

Evaluation of Insertion Speed and Hand Kinematics During Cochlear Implantation in a Fixed Cadaveric Temporal Bone Model

Radha Patel¹, Troy Wesson¹, Sarah Burgin^{1,2}

¹Indiana University School of Medicine; ²Indiana University School of Medicine, Department of Otolaryngology – Head & Neck Surgery

Background:

Cochlear implant is the treatment of choice for replacement of sensory deprivation from severe to profound sensorineural hearing loss. Slower insertion of the electrode into the cochlea leads to less intracochlear trauma. Accurate measures of hand motion and insertion speed during live cochlear implant electrode insertions on human subjects are limited.

Methods:

Data from a single surgeon was collected during insertion of a cochlear electrode into a cadaveric temporal bone using inertial measurement units (IMUs), devices that measure linear acceleration in 3 dimensions (x,y,z). The sensors were affixed as follows: dorsal second digit, dorsal hand, and dorsal wrist with three trials at each position. The extremity inserting the electrode into the inner ear was labeled “inserting limb,” while the other extremity was labeled “non-inserting limb.” Root mean square (RMS) calculations were utilized to record the net acceleration, from which average speed per trial was calculated using the midpoint method.

Results:

Mean speeds for first digit, hand, and wrist for the inserting limb were 0.23 ± 0.11 , 0.15 ± 0.06 , 0.16 ± 0.04 mm/s respectively. Mean speeds for first digit, hand, and wrist for the non-inserting limb were 0.26 ± 0.10 , 0.13 ± 0.03 , 0.16 ± 0.09 mm/s, respectively. The difference in speed between “inserting” and “non-inserting” limbs for all three IMU positions, as well as the relative speeds between all three positions, were statistically significant ($p < 0.001$).

Conclusion and Potential Impact:

Available literature suggests the mean insertion speed during live cochlear implant surgery is 96.5 mm/min (1.60 mm/s), which is significantly faster than the mean speeds collected during this fixed cadaveric temporal bone study regarding all three positions ($p < 0.001$). Though preliminary, this data of insertions speeds highlights the need for further investigation during live cochlear implant surgery on human subjects using IMUs.