Outcomes and Tinnitus Treatment with Cochlear Implants in Single-Sided Deafness Patients

Preliminary results

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Oticon Medical is sponsoring the study and my participation to the conference.

No other conflict of interest exists, none of the experimenters collaborating to the project were paid for their participation.
Promoter: Oticon Medical (Vallauris, France)

- **27 participants with SSD (single sided deafness) associated with disabling tinnitus.**
  Contralateral hearing normal or close to normal.

- **7 centers** (Paris Rothschild, Lille, Paris Pitié, Rennes, Tours, Lyon, Nice)

- **Objectives**
  Evaluate the effect of electrical stimulation on tinnitus

- **Secondary objectives**
  Evaluate the benefit in speech intelligibility provided by the CI (cochlear implant) for patients with SSD
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**Inclusion criteria**
- 18+ years old
- Unilateral severe to profound perceptual deafness associated with disabling tinnitus.
- Normal or near normal hearing on the other ear
- Disabling tinnitus: THI (tinnitus handicap inventory) > 58 and VAS (visual analog scale) ≥ 8 for tinnitus nuisance
- Participants unresponsive to usual tinnitus treatments
- Tinnitus duration between 1 and 15 years

**Exclusion criteria**
- Deafness related to a tumor of the auditory nerve
- Tinnitus related to extra-cochlear pathology
- Cochlear ossification
- Central neurological pathology
- Pulsing or fluctuating tinnitus
- Middle ear infection or tympanic perforation
- Depression with BDI (Beck Depression Inventory) >16 or negative recommendation from the psychologist/psychiatrist.
Objectives | Methods | Results | Conclusions
---|---|---|---
• **V1 – V2**: inclusion
• **V3**: implantation
• **V5**: white noise activation: white noise stimulation only (no environmental sounds)
  - **V6**: (1 month post activation) standard stimulation: stimulation by environmental sounds, like a standard IC
  - **V7**: (M1: 1 month post standard activation) fitting and controls
  - **V8**: fitting and controls
  - **V9**: fitting + intelligibility tests
  - **V10**: fitting + intelligibility tests
- 27 participants have been included in the study
- To this day, 15 patients completed the study: results for these 15 cases
1. Tinnitus evaluation

**Two visual analog scale (VAS):** loudness and distress

**Three questionnaires:**
- **Tinnitus Handicap Inventory (THI)** self-report tinnitus handicap measure. Evaluate the difficulties experienced in *everyday life* activities and *emotional* difficulties.
- **Tinnitus Reaction Questionnaire (TRQ)** evaluate the *general psychological distress* associated with tinnitus
- **Subjective tinnitus Severity Scale (STSS)** evaluate tinnitus *severity*
1. Tinnitus evaluation

**Significant effects of CI on tinnitus reduction** for all measures (THI, TRQ, STSS and VAS).

However, **2 participants withdrew from the study at V8** (3 months post-standard activation) because of a **lack of benefit or increase** of tinnitus.
**THI**: Tinnitus Handicap Inventory

emotional and everyday life aspects

**VAS**: Visual Analog Scale

**Main effect**

p<0.0001
**TRQ:**
Tinnitus Reaction Questionnaire

Psychological distress

Main effect p<0.0001

**STSS:**
Subjective tinnitus Severity Scale (STSS)

Severity

Main effect p<0.0001

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### Results

**TRQ:**
- **Psychological distress:***p=0.03* (Bonferroni corrected)

**STSS:**
- **Severity:***p=0.03* (Bonferroni corrected)

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**Conclusions**

- Significant psychological distress
- Significant distress
- No distress
- Severe
- Moderate
- Mild
2. Speech intelligibility measures

Speech in noise
Single word (Fournier monosyllabic) intelligibility in free field, normal hearing ear unplugged. Percent of words correctly identified measured:

- With and without the speech processor
- 2 SNR: -3dB and +5 dB
- In 3 different spatial configurations

Speech in quiet: results collected during speech therapy routine visit
Single word and sentence intelligibility, with masking of controlateral ear
2. Speech intelligibility measures

Benefit of CI on speech intelligibility in all conditions. Intelligibility with CI only develops over time.
N=15 patients

-3dB SNR

Effect of CI OFF/ON, p=0.02

Visit 10, 12 months post-activation

Better global performance with CI ON than OFF.

No significant interaction with the other factors (condition and SNR).
**Objectives**

**Methods**

**Results**

**Conclusions**

**N=15 patients**

**Visit 10, 12 months post-activation**

- **SONO**
  - Better with CI: 10
  - Same: 2
  - Worse: 3

- **SONCI**
  - Better with CI: 10
  - Same: 4
  - Worse: 1

- **SCINO**
  - Better with CI: 5
  - Same: 2
  - Worse: 8

Large variability, but most participants perform better with the CI in all conditions.
N=10 patients

Results collected during speech therapy routine visit

visit 10, 12 months post-activation

Speech in quiet:
Single word and sentence intelligibility, with masking of contralateral ear

Intelligibility with CI only develops over time.
Results collected during speech therapy routine visit

3. Localization

- White noise
- 5 loudspeakers
- 1 loudspeaker shift: 45° degree of error

3 different scores:
- Score /15 (number of good responses)
- Difficulty (1 point per 45° of error)
- Mean error degree
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| Results collected in equipped centers

3. Localization

Benefit of CI on localization abilities.
N=5 patients
Results collected in equipped centers

**Localization**

- **Score**
  - Without CI: lower score
  - With CI: higher score

- **Difficulty**
  - Without CI: higher difficulty
  - With CI: lower difficulty

- **Degree of error**
  - Without CI: higher degree of error
  - With CI: lower degree of error

**Better localization with CI:** higher score, less difficulty, smaller degree of error
4. Relationship between tinnitus and speech intelligibility

Correlation analyses. Prediction of overall improvement on tinnitus related scores with

- Number of hours of everyday use
- Scores at speech in noise tests
- Difference between CI ON and CI OFF in noise tests
- PTA (pure tone average thresholds)

➔ No significant correlation with PTA or number of hours, of daily use

➔ **Significant correlation with speech in noise scores** \( (R^2=0.73 \ p=0.04) \)

Highest correlations with **benefit of CI in S0N0** \( (R=0.63, \ p=0.05) \) and **S0NIC conditions** \( (R=0.70, \ p=0.02) \)
Preliminary results

- **Positive effect** of electrical stimulation on *tinnitus* for most patients:
  - In average, between pre-implant and 12 months post-activation:
    - Emotional and everyday effects of tinnitus drop from « Catastrophic » to « Mild »
    - Tinnitus severity drops from « Severe » to « Mild »
    - Psychological distress decrease from 56 à 22 (20: no distress)
    - VAS drops from 8 à 5-4
  - However, **2 participants** withdrew from the study because of a lack of benefit or increase of tinnitus.
  - Attention shifts from tinnitus to the desire to hear better.
  - Benefit of CI on *speech intelligibility*.
  - Benefit of CI on *localization abilities*.
  - **Correlation** between gain in speech intelligibility and tinnitus reduction
Thanks

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4. Relationship between tinnitus and speech intelligibility

→ Significant correlation with speech in noise scores. Highest correlations with benefit of CI in S0B0 and S0BIC conditions.
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<th>Authors</th>
<th>N</th>
<th>Stats</th>
<th>Follow up (months)</th>
<th>Localisation</th>
<th>Speech</th>
<th>Tinnitus</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Punte et al. 2012</td>
<td>7</td>
<td>VAS and TQ p=0.04</td>
<td>1, 3 and 6</td>
<td>N/A</td>
<td>N/A</td>
<td>VAS loudness; TQ</td>
<td>Tinnitus reduction minimal for 2 subjects, however still using CI</td>
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<tr>
<td>Ramos et al. 2012</td>
<td>10</td>
<td>NA</td>
<td>≥3</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>THI, VAS distress</td>
</tr>
<tr>
<td>Arndt et al. 2011</td>
<td>10</td>
<td>Comparison CI/unaided SONO NS; SCINHE S;</td>
<td>6</td>
<td>7 loudspeakers</td>
<td>HSM, OISa</td>
<td>VAS -distress</td>
<td>No improvement for 1 patient. Suppression in 2 cases, decrease in 7.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sound Localisation S; Tinnitus S</td>
<td></td>
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<tr>
<td>Firszt et al. 2012</td>
<td>10</td>
<td>Localization p&lt;0.05; speech perception TIMIT p&lt;0.05 for patients with HA</td>
<td>6 and 12</td>
<td>15 loudspeakers, 10° apart</td>
<td>CNC, HINT, TIMIT</td>
<td>N/A</td>
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<tr>
<td>Stelzig et al. 2011</td>
<td>4</td>
<td>N/A</td>
<td>6</td>
<td>N/A</td>
<td>HSM, OISa</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Tavoira Vieira et al. 2015</td>
<td>28</td>
<td>SONO, SONHE, SCINHE (p&lt;0.005), Tinnitus (p=0.011)</td>
<td>12 and 24</td>
<td>N/A</td>
<td>BKB - SIN</td>
<td>TRQ</td>
<td>2 subjects small or negative effects on tinnitus</td>
</tr>
<tr>
<td>Vermeire et al. 2008</td>
<td>20</td>
<td>SONO NS, SONCI for HA group only p=0.03, SCINO (p&lt;0.04)</td>
<td>12</td>
<td>N/A</td>
<td>LIST</td>
<td>N/A</td>
<td></td>
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<td>Punte et al. 2013</td>
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<tr>
<td>Mertens et al. 2013</td>
<td>15</td>
<td>VAS (CI ON / OFF) p&lt;0.01</td>
<td>12</td>
<td>N/A</td>
<td>N/A</td>
<td>VAS loudness; TQ</td>
<td></td>
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<tr>
<td>Buechner et al. 2010</td>
<td>5</td>
<td></td>
<td>12</td>
<td>N/A</td>
<td>OISa</td>
<td>VAS loudness and distress</td>
<td>Benefit on tinnitus varies with conditions and patients</td>
</tr>
<tr>
<td>Van de Heyning et al. 2008</td>
<td>22</td>
<td>VAS p&lt;0.01; TQ p&lt;0.01</td>
<td>24</td>
<td></td>
<td></td>
<td>VAS loudness; TQ</td>
<td></td>
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<tr>
<td>Cardieux et al. 2013</td>
<td>5</td>
<td>Speech and localization improvement for 3 subjects with HA out of 5 subjects</td>
<td>6</td>
<td>15 loudspeakers, 10° apart</td>
<td>CNC, HINT, BKN - SIN</td>
<td></td>
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<tr>
<td>Us</td>
<td>15</td>
<td>Speech SONO, SCINO, SONCI: global improvement with CI p=0.02; THI, TRQ, STSS, VAS loudness and distress (p&lt;0.05); localization</td>
<td>1,2, 3, 6 and 12</td>
<td>5 loudspeakers 45° apart</td>
<td>Fournier monosyllabic</td>
<td>THI, TRQ, STSS, VAS loudness and distress</td>
<td>2 patients left the study at 3 months because of lack of improvement or worsening of the tinnitus</td>
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