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Bone-conduction hearing aids in an elderly population: complications and quality of life assessment

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Abstract To determine whether an elderly population with hearing impairment can be adequately rehabilitated with a bone-conduction hearing aid and whether the putative relationship between the elderly and an increased complication rate is justified. The study design was a retrospective case note review with a postal and telephone questionnaire, which was carried out in a tertiary centre. All patients aged 60 or over underwent implantation with a bone-conduction aid between 2009 and 2013 for conductive, SSD or mixed hearing loss. Outcome measures were complication rates and quality of life assessment using the Glasgow Benefit Inventory. The influence of patient and surgical factors on the complication rate was assessed. Fifty-one patients were implanted. Mean age was 67 years (range 60–89 years). The mean benefit, satisfaction and global GBI scores were 70 % (range 0–100 %), 70 % (0–100 %) and 82 % (83–100 %), respectively. The residual disability was 18 % (0–25 %). The adverse skin reaction rate was 16 % and the fixture loss rate was 2 %. There was a demonstrable increase in the complication rate with the dermatome (45 %; 5 patients) compared to the Sheffield 'S' (13 %; 2 patients) or linear incision techniques (29 %; 7 patients). The bone-conduction hearing aids are ideal method of hearing rehabilitation in the elderly for all forms of hearing loss. It provides significant benefit with no increased complication rate, which is imperative if social isolation is to be avoided and cognition preserved in this growing elderly population.

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Introduction

Due to the increase in life expectancy, healthcare must provide for an ageing population and its hearing rehabilitation requirements. There is a strong relationship between hearing impairment in the elderly and psychosocial status, which can lead to social isolation, cognitive decline and the loss of independence [1, 2]. It is important to appreciate the relationship between a patient's level of cognition and their hearing impairment as successful rehabilitation of speech understanding is dependent on a reasonable cognitive level and vice versa in the over-75 age group [3].

Depending on the degree of hearing impairment and type of hearing loss, an air conduction hearing aid may not be sufficient. Bagai et al. [4] demonstrated that elderly patients who were not using their conventional aid were more likely to experience depression and anxiety, decreased social activity and paranoia compared to an age-matched group who were able to wear their conventional aid. It is, therefore, imperative that an alternative method of hearing rehabilitation must be sought in this patient group.

Since the bone-conduction hearing aid became commercially available in 1987, it has become a well-established method of hearing rehabilitation in patients with a conductive or mixed hearing loss or those with single-sided deafness (SSD) [3] in those patients who are not candidates for middle ear surgery and/or conventional hearing aids. In the elderly, the level of hearing impairment can be further confounded by the presence of presbyacusis in the better hearing ear, which affects between 25 and 40 % of the

population aged 65 or over, increasing to greater than 80 % in the over-85 age group [4]. Linstrom et al. [5] demonstrated the benefits of the bone-conduction aid in SSD as well as the improvement of speech recognition in background noise. Several studies have demonstrated that bone-conduction aids in patients with SSD are effective in reducing the psychosocial consequences associated with hearing impairment in the long-term [6–8].

Although there is evidence to state that bone-conduction devices are beneficial in the elderly, surgeons have been reluctant to perform the procedure due to the putative increased complication rate and poor hearing rehabilitation results.

The current study aims to determine whether performing implantation with a percutaneous bone-conduction hearing aid in the elderly gains them sufficient benefit and whether there is an association with a greater complication rate than in the under-60 population.

Methods and materials

Patients

All patients aged 60 or over who underwent implantation of a single type of bone-conduction device, the percutaneous BAHA^{TM} (Cochlear, Sweden) in a tertiary referral centre between 2009 and 2013 were included in the study.

All the patients were counselled prior to implantation of the device. They were given the option of conservative management, conventional hearing aid, bone-conduction hearing aid or middle ear surgery if appropriate. All were given a trial of a bone-conduction device on a headband prior to surgery.

Study design

Study design is retrospective case note review and postal and telephone questionnaire study.

Outcome measures

Outcome measures used were the Glasgow benefit index (GBI) to determine the level benefit and residual disability post-implantation and the rate of post-operative complications. The influence of patient and surgical factors on the complication rate was assessed. Patient factors included patient age, cause of hearing loss, comorbidities (diabetes and cardiovascular) and smoking status. Surgical factors included the surgical technique used (dermatome, Sheffield 'S' incision or linear incision) (Fig. 1a, b, c), the length of abutment, grade of surgeon (Consultant, Registrar or Fellow) and whether soft tissue reduction was performed.

Statistics

Statistical analysis was performed using the XLSTAT statistical computer program (Addinsoft, New York, USA). Logistic regression analysis and non-parametric tests were used to determine whether the factors were statistically significant. P values of less than 0.05 were considered significant.

Results

Fifty-one patients aged 60 or over were implanted with a percutaneous bone-conduction hearing aid between 2009 and 2013. The mean patient age was 67 (range 60–89 years). The male:female ratio was 22:35. The mean length of follow-up was 22.6 months (range 6–48 months). There were 49 primary and two revision procedures. Forty-two patients underwent implantation under general anaesthesia and nine under local anaesthesia with sedation. The indications for implantation are shown in Table 1. Thirteen patients had a conductive or mixed hearing loss due to a variety of pathologies for example. otosclerosis. These patients had originally been fitted with conventional hearing aids, but had not tolerated them or had not gained benefit with them. Therefore, they were offered a bone-conduction hearing aid.

Surgical technique

The majority of patients (47 %; 24 patients) underwent surgery using a linear incision with no soft tissue reduction. In 31 % (16 patients), the Sheffield 'S' incision was used, which involved a S-shaped incision with no soft tissue reduction, and in 22 % (11 patients) the dermatome was used to create the skin flap which involved significant soft tissue reduction (Fig. 2).

Abutment length

There was no statistically significant relationship between abutment length and complications using logistic regression analysis ($p = 0.163$) and non-parametric test ($p = 0.197$ Kruskal–Wallis) (Table 2).

Age of patient

Fifty-three per cent (27 patients) of those implanted were aged between 60 and 70 years of age with decreasing numbers in the 71–80 and 81–90 age groups with 18 % (9 patients) and 10 % (5 patients), respectively.

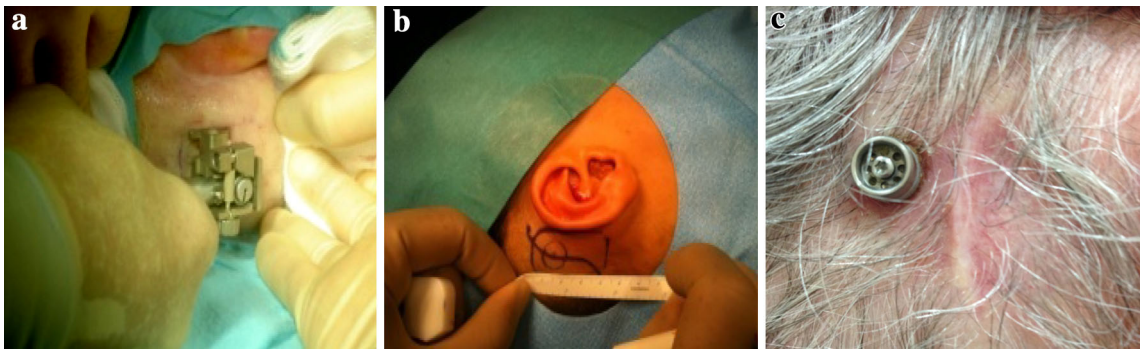

Fig. 1 Surgical technique used for the incision and skin flap. **a** Dermatome, **b** Sheffield 'S' incision and **c** linear incision

Table 1 Indication for implantation

Indication for surgery	No. of patients
Discharging mastoid cavity	20
No benefit from conventional hearing aid	13
Otitis externa	9
Single-sided deafness	4
CSOM	5

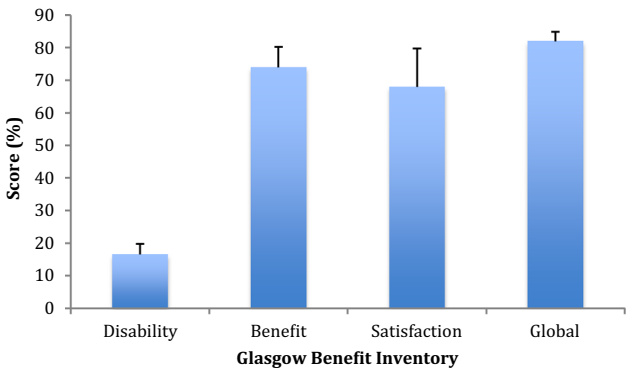

Fig. 2 Glasgow benefit inventory (GBI) scores for patients implanted with the bone-conduction device. Mean GBI score (%) +SEM ($n = 33$)

Comorbidities and smoking status

Table 3 demonstrates number of patients with co-morbidity and a positive smoking history.

Glasgow benefit inventory

There was a return rate of 94 % (50 patients) for the GBI postal and telephone questionnaire.

The mean benefit, satisfaction and global scores were 74 % (range 0–100 %), 72 % (range 0–100 %) and 82 % (range 38–100 %), respectively, whilst the residual disability remained low at 16 % (range 0–25 %). Two patients reported that they did not receive any benefit from the bone-conduction device, one of which remained a partial user and one who was implanted for SSD underwent removal of the implant and referral for a cochlear implant.

Table 2 Number of patients implanted with various abutment lengths

Length of abutment (mm)	Number of patients
4	2
5.5	12
6	1
8	1
8.5	1
9	13
10	9
12	10

Table 3 Co-morbidity and smoking status

Co-morbidity	Number of patients
Cardiovascular (hypertension, ischaemic heart disease, previous MI)	18
Diabetes mellitus	8
Other	24
Smoking status	
Current smoker	11
Ex-smoker	24
Non-smoker	16

Post-operative complications

Twenty-three per cent (12 patients) had post-operative complications ranging from temporary inflammation around the abutment to fixture loss (1 patient). Table 4

Table 4 Number of patients with each complication according to Holgers Classification

Holgers score	Number of patients
0	40
1	0
2	3
3	6
4	2

Holgers score. *Grade 0* no reaction; *Grade 1* Erythema with slight swelling around abutment; *Grade 2* Erythema, moistness and moderate swelling; *Grade 3* Erythema, moistness and moderate swelling with granulation around abutment; *Grade 4* Overt signs of infection resulting in removal of implant

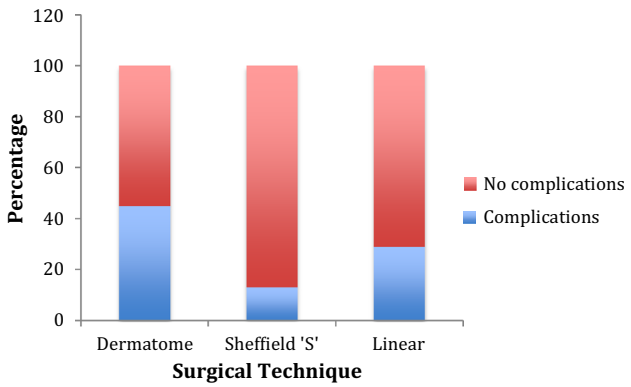

Fig. 3 The rates of complication for each surgical technique used

demonstrates the rate for each complication using Holgers Classification.

There was a demonstrable increase in the complication rate in those patients in whom the dermatome was used (45 %; 5 patients) compared to the Sheffield 'S' (13 %; 2 patients) or linear incision techniques (29 %; 7 patients) (Fig. 3). The relationship between surgical technique and post-operative complication rate was not statistically significant ($p = 0.149$, logistic regression; $p = 0.8$, Kruskal–Wallis test).

In addition, logistic regression analysis demonstrated no significant relationship between the complication rate and the age of patient, cause of hearing loss, grade of surgeon, or soft tissue reduction independently.

None of the patients reported problems with operating the sound processor or cleaning abutment and surrounding skin.

Discussion

The current study demonstrated that the majority of elderly patients gained considerable benefit with minimal residual disability from implantation with bone-conduction device using the GBI scores. This is in agreement with de Wolf et al. [9] who demonstrated a significant improvement in GBI scores in their study of 134 elderly patients implanted with a percutaneous bone-conduction device.

In the current study, four patients were implanted for SSD, three of which gained a considerable benefit from the device. This is comparable to Faber et al. [3], who demonstrated an improvement in the GBI score in all 11 elderly patients implanted for SSD.

In the current study, the rate of adverse skin reactions, which consisted of granulation and localised inflammation, was 16 % and the fixture loss rate was 2 %. This was comparable to other studies of elderly patients implanted with bone-conduction hearing aids. The rate of adverse skin reactions was equal to that of de Wolf et al. [10], in their study of 224 patients aged 60 or over, who demonstrated a rate of 16.9 %. The fixture loss rate was considerably lower in the current study with 2 % compared to 6.5 %. Calvo Bodnia et al. [11] demonstrated a slightly lower adverse skin reaction rate of 9 % and a fixture loss rate of 3.8 %. None of their patients had problems with skin overgrowth compared to 4 % in the current study. Six per cent had their implant removed due to discomfort or a lack of benefit compared to 2 % in this study.

The results were also comparable to a younger group of patients, aged under-60. Calvo Bodnia et al. [11] demonstrated an adverse skin reaction rate of 16 % with fixture loss of 2.5 %.

Irrespective of age, surgical technique appeared to have the greatest influence on complication rate. The dermatome was associated with the highest number of complications at 45 %, which was in agreement with van Rompaey et al. [12] who stated that 36.6 % of patients had adverse skin reactions using the dermatome technique. The linear and Sheffield 'S' incision techniques were associated with the fewest complications at 29 % and 13 %, respectively. In agreement with this, Calvo Bodnia et al. [11] demonstrated the lowest complication rate with the linear incision technique. Despite the surgical technique and abutment length not being significantly associated with an increased complication rate, it is the experience of the senior author (JR) that the linear incision and a longer abutment are associated with fewer complications. This is in agreement with Calvo Bodnia et al. [11] and Allis et al. [13] who demonstrated that a longer abutment length led to fewer complications.

Pre-operative concerns regarding dexterity and maintenance of the abutment as well as operation of the sound processor proved to be incorrect, a similar finding to de Wolf et al. [9] and Faber et al. [3].

The current study has demonstrated that bone-conduction hearing aid implantation in the elderly is not

associated with a significant post-operative complication rate and that it can adequately rehabilitate the majority of elderly patients who are fitted with it. This is vital if these patients are to be protected from social isolation and cognitive decline.

Conclusion

The percutaneous bone-conduction hearing aid is an ideal method of hearing rehabilitation in the elderly for all forms of hearing loss. There is no increased rate of complications and it provides significant benefit with reduced residual disability which is imperative if social isolation is to be avoided and cognition preserved in this growing ageing population.

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