Cochlear™ – connecting people to the world of sound

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Hearing

More than 280 million people in worldwide with moderate to profound hearing impairment
One to two of every 1,000 newborns have hearing impairment
Many of them may be candidates for a cochlear implant.
How hearing works

Sound is perceived naturally by way of air and bone conduction.

1. Sound waves travel through the ear canal and strike the eardrum.
2. These sound waves cause the eardrum and the three bones within the middle ear to vibrate.
3. These vibrations are transferred to the fluids in the inner ear – known as the cochlea – and cause the tiny hair cells in the cochlea to move.
4. The movement of the hair cells produces neural impulses which are sent along the hearing nerve to the brain, where they are interpreted as sound.

Even with a hearing aid...

Patients suffer from:

• Major communication difficulties
  – Speech comprehension especially in noise
  – Environmental sounds: doorbells, birds, sirens etc

High levels of dissatisfaction in their performance with hearing aids
The Cochlear Nucleus System has both external and internal parts:

- The sound processor is worn behind the ear.
- The cochlear implant is placed just under the skin, behind the ear.

### Hearing with Cochlear Implant

1. **The sound processor** captures sounds and converts them into digital code.
2. The sound processor transmits the digitally coded sound through the coil to the implant just under the skin.
3. The implant converts the digitally coded sound to electrical signals and sends them along the electrode array, which is positioned in the cochlea.
4. The implant’s electrodes stimulate the cochlea’s hearing nerve fibres, which relay the sound signals to the brain to produce hearing sensations.
Cochlear’s electrode portfolio – as unique as our customers

CONTOUR ADVANCE™ ELECTRODE
SLIM STRAIGHT ELECTRODE
HYBRID™ L24 ELECTRODE
STRAIGHT ELECTRODE

Cochlear Implant Surgery
Incision and Cortical Mastoidectomy

[Images of cochlear implant surgery]
Cochlear Implant Surgery
Posterior Tympanotomy

Cochlear Implant Surgery
Cochleostomy and Electrode Insertion
Surgical Variables

- Access through facial recess
- Anatomical limitations or abnormalities
- Cochleostomy location
- Method of electrode insertion
- Deployment of the stylet?
- Angle, or trajectory
- Speed of insertion
- Over or under insertion...

- Trauma?
- Residual Hearing?
- Suboptimal performance?
- Electrode damage...

Surgical Variable – Cochleostomy Location

Optimal Cochlear Implant Insertion Vectors.
Meshik, Xenia; Holden, Timothy; Chole, Richard; Hullar, Timothy
DOI: 10.1097/MAO.0b013e3181b76bb8

FIG 2. Anterolateral view of right labyrinth. Five vectors tangent to the centerline of the scala tympani are labeled a to e in order from the round-window superiorly to the inferiormost extent of the basal turn. Vector a passes through the center of the round window. The purple line represents the centerline of the scala tympani, which changes its orientation as the scala tympani curves along the basal turn. The changing curvature of the centerline causes the angles among the vectors to appear unequal.
Robotics & “Control”

Surgeon Control  Assisted Control  Automatic Control

The “Control Continuum”

More dependent on surgeon dexterity, decision-making and reaction time
Less dependent on surgeon dexterity and decision-making

Manual tools  Master-slave systems  Robot-assisted to control movement, remove tremor  Pre-op guided machines (as in neurosurgery)  Sensing tools, real-time decision making  Autonomous sensing in real time

Variability  Speed
CI Applications of the “Control Continuum”

More dependent on surgeon dexterity, decision-making and reaction time

Manual tools
- Master-slave systems
  - Eg., visual, audio or force feedback
- Robot-assisted to control movement, remove tremor
  - Eg., fixture allowing only controlled movement

Less dependent on surgeon dexterity and decision-making

Sensing tools, real-time decision making
- Eg., “Computer Assisted Insertion” with force sensing

Autonomous sensing in real time
- Eg., “Insertion Robot”

Variability

Speed

Example Projects

“Inser’tion Microphonic Tool”: Correlating with trauma

“OCT-Based Surgery”: Visualizing inner ear structures

Images courtesy of University of North Carolina, Chapel Hill

Image courtesy of Johns Hopkins University
Example Projects

“Percutaneous CI Surgery”: Based on regular CT scans
“Robotic Insertion Tool”: Based on electrode insertion path

Images courtesy of Vanderbilt University and Columbia University