

Bone conduction hearing implants (BCHIs); life-changing surgery. A quality of life (QoL) study reporting the impact of BCHI surgery on 163 patients' well-being

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ABSTRACT

Objective This study aimed to review the impact of bone conduction hearing implants (BCHIs) surgery on patients' quality of life (QoL) across general, physical, social and overall well-being domains.

Design A prospective correlational study.

Setting Single tertiary referral center in the UK.

Participants All adult patients undergoing their first BCHI over a 10-year and 6-month period (between June 1, 2012, and December 31, 2022). A total of 163 were included out of 195 potentially eligible participants.

Main outcome measure The Glasgow Health Status Inventory (GHSI) was used to assess patients' QoL pre and post BCHI surgery.

Results BCHI surgery showed significant improvements across all GHSI QoL domains; total ($p<0.0001$), general ($p<0.0001$), social ($p<0.0001$) and physical ($p<0.0001$).

Conclusion The largest of its kind, this study recognizes the wide-reaching impact of BCHIs on patients' QoL, evidencing them as a highly effective and life-improving surgical intervention.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Previous studies have reported improvements in hearing-specific quality of life (QoL) outcomes for bone conduction hearing implant (BCHI) patients; however, there is a paucity of large-sample prospective research on general QoL outcomes for BCHI patients.

WHAT THIS STUDY ADDS

⇒ This prospective study reports QoL improvements across total, general, social and physical domains across a decade of BCHI practice.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study will help to inform funding and policy decisions relating to BCHI services in the National Healthcare Service.



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INTRODUCTION

The audiological benefits of bone conduction hearing implants (BCHIs) for individuals with mixed or conductive hearing loss, who are unable to benefit from conventional air-conduction hearing aids, are well established.^{1 2} The most common indications for BCHIs are chronic otitis media, otitis externa and aural stenosis.³ There have been numerous studies reporting the QoL benefits of elective surgical procedures; however, there is limited research regarding the impact of BCHIs.¹ Where studies do exist, they tend to be retrospective in nature and limited by sample size and timescale.

Evidencing positive QoL outcomes is especially important in the publicly funded healthcare system, where funding for higher-cost elective interventions is scrutinized and

where the taxpayer must see value for money. In regard to patients with hearing loss, there is a general lack of high-quality research available to inform policy decisions.⁴ Strong evidence of improved patient well-being following BCHI will help to develop and expand BCHI services in the National Health Service (NHS). In order to receive a BCHI, patients must be identified and referred by healthcare professionals to a regional BCHI service. It is likely there are many more potentially eligible patients who do not reach such services due to a general lack of awareness among healthcare professionals of both BCHI technology and the referral pathways.

When it comes to elective surgical interventions, good quality of life (QoL) outcomes are arguably the most important indication of success. Patient-reported outcome measures (PROMs), which consist mainly of questionnaire-based tools, are generally

used to assess patient satisfaction following a treatment or intervention. They enable standardized assessment of how a patient experiences and feels their health condition.⁵ There is an increasing focus on PROMs in surgical practice as they are rightly recognized as a barometer of healthcare quality.^{6–8} In addition to assessing QoL outcomes, the use of PROMs can have unintended benefits, including improved communication between clinician and patient, management of patient expectations and reflection on individual surgeon practice. In publicly funded healthcare systems, PROMs are of particular importance where they can be used to rationalize the commissioning of services.

Some of the more common PROMs used in otology include the Glasgow Benefit Inventory (GBI), Short Form Survey (SF-36) and the EuroQol-5D (EQ-5D).⁹ The GBI consists of 18 questions answered using a five-point Likert scale and is designed as a single-use postintervention measure.¹⁰ Answers are subsequently divided into four domains: social (measuring amount of social support required), physical (including medication and consultation requirements), general (including changes in general and psychosocial health status) and total (combination of all).¹⁰

A meta-analysis of BCHIs' QoL outcomes for patients with single-sided sensorineural deafness reported improvements in hearing-specific QoL outcomes but not in generic QoL measures. The authors conclude there is a need for prospective data in this cohort.¹¹ One of the larger QoL studies of BCHI patients reported very favorable outcomes across all GBI domains in 227 patients across 10 years of practice in one UK center.¹² Similar, smaller studies have reported the comparable positive outcomes of GBI scores post-BCHI insertion.^{13 14} While this evidences high patient satisfaction, an inherent weakness of the GBI, as with many PROMs, is the retrospective nature and therefore reliance on accurate patient recall as well as vulnerability to other biases, including researcher effect.

The Glasgow Health Status Inventory (GHSI) is a modified version of the GBI that allows preintervention and postintervention comparison. It is a well-recognized PROM that has been validated in otolaryngological research.¹⁵ A previous study of 62 patients, conducted by colleagues, used the GHSI in this patient group and reported significant improvement in all QoL domains measured apart from the social domain, where no significant difference was seen between the GHSI score pre- and post-BCHI surgery.¹⁶ Here we present the largest known study of its kind, reviewing pre- and post-BCHI QoL outcomes across over 10 years of clinical practice.

As per the NHS Health Research Authority, explicit consent of patients was not required for this study. This study is an audit and quality assurance project, retrospective in nature and reporting the outcomes of existing practice.

METHODS AND MATERIALS

A prospective study was conducted on all adult patients who underwent BCHI insertion over a 10-year and 6-month period between June 2012 and December 2022 at a single UK center. Patients received a minimally invasive percutaneous BCHI with abutment in a single stage under either general or local anesthetic by an ENT consultant.

The GHSI was chosen as, unlike other available PROMS, it allows comparison of pre and post well-being, rather than merely retrospective reporting of well-being. All patients were asked to complete the 18-question GHSI pre- and post-BCHI insertion. The GHSI generates scores for each domain (social, physical, general and total) using a five-point Likert scale. This results in a score between –100 and +100, with the lowest number representing the poorest outcome and the highest the best outcome. The questionnaire was completed in the clinic with the same audiologist on average 3 months either side of the surgery, with a range of 1–6 months.

Age at the time of surgery, sex and indication for BCHI were recorded. Patients were included regardless of BCHI indication. Patients were excluded if they had a previous BCHI, were under the age of 18 or had not completed both the pre- and post-GHSI questionnaire.

RESULTS

A total of 291 patients had BCHI surgery between June 1, 2012, and December 31, 2022. All patients received unilateral BCHIs initially and were successfully placed. Of these patients, 128 (44.0%) were excluded; 29 were under the age of 18, 67 had a previous BCHI, and 32 did not complete both the pre- and post-GHSI questionnaire. The response rate was therefore 89.0%. Of the 163 patients included, 84 (52%) were female and 79 (48%) male, with an age range of 22–83 years and a median age of 51.8.

In terms of indications, 103 (63.2%) patients had BCHI for recurrent ear infections, 23 (14.1%) for mastoid cavity, 21 (12.9%) for 'other' indication including microtia and 16 (1.0%) because a behind-the-ear hearing aid was not loud enough ([figure 1](#)).

The GHSI scores were compared pre- and post-BCHI insertion, and the median and interquartile difference in scores were calculated. The Wilcoxon signed-rank test was used to calculate the significance level. This was performed using SPSS software. When comparing pre- and post-BCHI insertion, the GHSI score improved across all QoL domains except for social support, which appeared to 'worsen'. Total median GHSI score improved from –25.0 to 50.0 ($p<0.0001$), general GHSI from –41.7 to 66.6 ($p<0.0001$), physical from –33.0 to 0.0 ($p<0.0001$) and social from 66.7 to 0.0 ($p<0.0001$) ([table 1](#) and [figure 2](#)). The lowering of the social support score, in fact, represents an individual requiring less social support. It can therefore be reported that a significant improvement was seen across all QoL domains. The impact of indication

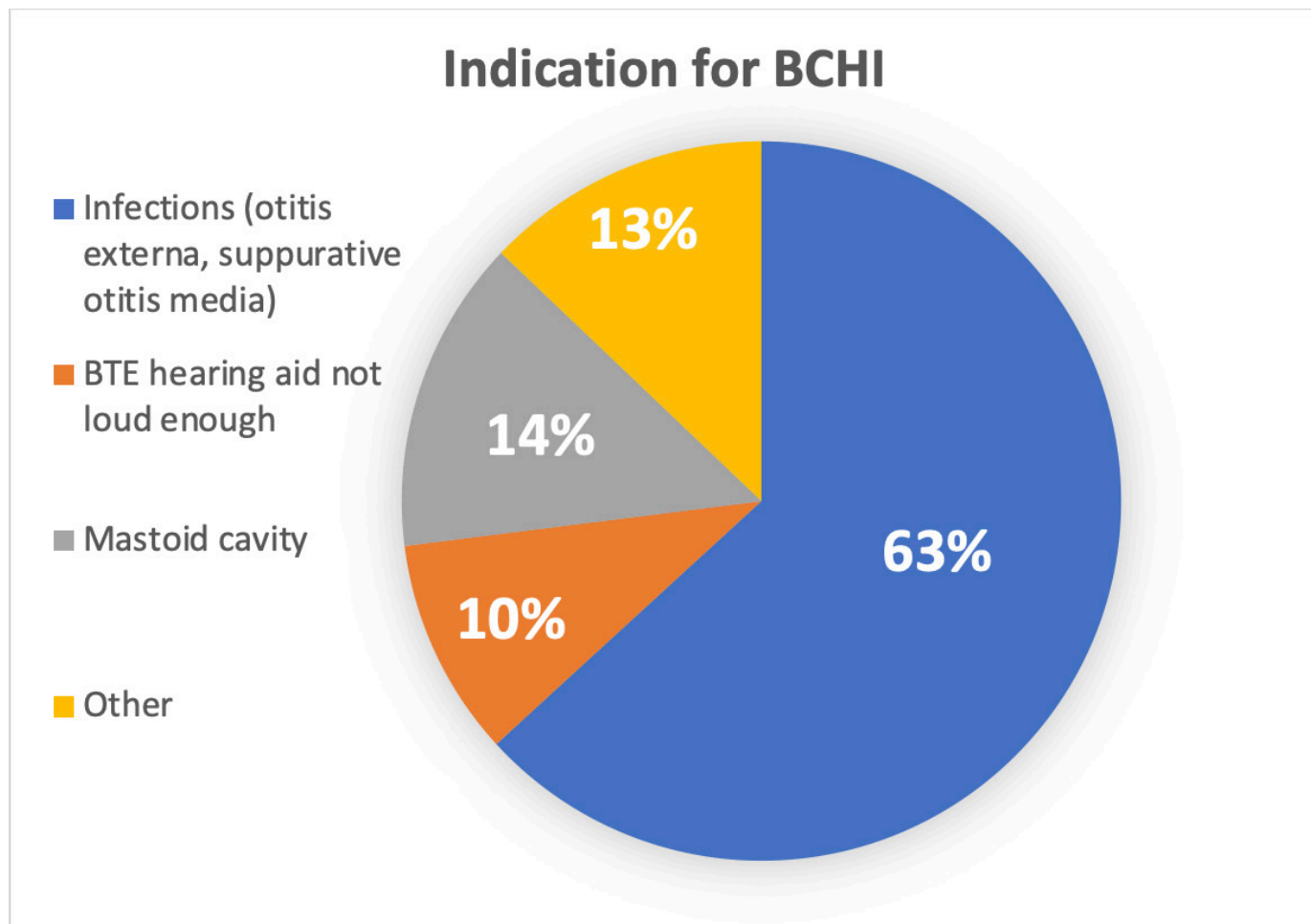


Figure 1 Indication for BCHI insertion. BCHI, bone conduction hearing implant; BTE, behind the ear.

for BCHI on GHSI domains was also explored. The indication for BCHI had no impact on well-being outcomes across all GHSI (table 2).

DISCUSSION

This large study over a significant period of time is unique in its reporting of both preintervention and postintervention QoL outcomes. It is noteworthy that every domain measured by the GHSI improved post-BCHI surgery. It is an easy assumption that the BCHI is merely a form of advanced hearing aid technology with purely audiological

benefits. Therefore, it may be expected that BCHIs improve many general and social QoL outcomes. Patients improved in confidence and self-esteem, experienced better social connection and felt less inconvenienced. However, this study also evidences many benefits patients experience from BCHIs beyond the expected. Gains were seen in less tangible general and social outcomes, including feeling less self-conscious, more optimistic about the future and feeling less embarrassed. The results reported here also show improvement in the physical domain; patients reported requiring fewer consultations with doctors, needing less medication and experiencing lower rates of illness.

It is interesting to note that the indication for BCHI had no bearing on GHSI scores; it can therefore be argued that patients stand to benefit from a BCHI regardless of their ear pathology. While previous similar studies have recorded indications for BCHIs, more research is needed regarding the impact of ear pathology on QoL outcomes.^{13 16 17}

While there are a variety of studies that report favorable general QoL outcomes post-BCHI, there is limited previous evidence of the impact of BCHIs on physical QoL or health-related QoL (HRQoL) measures.^{1 18} Table 3 summarizes previous studies on QoL outcomes in percutaneous BCHI patients, which

GHSI domain	Pre-BCHI median (IQ)	Post-BCHI median (IQ)	P value
Total	−25.0 (−44.2, −7.2)	50.0 (33.3, 66.7)	<0.0001
General	−41.7 (−68.9, −15.7)	66.6 (45.8, 87.5)	<0.0001
Social	66.7 (16.7, 83.3)	0.0 (0.0, 33.0)	<0.0001
Physical	−33.0 (−66.7, 0.0)	0.0 (0.0, 50.0)	<0.0001

BCHI, bone conduction hearing implant; GHSI, Glasgow Health Status Inventory; IQ, interquartile.

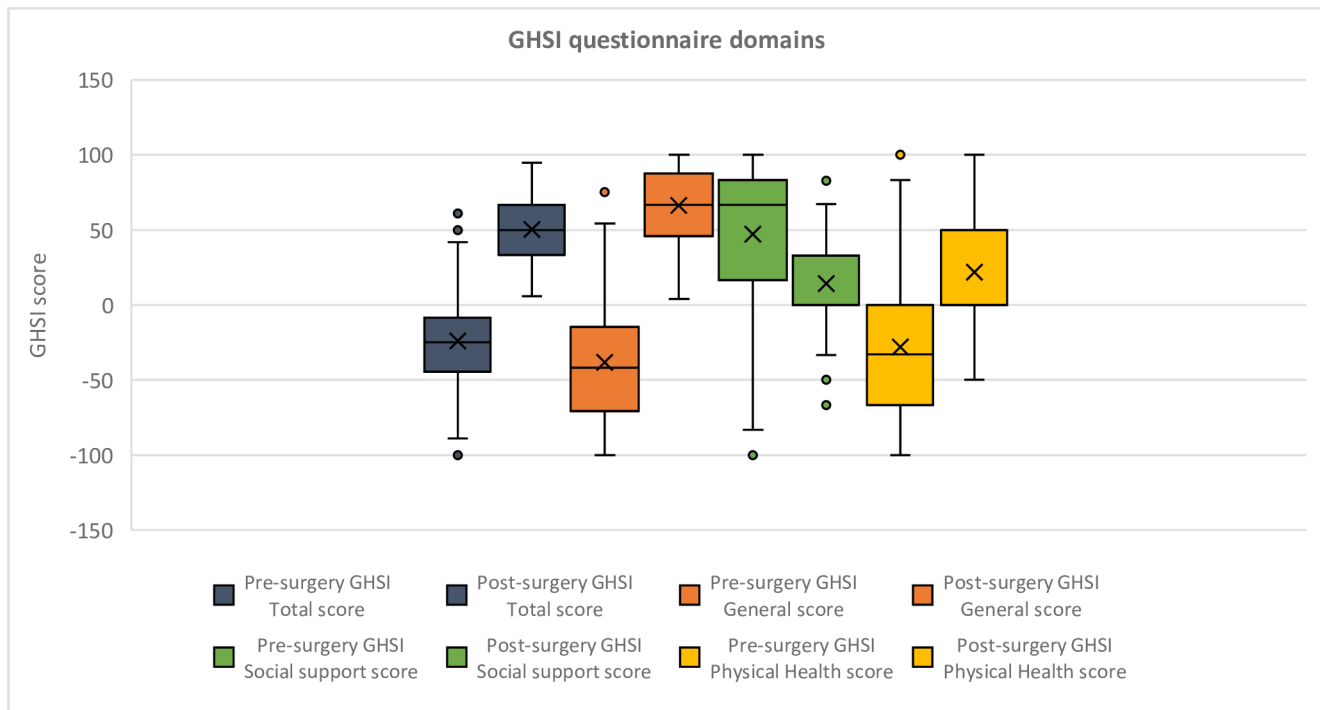


Figure 2 GHSI scores pre- and post-BCHI insertion. BCHI, bone conduction hearing implant; GHSI, Glasgow Health Status Inventory.

Table 2 Difference in Median and IQ GHSI scores by indication for BCHI		
GHSI domain	Median difference (IQ)	P value
Total		
Infections	82.0 (47.6, 108.0)	<0.0001
Other	69.4 (41.8, 88.8)	<0.0001
BTE not loud enough	62.3 (48.6, 77.1)	0.0002
Mastoid cavity	75.0 (55.6, 103.0)	<0.0001
General		
Infections	104.2 (71.5, 138.0)	<0.0001
Other	112.3 (79.3, 129.2)	<0.0001
BTE not loud enough	100.0 (63.0, 124.8)	<0.0001
Mastoid cavity	108.0 (95.8, 133.5)	<0.0001
Social		
Infections	−33.3 (−83.0, 0.0)	<0.0001
Other	−33.3 (−83.0, 0.0)	0.0271
BTE not loud enough	−50.0 (−74.8, −16.7)	0.0012
Mastoid cavity	−50.0 (−83.3, 0.0)	0.0162
Physical		
Infections	50.0 (16.7, 100.0)	<0.0001
Other	32.7 (0.0, 66.7)	0.002
BTE not loud enough	33.2 (0.0, 58.3)	0.0292
Mastoid cavity	33.3 (16.7, 99.7)	0.0009

BCHI, bone conduction hearing implants; BTE, behind the ear; GHSI, Glasgow Health Status Inventory; IQ, interquartile.

are mainly retrospective in nature with small sample sizes.

One study from Nijmegen reported pre- and post-BCHI intervention outcomes of 56 patients using SF-36, EQ-5D and Hearing Handicap and Disability Inventory. They found that there was no difference in general health pre- and post-BCHI; however, there was a significant improvement in disability and handicap ($p<0.01$).¹⁷ Our study indicates that BCHIs can result in improvement in HRQoL. The potential that BCHIs result in improvement in HRQoL requires further investigation.

Conversely,^{16 16} this study demonstrates improvement in the social domain, whereby patients reported needing less social support. It may be that the sample size used in the previous study was too small to note this effect.

Despite the strong evidence for the wide-ranging improvement in QoL following BCHI surgery, the limitations of this study must also be acknowledged. A large number of potential patients were excluded; however, a significant portion of these were patients with previous BCHI, where pre- and post-QoL measures would not be appropriate. The high response rate (89.0%) from the included patients is reassuring and higher than other comparable studies.^{12 13} Children were excluded, and the impact of age on QoL outcomes was not explored. Where early treatment of hearing loss will have audiological, social and educational benefits,¹⁹ it would be interesting to investigate this. No information was gathered on patients'

Table 3 Summary of research on quality of life outcomes in percutaneous BCI patients

Study title	Year	Sample size	Device	QoL instrument	Key findings
Bonebridge bone conduction implant. Hearing outcomes and quality of life in patients with conductive/mixed hearing loss. ¹⁹	2022	52	Bonebridge bone conduction implant (percutaneous)	APHAB	Global scores decreased from 56% (SD 10.4%) before surgery to 26.2% (SD 8.2%) after 6 months of follow-up
Do patients report quality of life improvements after fitting of their unilateral bone conducting hearing implant? ¹⁵	2021	62	Percutaneous BCI with abutment	GHSI	General, total and physical scores improved ($p<0.0001$), no improvement in social score.
Benefit and quality of life in older bone-anchored hearing aid users. ²⁰	2010	134	Percutaneous BCI with abutment	GBI, APHAB, NCIQ and HHIE-S	GBI mean benefit positive in 84%, APHAB scores ranged from 39 to 58%. The NCIQ showed good disability and handicap results (score range, 49–64). The HHIE-S showed that 60% of the patients had a mild to moderate handicap.
Patient quality of life with bone-anchored hearing aid: 10-year experience in Glasgow, Scotland. ²¹	2009	38	Range of percutaneous devices; BAHA Classic and Compact; Cochlear Europe, Addlestone, UK and BAHA Intenso and Divino; Cochlear Europe, Addlestone, UK	EMSQ, GBI	71% reported BCI improved QoL. Median total Glasgow Benefit Inventory Score of +33.3.
The Bone-Anchored Hearing Aid, Quality-of-Life Assessment. ¹⁶	2004	56	BAHA Classic or Cordelle (Entific Medical Systems)	SF-36, EQ-5D and HHDI	No difference in general health pre- and post-BCI; however, there was a significant improvement in disability and handicap ($p<0.01$)

APHAB, Abbreviated Profile of Hearing Aid Benefit; BCI, bone conduction hearing implant; EMSQ, Entific Medical Systems questionnaire; EQ-5D, EuroQoL-5D; GBI, Glasgow Benefit Inventory; GHSI, The Glasgow Health Status Inventory; HHDI, Hearing Handicap and Disability Inventory; HHIE-S, Hearing Handicap Inventory for the Elderly screening version; NCIQ, Nijmegen Cochlear Implant Questionnaire; QoL, quality of life; SF-36, Short form survey.

specific ear symptoms, such as pain, discharge or infection rate, and further information on the impact on HRQoL would be beneficial. This study reports the outcomes for patients who received percutaneous BCIs. As BCI technology develops and new devices enter the market, the impact on QoL may vary.

Conclusion

This study is unique in its measure of presurgical and postsurgical intervention QoL outcomes. Evidencing a wide range of far-reaching benefits experienced by a large number of patients over a decade of surgical practice. It is highly likely there are many potentially eligible patients who do not reach BCI services. We argue that there are very few other elective surgical interventions that result in such positive and life-changing outcomes, and it is important to raise

awareness of BCIs among healthcare professionals so that many more can benefit in the future.

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