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COCHLEAR IMPLANTS

Cochlear Implant Electrode Impedance as an Indirect Biomarker for Residual Hearing

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Background and Aim

Preserving residual hearing after cochlear implant (CI) surgery provides significant benefits to patients. Electrical impedances may be linked to the intracochlear tissue response and could act as a biomarker for residual hearing[1]. This study aims to explore the connection between residual hearing and impedance subcomponents in CI patients.

Material and Methods

A total of 42 patients with lateral wall electrode arrays from the same manufacturer were included in the study (Med-El Flex[28]). We analyzed pre- and post-surgery pure-tone audiograms and telemetry data over a 24-month follow-up period to assess the link between residual hearing and impedance using a linear mixed-effects model. Near- and far-field impedance components were estimated using recorded voltage matrices and a specialized algorithm[2,3].

Results

Our analysis showed that far-field impedance remained stable over time. Near-field impedance followed a dynamic course, peaking around 4 weeks at the start of the activation (Fig. 1).

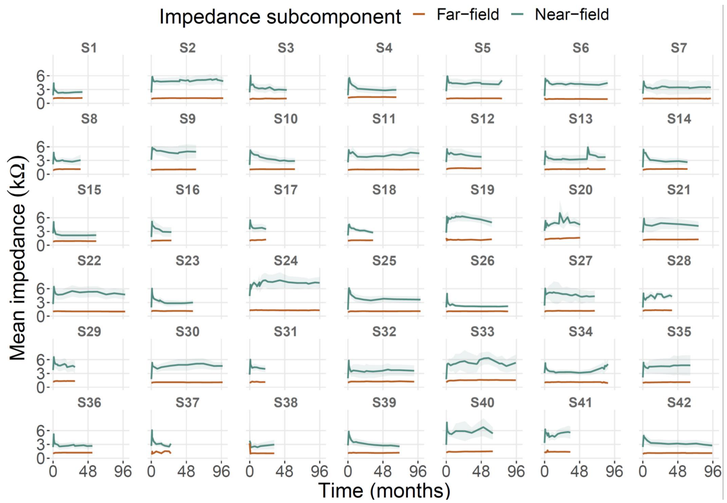

Figure 1. Evolution of averaged near-field and far-field impedances of 42 cases of all electrodes. The shaded area represents the 95% confidence interval of the mean.

Table 1. Linear mixed-effects model summary for residual hearing (in dB HL) and near-field/far-field impedance averaged over all electrodes.

	Coefficient	95% CI	p-value
Intercept	64.12	[-0.95; 129.9]	.08
Time (months)	-0.29	[-0.43; -0.16]	<.001
Near-field impedance (kΩ)	-3.81	[-4.57; -3.05]	<.001
Far-field impedance (kΩ)	1.67	[-2.55; 5.921]	.44

We identified a significant negative impact of near-field impedance on residual hearing (-3.8 dB HL per kΩ; p <.001), while far-field impedance had no significant association (Tab. 1; Fig. 2).

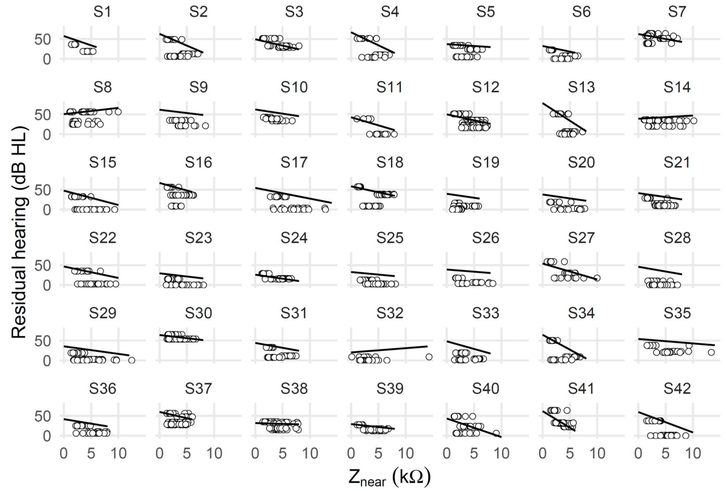

Figure 2. Scatter plot showing random intercepts and random slopes as estimated by the linear mixed-effects model between residual hearing (in dB HL) and near-field impedance.

Conclusion

Our findings highlight the potential of impedance subcomponents as objective biomarkers for monitoring outcomes in CI patients. Further studies will include dynamic parameters in the analysis.

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[1] Wimmer, W.; Sclabas, L.; Caversaccio, M.; Weder, S. Cochlear Implant Electrode Impedance as Potential Biomarker for Residual Hearing. Frontiers in Neurology 2022.
[2] Schraivogel, S.; Aebischer, P.; Wagner, F.; Weder, S.; Mantokoudis, G.; Caversaccio, M.; Wimmer, W. Postoperative Impedance-Based Estimation of Cochlear Implant Electrode Insertion Depth. Ear & Hearing 2023.
[3] Schraivogel, S.; Aebischer, P.; Weder, S.; Caversaccio, M.; Wimmer, W. Cochlear Implant Electrode Impedance Subcomponents as Biomarker for Residual Hearing. Frontiers in Neurology 2023

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