The Outcomes of Cochlear Implantation in Elderly Patients: A Single United Kingdom Center Experience

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Abstract

Objectives: The average life expectancy in the United Kingdom is currently nearly 80 years for a newborn baby with nearly 15% of the population, by 2040, being >75 years old. Hearing impairment is a common disability in the elderly individual, and there have been significant drives to support this population to lead longer and healthier working lives. We aimed to assess the long-term audiological and health-related quality-of-life benefits of cochlear implants (CI) in elderly individuals. Methods: A retrospective and cross-sectional study of patients who received a CI at ≥70 years. Data extracted included speech perception scores, adverse events, telephone use, and patient-reported outcome measures using the Glasgow Benefit Inventory questionnaire with a minimum of 12 months follow-up. Results: Sixty-four patients aged ≥70 years received a unilateral CI. A significant improvement in speech perception scores in all conditions was noted with no significant difference between differing age groups. Glasgow Benefit Inventory scores showed a significant positive impact on patients’ lives and their health status, with no significant difference between the differing age groups. Conclusions: Cochlear implantation is a safe and well-tolerated procedure in the elderly patients with significant improvements observed in audiological performance, health status, and social interactions.

Keywords

cochlear implant, elderly patients, audiology, patient-reported outcomes measures, Glasgow benefit inventory

Introduction

Hearing Loss in the Elderly Individual

The average life expectancy in the United Kingdom is currently 79.2 years for a newborn baby boy and 82.9 years for a girl.¹ It has been estimated that, by 2040, nearly 15% of the population will be over 75 years old in the United Kingdom. The Office for Budget Responsibility predict that total public spending will increase by nearly £80 billion over the next approximately 50 years principally due to the ageing population.² There are drives to support the ageing population to lead longer and healthier working lives and to address barriers that may limit later life learning.²

Hearing impairment is a very common problem among the elderly patients and is the third most common disability within the United States among the population older than 65 years.³ The prevalence of hearing loss (HL) in individuals aged 70 to 79 years is 55%, rising to 81% in those over 80 years, including 7.5% with severe-to-profound HL.⁴

The implications of HL in elderly patients extend beyond simply auditory perception. With advancing age, HL that has not been appropriately rehabilitated can have severely damaging effects on general health outcomes including cognition, mental health, and quality of life.⁵,⁶ A prospective case-control study demonstrated widespread cognitive impairment in elderly patients with severe hearing impairment compared to a matched control group.⁷

A large cohort study by Lin et al found HL to be independently associated with lower baseline cognitive scores and,
over a 6-year follow-up, result in an accelerated annual rate of cognitive decline.8 Hearing rehabilitation with hearing aids and cochlear implants (CI) has been shown to improve quality of life including cognitive skills and social performance score in elderly patients with a wide range of HL.9-11 A recent study demonstrated over 97% of patients had a significant improvement in cognition after only 18 months of appropriate auditory rehabilitation.12

In 2017, there were around 45 000 CIs implanted worldwide and the total number of CI users worldwide is close to 500 000.13 The number of people with CI is ever increasing, and within the United Kingdom, recent changes in the National Institute for Health and Care Excellence (NICE) criteria for CI candidacy has been estimated to result in a 70% increase in the number of CI recipients within 5 years.14

While the efficacy of CI in rehabilitation of severe-to-profound HL is well established, careful consideration should be given to the balance between the potential impact of any associated comorbidities and the perceived long-term benefit of CI in elderly individuals, as well as the potential risks of surgery.

In this study, we evaluated the audiological, communication, and quality of life outcomes in elderly patients who received CI in our center.

Patients and Methods

A retrospective analysis was performed on all patients who received a unilateral CI aged ≥70 years between January 01, 2008 and May 31, 2017 at St. Thomas’s Hearing Implant Centre, London, United Kingdom. Preoperative assessment included as a minimum pure tone audiometry, speech perception using the Bamford-Kowal-Bench (BKB) sentence test (70 dB SPL sound intensity) in quiet conditions (BKBq) and imaging. The decision to offer CI was based on the audiological profile as outlined in the NICE guidance at the time of implantation.14 Due to the gradual evolution in clinical practice at our center, some patients also had BKB in noise (BKBn) at +10 dB signal-to-noise ratio and the Arthur Boothroyd (AB) word list (phonemes) as additional speech perception testing. The patient’s ability to use the telephone with familiar speakers was also recorded.

All patients included in this study had a minimum of 12 months of follow-up. Outcome measures included immediate and delayed surgical complications, postoperative speech perception scores, the ability to use the telephone with familiar speakers and patient-reported outcome measure (PROM) using the Glasgow Benefit Inventory (GBI) questionnaire after at least 12 months of device use. The cohort was subdivided into 2 age groups: those aged between 70 and 79 years and those aged ≥80 years at the time of implantation.

The Shapiro-Wilk test of normality demonstrated the patient cohort could not be assumed to be normally distributed. The Mann-Whitney U Test was used to compare median values of independent un-paired data while the Wilcoxon signed-rank test compared dependent paired data. McNemar test was used to compare paired nominal data and the $\chi^2$ test for unpaired nominal data. Statistically significant difference was considered to be $P < .05$. All statistical analyses were performed with SPSS version 23.0 (IBM Corp., Armonk, New York).

Results

Demographics

Over the 10-year study period, 64 patients aged ≥70 years received a unilateral CI (31 females, 33 males). The median age at implantation was 76.4 ± 5.3 years (mean 77.0, range 70.0-90.1). The median duration of post-implantation follow-up was 32.2 ± 28.0 months (mean 43.0, range 12.0-124.4). The subdivision of age groups is shown in Figure 1. The increase in the number of patients implanted older than the age of 70 years between January 01, 2008 and June 30, 2017 is illustrated in Figure 2.

Over 75% (49/64) of patients had significant systemic comorbidities at the time of their CI surgery. The most common comorbidity was hypertension, noted in nearly 30% of patients. Other documented comorbidities included ischemic heart disease, diabetes mellitus, osteoporosis, and previous malignancy.

Surgery and Complications

Devices from 3 different CI manufacturers were used, with no statistically significant difference in device choice between the 2 age groups, 70 and 79 years and ≥80 years ($\chi^2 = 2.4, P = 0.3$). In 75% of the cases, there were no immediate postoperative complications. The most common complaint was early postoperative dizziness, reported in 20%. Persistent dizziness was unusual, with only 1 patient requiring formal vestibular rehabilitation. There were no increased rates of traumatic falls, fractures, or reduced mobility status.

Two (3%) patients required revision surgery. Of these, one patient had successful reimplantation following electrode extrusion. The other patient, who had initially derived great benefit from CI after implantation at 89 years old, developed

![Figure 1. The subdivision of age groups at time of cochlear implantation.](image-url)
an electrical device failure after 6 years and underwent explanta-
tion/reimplantation at the age of 95 years. After an initial
uncomplicated recovery, he developed repeated wound break-
down with implant extrusion and subsequently permanent
explantation.

Two (3%) patients became nonusers due to inadequate
audiological benefit. Of note, there had been no audiological,
medical, or radiological concerns about potential poor out-
comes during the preoperative CI assessment, nor surgical
complications for either patient (aged 73.3 and 80.0 years at
the time of implantation). Two (3%) patients died of unrelated
causes during the study period, at 33.1- and 33.6-months
post-implantation.

Audiological Outcomes

There were statistically significant improvements in the med-
ian scores across all 3 measures of speech perception follow-
ing implantation ($P < 0.05$, Wilcoxon signed-rank test; Figure
3). Speech perception scores improved postoperatively in
96.7% (58/60), with maximal benefit noted after just 3 months
in 87.5%. In 2 patients, there was no objective improvement
postoperatively (BKBq scores 0%-0% and 49%-44%, respec-
tively); one patient had partial electrode insertion due to dif-
cult anatomy. Despite the lack of improvement in objective
measures, both patients still reported subjective overall ben-
et and continue to use their device consistently.

There was no significant difference between the 70 and 79
and ≥80s age subgroups in the most recent BKBq, BKBn, and
AB words scores ($P = 0.28$, $P = 0.11$, and $P = 0.39$, respec-
tively, Mann-Whitney $U$ test).

Telephone

Data relating to telephone use pre- and post-CI was documen-
ted in 87.5% (56/64). Of these, only 8.9% (5/56) had been able
to communicate using the telephone to some extent preopera-
tively, with a median time of 48 months since last use (mean
88.3, range: 1.2-943.2). Following implantation, 67.9% (38/56)
were able to use the telephone. This increase was statistically
significant ($P < 0.05$, McNemar test). The younger age sub-
group was more likely to be able to achieve this ($\chi^2 = 5.3, P
< 0.05$). Only 1 patient who had been able to use the telephone
preoperatively was no longer able to do so following implanta-
tion. This was also 1 of the 2 patients who saw no objective
improvement in speech perception postoperatively.

Glasgow Benefit Inventory

Glasgow Benefit Inventory, first described in 1996, is a vali-
dated PROM which is utilized postoperatively to assess the
impact of the intervention on a patient. It consists of 18
questions and a 5-point Likert scale. Complete responses were
received in 68.8% (44/64), and the overall results from GBI and
each subdomain were calculated. As shown in Table 1, the
results showed a significant positive impact on patients’ lives
and their health status, notably within the “general” and
“social” domains in both age subgroups. The median GBI
score in our study cohort was 47.2 ± 19.9 (mean 55.1, range
19.1-86.1). The most significant benefit was noted within the
“general” and “social” domains. The median score in the 70-
to 79-year-old group was 48.6 ± 20.1 (mean 56.8, range 19.1-
86.1) and 45.8 ± 20.2 (mean 45.6, range 22.2-83.3) in the
≥80-year-old group. Positive benefit was observed in both age
groups with no statistically significant difference in scores between the 2 age groups in the overall score or the differing domains.

**Discussion**

*Cochlear Implants Outcomes in the Elderly Individuals*

The appropriateness of CI for hearing rehabilitation in the elderly patients has been a subject of interest for many years. The negative effect of HL in the elderly patients is well-documented, and hearing rehabilitation with CI has been suggested to play a role in limiting the age-related decline in health-related outcome in such patients.\(^5\)\(^-\)\(^1^1\)\(^,\)\(^1^6\) A recent study has shown significant improvements not only in auditory perception but also cognitive function following hearing rehabilitation with CI.\(^1^7\) Patients with impaired baseline cognitive function should, however, receive additional cognitive rehabilitation where appropriate to improve long-term outcomes.

We demonstrated improved speech perception (BKBq, BKBn, and AB words) in both age subgroups, suggesting that age alone is not a predictor of audiometric outcomes. Our experience is comparable to recent studies on CI outcomes in elderly recipients with postlingual deafness showing no significant correlation with age of implantation.\(^1^0\)\(^,\)\(^1^8\)\(^,\)\(^1^9\) It is likely that, rather than age alone, more clearly established prognostic indicators such as duration of unaided deafness should receive more consideration during candidacy assessment.

The ability to use the telephone was assessed, in view of its importance in daily life and our increasing reliance on it as a communication tool for social interactions. In our study, 67.9% of patients were able to achieve this following implantation, compared to 8.9% preoperatively. Although improvements were observed in both age subgroups, older patients had a reduced chance of telephone use following CI. With ever-improving technology, notably Bluetooth-compatible wireless hearing assistance technology, it is hoped that an increasing number of CI users will have easier access to telephone use.\(^2^0\)

**Adverse Events**

One aspect of CI in elderly patients is the perception of increased surgical risks, both related to general anesthesia and specific to CI. Perioperative anesthetic complications of CI

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**Table 1. Glasgow Benefit Inventory (GBI) Overall Scores With Subdivisions Into the 3 Different Domains Age Subgroups.**

|                  | Total   | General | Social  | Physical |
|------------------|---------|---------|---------|----------|
| Overall Median   | +47.2   | +68.8   | +66.7   | +0.0     |
| Overall standard deviation | 19.9    | 23.3    | 33.8    | 23.4     |
| Median 70-79 years | +48.6   | +70.8   | +66.6   | +0.0     |
| Standard deviation | 20.1    | 23.3    | 32.9    | 25.1     |
| Range            | +19.1 to +86.1 | +23.2 to +95.8 | +0.0 to +100.0 | −50.0 to +50.0 |
| Median ≥ 80 years | +45.8   | +50.0   | +50.0   | +0.0     |
| Standard deviation | 20.2    | 25.4    | 34.6    | 15.7     |
| Range            | +22.2 to +83.3 | +16.7 to +95.8 | 0 to +100 | −33.3 to +16.7 |
| P value (Mann-Whitney U test) | 0.121   | 0.234   | 0.126   | 0.347    |
surgery in the supposedly high-risk groups such as the elderly patients still tend to be low, as shown in this study, with no complications directly attributable to general anesthesia, despite over 75% having significant systemic comorbidities. There were no unexpected admissions to an intensive care or high dependency unit postoperatively.

Cochlear implants surgery is widely regarded as a safe operation. Complication rates are classified into minor and major depending on their severity, as illustrated in Table 2. The rate of major complications in our series was comparable to the reported literature, with 75% of patients having no postoperative complications at all. In a review article which analyzed over 20,000 patients, the overall delayed complication rate was found to be 5.7% with fewer complications in the adult cohort than the pediatric group. Both major and minor surgical complication rates in the elderly patients have been reported to be similar to other adult age groups.

Table 2. Comparison of Major and Minor Complications With Reported Rates of Complication in All Age Groups.

| Complication                             | Reported Rates in General Population | Our Series |
|------------------------------------------|--------------------------------------|------------|
| Major complications of cochlear implantation |                                      |            |
| Device failure                           | 3.4%                                 | 1.6%       |
| Mastoiditis                              | 1.4%                                 | 0%         |
| Skin and wound infections including requiring further surgery | 1.3%                                 | 1.6%       |
| Electrode issues                         | 1.9%                                 | 1.6%       |
| Device migration                         | 0.7%                                 | 1.6%       |
| Facial weakness                          | 0.6%                                 | 0%         |
| Cholesteatoma                            | 0.5%                                 | 0%         |
| CSF otorrhea                             | 0.3%                                 | 0%         |
| Meningitis                               | 0.2%                                 | 0%         |
| Minor complications of cochlear implantation |                                      |            |
| Vestibular symptoms including dizziness  | 3.9%                                 | 20.3%      |
| Taste disturbance                        | 2.8%                                 | 6.3%       |
| Troublesome tinnitus                     | 4.2%                                 | 1.6%       |
| Tympanic membrane perforation            | 0.5%                                 | 0%         |
| Recurrent oitis media                    | 0.8%                                 | 0%         |
| Chronic headaches                        | 0.9%                                 | 0%         |

Abbreviation: CSF, Cerebrospinal fluid.

Glasgow Benefit Inventory

Patient-reported outcome measures allowed us to assess the impact of CI on patient’s quality of life. A recent systematic review evaluating the utilization of GBI in otolaryngology demonstrated consistency of data in meta-analyses of studies on CI, supporting its use as a PROM tool in studies on CI outcomes.

There was no statistically significant difference between the 2 age groups in the overall GBI scores as well as within each of the 3 domains. In addition, there was no patient with a negative overall GBI score, although 18.2% had a negative score within the “physical health” domain. The overall benefit within the “physical health” domain was also considerably less, compared to the “general” and “social” subscale scores. This is not unexpected as receiving a CI would be in anticipation of reducing the amount of social support required and improving their general and social functions rather than physical health. Our positive findings are in keeping with the literature showing statistically significant improvement in PROMs after cochlear implantation.

Our median GBI score of +47.2 suggests a very strong improvement in quality of life after CI surgery; although a direct comparison is not possible, it is of interest that the GBI score following cataract surgery has been reported to be +23.2.

Conclusion

Cochlear implantation is a safe and well-tolerated procedure in elderly patients. Significant improvements are observed in audiological performance including telephone use and in patient-reported outcomes, although report of improved telephone use appears to be less pronounced in those over 80 years of age.

Authors’ Note

Dan Jiang and Irumee Pai are also affiliated with King’s College London, London, United Kingdom.
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