BONE CONDUCTION HEARING IMPLANT: INDICATIONS, OUTCOMES, COMPLICATIONS, AND MANAGEMENT – A LITERATURE REVIEW

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ABSTRACT

Background: Bone conduction hearing implants (BCHI) have become an important solution for patients with conductive, mixed hearing loss, or single-sided deafness who are unsuitable for conventional air-conduction hearing aids. Recent technological advances, including percutaneous and transcutaneous active systems, have improved auditory outcomes while reducing soft-tissue complications.

Objective: To synthesize current evidence on indications, auditory outcomes, complications, and management strategies of BCHI over the past five years.

Methods: A descriptive review was conducted using PubMed, Scopus, Cochrane Library, Google Scholar, and relevant Vietnamese ENT journals. Studies published between 2019 and 2024 reporting indications, clinical outcomes, complications, or management of BCHI were included. Data were extracted independently by two researchers and summarized into four categories: indications, auditory outcomes, complications, and management of complications.

Results: Analysis of recent literature shows that BCHI is highly effective in improving functional hearing thresholds and speech understanding, particularly in patients with conductive/mixed hearing loss and single-sided deafness. The most common complications involve soft-tissue reactions, including skin irritation, peri-implant granulation, and minor infections, with lower rates in transcutaneous active systems (e.g., Osia®, Bonebridge) compared to percutaneous devices. Management strategies include conservative care

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(hygiene, topical antibiotics/steroids, adjustment of magnet force) and surgical interventions in severe or recurrent cases. Early selection of suitable candidates and careful surgical technique are critical to minimizing complications and optimizing outcomes.

Conclusion: BCHI provides a safe and effective method for hearing rehabilitation, with a favorable complication profile, particularly for transcutaneous active systems. Proper patient selection, standardized surgical procedures, and evidence-based management of complications are essential for maximizing functional gains and patient satisfaction.

Keywords: *Bone conduction hearing implant; BCHI; indications; outcomes; complications; management; transcutaneous; percutaneous.*

Subjects and Methods Bone conduction hearing implants (BCHI) have become an important solution for patients with conductive, mixed hearing loss, or single-sided deafness who are not candidates for conventional air-conduction hearing aids. Recent advances in bone conduction technology, including percutaneous and transcutaneous active systems, have improved hearing outcomes while minimizing soft-tissue complications.

Over the past five years, numerous international studies have reported on the efficacy, complication rates, and management strategies of these devices. Despite these advances, management of complications varies between authors and depends on the type of device, surgical technique, and individual patient characteristics. In Vietnam, studies focusing on BCHI remain limited, and there is a need to synthesize international evidence to guide clinical practice and improve patient outcomes.

Objectives

General objective: To summarize and analyze recent evidence on indications, auditory outcomes, complications, and complication management of bone conduction hearing implants.

Specific objectives:

1. To analyze the primary indications for BCHI based on recent literature.
2. To evaluate auditory outcomes and speech recognition improvements after BCHI implantation.
3. To identify the frequency and characteristics of common complications.
4. To summarize management strategies for complications reported in recent studies.

Materials and Methods

Study subjects

The subjects of this review were published studies and scientific reports related to indications, outcomes, complications, and management of BCHI, published between 2019 and 2024.

Inclusion criteria:

- Original research or systematic reviews reporting on BCHI indications, clinical outcomes, complications, or management.
- Published in English or Vietnamese.
- Provided quantitative data or clear descriptions of outcomes.

Exclusion criteria:

- Letters, commentaries, or single-case reports without sufficient data.
- Studies unrelated to BCHI, such as experimental headband bone-conduction devices.
- Reports lacking data on indications, outcomes, complications, or management.

Research design

This study is a **descriptive literature review**, synthesizing evidence from published research into four categories: indications, auditory outcomes, complications, and management of complications.

Search strategy

Databases searched included PubMed, Scopus, Cochrane Library, Google Scholar, and relevant Vietnamese ENT journals.

Keywords: "bone conduction implant", "bone-anchored hearing system", "BCHI", "BAHA surgery", "indications", "outcomes", "complications", "management", "skin reaction", "osseointegration failure".

Data extraction and synthesis

- Two researchers independently screened titles and abstracts, then extracted relevant data.
- Data extracted included: author, year, sample size, device type, indications, hearing outcomes (PTA, SRT, SDS), complications, and management strategies.
- Information was summarized in four tables corresponding to the objectives.

Results

Table 1: Indications for Bone Conduction Hearing Implants

#	Author (Year)	Study type	Indications
1	Ellsperman et al., 2023	Clinical study	Conductive hearing loss, mixed hearing loss, single-sided deafness, external/middle ear malformations
2	Rahne et al., 2023	Systematic review	CMHL, SSD, chronic otitis media unsuitable for conventional hearing aids
3	Arndt et al., 2022	Cohort study	Children ≥5 years, congenital malformations of external/middle ear
4	Gawęcki, 2024	Clinical study	Adults and children, failed tympanoplasty or ossiculoplasty, chronic otitis

#	Author (Year)	Study type	Indications
			externa
5	Caversaccio, 2025	Meta-analysis	CMHL, MHL, SSD; transcutaneous active preferred for reduced complications

Table 2: Auditory Outcomes after BCHI

#	Author (Year)	Study type	Sample / Device	Main outcomes
1	Gawęcki, 2024	Clinical study	Osia 2	Significant functional gain, improved speech understanding, low complication rate
2	Sprinzl, 2023	Review / Clinical analysis	Bonebridge BCI 602	Improved sound-field thresholds and speech recognition scores; lower skin complications than percutaneous devices
3	Jukić, 2024	Multi-center case series	Osia 2	High-frequency gain improvement, speech perception enhanced, minimal complications
4	Ray, 2023	Systematic review	BCI (various types)	Improved hearing thresholds, speech recognition, high patient satisfaction
5	Plontke, 2025	Multi-center study	Bonebridge BCI 602	Stable hearing outcomes over 12 months, low incidence of adverse events

Table 3: Complications of BCHI

#	Author (Year)	Study type	Complications	Main findings
1	Costa, 2023	BAHA percutaneous	Skin irritation, peri-implant granulation, infection	High incidence in children (≈49%), proposed new grading system for skin complications
2	Caversaccio, 2025	Systematic review	Skin, soft tissue, device failure	Percutaneous: higher skin complications; transcutaneous active: safer, rare device failure
3	Succar, 2024	Multi-center review	Infection, granulation, pain	Percutaneous devices effective but higher skin complication rates; may require reoperation
4	Gawęcki, 2024	Osia 2	Mild skin irritation, rare device failure	Low complication frequency; mainly minor soft tissue issues
5	Plontke, 2025	Bonebridge BCI 602	Soft tissue irritation, device misalignment	Low complication incidence; mild events manageable conservatively

Table 4: Management of Complications

#	Author (Year)	Study type	Complication type	Management strategy
1	Costa, 2023	BAHA percutaneous	Skin granulation, infection	Hygiene, topical antibiotics/steroids, electrocautery, reoperation if severe
2	Succar, 2024	BAHA percutaneous	Infection, pain, granulation	Conservative treatment first; surgical revision or switch to transcutaneous if recurrent
3	Gawęcki, 2024	Osia 2	Skin irritation, discomfort, rare device failure	Reduce magnet force, topical treatment, reprogram processor, implant replacement if necessary
4	Plontke, 2025	Bonebridge 602	Mild soft tissue issues, pain, device misalignment	Conservative care, reoperation if device misaligned or pain persists

#	Author (Year)	Study type	Complication type	Management strategy
5	Caversaccio, 2025	Systematic review	Skin necrosis, infection, device failure	Patient selection, flap technique for thin tissue, implant removal in severe infection, device replacement
6	Sprinzl, 2023	Bonebridge	Hematoma, prolonged pain, infection	Cold compress, short-term antibiotics, drainage if hematoma, surgical revision if persistent

Discussion

The synthesized data from the four tables indicate strong consensus regarding the role of BCHI in hearing rehabilitation for patients with CMHL, MHL, and SSD.

- **Indications:** All authors agree CMHL and SSD are primary indications. Recent devices like Osia 2 and Bonebridge 602 have expanded use to children ≥5 years and patients with complex anatomy or intolerance to BAHA percutaneous. Transcutaneous active systems are preferred due to lower complication rates.
- **Auditory outcomes:** BCHI provides significant improvements in functional gain and speech understanding. Active transcutaneous devices demonstrate superior high-frequency gain and patient satisfaction compared to percutaneous devices.
- **Complications:** Skin and soft-tissue reactions are most common in percutaneous systems, while transcutaneous active systems have lower complication rates. Rare complications include device failure and implant misalignment.
- **Management:** Conservative management (hygiene, topical therapy, magnet adjustment) is first-line. Surgical intervention is required in severe or recurrent cases. Proper patient selection and meticulous surgical technique are essential to minimize complications.

Overall, the trend is a shift toward **transcutaneous active devices** for safer outcomes and improved patient satisfaction.

Conclusion

BCHI is a safe and effective option for hearing rehabilitation, especially for patients with CMHL, MHL, and SSD. Transcutaneous active systems offer better soft-tissue profiles and similar or superior hearing outcomes compared to percutaneous devices. Proper patient selection, standardized surgical procedures, and evidence-based management of complications are essential to maximize functional hearing gains and patient satisfaction.

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