OBJECTIVE

In this project, three-way interactions between sound waves in the subglottal and supraglottal tracts, the vibrations of the vocal folds, and laryngeal flow were investigated. The purpose was to determine if fluid-sound interactions were as significant as fluid-structure interactions during phonation. The effects of several acoustic loads on phonation were studied.

INTRODUCTION

*Different studies on voice production have demonstrated that forces that are in phase with the velocity of the tissue of the vocal folds are favorable to phonation (Rothstein, 1981; Titze 1988; Fulcher et al., 2000). These forces can be produced by: *

A) a "mucosal wave" in the cover of the vocal folds. The driving force is produced by fluid-structure interactions.

An inertial impedance in the vocal tract (f0+1). The driving force is produced by fluid-sound interactions.

The relative importance between fluid-structure and fluid sound interaction in phonation is still unknown.

The role of other supraglottal loadings and the subglottal tract is not clear.

Traditional one-mass models cannot reach self-sustained oscillations (SSO) without significant fluid-sound interactions, since the effects of the mucosal wave are not in phase with the velocity of the subglottal source.

For these models, the effects of the mucosal wave can be introduced in the flow instead of the structure using a uniform discharge coefficient (ODC).

INTERACTIVE MODEL OF PHONATION

• Based on a previous one-mass model (Fulcher et al., 2000), where negative Coulomb damping is used to drive the folds.

• Fluid-structure interactions, fluid-sound interactions and collision effects were added to the previous model.

• Bernoulli’s equation and obstruction theory were used. A smooth time-varying ODC resisted the effects of the mucosal wave.

• The ODC for converging and diverging glottal shapes were taken from experimental data (Park et al., 2006).

• Fluid-structure interactions

• Fluid-sound interaction

• Phase plot only (displacement vs. velocity)

• Infinitely long tubes, uniform tubes with variable area

CONCLUSIONS

• The interactive one-mass model was able to illustrate the same effects only seen in higher order models.

• Results comparable with other studies using finite elements (Alipour et al., 2003) and higher order models (Story and Titze, 1995).

• The supraglottal and subglottal tracts played different roles

• The vocal tract was more dominant than the subglottal tract

• The effects were significantly more pronounced

REFERENCES


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