

TIP FOLD OVER & SCALAR DEVIATION

By

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I. Introduction:

The correct position of the electrode array in the cochlea is an important factor for the outcome of hearing

II. Definition:

If during insertion; the electrode tip is getting stuck with any of the intra-cochlear structures and the surgeon does not feel it and further keep pushing of the electrode; This may result in either:

- i. Tip fold over: The electrode tip is temporarily held stationary giving chance to the more proximal electrode to advance bypassing it.
- ii. Scalar deviation: Penetration into scala vestibuli

III. Incidence:

- a. Lassig et al found that 13% may experience problems pertaining to electrode array positioning
- b. Zuniga et al reported that Tip fold-over occurred at a rate of 1.98% In a large academic center with experienced surgeons. This was not immediately identifiable clinically and it occurred predominantly at 270°
- c. Dhanasingh & Jolly summarizes the 38 peer reviewed publications that collectively reported on electrode tip fold-over and scalar deviation issues. They have concluded that both tip fold and scalar deviation are approximately 5 times higher with the pre-curved electrodes in comparison to the lateral wall electrodes.
- d. The increased use of very delicate electrodes (flexible; small diameter) may lead to increase incidence of tip fold over (Balkany)

IV. Pathophysiology:

Ramos et al identified 3 common errors which can lead to tip fold over during insertion of Peri-modiolar electrode:

- i. Improper rotation of the electrode at the cochleostomy (should be toward the modiolus)
- ii. Over-insertion of the electrode 'sheath'
- iii. Early extrusion of the array from the sheath

V. Intra-operative Evaluation:

- a. Electrophysiological tests:
 - i. Electrically evoked compound action potential (ECAP) cannot predict tip fold over

- ii. Electrical impedance (EI): can identify open circuits (high impedance) and short circuits (low impedance).
- iii. Spread of excitation (SOE) depicts the selectivity of neural excitation fields around each electrode. Overlap of electric field suggests tip foldover (Zuniga et al)
- iv. Electric field imaging (EFI). It looks at the electrical impedance and voltage change between each combination of pairs of intracochlear electrodes (Vanpoucke et al)
- v. Intra-operative electrocochleography: Recently has been used as a research tool in finding the scalar deviation (Koka et al. (2018)
- b. X-ray imaging studies
 - i. Techniques
 - 1. C Arm
 - 2. Fluoroscopy via Stenvers view: It requires experience to align the view and limit radiation exposure
 - 3. 3-D rotational X-ray (Grolman et al)
 - ii. High predictive value in detecting tip rollover.

VI. Post-operative Diagnosis:

- a. X-ray in modified Stenver's view
- b. CT Scan: Gold standard in most clinics
- c. CT scan with 3D Reconstruction

VII. Consequences:

- a. May impact hearing outcome
- b. Pitch confusion; Tinnitus and vertigo
- c. Flat or reduced response involving affected electrodes
- d. New bone and fibrous tissue formation right at the place where the intra-cochlear electrode bending, kinking and tip fold-over

VIII. Management:

- a. Re- Mapping:
 - i. Deactivation of overlapping electrodes
 - ii. Re-Program all electrode contacts
 - iii. Image-guided cochlear implant programming strategy (Noble et al)
- b. Revision surgery:
 - i. Re-Insertion or
 - ii. Use of back up device

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