OAEs and P300 Responses in Patients with CRF Undergoing Hemodialysis

Mona Mourad, MD, PhD
Hesham Kozou, MD

Audiology Unit
ORL-HNS Department
Alexandria University-Egypt

Ear and Kidney

• There are a number of anatomical (ultra-structure), functional, toxicological, and pharmacological similarities between inner ear cells and cells of the kidney tubules.
Ear and Kidney

- Renal disease has been implicated as a causal factor in auditory pathology. The etiology includes:
  - Fluid and electrolyte disturbances
  - Ototoxic diuretics and antibiotics
  - Infection
  - Hypertension, DM, arteriosclerotic vascular disease
  - Hemodynamic changes in renal disease and dialysis

- The influence of dialysis on hearing is CONTROVERSIAL.
**Aim of the study**

- To show the effect of blood chemistry changes pre- and post-hemodialysis on the auditory physiology in subjects of chronic renal failure undergoing regular hemodialysis.

**Subjects**

- **Twenty** adult males suffering from CRF with a mean age of 49.9 ± 10.3 years (range 33 to 69 years). All of them were undergoing regular acetate hemodialysis three times per week and for 4 hours each time for an average period of 4.9 ± 2.4 years (range 2 to 12 years).

- **Twenty** healthy age-matched adult males, served as a control group.
Methods: Pre-dialysis

- Complete medical and otological history.
- Otoscopic examination.
- Tympanometry and acoustic reflex thresholds (*Amplaid 720*).
- Pure tone audiometry (*Amplaid 209*).
- TEOAE and DPE (*ILO-96 otodynamic analyzer, ver 5.6Y*).
- P300 responses (*Esaote, QSI 9500*).
- Blood chemistry (BUN, Creatinine, Na, K).

Methods: Dialysis session
**Methods:**  
**Immediately Post-dialysis**

- Pure tone audiometry (*Amplaid 209*)
- TEOAE and DPE (*ILO-96 otodynamic analyzer, ver 5.6Y*)
- P300 responses (*Esaote, QSI 9500*).
- Blood chemistry (BUN, Creatinine, Na, K).

**Methods:**  
**Control Group**

- Otoscopic examination.
- Tympanometry and acoustic reflex thresholds (*Amplaid 720*).
- Pure tone audiometry (*Amplaid 209*).
- TEOAE and DPE (*ILO-96 otodynamic analyzer, ver 5.6Y*).
- P300 responses (*Esaote, QSI 9500*).
Methods: P300 Recording

- **Stimulus**
  - Tone bursts (1 & 4 KHz)
  - Rate 1.1/s
  - Rare = 15%
  - Duration 100 ms
  - Binaural presentation
  - Level of presentation of 70 dB nHL

- **Recording**
  - 0.1 - 30 Hz filter
  - Fz, Cz, Pz channels
  - 500 ms time window plus 100 ms pre-stimulus

---

Results: Blood Chemistry

<table>
<thead>
<tr>
<th>Urea level (mg/dl)</th>
<th>Pre-dialysis</th>
<th>Post-dialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>200</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>250</td>
<td></td>
<td>250</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Creatinine level (mg/dl)</th>
<th>Pre-dialysis</th>
<th>Post-dialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Serum sodium (mEq/L)</th>
<th>Pre-dialysis</th>
<th>Post-dialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>120</td>
<td></td>
<td>120</td>
</tr>
<tr>
<td>130</td>
<td></td>
<td>130</td>
</tr>
<tr>
<td>140</td>
<td></td>
<td>140</td>
</tr>
<tr>
<td>150</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>160</td>
<td></td>
<td>160</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Serum potassium (mg/dl)</th>
<th>Pre-dialysis</th>
<th>Post-dialysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>
**Results: Pure tone thresholds**

Pre Vs post-dialysis:
No difference

Patients Vs controls:
Difference at 4, 6 and 8 kHz.

**Results: TEOAEs**

Overall echo-level

Pre Vs post-dialysis: No significant difference
Patients Vs controls: Significant difference
Results: TEOAEs

Pre-dialysis

Post-dialysis

Right

Left

Results: DPEs

dB SPL

Pre-dialysis Post-dialysis Controls

1000 Hz 2000 Hz 3000 Hz 4000 Hz 5000 Hz 6000 Hz

Pre Vs post-dialysis: No significant difference
Patients Vs controls: Significant difference at all freq.
Results: DPEs

Pre-dialysis

Post-dialysis

Right

Left

OAEs Improvement Criteria

Mean presentation (Pre Vs Post Mean) Categorical presentation (Pre Vs Post Pass-Fail criteria)

<table>
<thead>
<tr>
<th>TEOAEs</th>
<th>DPEs</th>
<th>TEOAEs</th>
<th>DPEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall mean echo-level</td>
<td>Mean amplitude across frequencies</td>
<td>Presence of response across frequencies</td>
<td>DP amplitude 2 S.D. above noise floor</td>
</tr>
</tbody>
</table>

- Improvement 63.3%
- Deterioration 36.7%
- Improvement 50.0%
- Deterioration 50.0%
- Improvement 83.3%
- Deterioration 13.3%
- No change 8.3%
- Improvement 86.7%
- No change 13.3%
Results: P300 latencies

Results: P300 Amplitude
Results: P300 Under the Curve

![Bar chart showing P300 area comparison between controls and pre/post dialysis for passive and active tasks.]

Results: P300 Under the Curve

![Pie charts showing changes in P300 waveform area following dialysis for passive and active tasks.]

Changes in P300 Waveform Area (increase/decrease) following dialysis:
- Passive task:
  - Decreased: 57.1%
  - Increased: 42.9%
- Active task:
  - Decreased: 66.7%
  - Increased: 33.3%
Results: P300 in CRF cases

Pre-dialysis  Post-dialysis

Passive

Active
Conclusion:

- Renal pathology significantly affect hearing, cochlear physiology and auditory cognitive function.
- Hemodialysis has neither negative nor positive effect on hearing, cochlear physiology or auditory cognition.
- The cochlear pathophysiology in chronic renal disease is reflected in EOAEs before showing up on the audiogram.
- Active/Attentive auditory processing is more affected than Passive/non-attentive processing in chronic renal disease.
- The beneficial effect of hemodialysis on blood chemistry does not necessarily associated with parallel improvement in the cochlear physiology or central auditory processing.

Thank you.