Global Scientific JOURNALS

GSJ: Volume 8, Issue 2, February 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

COMPARISON OF NEURAL RESPONSE TELEMETRY THRESHOLDS IN PERIMODIOLAR AND STRAIGHT ELECTRODE ARRAYS

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Introduction

A cochlear implant (CI) is a hearing device designed to restore hearing sensation in children and adults diagnosed as having severe to profound bilateral sensorineural hearing impairment and who are observed to get limited benefit from hearing aid. Cochlear implants bypass the damaged hair cells in the inner ear and stimulate the auditory nerve to send signals to the brain.

Mapping is the term used for programming a cochlear implant to the specifications and needs of its user. MAPs are programs which are used to optimize the CI user's access to sound by adjusting the input to the electrodes array that is implanted into the cochlea. Each cochlear implant company has different terminology, different programming strategies, and different capacities for various MAPs on their processors. In mapping the beeps are presented by the audiologist and the participant's responses are noticed based on which their threshold levels (T levels) and the comfortable levels (C-level) are recorded for each electrode. The audiologist also adjusts the stimulation rate used in mapping.

Electrodes are electrical connection which is placed on close approximation to ganglion cells responsible for transmitting the electrical impulses to the portion of the brain responsible for hearing (Wilson). Electrical pulses are fired at various positions on an electrode array. The electrode array is composed of conductive, corrosion-resistant, noble metal platinum iridium alloy electrodes separated by flexible poly(di methyl siloxane)(silicon rubber) insulation (Clements *et el*. 2002).Each electrode is placed in direct contact with a single nerve cell such that the nerve upon receiving a sound stimulates with an appropriate frequency.

To study the functioning of an electrode array, it is important to understand how the cochlea functions as a biological transducer converting the sound waves into electrical impulses.

Since the material used to make electrode arrays is an insulated material made of poly (dimythyl siloxane) is both flexible and mouldable, there are two types of arrays available i.e. contoured and straight electrode array. As compared between the both, contour require slightly larger cochleostomies (incisions in the cochlea) than the straight array, however as noticed and studied contour array achieve closer apposition to a greater portion of the nerve positioned on the inner aspect of the cochlea. Whereas the tension generated in bending the straight electrode into a spiral formation forces the insulated portion of the electrode to bend along the outer aspect of the cochlea creating more gap between the electrodes and the nerves stimulated by them respectfully. An array of 22 electrodes wound in the cochlea send impulses to respective nerves in the Scala tympani and then to the brain via auditory nerve.

NRT (Neural Response Telemetry) is a quick and non-invasive objective measure of peripheral neural function at up to twenty two intra cochlear sites and provides a useful guide in checking the integrity of the cochlear implant, estimating the telemetry thresholds, programming infants, children and adults. Neural response telemetry gives us useful objective information both intra operatively and during fitting. After surgery, it generally takes three to five weeks for the incision to heal. The implant recipient is then fitted with the external components. The system is programmed to meet each individual's hearing needs.

Once the incision heals the surgeon will give an approval to the audiologist to go ahead with programming. Audiologist will fit the external parts of the cochlear implant. The transmitter coil is placed over the receiver. The microphone is placed over the ear. The transmitter and microphone is connected to the speech processor.
The neural response ability depends upon the neural tissue, the stimulus being used and the recording techniques being used. Neural response telemetry is a method through which the electrical compound action potential (ECAP) is obtained.
An electrical compound action potential (ECAP) consists of a small positive peak (P1) followed by a negative peak (N1) which is followed by a positive peak (P2) again. The latency of the potential between stimulus onset and onset of the P1 is about 100 to 300 microseconds. The amplitude of evoked potential is the difference between the N1 and P2 onset. As based on studies the amplitude of the ECAP varies from 100 to 1300 microvolt. The amplitude usually increases with the magnitude of the stimulus because more nerve fibres are contributing to the response as the level of the stimulus is increased.
NRT can be helpful in obtaining important measurements from children or uncooperative adult patients. As soon as the electrode is present in the cochlea, NRT allows professionals to gain important information about the functionality of the cochlear implant and its ability to stimulate neurons. Knowing that the brain is able to receive stimulation may be reassuring to the patient that their cochlear implant system will work properly. During the fitting process, feedback given by patients can be compared to the objective measures performed by NRT. This provides for an optimised fitting. Should potential complications arise, whether in the operating theatre or during fitting, NRT may be a helpful tool in assisting professionals to locate the source of the problem so that further action can be taken.

AIM AND OBJECTIVE:

The aim of the study was to study the stimulation variation based on insertion of the electrode array and the type of array used in the cochlear implant.

METHODOLOGY AND MATERIAL

A total of 30 children who had underwent cochlear implant aged from 0 to 10 years (mean age ± SD, 5±0.3) were include in the study , Fifteen children each group respectively in the age group of 0-10 years (mean age ± SD, 5±0.3) participated in the study. Cochlear implant recipient with congenital deafness with no cochlear anomaly and normal vestibulo cochlear nerve were included in the study. The children included in the study were based on the electrode array fitted in the implant. Fifteen children with cochlear implant straight electrode array were compared against fifteen children with contour electrode array.

Electrode array:

The straight electrode array used comprised of 22 conducting platinum bands, spaced at intervals of 0.7 mm and numbered in basal to apical directingThe pre modiolar electrode array which comprises 22 half banded electrode contacts without stiffening rings. The implant is built by the same integrated circuit as that of straight electrode and the inter electrode spacing in pre modiolar not uniform and ranges between 0.57to 0.81mm

The premodiolar electrode array differs from the straight one by its positioning in the cochlea, proximal t the dendrites which has been verified through X ray studies

TEST PROCEDURES

The data collection of the study included programming the cochlear implant and the obtaining of neural telemetry response. The neural response telemetry (NRT) software in both the electrode arrays i.e. straight and contour respectively was used for measuring the neural response telemetry in children and the recording parameters were determined by the use of optimization feature in the software.

RESULTS

The electrode interaction functions from the measurements of ECAP at 1,6,11,16,22 probe locations were considered. The electrode interaction in the both the types of arrays were calculated using the neural telemetry responses at the above mentioned electrodes and the statistical analysis was carried out. Statistical analysis was done using two tailed Z test usind SPSS software to study the variation in both the types f electrode arrays and see the varitions in the neural response telemetry values obtained from measuring in both the electride arrays i.e. pre modiolar and straight electrode arrays respectively.

Results indicated that ECAP recordings measured through neural response telemetry were statistically significantly lower in children with perimodiolar electrode array compared to those with the straight electrode array.

DISCUSSION

From the above results we came to the conclusion that there was significant difference obtained between both the from the measurement of neural response telemetry. The insertion of the perimodiolar electrode array is deeper and positioned close to the modiolus whereas the straight electrode array is positioned close to the lateral wall hence the current levels required for stimulation to elicit electrically evoked compound action potentials were lesser than that required for the straight electrode array.

SUMMARY AND CONCLUSION

This study gives us a view that there is significant difference seen asked on the type of electrode array insertion done in a cochlear implanted child. The child who has been inserted with pre modiular insertion required lesser elicitation of evoked action potential than the straight electrode arrays as they differed in the way they were inserted. Hence we can come to a conclusion the pre modiular electrode array insertion would help us in giving better neural responses the straight arrays