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Research Article

Variation in Electrode Impedance in Cochlear Implant Recipients Over a Period of Time

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Keywords

- Impedance; Cochlear implantation; Intra cochlear electrode; MED-EL SONATA Ti 100 cochlear implant; Pediatrics

Abstract

Objective: This study assessed the electrode impedance change in MED-EL SONATA Ti100 FLEX SOFT during implantation, switch on and post switch on over a period of 12 months.

Design: It is a retrospective study.

Study sample: It includes 60 pediatrics all of whom were implanted between 2014 and 2016.

Results: It is found that the electrode impedance increased abruptly during switch on than intraoperative impedance value and it recovers back to near intraoperative value.

INTRODUCTION

Electrode is the integral component of cochlear implant. An important aspect of electrode is its impedance. Measurement of electrode impedance provides an indication of electrode integrity, status of electrode tissue surface [1]. Electrode impedance is primarily related to resistive characteristics of the field and tissue surrounding the electrode [1,2]. It depends on the surface area of electrodes, morphological processor and electrochemical processors initiated by electrical stimulation [1].

Impedance increases between intra operative and initial session of speech processor being fitted [3]. Over first few weeks protein absorption and tissue growth occurs over the array, thereby increasing the impedance [4]. In some implantees impedance increases due to air-bubble formation while insertion of the array. The reduction in electrode impedance after electrical stimulation is explained by the formation of hydride layer on the surface of the electrode which in turn increases the surface area of the electrode, thus reducing the impedance [1].

The surface area of the electrodes decreases form base to apex i.e., impedance value increases from base to apex electrode [5].

The overall objective of this study was to know the reason and duration of recovery of electrode impedance to the near intra-operative impedance value.

MATERIAL AND METHODS

Subjects

Sixty cochlear implant recipients were included in the study. All subjects were implanted between 2014 and 2016 with MED – EL SONATA Ti 100 cochlear implant. The recipients were between two to six years old. For all the CI recipients the electrode were fully inserted without any surgical complications.

Implant design

MED-EL SONATA Ti100 flex soft was implanted. It consists of seven paired and five unpaired titanium electrodes equally distributed over 26.4mm total length. The electrodes are numbered from 1 to 12 from apex to base [6]. The electrode array is inserted through round window. The diameter of the electrode decreases in an apical direction.

Electrode width also decreases from base to apical [1.8 to 0.5 mm].

Electrode impedance measurement

The device were active using Diagnostic Interference box and programming software Maestro software provided by the manufacturer. (MED–EL Austria). Electrical stimulation is given through DIP Coil via the interface; connected to the lap containing the maestro software.

Impedance was measured throughout a period of 12 months from activation. Each month includes electrode impedance values of 5 cochlear implantees.

RESULTS

Impedance of the electrodes decreases in a slow manner postoperatively near to the intraoperative impedance value

(figure 1-5). This decrease in impedance post-operatively is due the electrical stimulation of the electrodes which in turn increases the hydride layer of electrode thus increasing the surface area leading to decrease in impedance value. Statistical analysis of our study shows that the recovery of impedance begins by 4 months of post-activation of implant (Table 1).

Table 1: Shows the significant difference in electrode impedance values between intra-op and switch on, between switch on and post activation months over a period of 12 months.

VARIABLES	SIGNIFICANT DIFFERENCE
Intra-op and switch on	0.006
Switch on and 1 month post switch on	0.308
Switch on and 2 month pot switch on	0.182
Switch on and 3 month post switch on	0.272
Switch on and 4 month post switch on	0.011
Switch on and 5 month post switch on	0.012
Switch on and 6 month post switch on	0.012
Switch on and 7 month post switch on	0.017
Switch on and 8 month post switch on	0.009
Switch on and 9 month post switch on	0.004
Switch on and 10 month post switch on	0.002
Switch on and 11 month post switch on	0.023
Switch on and 12 month post switch on	0.005

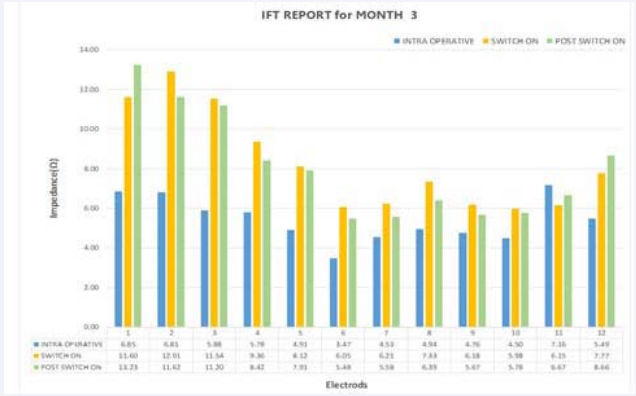

Figure 1 Impedance values of intra-op, switch on, 3 months of post activation.

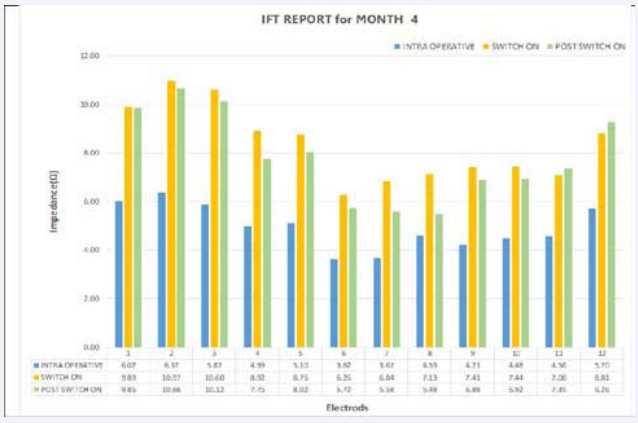

Figure 2 Impedance values of intra-op, switch on, 4months of post activation.

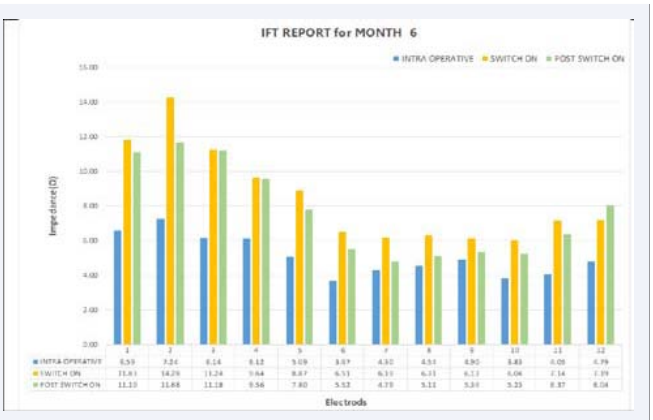

Figure 3 Impedance values of intra-op, switch on, 6months of post activation.

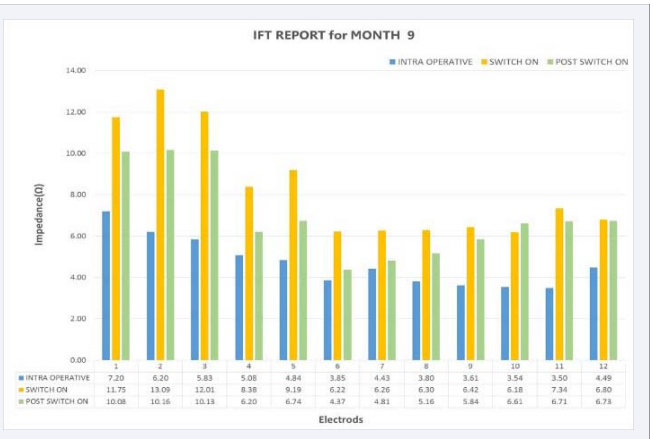

Figure 4 Impedance values of intra-op, switch on, 9months of post activation.

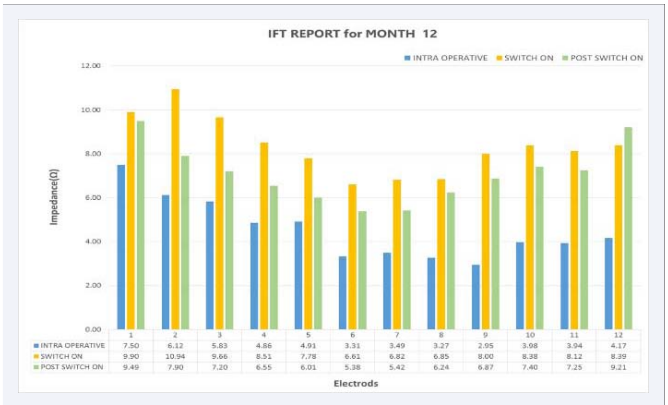

Figure 5 Impedance values of intra-op, switch on, 12months of post activation.

CONCLUSION

The main findings of this study were that, on average, 1. Electrode impedances increased during switch on. 2. Increase in impedance was due to protein absorption of electrode and tissue growth over electrode. 3. It also showed that the impedance was low for basal electrodes than apical and this is due to small surface area of apical electrodes. 4. Electrode impedance decreases on post activation specifically from 4 months of activation. 5. The

reason for the reduction of impedance is electrical stimulation of electrodes.

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