

The effect of velopharyngeal gap size on the acoustics and perceived severity of voice disorder

[Doug Dembinski](#)¹, Liran Oren¹, Ann Kummer², Alex Maddox¹, and Sid Khosla¹

¹Department of Otolaryngology - Head and Neck Surgery, University of Cincinnati

²Division of Speech-Language Pathology, Cincinnati Children's Hospital

Background

The velopharyngeal valve is an important speech mechanism because it serves to direct sound and airflow into the appropriate cavity for each speech sound. The term *velopharyngeal insufficiency* (VPI) is typically used to describe velopharyngeal dysfunction due to abnormal structure. VPI is most common in children with cleft palate and can lead to hypernasality, nasal air emission, and abnormal speech production. Clinical studies have shown that the severity of VPI does not correlate well with the perceived severity of the speech disorder. Therefore, a better understanding of the way an inadequate velopharyngeal valve affects resonance and airflow, and thus the perception of speech severity, is necessary for better treatment of VPI.

Aims/Hypothesis

1. Develop a three-dimensional model of the upper airway that closely matches measured anatomical data from children with velopharyngeal insufficiency.
2. Examine how the size of the velopharyngeal valve opening affects the resonance and aeroacoustic characteristics of speech.

Methods

CT images were obtained from a healthy 3.5-year-old child. The CT images were stitched using commercially available software to generate a 3-D model of the airway. The digital airway model was used to generate a mold of the airway model using 3-D printing technology. The mold was then embedded in liquid silicone, generating a cast of the airway model. The mold material was then removed by running water through the silicone, leaving an exact replica of the airway geometry. The model was then attached to a piping system that allowed water to be pushed through the model, simulating expiration. Velocity and turbulent characteristics of the airflow were captured using particle image velocimetry.

Results

PIV images were obtained using the model and a velocity field was generated. Initial results indicate that a turbulence gradient exists across the velopharyngeal valve.

Conclusions

The viability of this method for analysis of turbulence characteristics in a VPI model has been confirmed. Moving forward, additional models with varying velopharyngeal gap size will be generated, allowing for the relationship between gap size and aeroacoustics to be examined.

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