Acoustic Emissions Generated by the TMJ of Patients with JIA and their Implication on Assessment and Screening

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BACKGROUND
- The temporomandibular joint (TMJ) is one of the most commonly affected joints in juvenile idiopathic arthritis (JIA) (up to 45% of cases).1
- Crepitus in an involved TMJ is a common but poorly understood sign.
- There is a discrepancy between clinical signs and presence of arthritis of the TMJ, which makes recognizing involvement and effective intervention difficult.
- Combined imaging studies are necessary for a formal diagnosis, but are time consuming, expensive, and may not show involvement until the disease has sufficiently progressed.
- Joint sounds have previously been shown to correlate well with JIA affected knees.2
- These sounds have potential to be a non-invasive measurement and/or physiologic biomarker of TMJ involvement in JIA.

OBJECTIVE
- Characterize the acoustic emission profile of the jaws of children with JIA and use that to propose a novel method for screening for affected TMJs.

METHODS
- Subjects: 12 children with JIA, 7 healthy controls
- 2 uniaxial Dynan accelerometers and headgear for positioning microphones onto the TMJ
- Subjects performed 10 cycles of standardized movements (e.g. open/close, protrude/retrude, medial/lateral) at a rate of 1 cycle per 4 seconds while watching a demonstration video (Fig 1). The video allows children of all ages are able to easily reproduce the exercises.
- While performing the exercises, the sounds are recorded using a custom Matlab script that records both microphones simultaneously.

RESULTS
- Signals between the healthy controls and patients with JIA are different.
- Sounds produced by patients with JIA appear more chaotic with periodic large clicks.
- The b-value metric showed significant differences between the two groups (p=0.0185).
- These b-value findings are comparable to early findings we have seen in the case of knee acoustic emissions in children with JIA.3

CONCLUSIONS
- Children with JIA show significantly more powerful, more repetitive, and more chaotic sound profiles compared to children with healthy joints.
- Wearable, acoustic sensors can provide a novel method for non-invasively detecting joint health.

REFERENCES

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ABSTRACT

Figure 1. TMJ sound recording headset while performing jaw exercises

Figure 2. Open/Close Time Domain Signals. Representative time domain signal of age and gender matched participants, healthy control (top) had virtually no sounds, whereas JIA patient (bottom) had repetitive clicks and grinding.

Figure 3. Signal Analysis and Representative b-Value Calculations. Each microphone’s recorded acoustic signal (i) is bandpass filtered (250 Hz – 20 kHz), (ii) is noise reduced using spectral subtraction, (iii) peaks are detected above a threshold (RMS Power + noise maximum), (iv) peaks are ordered based on amplitude, and (v) the log of the ordered peaks is taken. The slope of the line in (v) is the b-value.

Figure 4. b-Value Analysis: The b-value was compared between the healthy and diseased groups. It was significantly different when compared using a one-tailed, unmatched t-test. (p< 0.0185)