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Research Paper

# The impact of round window vs cochleostomy surgical approaches on interscalar excursions in the cochlea: Preliminary results from a flat-panel computed tomography study

Nicole T. Jiam, Charles J. Limb*

*Department of Otolaryngology — Head and Neck Surgery, University of California San Francisco School of Medicine, USA*

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Flat-panel computed tomography;
Surgical approach

**Abstract** *Objective:* To evaluate incidence of interscalar excursions between round window (RW) and cochleostomy approaches for cochlear implant (CI) insertion.
*Methods:* This was a retrospective case-comparison. Flat-panel CT (FPCT) scans for 8 CI users with Med-El standard length electrode arrays were collected. Surgical technique was identified by a combination of operative notes and FPCT imaging. Four cochleae underwent round window insertion and 4 cochleae underwent cochleostomy approaches anterior and inferior to the round window.
*Results:* In our pilot study, cochleostomy approaches were associated with a higher likelihood of interscalar excursion. Within the cochleostomy group, we found 29% of electrode contacts (14 of 48 electrodes) to be outside the scala tympani. On the other hand, 8.5% of the electrode contacts (4 of 47 electrodes) in the round window insertion group were extra-scalar to the scala tympani. These displacements occurred at a mean angle of occurrence of 364° ± 133°, near the apex of the cochlea. Round window electrode displacements tend to localize at angle of occurrences of 400° or greater. Cochleostomy electrodes occurred at an angle of occurrence of 19°—490°.

* Corresponding author. Division of Otology, Neurotology and Skull Base Surgery, Douglas Grant Cochlear Implant Center, Department of Otolaryngology — Head and Neck Surgery, University of California San Francisco School of Medicine, USA.
*E-mail address:* charles.limb@ucsf.edu (C.J. Limb).
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*Conclusions:* Currently, the optimal surgical approach for standard CI electrode insertion is highly debated, to a certain extent due to a lack of post-operative assessment of intracochlear electrode contact. Based on our preliminary findings, cochleostomy approach is associated with an increased likelihood of interscalar excursions, and these findings should be further evaluated with future prospective studies.


## Introduction

Cochlear implantation is a common surgical procedure used to restore speech perception in adults and children with severe-to-profound hearing loss. The internal component of the surgically implanted device is comprised of a processor and electrode array and works by replacing hair cell function with electrical impulses.

It has been established that one of the main determinants of successful audiological outcome is minimal interscalar excursions.[1] In fact, when cochlear implantation was first offered for the hard of hearing, surgical eligibility was limited to individuals with total deafness because this procedure frequently destroyed any remaining residual hearing. Over time, surgical technique has been refined to minimize intracochlear trauma and to optimize placement of electrode contacts within the scala tympani with respect to spiral ganglion neurons. This emphasis on soft surgical technique focuses on preserving residual hearing in the cochlear apex by modifying various components of the operation such as blood and bone dust entry, steroid use, surgical site of insertion, perilymph leakage and suctioning, and depth of insertion.[2] Atraumatic surgery has since been of importance to the scientific and medical community as developments in cochlear implant (CI) models (e.g. mid-scala CIs) are increasingly focused on reducing intracochlear trauma.

Round window insertion (RW) and cochleostomy approaches are the two of the most common surgical techniques employed in cochlear implantation (CI). These two approaches are often used interchangeably by otologic surgeons, which may be in part due to a lack of literature comparing these two techniques. It has been previously proposed that cochleostomy approaches may reduce disruption to intracochlear fluid dynamics and the cochlear aqueduct[2] and increase electrode contact distance to the osseous spiral lamina and membranes. However, there has been a growing trend towards round window insertion[3–5] in favor over cochleostomy approaches, with reports of less traumatic insertions in cadaveric dissection studies.[4,5]

A significant challenge otologic surgeons face at the time of cochlear implantation is the lack of electrode array visualization, which undermines knowledge of final electrode contact position. Standard imaging modalities, such as multislice computed tomography (MSCT), have also been rendered useless in visualizing the electrode array in CI users due to the significant metallic artifact from the electrode contacts. Flat-panel computed tomography (FPCT) is a new imaging technique that provides high resolution images of CI electrode arrays *in vivo* by overcoming the temporal bone attenuation and metallic noise seen in traditional CT imaging of electrode position.[6,7] The degree of quality is so significant that individual electrode contacts can be delineated, thus permitting assessment of final electrode position.[8] In this study, we used high-resolution FPCT imaging to evaluate the impact of cochleostomy approaches and round window insertion on CI electrode interscalar excursion.

## Material and methods

Eight subjects underwent previous cochlear implantation with Med-El standard 12-electrode contact arrays (31.5 mm linear insertion length, 2.4 mm between contacts). We evaluated 2 males and 6 females with a mean age of 52 years (range: 21—64 years). One of the research participants was a bilateral CI user. Details regarding the demographics of our research participants can be found in Table 1. A standard posterior tympanotomy approach was used for all cases. The surgical insertion technique was identified using a combination of operative notes and computed tomography visualization in the coronal oblique, sagittal oblique, and axial oblique sections. Implantation approach varied between pure round window (RW) insertions and cochleostomies (COCH) anterior and inferior to the RW. In this study, the term 'cochleostomy' refers to a separate opening into the cochlea and not an extension of the round window. The local institutional review board approved the study protocol, and we obtained written informed consent from all participants.

FPCT datasets were collected between January and August 2013.[7] Participants had their FPCT (DynaCT; Siemens, Erlangen, Germany) scans taken on a flat-panel angiography system (Axiom Artis Zee; Siemens) with commercially available software (Syngo DynaCT; Siemens). Collimated 20-s head FPCT scans were taken using the following parameters: 109 kV, small focus, 200° rotation angle, and 0.4° per frame angulation step. A commercially available workstation (Leonardo DynaCT InSpace 3D Software; Siemens) was used for post-processing. High resolution secondary reconstructions were created using the following parameters: manually generated voxels of interest to include only the electrode array; voxel size of 0.07—0.08 mm with the creation of secondary reconstructions, 512 $\times$ 512 section matrix; HU kernel types; and normal, auto, and sharp image characteristics. DICOM data processing was performed using open source imaging software for Mac OSX (OsiriX; Pixmeo, Los Angeles,