Electrode Trauma Assessed by Microdissection

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Why worry about electrode trauma?

- Bilateral Implants
- Electro-acoustic implants
- Electrophonic hearing
- Preservation of ganglion cells?
Electrode Trauma

• There are many ways to evaluate electrode trauma including:
  – Animal studies both *in vivo* and post mortem
    • Control individual variability, cause of deafness, surgical technique
  – Human temporal bones after implantation
    • Evaluate long term changes
  – Cadaveric temporal bones that have never been implanted
    • Allow evaluation of insertion dynamics
      – Radiographic
      – Microdissection
      – Conventional sections

Microdissection

– Microdissection allows direct visualization of soft tissues, particularly the basilar membrane, as the electrode is inserted.
– Microdissection allows one to study the 1\textsuperscript{st} order neuron in surface preparations of the osseous spiral lamina as well as celloidin sections of the modiolus.
Drill Down

Staining
Decalcification

Bone removal
Cochleostomy

Complete Dissection for CI Modeling
Apex of cochlea

Organ of Corti (apical)

Dissection by G. Wright PhD & Dr. P. Roland, University of Texas

Surface Prep
Electrode Trauma

- Cochleostomy
- Damage due to electrode insertion
- New bone formation and fibrosis
- Infection

Cochleostomy

- Perilymph loss
- Bone dust
- Infection
- OSL injury
- Acoustic trauma
- Heals with fibrous tissue
Cochleostomy

Facial recess
vasculature
Promontory
Electrode

Sheat
Scala tympani

(electrode removed)

Prof. Brunner, Augsburg, Germany
Insertion of Electrode Array

- Contact can produce:
  - Endosteal injury
  - Kinking
  - Fracture or dislocation of the OSL (SGCs decreased by 50% Sutton 1980)
  - Displacement or perforation of the basilar membrane (mixing of peri- & endo-)
  - Dissection of the spiral ligament
  - Vascular injury

*Cadaveric: Shepherd, Kennedy, Sutton, Welling, Gstoettner & Johnnson
*Post Mortem: Clark, Fayad, O’Leary, Zappia, Linthicum, Johnsson, Marsh, & Nadol*

Two approaches

- Insertion into fresh or fixed temporal bones followed by dissection
- Dissection followed by electrode insertion under direct visualization
Med El Array

Basilar Membrane and OSL

Rupture @ Spiral ligament

Kennedy  Laryngoscope  1987
Basilar Membrane and OSL
Insertion of Electrode Array

- There is a tendency for the electrode to ride superiorly, indenting the spiral ligament.
- As the electrode passes from the lower to the upper basilar turn there is a tendency to elevate (or tear) the basilar membrane (at 180-240 degrees).
- Tip appears to be the principal source of damage.

Tip displacement
Proximal “buckling”

OSL fracture
Summary of findings
Using Eshraghi Trauma Scale

Standard Helix Electrodes

#1 - 4 (osseous lamina fracture; electrode buckling)
#2 - 1 (elevation of basilar membra./spiral ligament)
#3 - 0 (no damage)
#4 - 1 (slight elevation/distortion of basilar memb.)
#5 - 0 (no damage)
#6 - 0 (no damage)
Vascular Injury

- Veins in wall of scala media
- Inferior & superior cochlear vein
- Anastomotic veins
- Vas Spirale
Anastamotic vein
Vas Spirale

New bone Formation

- Generally fewer SGC in bones with greatest new bone formation
- Commonest sites:
  - Outer wall of ST extending from RW
  - Beneath the OSL
  - Within the fibrous tissue tract surrounding array
- Correlated with bone dust and endosteal trauma (but extent is variable and unpredictable)
Residual Sensorineural Elements

Hair Cells

Dendrites

Spiral Ganglion Cells

Med-El
• Nucleus contour and Advance Bionics Helix lie very close to SGCs
  – More focused stimulation of SGCs
  – Lower energy requirement
  – Diminished channel interaction

• Med-El lies closer to dendrites & HCs.
  – More selective if dendrites present, especially apical dendrites
  – Avoids trauma to modiolus

Multi-channel Implant

Rupture into scala media
(13mm)

Electrodes

Johnsson LG 1982
“Off The Stylet”

Softip Cautions
QUESTIONS ?