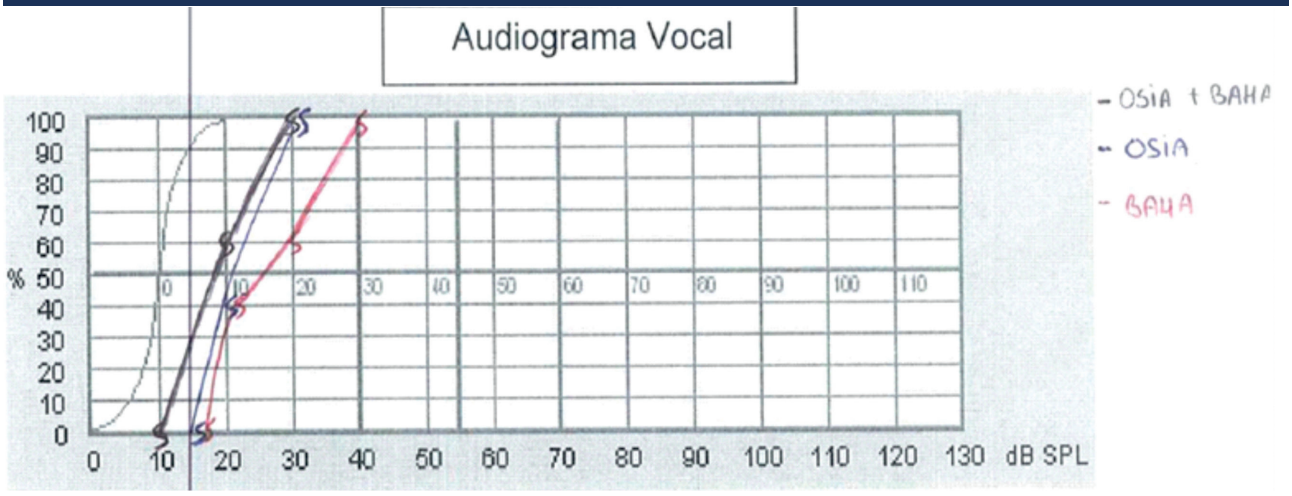


Figure 7
Speech audiogram in noise with Baha® Attract (red) (SRT 40 dB, 100% maximum intelligibility at 60 dB), Osia® (blue) (SRT 25 dB, 100% maximum intelligibility at 50 dB), and Baha® Attract + Osia® (black) (SRT 35 dB, 100% maximum intelligibility at 45 dB)

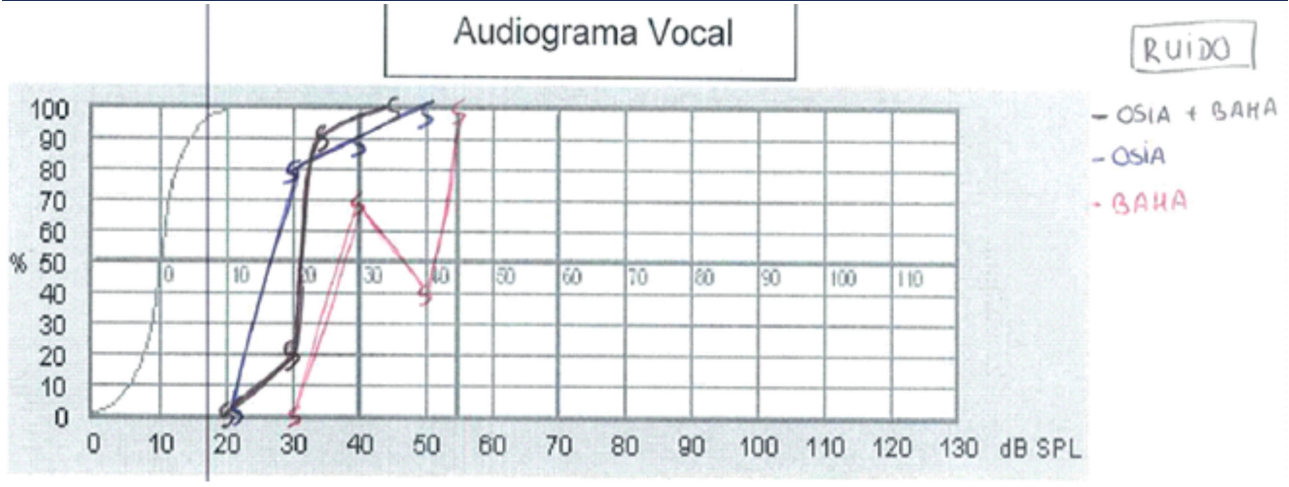


Table 2
P-SSQ questionnaire

Parameters	Pre-implantation	Baha® Attract	Osia®	Baha® + Osia®
1. Speech hearing	6,2	8,1	9,6	9,3
2. Spatial hearing	6,6	7	8,9	9
3. Qualities of hearing	7,7	7,7	9,1	8,9

P-SSQ, the Portuguese version of the Speech, Spatial and Qualities of Hearing Scale

that when the air-bone gap exceeds 30–35 dB, bone conduction implants offer superior benefits over conventional hearing aids[14,15]. According to Panagiotis A.[7] , audiometric indications for Baha® Attract included unilateral sensorineural hearing loss (55.6%) and conductive hearing loss (44.4%). Otologic indications included EAC atresia (36.4%), chronic otitis media (27.3%), EAC stenosis (9.1%), enlarged vestibular aqueduct and Mondini dysplasia (18.2%), ossicular chain malformation (9.1%), and primary ciliary dyskinesia (9.1%).

The maximum bone conduction thresholds are 55–65 dB for Baha® Attract (depending on the processor) and 55 dB for Osia®. Word recognition scores should exceed 60%[9,16]. Eligible patients must undergo a test with the Baha® Softband, and if there is no improvement, surgery is not recommended.

Both devices are approved for patients ≥5 years of age.

Surgery

The main steps for Baha® Attract implantation are similar to those for BAHA®, and the Attract can be surgically converted into BAHA®[9].

For Osia®, the ideal implant site is horizontally aligned with the EAC, without contact with the auricle. Due to the implant size, a minimum distance of ≥15 between the incision and implant is recommended[17].

In the present case, no bone removal was necessary for Osia® implantation, as the selected site provided full bone support, minimizing feedback. Skin thickness reduction was not required in either surgery, but skin should be <9 mm thick to ensure stable magnet connection.

Intra- and perioperative complications

Both surgeries share potential risks, including dural exposure, sigmoid sinus injury, and entry into the mastoid cavity, which may impact osseointegration. In patients with previous mastoidectomy, placement near the tegmen is advised due to the likelihood of finding compact bone[16]. Surgical site infections can be prevented by administering broad-spectrum antibiotics pre- and intraoperatively. Postoperatively, a compressive dressing is recommended for at least 24 h. Our patient received intra- and postoperative antibiotics and maintained the compressive dressing for 7 days.

Processor activation

Processor activation should be delayed for 4–6 weeks to enable osseointegration[7], with longer intervals in case of tissue edema.

Audiometry

According to the literature, pure tone audiometry shows similar PTA gain with both devices (ranging from 38.8–42.8 dB)[7], although Baha® Attract shows reduced performance at extreme frequencies (250 and 4 kHz). Pediatric patients tend to show better outcomes than adults (PTA gain of 30.6 vs. 18.4 dB), likely due to the thinner soft tissues[18–21]. Our findings align with these data: while PTA improvement was the same for both devices (40 dB), Osia® showed less variation across frequencies.

As reported by Wojciech Gawęcki et al.[22], Osia® outperformed Baha® Attract in speech-in-noise conditions (SRT improvement: 35 dB with Osia® vs. 20 dB with Baha® Attract).

Although there are no reported cases in which both devices were used simultaneously,

studies comparing unilateral with bilateral bone conduction implants[23] have revealed improved PTA, better speech understanding in quiet environments, and enhanced sound localization and lateralization. However, under noise conditions, especially when the noise is directed toward the shadowed ear, speech understanding was better in patients with unilateral implants. In our case, none of the audiometric tests showed superior results when using both devices simultaneously compared to Osia® alone.

Questionnaires

Goycoolea et al.[24] used the short version of the SSQ-12 to evaluate Osia® candidates. All patients reported improvement across all three domains of the questionnaire, with further gains observed over time post-implantation (Table 3). Conversely, Gawecki et al.[22] compared the Baha® Attract and Osia® systems and reported lower SSQ-12 scores for Osia® (Table 4).

In our case, in line with the audiometric results, the scores in the "Speech Hearing" and "Qualities of Hearing" domains of the P-SSQ were superior with Osia® (Table 2). Only the "Spatial Hearing" domain showed advantageous binaural stimulation with the combined use of both devices, as also reported in a previous study[23].

Long-term complications

Use of Baha® Attract is associated with long-term complications in 21.3% of cases, mostly because of the strength of the magnet. Excessive magnetic force may cause pain and erythema, while insufficient force increases the risk of processor detachment (1.1%)[21]. In the present case, the patient experienced erythema and localized pain, which were managed with corticosteroid ointment and magnet force adjustments as needed. Other complications described in the literature include seroma or hematoma (4.4%) and paresthesia in the flap area (8.9%)[25]. With the Osia® system, the magnet is only required to hold the sound processor in place, as vibration is generated within the implanted transducer. Consequently, soft tissue complications due to pressure, vibration, or heat at the magnet site are rare[16].

Conclusion

Osseointegrated implants represent a valuable hearing rehabilitation option for patients with congenital malformations. The Osia® system provides substantial hearing gains across low and high frequencies, improving speech recognition in both quiet and noisy environments, and is associated with a low complication rate. Despite the better audiometric outcomes achieved with

Table 3
SSQ-12 results in the study by Goycoolea et al. [24]

Questionnaire domains	Pré-Osia®	Pós-Osia® (2 months)	Pós-Osia® (6 months)
Speech hearing	4,2	6,5	7,5
Spatial hearing	4	5,5	6
Qualities of hearing	5	7	7,5

SSQ-12, 12-item Speech, Spatial and Qualities of Hearing Scale

Table 4
SSQ-12 results in the study by Gawecki et al. [22]

Questionnaire domains	Pré-Baha® Attract	Pós-Baha® Attract	Pré-Osia®	Pós-Osia®
Speech hearing	4,5	7,2	4,5	6,2
Spatial hearing	4,1	6,7	3,7	6
Qualities of hearing	5,2	7,4	5	6,9

SSQ-12, 12-item Speech, Spatial and Qualities of Hearing Scale

Osia® alone, the benefits of binaural hearing remain significant, and in most situations, the combined use of both devices is preferred.

Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Data Confidentiality

The authors declare having followed the protocols used at their working center regarding patient data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and the 2013 Helsinki Declaration of The World Medical Association.

Funding Sources

This work did not receive any contribution, funding, or scholarship.

Availability of scientific data

There are no datasets available, or publicity related to this work.

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