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COCHLEAR IMPLANT ELECTROPHYSIOLOGY

The Interphase gap (IPG) effect on electrically evoked compound action potential recorded from cochlear implant users with varied deaf duration

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ABSTRACT

Introduction: The sensitivity of electrically evoked compound action potential (ECAP) to changes in the interphase gap (The IPG effect) is associated with the functional status of the auditory nerve in cochlear implant (CI) users. This study aimed to investigate the feasibility of the IPG effect on ECAP responses to characterize the functional status of the auditory nerve across CI users.

Methods: Twenty-nine adults who were implanted with Nucleus CI participated in this study. They were divided into two groups per the deaf duration on the implanted ear; thirteen had relatively shorter deaf duration (mean = 60.6 months) while nineteen had longer deaf duration (mean = 295.5 months). ECAP responses were recorded via neural response telemetry by changing the IPG of the electrical pulse (IPG 7, 28, 56) across various levels. The IPG effect on ECAP threshold, maximum ECAP amplitude, and the slope of the growth function were calculated and compared between groups.

Results: When the IPG was increased from the default (7) to 28, the IPG effect on maximum ECAP amplitude and the slope of the growth function were significantly larger in subjects with shorter deaf duration than those with longer deaf duration. The IPG effect on ECAP threshold was not significantly different between groups. When the IPG was further extended from default (7) to 56, the IPG effect on maximum ECAP amplitude and the slope were significantly larger in the shorter duration group, while the ECAP threshold showed a marginal IPG effect between groups.

Conclusion: Results indicate the IPG effect of ECAP amplitude and the slope of the growth function may have the potential as sensitive metrics to characterize the functional status of the cochlear nerve that could help better understand large individual variabilities in CI outcomes.

OBJECTIVE

- To investigate the feasibility of the IPG effect on ECAP measures to characterize the functional status of the auditory nerve (AN) noninvasively in cochlear implant (CI) users

METHODS

Study Participants

- 43 adults w/ CI were divided into 2 groups by the duration of hearing loss **(Table 1)**

Table 1. Demographic information of study participants

Groups	N	HL Duration (m)	Electrode type	Mean Age (y)	Mean CI Use (m)
Shorter HL Duration (< 10y)	22	39.86 (SD = 34.8)	CI622 (n = 16) CI632 (n = 6)	46.81 (SD = 14.62)	21.53 (SD = 18.19)
Longer HL Duration (≥ 10y)	21	281.71 (SD = 131.48)	CI622 (n = 9) CI632 (n = 12)	43.42 (SD = 13.77)	15.12 (SD = 18.19)
Total	43	157.97 (SD = 154.27)		45.16 (SD = 14.15)	13.95 (SD = 15.45)

Measurement Metrics

- **ECAP Threshold**, **Slope**, **Maximum amplitude** measured across various IPG (7, 28, 56) and compared b/w groups **(Figs. 1-3)**

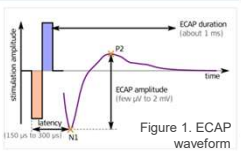

Figure 1. ECAP waveform

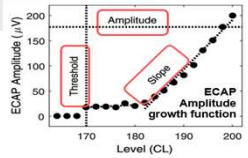

Figure 2. ECAP Amplitude growth function

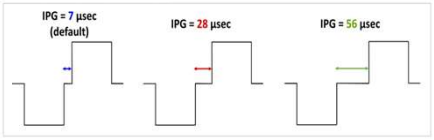

Figure 3. Various IPG of the electrical pulse

RESULTS

- When IPG was systemically varied from default (7) to 56, ECAP slope and maximum amplitude were significantly larger in subjects w/ relatively shorter duration of HL **(Fig. 4)**
- When IPG was changed from default (7) to 28 or 7 to 56, the IPG effect on ECAP slope and maximum amplitude were significantly larger in subjects w/ shorter HL duration **(Fig. 5)**
- IPG effect on ECAP threshold was not significantly different between groups and any IPG change b/w groups **(Figs. 4-5)**

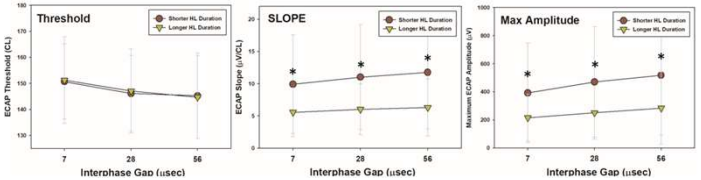

Figure 4. IPG effect on ECAP threshold, slope, and maximum amplitude b/w two groups w/ varied HL duration

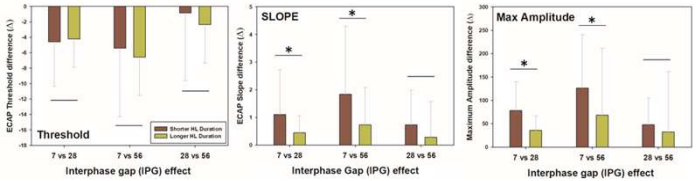

Figure 5. The size of IPG effect on ECAP threshold, slope, and maximum amplitude

DISCUSSION / CONCLUSION

- Increasing the IPG resulted in steeper ECAP slopes and larger ECAP amplitudes
- The size of the IPG effect on ECAP slope and ampllitude was significantly larger in subjects w/ shorter HL duration than those wi/ longer duration of HL
- Underlying mechanism for improved ECAPs at longer IPGs
  - Increasing the IPG makes the action potential generated by the leading cathodic pulse less susceptible to be abolished by the lagging anodic pulse *(Rubinstein et al., 2001; Shepherd & Javel, 1999)*
  - If the functional status of AN fibers deteriorates w/ longer HL duration, this may affect the effectiveness of increasing the IPG on improving the probability of spike initiation at AN
- New ECAP testing paradigm of systemically changing the IPG may potentially be used to assess the functional status of the AN in CI users

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