The Case for Intra-Operative X-Ray: Illustrative Cases and Literature Review

Cheryl Yu, MD, Sarah Debs, MD, Rhea Singh, BS, Sean Kastetter, CCC-A, Akilah Pierre-Louis, BS, Daniel H. Coelho, MD

Department of Otolaryngology – Head & Neck Surgery
Virginia Commonwealth University Health System
Disclosures

- None
Introduction

• Cochlear implant technology and surgical technique continue to develop and evolve over time
• **Decreasing complication rates ~3%** (Binnetoglu et al., 2020)
• Most common major complications
  • Device extrusion
  • Wound infection
  • Device failure
• **Electrode misplacement**
• Proper array positioning of all electrodes within scala tympani crucial to optimal performance
Tip-rollover/ Tip-foldover

- Near **180-degree bending or kinking** of apical array
- Most frequently at 270-degree insertion depth
- **Up to 5%** incidence (Dhanasingh & Jolly, 2019)
- More commonly associated with precurved perimodiolar electrodes
- **Often no reliably identifiable electrophysiologic abnormalities**
- Can occur with **normal neural response telemetries (NRTs)**
- Often goes undetected until later
Why does it matter?

- Proper array positioning → optimal performance
- Late or undetected mispositioning → audiologic, personal, economic impact
- Vast array of modalities exist for confirmation of intraoperative placement
  - Plain film radiography, fluoroscopy, CT, electrophysiology testing
- Imaging for routine cases remains controversial
- No universal protocol exists
Current Trends

- Surveyed practice habits and opinions regarding intraoperative testing
- Majority used some sort of testing
  - **ECAPs and EIs (38%)**
  - **ECAPs/ EIs with plain X-ray (13%)**
  - Fluoroscopy alone (8%)
  - X-ray alone (5%)
  - ECAPs/Eis with stapes reflex testing (3%)
- **33% used no testing at all**
- **54% added IOXR in ‘abnormal’ cases**
- **No practitioner pattern**
- 89% felt testing ‘rarely’ or ‘never’ changed management
- Tested for **reassurance**
Case Series

• **Four cases** (4/≈1000) of electrode mispositioning
• Traditional trans-mastoid posterior tympanotomy facial recess approach
  • Both intraoperative telemetry (**impedance and auditory response compound action potential thresholds**) and single plain **X-ray** of skull (modified Stenvers view) are performed
• IOXR is performed either before or after EP testing
Case 1

- 83-year-old-male with a 15-year history of idiopathic progressive hearing loss
- Preop imaging (CT) unremarkable
- Cochlear Nucleus 622 electrode
- **Easy insertion without resistance**
Case 1
Case 2

- 57-year-old female with poorly controlled schizophrenia admitted for meningitis and pneumonia
- Found to have profound bilateral hearing loss that was noted to be exacerbating her schizophrenia
- Preop imaging (MRI) unremarkable
- Cochlear Nucleus 522 electrode
- **Easy insertion without resistance**
Case 2
Case 3

- 93-year-old male with 30+ year of progressive hearing loss and military-noise exposure
- Preop imaging (MRI) unremarkable
- Cochlear Nucleus 622 electrode
- Easy insertion without resistance
- Normal impedances and NRTs
Case 4 – BONUS!

- 30-year-old female with post-meningitic hearing loss in childhood and previous left CI (N22) placed at age 9
- Daily user but loss of electrodes over time consistent with a ‘soft’ failure
- Underwent replacement of failing device
- **Pre-explant XR available** and unremarkable
- Cochlear Nucleus 512 electrode
- **Minimal resistance met at approximately mid-insertion depth**
Discussion

- EP reliably tests the **neural interface integrity**
- **Does NOT** reliably determine specific positional differences
- **97% sensitivity, 100% specificity** compared to X-ray (Al Omari et al., 2019)
- Radiography readily detects **exact positioning**
- **Identify \(\rightarrow\) immediate and easy adjustment** and repositioning
- Avoids future revision and associated costs, surgical/anesthetic risks
- As electrodes become more fine and delicate, misplacements may become **more prevalent** further heightening need for proper identification
Plain Film Radiography

- Plain film X-ray accessible, feasible, accurate
- **Stenvers view** (transorbital X-ray), classic or modified, is generally enough
- Average added operational time **3 minutes**
- Proper technique imperative
- Copeland et al. cited **up to 16%** requiring more than one intraoperative film

Image: https://radiopaedia.org/cases/modified-stenvers-view
Conclusion

• **Currently no universal adoption of a sole technique** for confirming intraoperative placement
• **IOXR is a feasible, safe, and effective method**
• **Helpful** even in cases of **normal electrophysiologic testing**
• Can be helpful in **revision** cases as indicator of original positioning
• **Should be employed routinely in all cases**
REFERENCES


