Acoustic Emission Based Assessment of Temporomandibular Joints

Daniel Whittingslow MD/PhD Candidate
Omer Inan PhD, Sampath Prahalad MD,
Shelly Abramowicz DMD, MPH, FACS

Children’s Healthcare of Atlanta
Georgia Tech
Emory University
BACKGROUND

• Sounds from the TMJ are a common but poorly understood clinical sign.
• The TMJ is difficult to examine, and diagnosis depends heavily on imaging.
• Joint sounds have previously been shown to correlate with pathologies in the knee.¹

PURPOSE

• Record and analyze TMJ sounds (acoustic emissions, AE).
• To develop an instrumented headset for recording sounds from the TMJ.
• To determine sound features that could help screen for pathologic conditions in the jaw.
MATERIALS AND METHODS

Study design
  – Case-Control

Inclusion criteria
  – Age 6-18
  – No history of jaw disease, damage, or orthodontics
  – No history of craniofacial syndromes affecting the TMJ
  – No systemic disease affecting the TMJ

Statistical Analysis
  – 2 tailed unmatched t-test (p <0.05)
MATERIALS AND METHODS

- Ten maximal incisal openings (MIO) and lateral excursions while wearing headset

TMJ Sound Recording Headset with Integrated Contact Microphones

TMJ sound recording headset is worn while performing jaw exercises.
# Study Demographics

<table>
<thead>
<tr>
<th></th>
<th>TMJ +</th>
<th>TMJ -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrolled</td>
<td>3 male</td>
<td>5 male</td>
</tr>
<tr>
<td></td>
<td>12 female</td>
<td>15 female</td>
</tr>
<tr>
<td>Age (years)</td>
<td>14.3</td>
<td>11.9</td>
</tr>
</tbody>
</table>
RESULTS – Time Domain Signals

- **Medial-Lateral**
  - TMJ Sounds
    - Audio Units (mm/s²)
      - Time (s)
    - Medial-Lateral
  - No TMJ Sounds
    - Audio Units (mm/s²)
      - Time (s)

- **Open-Close**
  - TMJ Sounds
    - Audio Units (mm/s²)
      - Time (s)
  - No TMJ Sounds
    - Audio Units (mm/s²)
      - Time (s)
DATA ANALYSIS METHOD: b-Value Analysis

(i) Bandpass Filter

(ii) Peak Detection

(iii) Peaks w.r.t. Amplitude

(iv) log of Ordered Peaks

Acoustical Emission Amplitude (dB)
b-Value Comparison

Medial-Lateral b-Values

Open-Close b-Values

p = 0.00014

p = 0.01
CONCLUSIONS

- Time-Domain AE signals are more chaotic in patients with TMJ sounds.
- The b-Value showed significant differences between the two groups.
- In the future, TMJ AEs could serve as a non-invasive biomarker of TMJ health.