Pakistan Journal of Otolaryngology 2013; 29 : 62-66

Case Series

Cochlear Implantation Program Among Nigerians (Black Africans)

Y.B. Amusa, A.O. Adeniji, J.A.E. Eziyi, T.O. Olarinoye, A.O. Adeyemo, Grace Ogunniyi

ABSTRACT: OBJECTIVE: We report the first ever Cochlear Implantation (CI) program among the Nigerians (black Africans), using the short electrode implant and the minimal access surgery technique, the peculiar challenges encountered as a developing country are also discussed. PLACE AND DURATION OF STUDY: Department of Otorhinolaryngology, College of Health Seiences, Obafemi Awolowo University, Ile-Ife, Nigeria, during Jun 2008 and May 2011. PATIENTS & METHODS: We retrospectively reviewed the case notes of the eight patients who had CI followed by speech rehabilitation between 2008 and 2011 in our centre. We obtained information on demography, socioeconomic status, source of funding for the implant, clinical presentation, aetiology, high resolution petromastoid computerized tomography (HRCT), surgery, outcome of surgery, and rehabilitation. RESULTS: Eight patients were implanted in this study, onset and etiology of the deafness varied. All had a successful implantation with no major postoperative complication noted and they developed environmental sound awareness and speech discrimination with a variable degree of expressive language where applicable. Outcome in the postmeningitic deafness was also impressive despite minimal cochlear fibrosis. CONCLUSION: Our CI was effective for aural rehabilitation of profound sensorineural hearing loss caused by all the etiological agents in this review. We had various challenges ranging from logistics, facilities, manpower, others related to our poor resource setting. As cochlear implant technology evolves and surgical techniques continue to improve, our center will continue its efforts to provide effective hearing.

Key Words: : Cochlear implant, Short electrode, Black Africans, Challenges.

INTRODUCTION: Practicing otologists among the black Africans have over the years been helpless in achieving meaningful rehabilitation of the profoundly deaf who form a major part of their clinic as many of such patients over the years return home with their parents or guardians without any definite hope of restoration of their hearing or meaningful rehabilitation within reach. Such was the common experience at the dedicated deaf clinic of our center prior to the year 2008 as most sessions with patients and parents end up with them crying out of disappointment. Worldwide, the journey out of frustration for the profoundly deaf started as early as 1957, when Djourno and Eryies observed that activation of the auditory nerve with an electrified device provides auditory stimulation in a patient[1]. Doyle and Doyle's early experiments of 1963, on the scala tympani preceded the first House/3M single channel implant of 1972[2]. Blair Simmons in 1964 at California succeeded in the surgical placement of a 6-electrode array in the modiolus of a human volunteer[3]. In 1984, the US food and drug administration (FDA) approved the use of the House-3M single-channel implant, then the multichannel Nucleus 22-channel implant for adults and then children in 1985 and 1990 respectively. A multichannel cochlear implant consists of two parts, a receiver stimulator implanted in the temporal bone consisting of a receiver coil with an electrode array inserted into the cochlea, and an external device. The three main components of the external device are the microphone, speech processor and a transmitter coil conveying signals from the processor across the skin to the electrode array (Figure 1). The microphone picks up sounds and transfers them to the speech processor. These sound signals are analyzed and converted to a form suitable for transmission by the processor. In most devices these transformed signals reach the electrodes by radio-frequency transmission from the transmitter coil resting on the head to the implanted receiver coil. Profound deafness in the majority of cases results from damage to the sensory cells in the 'Organ of Corti' in the inner ear, due to various causes. CI helps this group of patients since it bypasses the damaged part of the auditory pathway and stimulates the surviving spiral ganglion cells directly with electrical signals. The aim of this was to simulate the activity of normal cochlea, by stimulating the tonotopically arranged surviving neural elements resulting in a significant improvement in the speech perception capability. The various efforts made to improve on the multichannel implant have led to the development of this full spectrum implant used in this series. The cochlear implant is the only medical intervention that can restore hearing to a totally deaf person, as of April 2009, approximately 188,000 people worldwide had received cochlear implants[4]. In the United States, about 40,000 adults and over 30,000 children are recipients[5]. Whereas, in the sub-Saharan Africa there is no documentation of any cochlear implantation completely programmed locally until this report. Many reasons can be adduced for this, ranging from manpower, the technical skills, as well as the cost. The cost of implant device alone, excluding surgery and rehabilitation, is priced between US $15,000 and US $35,000 depending on the implant type and the

Otorhinolaryngology Department, College of Health Sciences, Obafemi Awolowo University, Ile-Ife, Nigeria.

Figure 1: Cochlear implant.

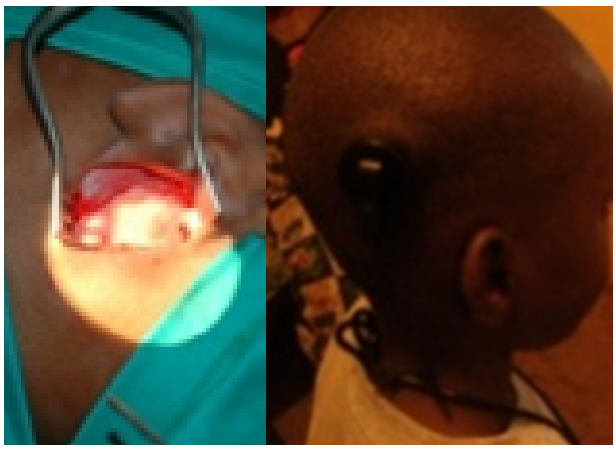

Figure 2: During and after surgery.

specific market. Arguably due to this high cost, majority of the beneficiaries are in the advanced countries of the world. Presently cochlear implant program is already in Egypt, Republic of South Africa and recently Nigeria which we now report. According to the World Health Organization (WHO), more than 80% of the world's 120million people who have disabling hearing difficulties live in developing countries. With a personal average annual income of well below US $2,000, the present cochlear implant is virtually unavailable for deaf people in developing nations especially the black Africans. This article documents the Nigerian experience (the black Africans) with the cochlear implantation program as a resource challenge country without any previous national policy for this program.

PATIENTS AND METHODS: We retrospectively reviewed the case file of the 8 patients who had cochlear implantation done followed by rehabilitation in our centre. The study period was between June 2008 and May 2011.We obtained information on the patients' bio data, clinical presentation, diagnosis, Pure Tone Audiometry, Tympanometry, Otoacoustic emission (OAE), Auditory Brainstem Evoked Response (ABR), high resolution petromastoid computerized tomography (HRCT) to establish the patency of the cochlea[6], implant type, surgical procedure, outcome of surgery, complications and speech rehabilitation from the patients' case files. The outcome after speech rehabilitation was divided into six depending on whether the patients did not respond to sound, responded to sound at low frequencies only, responded to sound at high frequencies only, responded to sound across all frequencies, developed reasonable speech, did not develop speech. Data regarding the age and aetiology of deafness of the study group are as shown in Table 1.

THE DEVICE: The cochlear implants are surgically implantable electronic devices for stimulating the spiral ganglion via the cochlea in hearing impaired patients. They are manufactured by a few companies worldwide and are in Australia, Austria, France, South Korea, Spain and United States of America. The cost-effectiveness of the device and the surgery remains the major factor considered in determining who among the many potential candidates get implanted. The CI type ienjoysound(ies)-250 manufactured by Material Solutions Technology Co., Ltd. of South Korea was implanted in all the patients. It is simple, cost-effective; it has a short electrode and provides a full spectrum of hearing as well as the preservation of residual hearing of the patient. The relatively simple technique of implantation makes it easier for relatively younger otologists with less experience in inner ear surgeries. Presence of after sale service also made it more reassuring to us. The products are approved by CE, KFDA and ISO.

THE TEAM: Our CI team comprised of the ENT surgeon, Audiologist/ Speech therapist, Psychologist, Social workers, Radiologist, Pediatricians, Teachers for the deaf, Psychiatrists, Neurologist, Anesthetist, and Implant nurses. Our team had to bear several burdens but majorly resting upon the surgeon and the speech therapist. Absence of the diagnostic facilities necessary for the preoperative assessment of the implant patient was an initial task for the patients and the team. Fund was as always a major problem we had to contend with. The team was headed by the Head of Ear, Nose and Throat Surgery; an Otologist, supported by other ENT surgeons and resident doctors. All surgeons had earlier repeated refresher courses in temporal bone dissection anchored by local and international faculties, so as to get more acquainted with middle and inner ear anatomy, and surgical techniques. Our audiologist who performed the speech therapy had special overseas training course for rehabilitation of the cochlear implant patients. Other members of the team were encouraged to participate fully, especially the social worker for follow up of the patients. We had a robust technical support by the manufacturer especially at the initial period.

INTERVENTION:

(A) PRE-OPERATIVE EVALUATIONS. This included the Pure tone audiometry, Free field audiometry, Otoacoustic emission (OAE), Auditory brain stem response (ABR) testing were ordered as required. Complete medical history and physical examination

Figure 3: Age at implantation (Yrs).

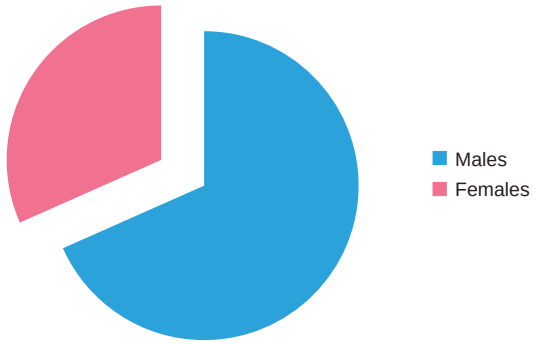

Figure 4: Sex distribution.

were performed to ensure that the patient was fit for anaesthesia and to rule out other congenital anomalies. A full head and neck examination was also carried out to rule out the presence of an active middle ear disease. Examination of all other systems especially the eye was done in the congenital deafness and the cerebral palsy. Computerized tomography scan was done to image the structure of the cochlea and identify any abnormalities or malformation. It had been said that severe abnormalities may present surgical challenges but do not necessarily preclude patients from CI surgery. One case of cochlear fibrosis was found in the patient with meningitis. Psychological evaluation was also carried out to assess the child's cognition function to rule out factors other than hearing impairment which may be inhibiting child's auditory development such as learning disorder. Neurological evaluation was also done by the other members of the team. The patients and relations were adequately counseled on expectation and a specially prepared and administered informed consent document was obtained before surgery.

(B) SURGERY: The hypotensive general anaesthesia was employed in all the cases as widely used[7]. The conventional cochlear implantation procedure involves either a cortical mastoidectomy and facial recess approach[8], or a cortical mastoidectomy and hypo-tympanotomy approach[9] to access the promontory, this however usually necessitates raising of a large scalp flap, also the facial nerve is at risk of damage. One of the unique features of this implant is that the surgical procedure for the implantation was by the simplified and less invasive minimal access technique in which neither of the usual approaches were used but, via a minimal postauricular incision, with raising a tympanomeatal flap followed by mobilizing the fibrous annulus of the tympanic membrane out of the tympanic sulcus. From here the promontory is identified and using the skeeter drill, the cochleostomy perfomed and from here only about 6mm of the tip of the electrode of the cochlear implant is inserted (short electrode insertion). Both the technique of the surgery and the technology of the implant are simpler, and poses no danger to the facial nerve and preserves residual hearing of the patient because only a short portion of one electrode is implanted into the base of the cochlea using the iES 250 device.

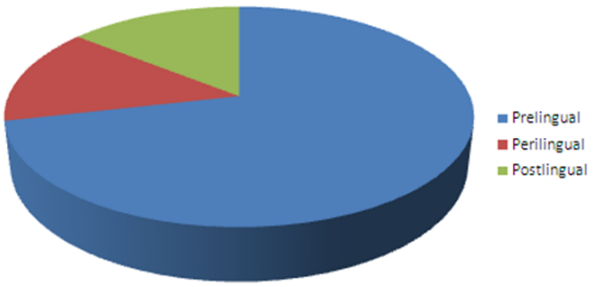

Figure 5: Onset of deafness.

RESULTS : Eight patients had cochlear implantation followed by rehabilitation over the study period. Age range at implantation was between 14 months and 19 years (see Fig. 3). mean age was 8 years. There were 5 males and 3 females; sex ratio was 5:3 (Fig. 4). The male preponderance in this study is consistent with previous similar studies in West Africa[10]. Onset of deafness: Pre, Peri and Post lingual is depicted in Fig. 5.

AETIOLOGY: The predominant causes of deafness preventable causes as 7 out of the 8 patients who had the implantation had acquired deafness. Workers in this environment had earlier found acquired deafness to be the most predominant[11]. Measles was the cause in 12.5% of our patients and this is comparable with a figure of 19.3% in the causes of childhood deafness in Nigeria[12] and more recently 13.9%[13]. Meningitis is still a major cause of preventable deafness as it is said that 15% of patients who survive acute bacterial meningitis develop neurological sequelae, and permanent sensorineural hearing loss account for approximately 75% of these cases[11,14].

POST IMPLANT RESPONSE: Implantation of the device is usually followed by its switch on and mapping after a period of 6weeks, however 'switch on' was done within 24 hrs- 5days post-operatively in all our patients and it was successful in all the patients, this is because of the simple nature of the procedure with minimal raising of flap and therefore less oedema over the internal device. The 'switch on' was followed by a final 'hook on' and mapping This is then followed by the auditory verbal training which is given by the speech therapist intensively. At the initial switch on and the final hook on and mapping, response was 100% as all the patients responded to sound. The

S/N	Age (yrs)	Aetiology	No. of Patients
1	9	Congenital	1
2	4	Post Measles	1
3	12	Post Traumatic	1
4	19	Post Meningitis	1
5	3	Post febrile illness	2
6	1.2	Post Cerebral palsy	1
7	8	Uncertain	1

Table 1: Showing the age at implantation and aetiology of deafness of the patients implanted.

Outcome Measure	No of Patients
No response to sound	None (0%)
Responded to sound at low frequencies only	None (0%)
Responded to sound at high frequencies only	None (0%)
Responded to sound across all frequencies	8 (100%)
Developed reasonable speech	5(62.5%)
Has not develop speech	1 (12.5%)

Table 2: Table showing response of patients.

auditory verbal training was generally done intensively, and patients had to stay in or close to the hospital for the first 6 weeks, following this the patients were given appointments monthly, then 3 monthly, then twice in a year depending on how well they were responding. Our rehabilitation was however individualized to cater for the needs of each of the patients, the patient from the neighboring African country was discharged a week after the switch on and mapping. The care givers were also educated on the rehabilitation.

POST REHABILITATION: The outcome after speech rehabilitation was divided into six depending on whether the patients had responded to sound and at which frequencies, as well as speech development. One of the patients was however not available for assessment at the time of putting up the paper, this patient was the one who was brought in from the neighboring African country. There was a good response to sound across all frequencies in most patients, there was however poor perception in the high frequency range for the post menigitic deafness in the initial period (this is explainable by the affectation of the basal turn of the cochlea by the fibrosis), this however gradually improved over time. Audiological evaluation was also challenging occasionally in the post cerebral palsy and the same patient had a poor speech development despite evidence that he perceived sound (Table 2). Overall, all the patients responded to sound, while those above 4 years were already making simple sentences within 12 months of commencement of the therapy. The star patient was the 19year old with post meningitic deafness, he attended the national conference of the Otolaryngologists (ORLSON) of our country about 8months after the implant surgery and there he was able to jot down notes!

COMPLICATIONS: There was no major complication in our report. The report by MRC institute of Hearing Research on the evaluation of the national cochlear implant program confirmed that the occurrence of major complications was acceptably low[15]. In our series, two patients had psychological breakdown, in one of these patients who had post meningitic deafness, his understanding of speech did not occur as fast as he expected and he wanted to sit for the post university examination interview, he was however promptly attended to by the other members of the team, in the second patient it appeared to be constitutional. Two of the patients were not complying with rehabilitation appointments; this still occurred despite using acceptable standards for our candidacy. External auditory canal flap necrosis occurred in one of the patients necessitating a supervised sterile clinic aural toileting leading to re-epithelialisation within a few weeks. Functioning of the implant (battery) was poor in one of the paediatric patient, and this was probably due to erratic power supply for charging the implant battery or the use of direct current (generator) to charge the implant battery, or both and this had been replaced the company. There was no case needing re-implantation. The simple nature of the procedure; avoiding mastoidectomy, good candidate selection, preoperative preparation coupled with meticulous surgery may be responsible for the good outcome and absence of major complications. However, it is also true that the relatively small number of our series may also contribute. Post implant CT scan was also done in two of the patients and the implant was found to be in place.

CANDIDACY: Our criteria used for selecting patients are similar to those obtained worldwide with slight modification and emphasis on funds and good social support, and this included that : None of our patients was less than 12 months, confirmed diagnosis of profound sensory neural hearing loss, with an intact eight nerve function demonstrable by ABR, with a patent cochlea. There was however partial cochlear ossification in one of the patients demonstrated on the HRCT scan, in this patient, the etiology was the meningitis, the procedure was however successful but he had deficiency in hearing at high frequency. There should also be no contraindication to elective surgery and general anaesthesia.

CHALLENGES ENCOUNTERED: During the process of commencement of the OAUTHC CI programs some of the challenges encountered included:

Logistics: Absence of facility the ABR, OEA was a major challenge for which we had to make arrangement for our patient to go to Lagos (about 250kilometers away) for the tests. Vaccination: Meningococal vaccine which was given to all the patients in which it was required had to be source from the Northern part of Nigeria a distance of more than 400kilometers as it was not readily available.

COST OF IMPLANTS: This was by far one of the most important challenges we faced. The number of patients attending the dedicated deaf clinic of our center was well over four hundred and only a few of these prospective candidates could afford the cost of the implant.

REHABILITATION: Facilities for Rehabilitation was not fully available as our audiology room also doubled as the speech therapy clinic. We did not have a dedicated speech therapist for the auditory verbal training but through our motivation and overseas training our audiologist was able to perform the

auditory verbal training for our patients. *FUNDING:* This was a big problem throughout the program. Skepticisms from the people: This was expressed initially by some of the patient's relatives and even some members of the medical community since this is a very new introduction in Nigeria medical practice.

CONCLUSION: The CI program of our center among the black Africans is very successful despite many odds against it. The simple nature of the implantation technique, the advanced nature of the technology coupled with the relatively cheaper cost makes it the implant of choice in any part of the world. The main report by the MRC institute of hearing research on the evaluation of the national cochlear implant program in UK confirms with relevant data the benefits of cochlear implants for the rehabilitation of deaf patients[15]. At this phase of CI program in Nigeria which serves the entire black Africans it is highly beneficial to the patients and is therefore a welcome development, but is faced with myriads of challenges ranging from social, financial, manpower, to policy issues and others related to a poor resource setting. We recommend institutionalization of Nigerian Cochlear Implant Group (NCIG) which has already been kick started by the OAUTHC CIG, establishment of Ear health commission under the Federal and State governments and that, funding for cochlear implantation and rehabilitation must be provided by this body following a positive assessment by the specialist cochlear implant centre. There is need for equipping the several otolaryngology centers with up to date audiological facilities to aid in hospital diagnosis and help in community hearing screening. The availability of these facilities will help to improve our management outcome further. In addition, we recommend this implant type with its surgical technique for patients in whom it is indicated due to its numerous advantages. It is also hoped that international non-governmental organizations will come to the aid of the deaf in the black African countries.

ACKNOWLEDGEMENT: The authors thank Dr Miklu Senapati for his efforts and support in practically establishing the Nigerian Cochlear Implant Group. We thank all the ENT specialists in Nigeria for their support and positive criticisms of our program. Many thanks also to the entire members of the Cochlear Implant team for their invaluable help in this program.

REFERENCES:

1. Djourno A, Eryies C. Prosthese auditive par excitation electrique a distance du nerf sensoriel a l'aide d'un bobinage inclus a demeure. [Auditory prosthesis by means of a distant electrical stimulation of a sensory nerve with the use of an indwelling coil]. Presse Med. 1957; 65: 1417.
2. Doyle J, Doyle D. Electrical stimulation of the nerve deafness. Bulletin of the Los Angeles Neurological Society. 1963;28:148-50.
3. Simmons FB. Electrical stimulation of the auditory nerve in man. Arch. Otolaryngol. 1966; 84: 2-54.
4. Jennifer Davis (2009-10-29). "Peoria's first cochlear implant surgery has grandfather rediscovering life". Peoria's Journal Star. http://www.pjstar.com/features/x876590686/Peoria-s-first-cochlear-implant-surgery has-grandfather-rediscovering-life.
5. Mary Brophy Marcus (2009-08-17). "Eyeing smaller, faster, smarter ear implants". USA Today. http://www.usatoday.com/news/health/2009-08-16-cochlear-implant_N.htm.
6. Phelps PD, Anis JAD, Robinson P J. Imaging for cochlear implants. Br J Radiol 1990; 63: 512-6.
7. G John, JG Toner. Cochlear Implantations in Northern Ireland: An overview of the first five years. The Ulster Medical Journal. 1999; 68: 12-6.
8. House WF. The cochlear implant. In Braekmann D. E (ed): Neurological surgery of the ear and Skull Base. New York: Rave Press, 1982.
9. Michelson RP, Schindler RA: Multichannel cochlear implant: Prelimnary result in man. Laryngoscope1981;91:38-42.
10. Ologe and Akande. Pattern of disabilities in a residential school for the handicapped in Ilorin, Nigeria. Nigerian Postgraduate Medical Journal 2003;10(4):208-10.
11. McPherson B, Holborow CA. A study of deafness in West Africa: the Gambian Hearing Health Project. International Journal of Paediatric Otorhinolaryngology 1985;10:115-35.
12. Holborow C, Martinson FD, Anger NA study of deafness in West Africa. International Journal of Pediatric Otorhinolaryngology. 1982;4: 107-32.
13. AD Dunmade, S Segun-Busari, TG Olajide, FE Ologe. Profound Bilateral Sensorineural Hearing Loss in Nigerian Children: Any Shift in Etiology? J. Deaf Stud. Deaf Educ. 2007;12 (1): 112-8.
14. Brobby G.W Causes of congenital and acquired total Sensorineural Hearing Loss in Ghanaian children. Tropical Doctor 1988;18: 30-2.
15. Summerfield AQ, Marshall DH. Cochlear implantation in the UK 1990-1994. Report by the MRC institute of hearing research on the evaluation of the national cochlear implant program. 1995;63:89, 171-85.