A Model to Evaluate Electrode Explant Force and Trauma

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Disclosures

- Advisory Board
  - Cochlear Americas
  - Advanced Bionics

- Research Funding
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- This study was supported by Cochlear Americas
Explant Trauma - Introduction

Implanted temporal bone with patent lumen

In Vivo after 10yrs - New bone/fibrosis due to cochlear implant. Nadol et. al. 2006

Fayad et al

Histogram of average new bone/fibrosis (n=7). Mean duration =7.3yrs (1-17yrs); Somdas et. al. 2007
The volume of fibrosis/ossification around the electrode will depend on:

- Biological response to the foreign body
- Insult from initial insertion (trauma)
- Introduction of blood/bone dust during surgery and electrode insertion
- Etiology or genetic factors
- Duration of implantation

Questions:

- What is the effect of explant on the intra-cochlea structures?
- How does electrode position in scala tympani affect explant trauma?
- Is explant force alone an accurate indictor/predictor for explant trauma?
Explant Trauma Theoretical Model

**Capstan Principle** – Tension on a flexible line wrapped around a cylinder will differ on either side and is a function of the total contact angle ($\varphi$) and coefficient of friction ($\mu$) between the line and cylinder.

\[ T(\text{load}) = T(\text{hold})e^{\mu \varphi} \]
Explant Trauma Theoretical Model

Lateral Electrode Position:
• Inward force as electrode explanted
• Approaches a modiolar position
• Disrupts surrounding Fibrous tissue

Modiolar Electrode Position:
• Inward force as electrode explanted
• Remains in a modiolar position
• Surrounding tissue remains intact
Explant Trauma Model (Condition 1 - LFT)

In-Vitro Model Design:

- 2D Cochlea Bone Model.
- Electrode in patent lumen, backfilled with Gelatine.
- Assuming ST completely-homogeneous filled.
- Force measure via Instron
Explant Trauma - In Vitro Model

- Explant Force ≠ Explant trauma
- Explant force values are similar to insertion forces values
- Fibrous tissue disruption including or close to BM more likely with lateral wall electrodes
Conclusions

• In-vitro model suggests that explant trauma is dependant on the presence/type of fibrous tissue.

• In-vitro model indicates that fibrous tissue disruption is greatest with more deeply inserted lateral wall electrodes.

• Explant forces is not necessarily an accurate indicator of explant trauma.
Thank You