A COMPARISON OF IMPEDANCES, DYNAMIC RANGES AND NRTs FOR THE NUCLEUS 422 AND CONTOUR ELECTRODE ARRAYS

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Background

• A pre-curved, perimodiolar electrode array was introduced by Cochlear Corporation in 2000 to replace the straight Nucleus 22.

• Claudiu Treaba, Tom Roland and surgeons from Australia, Germany and the U.S. were major contributors in the design of the Contour Advance electrode.

• With this design the stimulation contacts are placed closer to the spiral ganglion cells by matching the natural shape of the cochlea.

• Focused spiral ganglion stimulation could be achieved with modiolar wall electrode placement.
Background

• Research had shown that perimodiolar electrodes deliver unprecedented hearing performance, more focused stimulation and greater power efficiency.

• With introduction of the contour electrode, changes in programming as compared to the N22 straight electrode were noted.

• T and C levels seemed to be much more consistent.
Background

• Skarzynski et al. 2012: preliminary report described the new, thinner, lateral wall intracochlear electrode array that was incorporated into the Nucleus Straight Research Array (SRA) cochlear implant.

• Developed by the first author in collaboration with Cochlear Ltd., Sydney.

• The SRA, renamed Slim Straight TM array, is now available in the Nucleus CI422.
Characteristics of the CA and the CI422

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Contour Advance Electrode Array</th>
<th>CI422 Electrode Array</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Concept</td>
<td>• Pre-Curved for perimodiolar wall placement (modiolus hugging)</td>
<td>• Slim Straight</td>
</tr>
<tr>
<td></td>
<td>• Focused spiral ganglion stimulation and greater power efficiency</td>
<td>• Smooth surface to minimize trauma</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For lateral wall placement</td>
</tr>
<tr>
<td>Receiver Stimulator</td>
<td>CIRE24</td>
<td>CIRE24</td>
</tr>
<tr>
<td>Active Length</td>
<td>15 mm</td>
<td>20 mm</td>
</tr>
</tbody>
</table>
# Characteristics of the CA and the CI422

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Contour Advance Electrode Array</th>
<th>CI422 Electrode Array</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter at apex</td>
<td>0.5 mm</td>
<td>0.3 mm</td>
</tr>
<tr>
<td>Diameter at base</td>
<td>0.8 mm</td>
<td>0.6 mm</td>
</tr>
<tr>
<td>Diameter at tip</td>
<td>0.2 mm</td>
<td></td>
</tr>
<tr>
<td>Electrode Contacts</td>
<td>• 22 half- banded</td>
<td>• 22 half- banded</td>
</tr>
<tr>
<td></td>
<td>• Medial facing</td>
<td>• Medial facing</td>
</tr>
<tr>
<td></td>
<td>• Larger surface contact</td>
<td></td>
</tr>
<tr>
<td></td>
<td>positioned in a non-uniform</td>
<td></td>
</tr>
<tr>
<td></td>
<td>arrangement</td>
<td></td>
</tr>
</tbody>
</table>
Case study-Map comparison

Contour
Examples of programming with the two electrodes

Contour map

CI422 map
Hypothesis

The modiolar wall placement of the Contour electrode produces more consistent proximity to the spiral ganglion cells and thus results in more consistent T and C levels, greater power efficiency, and less variation in impedances than the Slim Straight lateral wall design.
Methods: Procedures

• Retrospective chart review
• Data recorded at second programming and at 3 to 6 month programming sessions
• Data analyzed statistically to determine if actual differences exist between the two electrode designs
Methods: Procedures

• Data recorded included:
  ▪ Threshold levels
  ▪ Comfort levels
  ▪ NRT thresholds
  ▪ Dynamic range
  ▪ Pulse width
  ▪ Impedances
Methods: Subjects

• 91 subjects for impedance comparison
  ▪ 62 CI 422 patients implanted between 2012 and 2014
  ▪ 29 Contour Advance patients implanted between 2011 and 2014
  ▪ No CI512 patients were included
• Gender
  ▪ 43 female
  ▪ 48 male
• Mean age at implant 46
• Age range 7 months to 89 years
Methods: Subjects

• 54 subjects with complete data:
  ▪ 40 CI 422 users
  ▪ 14 Contour users

• Gender
  ▪ 28 females
  ▪ 25 males

• Mean age at implantation 46 years

• Age range 5-89 years
Methods: Subjects

• Inclusion criteria included:
  ▪ Programmed by counting T levels
  ▪ Consistent and reliable judgment of C levels or presence of stapedial reflexes
Results

Are T and C levels different for the two electrode designs?

This could not be analyzed with current data. Variations in PW could not be taken into account due to sample sizes.
Are pulse widths different between the two electrode designs?

<table>
<thead>
<tr>
<th></th>
<th>25</th>
<th>37</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>422</td>
<td>57%</td>
<td>38%</td>
<td>5%</td>
</tr>
<tr>
<td>Contour</td>
<td>79%</td>
<td>21%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Results

Are impedances different for the two electrode designs? No significant differences at 95% confidence intervals

2\textsuperscript{nd} visit

3 to 6 mo visit
Results

Are dynamic ranges different between the two electrode designs?
No significant differences at 95% confidence intervals for any electrodes

2nd visit

3 to 6 mo visit
Results

Are NRTs different between the two electrode designs?

No significant differences at 95% confidence intervals for any electrodes

2\textsuperscript{nd} visit

3 to 6 mo visit
Conclusions

• Even though there were no significant differences at 95% confidence intervals, there were trends that reflected our clinical impressions and may bear further study.

• There is too much variability in programming across patients to generalize (levels needs).

• Clinical application: Every patient has to be programmed on an individualized basis. We cannot assume all 422 DRs are narrower across the array, or that all Contour impedances are lower.
Future directions

• Speech perception results
• Hearing preservation