Pharyngeal air pressure along the vocal tract during vowels and semi-occluded vocal tract exercises: A pilot study using high-resolution pharyngeal manometry

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Introduction

The study of air pressure in the vocal tract is central to the study of voice. Vocal tract air pressure is associated with phonatory efficiency, and changes to air pressure impact the vocal acoustic signal[1-3]. As such, accurate air pressure measurement is important for research and clinical practice[4]. Current methods of air pressure measurement in the vocal tract are generally limited to the anterior oral cavity and to a restricted number of phonatory gestures [4,5]. This is problematic because air pressure at different locations in the vocal tract may vary. This feasibility study proposes a novel method of measuring air pressure simultaneously at multiple levels of the lower vocal tract using high-resolution pharyngeal manometry (HRM).

Methods

Two males with prior singing training underwent HRM. A catheter was passed transnasally and air pressure was measured simultaneously at 5 points 1cm apart in the lower vocal tract between the velopharyngeal port and the upper esophageal sphincter during multiple phonatory gestures, including semi-occluded vocal tract exercises[6]. Air pressure was compared among locations in the vocal tract and among phonatory gestures. Pressure measurements obtained in the current study were compared to those reported in similar studies that measured air pressure in the anterior vocal tract. Descriptive statistics were calculated for pressure data at each of the 5 sensors for each task, as well as for each task combined across sensors. Means, standard deviations and confidence intervals from the current study were then compared to those reported in the extant literature [7,8].

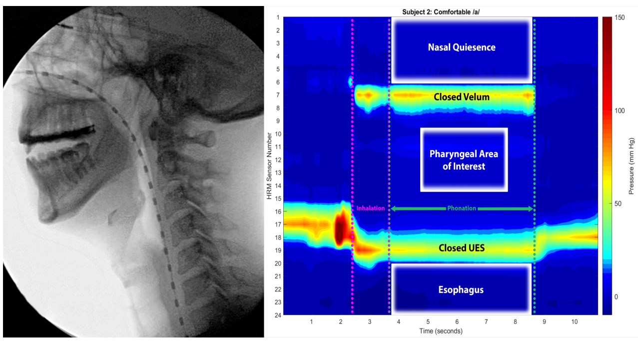

Figure 1: Left: Sample Fluoroscopic image of transnasal catheter placement during HRM. Right: spatiotemporal plot of pressure differentials during HRM. Warmer colors represent increasing pressure. Pharyngeal Area of Interest demonstrates the location of the sensors on the y-axis from which data were analyzed.

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Results

HRM was well-tolerated in both subjects. Pressures were non-uniform across lower vocal tract locations, with increased pressure observed immediately distal to the velopharyngeal port. Air pressure averaged across all sensors did not consistently fit into confidence intervals for air pressures taken from the anterior oral cavity during the same tasks in the extant literature. Pressure relationships among sensors differed by type of phonatory task performed. Pharyngeal air pressure increased with increasing vocal tract semi-occlusion.

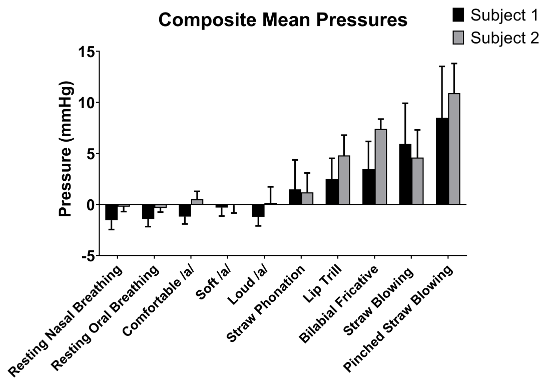

Figure 2: Mean pressure averaged across all five sensors for each subject. Error bars indicate standard deviation.

Discussion

HRM is capable of measuring pressure simultaneously at multiple levels of the lower vocal tract during phonatory tasks with high spatial and temporal resolution, providing rich data with which to analyze the physical properties of voice production. This study demonstrates inconsistencies in pressure at different locations in the lower vocal tract during semi-occluded vocal tract exercises. This instrumental assessment may be useful in future assays exploring differences in air pressure in the lower vocal tract between normal and disordered populations.

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