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MAIN ARTICLE

Cochlear implantation in Malawi: report of the first four cases

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Abstract

Objective: This paper reports on the first four cochlear implant cases in Malawi.

Case reports: Three patients were deafened from infectious diseases and one from an unknown cause. They all had post-lingual deafness. Six months after the last implant, they are all progressing well.

Conclusion: Despite significant practical difficulties, it has proved possible, with the right support, to carry out cochlear implantation in one of the world's poorest countries. The project has also raised awareness of deafness in Malawi and highlighted significant public health issues relating to the aetiology of deafness in developing countries.

Key words: Cochlear Implants; Africa; Hearing Loss

Introduction

The World Health Organization (WHO) estimates that there are 360 million persons worldwide with disabling hearing loss, equating to 5.3 per cent of the world's population.[1] Disabling hearing loss refers to a hearing loss in the better hearing ear of greater than 40 dB in adults and greater than 30 dB in children. Such losses significantly affect a person's ability to communicate using speech and language. The prevalence of disabling hearing loss in children is estimated to be 32 million worldwide, with the greatest numbers in South Asia, Asia Pacific and Sub-Saharan Africa.[2] The incidence of severe-to-profound congenital sensorineural hearing loss is five to six times higher in low- to middle-income countries than in the USA and Europe.[3]

Since the introduction of multichannel cochlear implants in 1984, the potential hearing and speech outcomes of individuals with severe-to-profound hearing loss have been revolutionised.[4] Cochlear implants have become the treatment of choice for many individuals with severe or profound sensorineural hearing loss, and have been shown to be a cost-effective intervention in high-income countries. Device costs and post-implant rehabilitation costs have been a deterrent to many low- and middle-income countries in accessing cochlear implants.

One of the authors (DRS) visited Malawi, a low income country, as part of a sabbatical in 2013, and during the visit saw the tremendous need of profoundly deaf patients in the country. This visit led to the concept of carrying out cochlear implantations in Malawi. This paper outlines how, despite the challenges, two cochlear implants were successfully implanted in September 2014, with a further two cases in February 2016. As well as addressing the practical and ethical issues, it also outlines future plans in developing both implant and otological surgery in Malawi and Southern Africa.

Case reports

Case one

A nine-year-old girl presented in 2014 with a history of bilateral hearing loss following mumps infection three years previously. At the time of the infection, the child was in standard one class at school. There was no history of ear infections, or significant antenatal or general medical history, prior to 2006. Immunisation records were reported as complete, human immunodeficiency virus (HIV) test results were negative and her development was otherwise normal.

No abnormality was found on examination, with normal tympanic membranes bilaterally. Transient evoked oto-acoustic emissions were absent, with normal tympanometry findings bilaterally. Pure tone audiometry revealed a bilateral profound sensorineural hearing loss. Auditory brainstem response audiometry showed no waveform present up to 75 dBnHL in both ears. A computed tomography (CT) scan revealed a normal cochlear structure bilaterally.

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Case two

A 17-year-old boy presented with a history of hearing loss secondary to quinine treatment for malaria in 2010. He had no history of otalgia or otorrhoea. His medical history up to that time was unremarkable except for one episode of mumps which had not left any sequelae. He had normal hearing prior to the illness and there was only a minor family history of hearing loss (his grandmother had a hearing loss). He had normal developmental milestones and HIV test results were negative.

On examination, both tympanic membranes were normal, and the rest of the head and neck examination findings were unremarkable. Tympanometry showed bilateral type A tympanograms, but pure tone audiometry revealed a profound sensorineural hearing loss bilaterally. A CT scan revealed a normal cochlear structure in both ears.

Case three

A seven-year-old girl suddenly, in 2014, woke up one night crying and complaining of being unable to hear. There was no preceding illness, head injury or any other unusual circumstances. She was in standard one class at school, but stopped going to school because she could not hear. On presentation, she was able to write numbers between 1 and 10, and her speech was very clear. She was HIV-negative and had no history of ear infections.

Examination findings were unremarkable, with normal tympanic membranes bilaterally. Transient evoked oto-acoustic emissions were absent for both ears, with normal tympanometry bilaterally. Pure tone audiometry revealed a bilateral profound sensorineural hearing loss. The CT scan showed no abnormality.

Case four

A nine-year-old boy presented with hearing loss one month after a malaria infection for which he had received quinine treatment. He was HIV-negative, with no history of ear infections. He had reached normal developmental milestones at that time. He was attending school in standard two class, with good reading and writing skills (in the local language, Chichewa).

Examination revealed normal tympanic membranes, with no other abnormality on head and neck examination. Transient evoked oto-acoustic emissions were absent in both ears, with normal tympanometry bilaterally. Pure tone audiometry revealed a bilateral profound sensorineural hearing loss. The patient was fitted with high-powered Phonak Naida™ Q30 UP hearing aids, but was able to only detect some environmental sounds using them. The CT scan was normal.

Operative and post-operative details

As there was no audiological or medical preference with regard to choice of ear, the right ear was implanted in all four cases. A standard cortical mastoidectomy and posterior tympanotomy approach was used, with a cochleostomy anterior to the round window. Med-El (Innsbruck, Austria) cochlear implant devices were used; full insertion was achieved in 3 cases, with 10 out of 12 electrodes inserted in case three.

Normal impedances and neural response telemetry were confirmed intra-operatively. A plain X-ray 1 day post-operatively confirmed a satisfactory electrode position within the cochlear in all four patients. The patients were discharged from hospital the following day.

The devices were switched on between 6 and 10 weeks post-operatively. At the initial switch on, it was felt important to have an experienced audiologist available, and this led to a delay due to administration difficulties in obtaining a travel visa.

On the 1st post-operative day, we attempted to obtain threshold and comfort levels on each electrode for each patient. However, because of language, age and communication issues, we were only able to obtain these for case two, the eldest of the children. We set a standard map and measured levels in the free field, using a response task typically used for play audiometry, to measure the aided levels with the implant, and activated the processor. We made further adjustments whilst the map was live.

The cochlear implant was activated about two months post-operatively, at the ABC Clinic in Lilongwe. The patients were immediately able to detect and appreciate some sounds.

Follow-up appointments were overseen by one of the authors (RB), who is an Australian audiologist, permanently based in Lilongwe, with previous cochlear implant experience, helped by Malawian audiology assistants. Appointments were initially every week, then every two to four weeks, and finally every six months. All the children needed financial support to attend appointments. One patient (case one) lived 5–6 hours away from the clinic, which necessitated charitable support (from the ABC Clinic) for each visit, to provide accommodation, food and transport for herself and her mother.

Each cochlear implant recipient has required at least one replacement processor. Our experience was that 'ear level' audio processors (such as the Opus 2 (Med-El)) were easily damaged by dirt and dust, and were more susceptible to rust from the humidity. The 'head level' Rondo processors (Med-El), however, have proved much more robust in this regard. Nevertheless, we have had issues with breakage of the microphone covers in two Rondo processors.

Results

The surgical procedures were carried out in the ENT operating theatres at the Queen Elizabeth Central Hospital, Blantyre, Malawi. There were no post-operative complications.

All four implantees wear their implant at all times. The patients and families have adapted to the management of the processors, and the cleaning, storage,

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battery changes and so on. Three patients have now returned to full-time education and case three is due to commence school in the near future.

We have performed phoneme and word detection and discrimination testing and exercise with each of the children except case one. There are currently no standardised Chichewa (national language of Malawi) words or sentence tests.

Case one is in school and adjusting well, but still has difficulties in most of the school subjects. She remained absent from school for two years prior to implantation. The aided threshold levels for case one were 30 dB across the board (Table I).

Case two enjoys going to school and has settled well, although his academic level is currently 67th of 75 children in his standard five class, and he is still struggling with several school subjects. He failed most subjects, but was given a conceded pass to the next year level taking into account his disability. Extra classes have now been arranged for him. His aided threshold levels were 25 dB across the board (Table I). He has had speech and language therapy, focusing on perception and the production of English vowels. He has demonstrated the ability to discriminate and identify vowels. He communicates well using a mobile phone.

Case three is not yet in school. So far, she is able to socialise with friends and is adjusting well with the cochlear implant. Her aided threshold levels were 25–35 dB across the board (Table I). She has had speech and language therapy sessions, and her mother reports that most of her Chichewa words are now clearer.

Case four has returned to school and is adjusting well. He went back to school two weeks after switch on. His aided threshold levels were 30–40 dB across the board (Table I). He has had speech therapy sessions, and is able to repeat most words in English and Chichewa without any problems. He received the fifth best grades in his class at the end of the school year in July 2016.

All guardians reported that their children had not experienced any issues with regard to social stigma with other members of their community.

Discussion

Three of our patients had avoidable aetiologies, illustrating the many public health issues relating to acquired deafness in the developing world. Malawi is one of the world's poorest and least developed countries. It has a population of 17 million, with over half living below the poverty line. Life expectancy is little over 50 years, with 1 in 8 children dying before the age of 5 years. The main health burden in Malawi is HIV (10.3 per cent of the population are HIV-positive), along with tuberculosis and malaria, which together account for 40 per cent of hospital deaths.[5,6] Common infectious diseases, together with untreated ear infections, mean that the population is twice as likely as those in Europe to be born with or develop hearing loss.

TABLE I
HEARING THRESHOLDS BEFORE AND AFTER COCHLEAR IMPLANTATION

Case number	Hearing thresholds (dB)	
	Before cochlear implantation	After cochlear implantation*
1	80–120	30
2	105–120	25
3	100–120	25–35
4	100–120	30–40

*Aided thresholds, across all frequencies

All our patients had post-lingual hearing impairment and had a relatively short duration of deafness. The authors felt that it was preferable to treat post-lingually deaf patients as a starting point for a cochlear implant programme in a resource-limited country. This was because the resources required for the identification and rehabilitation of pre-lingual deafness are significantly greater, and would require the development of more rehabilitation expertise.[7]

The implantations would not have been possible without support from the implant manufacturer (Med-El) in providing the implants, and the audiological support available in the form of audiologists working in Malawi (for charitable organisations) who had experience in implant programming. Malawian audiology assistants and officers were also involved in the programming. It is very encouraging for future development that four Malawian audiology assistants are currently undertaking a Master of Science degree in audiology in the UK. They all will be returning to Malawi shortly to work as audiologists in the two well-equipped audiology centres in Lilongwe and Blantyre. The rehabilitation post-surgery is significantly improved with the development of these two state of the art audiology clinics; the audiology unit at the Queen Elizabeth Central Hospital in Blantyre is largely funded by Sound Seekers, a UK charity, and the ABC Clinic in Lilongwe is largely funded by Sonova's Hear the World Foundation.

The infrastructure of the whole ENT department has developed significantly over the past few years as a result of charitable support. Alongside the cochlear implantation developments, there has been specific work to develop the facility in order to carry out all aspects of otological surgery. This includes the charitable donation of two drill systems – the first otological drill systems in Malawi. Further developments are essential, particularly in the area of training staff including ENT surgeons (the co-author being one of only two ENT surgeons in the whole of Malawi).

Rehabilitation is an important issue in terms of optimising the benefit from cochlear implants. The input of teachers and speech and language specialists in cochlear implant programmes is well established in developed countries. Whilst the four cases in Malawi have basically been supported by the audiology teams

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working with the patient's families, plans are now in place to train three professionals to provide rehabilitation support in the future. We believe that increasing the training of specialists working with families and schools may open the possibility of implantations in younger children in the future.

Outside of South Africa, the only other Southern African country to publish details of a cochlear implantation is Uganda; the authors emphasised the importance of rehabilitation support (from three speech therapists) in this one case.[8]

All children in this report needed financial support to attend the therapy and follow-up sessions. The batteries are being provided free of charge to all children by the ABC Clinic. The importance of such initial support was also highlighted by a study from Nigeria.[9] This needs to be considered when planning future implantations and developing the cochlear implant service. The potential number of patients in Malawi who would benefit from implantation is huge. We feel that proximity to an audiology clinic for programming is very important. In terms of making the service viable in the longer term, we are investigating how the intervention can be at least partly funded locally, either by individuals, communities or charities. In the future, one hopes that government resources will be available.

As African countries develop economically, it is highly likely that cochlear implantation will become more relevant throughout the continent. Emmet *et al*. showed that cochlear implantation is highly cost effective in South Africa, the one country with a robust national cochlear implantation programme in this region.[3] In Nigeria, cochlear implantation can meet the cost-effective threshold, even when substantial growth of infrastructure and capacity are required. Using the WHO standard of cost effectiveness ratio / gross domestic product per capita of less than 3, cochlear implantation in Malawi is currently not cost effective, with a ratio of around 9. This is largely because of the cost of the device.[3] Given that the devices fitted to these four children were donated by Med-El, with drill equipment sponsored by CBM International (Bensheim, Germany), it has been possible to have other programme costs, such as salaries, logistical expenses, operating theatre time and follow-up services, covered by a number of stakeholders.

The developing world faces many practical difficulties, such as limited resources, for the diagnosis and management of ear and hearing disorders. A recent study by Mulwafu *et al*. has shown that the availability of equipment in Sub-Saharan African countries remains poor, with 66–87 per cent of respondents in the countries rating the availability of equipment as nil or poor.[10] Respondents cited lack of availability of basic equipment as the most frequent limiting factor in providing ENT services. Poor infrastructure and lack of equipment are deterrents to working in such countries. This may explain why there are few specialist ENT surgeons, with basic ENT services sometimes provided by general surgeons. The challenge is potentially to transfer more specialised skills to the ENT surgeons in these developing countries, whilst developing protocols and associated training to 'task-shift' some general ENT procedures to primary- and middle-level health workers, thus increasing access to ENT services generally.

The importance of partnerships between higher resource countries, universities and implant manufacturers was also highlighted by Emmet *et al*.[3] These partnerships can improve infrastructure and capacity in emerging economies, and change the landscape of profound hearing loss management worldwide, shifting the focus from high-resource environments to a truly global perspective.

- **Despite logistical and resource challenges, cochlear implantation is possible in developing countries**
- **There is a need for appropriate support through global partnerships to perform cochlear implantation in developing countries**
- **Patient selection is crucial; post-lingually deaf candidates are most appropriate for a developing programme**

Conclusion

Despite significant practical difficulties, it has proved possible, with the right support, to carry out cochlear implantation in one of the world's poorest countries. There have been immediate 'offshoot' benefits regarding the facilities; future plans are in place to carry out regular weeks of otological surgery, including developing a cochlear implantation programme. The longer-term aim is to train a Malawian otologist. The project has also raised awareness of deafness in Malawi and highlighted significant public health issues relating to the aetiology of deafness in Third World countries.

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