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Safety of radiofrequency ablation for adenotonsillectomy after cochlear implantation

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ABSTRACT

Objective: While a cadaveric animal study has suggested that radiofrequency ablation can be safely used in patients with cochlear implants, no *in vivo* studies have been published to confirm that radiofrequency ablation does not alter the integrity of the cochlear implant device.

Methods: Cochlear implant impedance and functional performance were studied through a prospective case series in five children with seven functioning multichannel implants before and after radiofrequency ablation adenotonsillectomy.

Results: There were 4 females and 1 male patient, aged 6–10 years (mean 8.5 ± 1.95 years) with 7 functioning implants. Pre- and post-surgical impedance testing revealed all electrodes were within normal operating limits. There was no statistically significant difference between the mean pre and post-operative impedances in 5 of the 7 tested implants ($P = 0.2–0.8$). The other two implants showed statistically significant improvement in impedance values which were not clinically significant ($P = 0.02$ and $P < 0.001$). Speech perception was unchanged as was functional performance for all 7 tested implants.

Conclusions: We found that radiofrequency ablation used in the oropharynx during adenotonsillectomy did not alter the integrity of the cochlear implant devices when assessed using electrode impedance testing, audiometry and speech perception evaluation. These results confirm those reported in previous *in vitro* studies and confirm the safety of radiofrequency ablation adenotonsillectomy for children who have undergone previous cochlear implant placement.

1. Introduction

Cochlear implants (CIs) were first approved to treat hearing loss in children in 1990 and approximately 30,000 CIs have been implanted in children worldwide [1]. While the age of implantation varies, studies have shown improved language development when children receive a CI prior to 18 months of age [2]. Similar to children without hearing impairment, 2%–4% of these children may develop sleep disordered breathing (SDB) with a peak incidence between 2 and 6 years of age. Likewise, recurrent tonsillitis may develop in school-age children, which is after the typical age of CI implantation. Due to the potential physiologic and neurocognitive complications of sleep disordered breathing, the poor quality of life, and high frequency of work and school absences associated with recurrent tonsillitis, adenotonsillectomy remains the recommended treatment for these pathologies.

Monopolar cautery is the most commonly employed modality used to remove tonsils in the United States. However, it is not recommended for adenotonsillectomy in children with CIs due to concern for electrical and thermal damage to the implants. Instead, cold steel tonsil resection

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or bipolar electrocautery have been used to remove tonsils in these children. In the early 2000s, radiofrequency ablation (RFA) was introduced for tonsillar removal. RFA is theoretically safer to use in children with CIs as it uses a bipolar-type technology that results in reduced spread of electrical current as well as lower overall tissue temperatures when compared to traditional electrocautery [3]. In light of these benefits, as well as reports of reduced pain, time to return to normal diet, and time to return to normal activity when compared to monopolar electrocautery [4], a single animal study was carried out to evaluate the safety of RFA use in the nasopharynx [5]. This study reported that RFA had no negative effects on CI integrity in a cadaveric pig model. However, to our knowledge there have been no *in vivo* studies evaluating the effect of RFA adenotonsillectomy on CI integrity. The objective of this study was to evaluate if RFA adenotonsillectomy had any effect on the integrity of implanted CI devices *in vivo*.

2. Methods

2.1. Subjects

This was a prospective case series performed from September 2008 to June 2010 at Johns Hopkins Hospital. Consecutive children (≤18 years of age), who had previously undergone cochlear implantation, had a functioning CI, and were determined to need adenotonsillectomy for SDB or recurrent tonsillitis were included in the study. No children were excluded from the study. Approval for this study was obtained from the Institutional Review Board at Johns Hopkins School of Medicine.

2.2. Radiofrequency surgery

Radiofrequency ablation was performed with the Coblator II system using an Evac Xtra Plasma Wand (ArthroCare Corporation, Sunnyvale, CA) for both tonsil and adenoid removal. Both the tonsils and adenoids were removed at settings of 7 W for ablation and 3 W for coagulation. The tonsils were removed in their entirety.

2.3. Cochlear implant integrity testing

The children in this study had been previously implanted with the following CI devices: Advanced Bionics HiRes 90 K HiFocus, Cochlear Nucleus 24 Contour, Cochlear Nucleus Freedom Contour Advance, and Clarion HiFocus 1. Impedance testing was carried out from 16 to 22 Ohm for each CI unit according to the manufacturer's specifications prior to and after surgery in order to assess for increased impedances which would suggest damage to the implant. Pre and post-surgical impedance values were measured for each electrode and the differences were calculated. The impedances for each electrode before and after surgery were also combined to determine the mean impedance for each implant. Pre- and post-surgery functional performance testing was performed to assess patient hearing. Auditory testing was done at level 3 and 7 settings. Speech perception testing was done as well to assess CI function.

2.4. Statistical analysis

Wilcoxon matched-pairs signed rank test was used to analyze pre- and post-surgical tested values for each CI unit impedance. Data was analyzed using Stata 12 (Stata Corporation, College Station, TX). Significance was considered at a P value of < 0.05.

3. Results

Five subjects were enrolled in the study (4 female) with a mean age of 8.5 years (range 6–10 years). Patient demographics are summarized in Table 1. Two children had bilateral CIs and thus 7 functioning multichannel implants were assessed before and after adenotonsillectomy.

Table 1
Patient demographics for children with a cochlear implant undergoing adenotonsillectomy removal with radiofrequency ablation.

Subject	Age (years)	Race	Gender	Indication for Adenotonsillectomy
1	10.7	Black	Female	Mild OSA
2	7.2	White	Male	SDB
3	10.2	White	Female	Moderate OSA
4	8.5	White	Female	Recurrent Tonsillitis
5	6.1	Black	Female	Mild OSA

OSA = Obstructive sleep apnea OSA, SDB = Sleep disordered breathing.

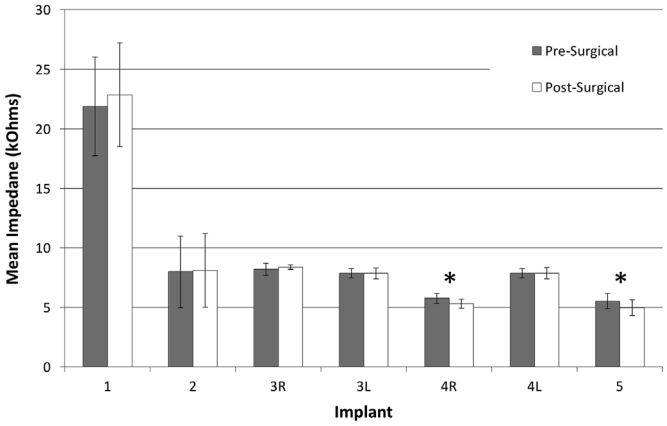

Fig. 1. Mean impedance values pre- and post-surgery. Bars, Mean ± standard error. *P < 0.05.

Pre- and post-surgical impedance testing revealed all electrodes were within normal operating limits. Paired evaluation of each implant before and after adenotonsillectomy revealed no statistically significant difference for the mean post-operative impedances in 5 of the 7 tested implants ($P = 0.2$–0.8) (Fig. 1). The impedance of each electrode before and after surgery, as well as the difference, are summarized in Table 2. When evaluating the individual electrode results, only patients 4 (right side only) and 5 had a statistically significant change in impedances although the postoperative findings remained within normal operating range and impedances were lower than the preoperative values (Table 2). The two with statistically significant post-operative impedances ($P = 0.02$ and $P < 0.001$) were within the normal operating range of 3.5–13 kOhms, and both showed a reduction in impedance which is not clinically significant. Speech perception was unchanged, as was functional performance for all 7 tested implants (Table 3).

4. Discussion

We found that radiofrequency used in the oropharynx during adenotonsillectomy did not alter the integrity of the CI devices. Impedance testing revealed no change in 5 of 7 implants after surgery, and small statistically significant impedance changes in 2 of the 7 implants, which were not clinically relevant as these changes were an improvement in electrode function. In addition, all implant functionality remained within the manufacturers' normal operational values. There was also no decrement in functional performance when assessed with audiometry and speech perception evaluation.

Traditionally, CI manufacturers have advised against using electrosurgery in patients with a CI due to concern for damage to the device or surrounding tissue by radiofrequency, electrical, or thermal means [6–8]. Studies have shown conflicting results for effects of traditional monopolar electrocautery surgery on CIs in varying cadaveric models [9–11]. These disagreeing results call into question the safety of