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- Email customerservice@AudiologyOnline.com
Intra- and Post-Operative Electrocochleography in Cochlear Implants

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Disclosure

- Prior employment in the research development and technology department of Sonova for 13 years (11 years at Advanced Bionics and 2 years at Phonak).
- Consultant for Advanced Bionics
- Advisory board member and consultant for Envoy Medical
- Research support from Advanced Bionics and Cochlear Corporation.
Learning Outcomes

After this course, participants will be able to:

- Describe electrical potentials measured using electrocochleography.
- Explain intra-operative application of electrocochleography during cochlear implant surgery.
- Describe post-operative application of electrocochleography in cochlear implant patients with residual hearing.

Cochlear Implants

- Cochlear implants (CIs) is a medical device that is used to restore hearing sensation and speech perception in patients with varying degrees of hearing impairment.

Advanced Bionics

Cochlear

Med-EL
Cochlear Implants

Who qualifies for a cochlear implant?

Patient with severe-to-profound hearing loss.
Cochlear Implants

Patients with partial hearing loss receive benefit from cochlear implantation (e.g., Dorman et al., 2008)

In patients with preserved residual hearing acoustic + electric hearing provides best cochlear implant outcome (e.g., Gifford et al., 2013)
Cochlear Implants

- Many patients show a decrease or complete loss of residual hearing after cochlear implant surgery (Huart et al., 2014).

- Several intra-operative and post-surgical factors likely contribute to the loss of hearing after cochlear implantation.

Cochlear Implants

- Electrode insertion trauma to the basilar membrane can lead to loss of residual hearing (e.g., Roland et al., 2005).

- Ideally the entire array should be placed into the scala tympani.

Downing (2018)
Cochlear Implants

- Electrodes can translocate from scala tympani into the scala vestibuli (Holden et al., 2013).

- With the current technology we are unable to visualize the electrode location during the placement of the electrode array.

Electrocochleography

Electrocochleography (ECOG) is a technique used to measure electrical potentials from the cochlea and auditory nerve.
Electrocochleography

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Acoustic</th>
<th>Electric (eCAP)</th>
<th>Electric (eCAP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tone bursts or clicks</td>
<td>Analog or biphasic pulses</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recording</th>
<th>Electrodes</th>
<th>Surface electrodes or tip-trodes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Transtympanic or extracochlear electrodes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cochlear implant electrodes</td>
</tr>
</tbody>
</table>

ECOG

Wever and Bray (1930)
ECOG

CM – Outer hair cells (ongoing response)
ANN – Auditory nerve (ongoing response)
SP – Hair cells (ongoing response)
CAP – Auditory nerve (onset – offset response)
(Forgues et al., 2013)
ECOG

Condensation

Rarefaction

Stimulus
CM

1 - 1

Subtract

1 (1 - 1)

ECOG

Condensation

Rarefaction

Stimulus
ANN

1 + (1 - 1)

Add

1 + (1 - 1)
ECOG

1 Condensation
1 Rarefaction

1 - (-1) CM
1 + (-1) ANN
ECOG and CI

Stimulus

Train of acoustic tone burst (e.g., 500 Hz @ 100 dB HL)

Recording electrodes

Source
www.advancedbionics.com
www.cochlear.com

ECOG and CI

2000 Hz  1000 Hz  500 Hz  250 Hz

Basilar membrane

Basal end  Apical end

CM (µV)

Time
Intra-op ECOG set up

- Tone generator
- Insert earphone tube
- Electrocochleography software
- POD/CPI-3 Processor
- Cable and headpiece/coil
- Implant
- Electrode array

Bone wax
Intra-op ECOG set up

- Insert earphone tube
- Electrode array
- Coil/Headpiece
- Sleeve

Intra-op ECOG monitoring

Video 1
Intra-op ECOG monitoring

Video 2

Intra-op ECOG monitoring

Video 3
Intra-op ECOG monitoring


Post-op ECOG audiogram

Koka, Saoji, and Litvak (2017)
Post-op ECOG audiogram

Koka, Saoji, and Litvak (2017)
Post-op ECOG audiogram

Video 4

Post-op ECOG audiogram

- Intra-op CM thresholds
- Pre-op pure tone thresholds
Post-op ECOG audiogram

Post-operative ECOG measurements can be used as an objective tool to:

- Predict pure tone thresholds in cochlear implant patients with post-operative residual hearing (Koka et al., 2017).
- Reliably measure air-bone gap in cochlear implants patients (Koka et al., 2017).
- Measure electric and acoustic interaction in cochlear implants (Koka and Litvak, 2017).
- Determine the location of cochlear implant electrode along the cochlear space.
Thank you!

References