Advantages of RW insertion

- Reduce the amount of drilling required for electrode placement
  - reduce the risk of acoustic trauma
  - minimize loss of perilymph
  - Minimize entry of bone dust into scala tympani.
- It may also be possible to seal the tissues immediately around the electrode more effectively
  - faster healing
  - decreasing the risk of inner ear infection.
- Stimulate more basally located neuronal elements since an electrode enters the cochlea in a more basal position.
Challenges to RW insertion

- The limited extent to which the round window membrane is exposed to view in the middle ear
- Variations in morphology of the round window opening that may impact successful electrode insertion, especially the angle of insertion

Cochleostomy

- Some of earliest insertions through RWM
- Abandoned because it was believed that angle of insertion increased likelihood of trauma to OSL & BM

Hearing Conservation & the Cochleostomy

- Perilymph loss
- Acoustic trauma
- Bone dust
- OSL injury
- Infection
  - Heals with fibrous tissue

Anatomy

- The RWN has 3 important characteristic:
  - Post-sup overhang smaller than the ant-inf overhang
  - After removal of the post-sup overhang, the posterior RWN still hard to see
  - Posterior RWN extremely close to the OSL (0.1mm).
- Conical shape of the RWM results from fusion with the base of the OSL
- Takahashi
  - 6 Temporal bones
    - 3 had part of RWM visible: 28.3%, 10.7 %, & 14.6%.
    - 3 had no part of RWM visible

Nadol Ann Otol Rhinol Laryngol 2001
Franz et al J of Laryngol & Otol 1987
Takahashi & Sando Laryngoscope 1990
Crista Semilunaris

- Crista semilunaris forms the anterior–inferior sharp bony margin of the RW.
- Only the medial portion of ST is available for electrode insertion.
- If you must see all of ST, then you must remove crista semilunaris

Franz et al J of Laryngol & Otol 1987

O’Leary
- 8 implanted temporal bones
  4 w/o significant trauma
  4 with significant trauma

Is there an reason to be concerned about modiolar contact?
Canaliculi perforantes
What about other medial wall structures?
The Cochlear Aqueduct
The Problem

- Inferior portion of basal turn is **inferior** or anterior-inferior to inferior edge of RW

Takahashi & Sando  Laryngoscope 1990
With respect to path thru FR array must be inserted from superior to inferior: Ave. 16.0° ± 5.3° (10.7-23.9)

For completely straight insertion into most basal scala tym, some bone (ave 0.7mm) of ant-inf rim of RW would need to be removed

Takahashi & Sando Laryngoscope 1990
How much of the RWM is visible?
Methods

A series of 30 temporal bones was dissected to permit microscopic study of the RW region.

15 embalmed cadaveric specimens

- Posterior tympanotomy approach
- Photographs were made of the RW looking through the facial recess using an angle of view that provided maximum visibility of the RW niche.
- The anterior and posterior-superior bony overhangs of the RW were then drilled away, keeping the RWM which was then photographed
- After drilling, the RW was photographed again using the same magnification and angle of view as for the first photographs.
- The resulting images were used to measure the surface area of the RWM visible before and after drilling. These measurements were done using NIH Image software
Visible RWM before and after removal of margins of RWN

Results

<table>
<thead>
<tr>
<th>TB #</th>
<th>Pre</th>
<th>Post</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB 1</td>
<td>0.67</td>
<td>1.09</td>
<td>1.63 X</td>
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<tr>
<td>TB 2</td>
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<td>TB 3</td>
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<tr>
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<td>1.16</td>
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<tr>
<td>TB 11</td>
<td>0.26</td>
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<td>TB 13</td>
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<td>0.56</td>
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<tr>
<td>TB 14</td>
<td>0.42</td>
<td>0.65</td>
<td>1.55 X</td>
</tr>
<tr>
<td>TB 15</td>
<td>0.48</td>
<td>0.84</td>
<td>1.75 X</td>
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The RW was then photographed from inside scala tympani to permit surface area measurements of the entire vertical segment of the round window membrane.

The measurements were done using digital images analyzed with NIH Image software.

These data provided an estimate of the maximum size of the opening potentially available for electrode insertion.
**Results**

Area of Vertical Part of Round Window Membrane As Seen From Scala Tympani

<table>
<thead>
<tr>
<th>Specimen #</th>
<th>Round Window Area (mm²)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1.60</td>
</tr>
<tr>
<td>2</td>
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<td>15</td>
<td>1.46</td>
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</tbody>
</table>

**Irregularities**

- one-third of our specimens had a bony projection (cristae semilunaris), which arises near the opening of the cochlear aqueduct
  - Limits the size of the RW opening.
  - Displaces an electrode toward the basilar membrane
  - Restricts the angle of entry so as to direct the electrode toward the modiolus
  - Drilling away this portion of the RW margin allows an electrode to enter the central part of scala tympani
Surgical technique

- Large facial recess.
  - Extend to the origin of the chorda tympani.
  - Removal of the incus buttress may be necessary.
  - Occasionally bone must be removed anterior and medial to the facial nerve.
- Remove mucosa.
- If bony overhangs minimal, insert electrode.
- If not, remove overhangs until the anterior inferior portion of the annulus of the round RWM is visualized.
- If there is still insufficient room, 1-2 mm of bone adjacent to the anterior-inferior RW annulus can be removed. 1 mm is usually enough.
Advantages

1) Most surgeons will be comfortable with since it utilizes a standard mastoidectomy and posterior tympanotomy.
2) The extent of drilling (and therefore the amount of trauma) associated with cochleostomy placement is minimized.
3) The approach uses visible and reliable landmarks that improve the probability that the electrode will enter the middle of scala tympani below the basilar membrane and spiral ligament.
4) It permits an angle of insertion that minimizes intracochlear trauma.

Conclusion

The round window was easily visualized in all specimens via a facial recess approach.
By drilling the bony overhangs the area of the round window visualization increased on average by a factor of 1.63.
Conclusion

- Electrode arrays can be inserted through the RW without trauma to the OSL or BM
- Contact with the modiolus may occur unless part of the crista semilunaris is removed
- The angle of insertion should be steep which may require removing the posterior lip of the niche
- A clear understanding of the anatomy is necessary to do so

Conclusion

- Smaller, more flexible arrays may be more adaptable to this approach
- RW insertion may produce less acoustic & mechanical trauma, allow a few more contacts to be functionally inserted, generate less bone dust and seal more effectively and rapidly
Why Revisit?

• Potential Advantages
  – Technically more straightforward, better landmarks
  – Less drilling; sometimes none
    • Less vibratory/acoustic trauma
  – Longer insertion
  – Earlier point of contact ??
  – Easier to seal??

• Potential Disadvantages
  – Posterior half very close to OSL (0.1mm)
  – Access to medial half of ST only
  – Requires careful angle of insertion
  – False membranes
  – Physiologic function must be retained