Estimating Subglottal Pressure During Phonation with a Neck-Surface Accelerometer Sensor

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**Purpose**

The purpose of this study was to evaluate the potential for the noninvasive estimation of subglottal air pressure using a neck-surface accelerometer and to compare the accuracy of accelerometer-derived subglottal pressure relative to accelerometer-derived sound pressure level.

**Methods**

Indirect estimates of subglottal pressure ($P_g$) were obtained from 10 vocally-healthy adults (5 female, 5 male) during loud-to-soft repetitions of /p/-vowel gestures at three pitch levels (low, comfortable, high) in three vowel contexts (/a/, /i/, /u/) in the modal voice register. Simultaneous recordings were made of subglottal neck-surface acceleration (ACC), intraglottal pressure (IOP), and radiated acoustic pressure (MIC).

- **Vowel:** root-mean-square (RMS) amplitude of ACC and MIC
- **/p/:** $P_g$, from average of IOP plateaus before and after vowel

**Results**

Illustrative scatter plots for female subject F3

- $P_g$-ACC: ACC-derived $P_g$ exhibits lower uncertainty than with MIC signal amplitude.
- Linear regressions were performed to examine the effects of vowel context and pitch condition on slopes and intercepts.
- 95% prediction interval ($PI_{95}$) computed uncertainty in estimating $P_g$ using ACC and MIC signal amplitudes.

**Discussion**

- Correlation of ACC signal amplitude $P_g$ was stronger than with MIC signal amplitude.
- $PI_{95}$ for ACC-derived $P_g$: $r^2 = 0.68–0.93$
- $PI_{95}$ for MIC-derived $P_g$: $r^2 = 0.46–0.81$
- Vowel context and phonatory pitch both contributed to the uncertainty in estimating SPL using ACC signal amplitude.
- Sensitivity to vowel and pitch when estimating $P_g$ with ACC signal amplitude.
- Results support the continued estimation of $P_g$ using an ACC sensor due to the reduced uncertainty associated with ACC-derived $P_g$ versus the uncertainty associated with ACC-derived SPL.

**Conclusions and Future Work**

This study demonstrated the potential for non-invasively estimating subglottal air pressure using a neck-surface accelerometer. Modal register data obtained from ten vocally-healthy participants revealed that accelerometer signal amplitude correlated better with estimates of subglottal air pressure than with acoustic SPL.

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**References**