Optical Coherence Tomography Imaging of the Inner Ear: A Feasability Study With Implications for Cochlear Implantation

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Seminar Presentation

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Presentation Outline

- Project Overview and Paper Selection
- Problem
- Theory
- Experiment
- Assessment

Project Overview

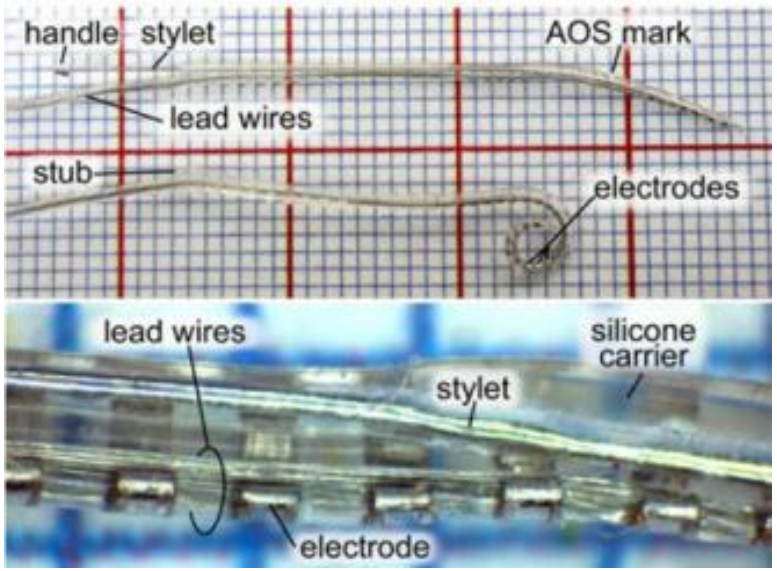
- Cochlear Implant
  - Used to restore function to the cochlea
  - Standard practice is manual insertion via forceps
- Project goals
  - Image the cochlea using OCT Imaging
  - Create Models from OCT images
  - Create Virtual Fixtures for use in inserting electrode array
  - Enact virtual fixtures on steady-hand robot and insert implant

Paper Selection

- Paper Topic
  - Cochlear Implantation using OCT Feasibility study
  - Efficacy of OCT Imaging on temporal bone
- Feasibility of Project
  - Strength of OCT signal
  - Possibility of contour creation
- Accuracy of Constructed Models
  - Precision of contours detected in OCT scans
  - Precision of constructed model

Problem

- Current practice
  - Manual insertion via forceps
  - Relies on marker a fixed distance from implant tip
- Issues with standard practice
  - Low visibility
  - Precision needed
  - Hand tremors
  - Possibility of inaccurate placement



Courtesy L. Kratchman et al

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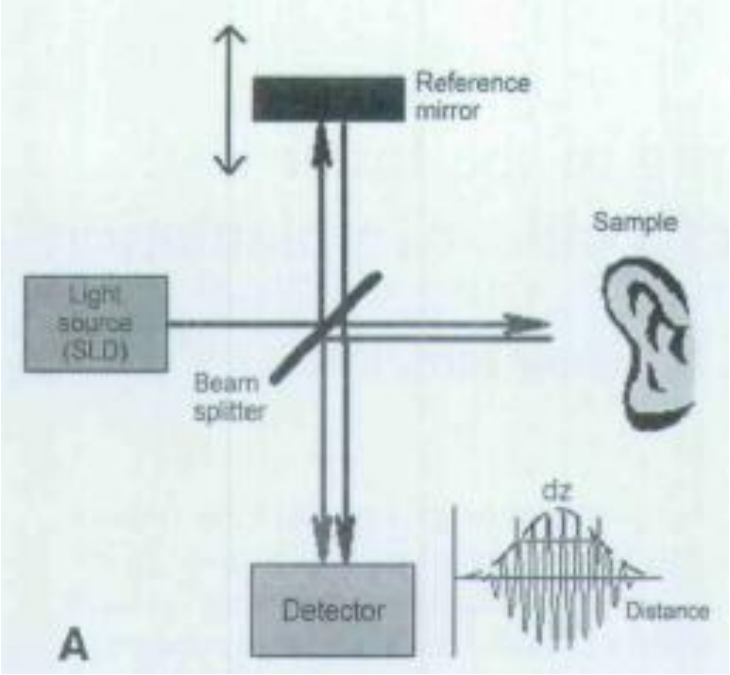
Theory

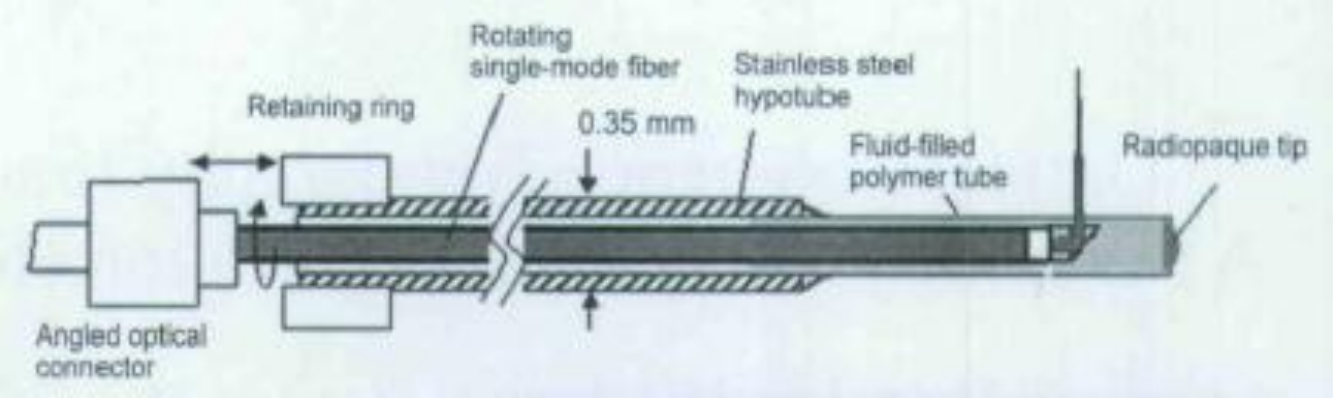


Courtesy Lin et al

- Interferometry principle of light
  - Beams of light travel different distances
  - Phase difference indicates distance
- OCT setup
  - Beam from light source split
  - One beam hits reference mirror
  - Other bounces off of temporal bone
  - Recombined at detector
  - Phase difference analyzed

Experimental Setup

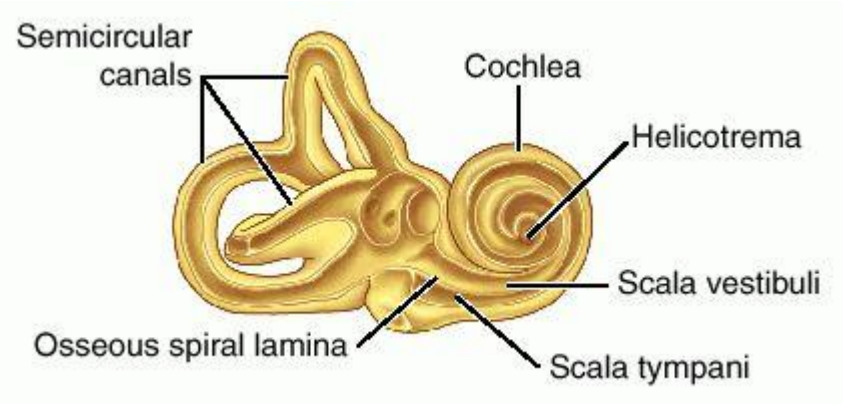
- Rotating OCT probe developed
  - Scans are taken as probe rotates in cochlea
  - For each rotation, the scans are fit to a polar graph
  - These b-scans are taken at multiple depths



Courtesy Lin et al

Experimental Results

- Rotating OCT probe mouse test
  - Probe inserted into mouse tympanic cavity
  - B-scans imaged at 1 Hz
- Rotating OCT probe human test
  - Probe inserted into cadaveric cochlea
  - B-scans imaged at 3.1 Hz
- Key results
  - Scala vestibuli
  - Scala tympani
  - Basilar membrane
  - Resolution of roughly 10 micrometers



Courtesy Dorland's Medical Dictionary

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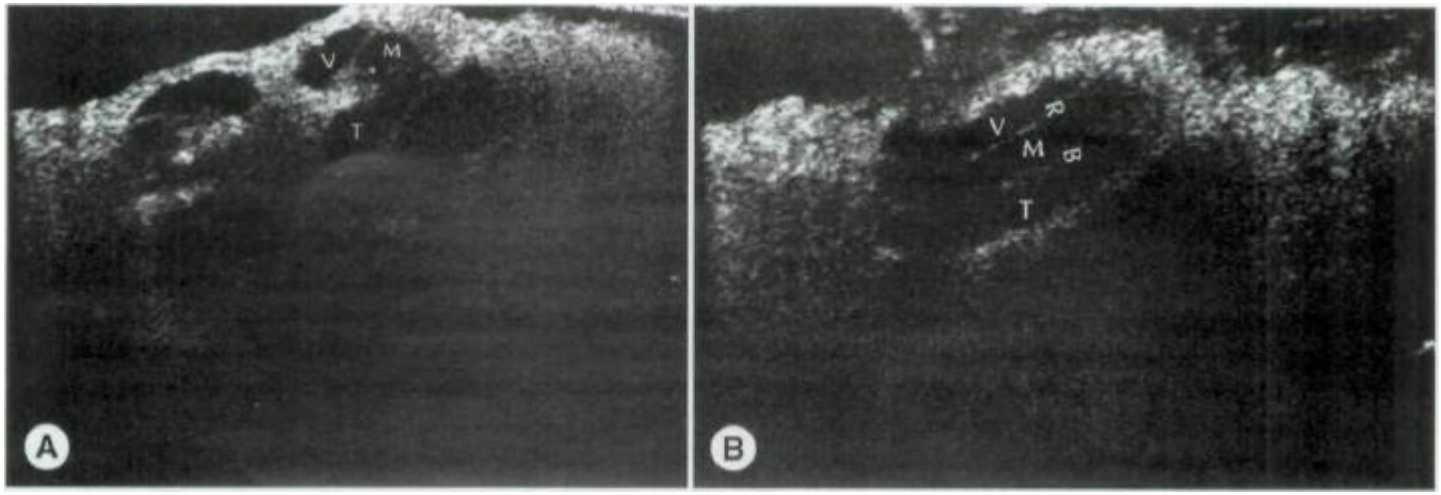
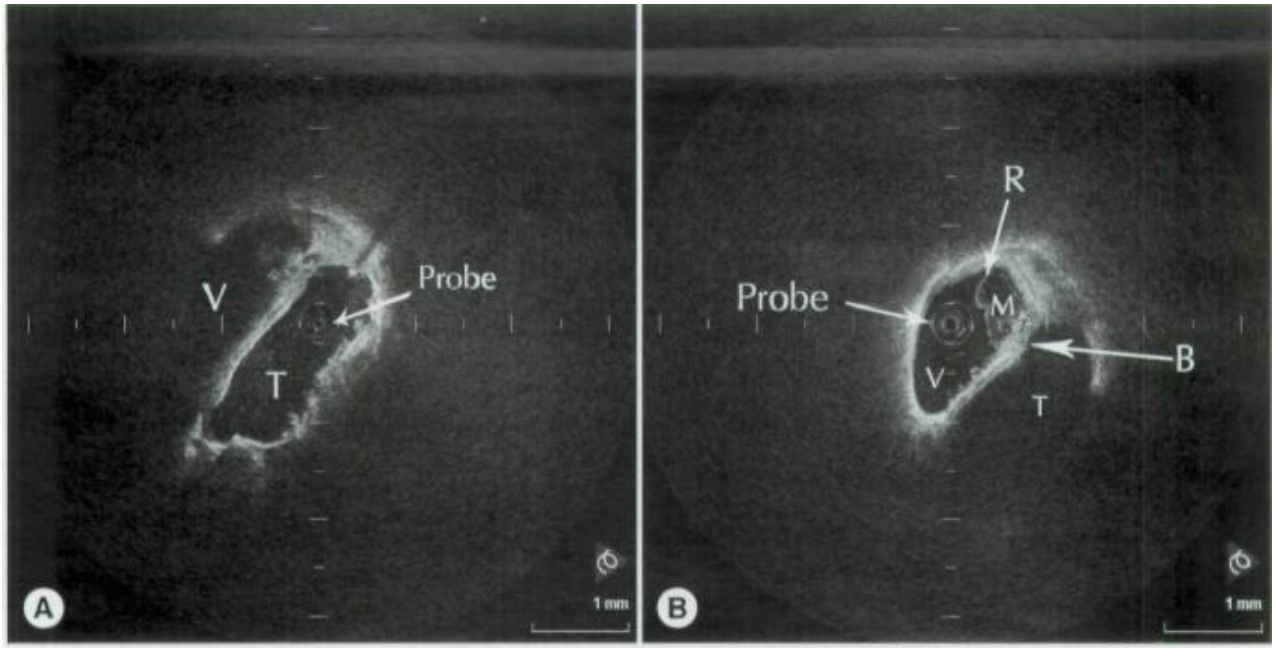
Experimental Results (continued)



Courtesy Lin et al

Experimental Results (continued)



Courtesy Lin et al

Assessment

- Relevance of results to project
  - Similar side-viewing OCT probe setup
  - Possibility of contour not addressed
  - Key structures identified
  - Signal strong enough to see into adjacent cavities
  - Informative about cochlear structure
  - Lacked detail concerning precision
- Future Work
  - Identifying endolymphatic hydrops
  - Intratympanic injections
  - Various other otologic procedures

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Questions?