Pressure and Flow Comparisons Across Vocal Pathologies

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Summary: Objective. The aim of this study was to aid in the distinction among hyperadductive dysphonias by evaluating peak glottal pressure, release burst, and mid and final airflow values across repeated /pa/ syllable trains.
Methods. Sixty subjects were assessed for aerodynamic patterns during onset-offset for the /papapapapa/ task in modal voice. Subject groups included adductory spasmodic dysphonia (AdSD), benign vocal fold lesion, primary muscle tension dysphonia (MTD-1), secondary muscle tension dysphonia with an identifiable primary benign vocal fold lesion (MTD-2), vocal fold paresis or paralysis, and normal controls.
Results. Increased peak pressure (PP) was found for AdSD and MTD-2 subjects compared with controls. Release burst and mid airflow were not significantly different among groups. Final airflow was significantly higher for AdSD compared with the other groups. Final airflow was significantly lower for MTD-1.
Conclusions. Significant differences in aerodynamics are seen in subjects with AdSD compared to MTD. AdSD was characterized by higher PP and higher final airflow. MTD-1 was characterized by lower final airflow, whereas MTD-2 was characterized by higher PP. Aerodynamic evaluation may aid in differential diagnosis for those patients in whom distinction among hyperadductive disorders is challenging.
Key Words: Spasmodic dysphonia–Muscle tension dysphonia–Laryngeal aerodynamics–Voice pressure and flow–Larynx.

BACKGROUND

In normal voice and motor control, aerodynamic measures are characterized by a fairly steady and reliable onset-offset of the glottal flow in the phonemic coordination from consonant to vowel, as well as a fairly consistent strength of intraoral pressure during [p] production. During /pa/ syllable trains, there is a buildup of intraoral pressure as the lips close for [p], leading to a peak pressure (PP), and then a drop-off of pressure as the lips open to begin the final portion of [p] production. As the lips open, the airflow previously held behind the closed lips is suddenly released into the "release burst" (RB), which signals the end portion of the [p] production. Glottal airflow then stabilizes during the [a] portion of the /pa/ syllable train. As the syllable train is repeated, glottal airflow shuts down at the end of the [a] as the lips close for the next [p] production. Dysphonic speech may be marked by voicing discoordination because of mass effect, neurologic disturbance, muscular tension, or mucus loading on the vocal folds. Although voicing disturbances may be examined through acoustic signals, aerodynamic measures permit a detailed examination of flow and pressure changes.

Prior studies have examined differences in aerodynamic measures among different pathologic etiologies of dysphonia.[1,2] However, little research has evaluated the pressure-flow coordination at syllable transitions in dysphonic subjects. Although peak intraoral pressures may be consistent in the dysphonic population, control of pressure-flow discoordination, particularly during the coordination of one [pa] syllable to the next [pa] production in a repeated /pa/ syllable train, may yield important information on glottic function skills. This finding may be particularly true for patients with adductory spasmodic dysphonia (AdSD) who have reduced neuromuscular control at the glottis, when compared to other non-neurologic causes of dysphonia. Higgins et al reported on aerodynamic differences among AdSD, muscle tension dysphonia (MTD), and normal subjects.[3] Higgins et al found no significant difference in the mean phonatory airflow across the different groups, but did find a very large intersubject variation in the mean phonatory airflow for patients with both AdSD and MTD. The hypothesis of the present study is that a closer examination of aerodynamic management of onset-offset during the /pa/ syllable train may yield important information in the diagnostic assessment of AdSD, and may provide important information in the differentiation of AdSD from other dysphonias.

STATEMENT OF PURPOSE

The present study sought to determine whether aerodynamic characteristics could be used to differentiate AdSD from other dysphonias. To determine differences across disorders, an institutional review board-approved study examined the aerodynamics (glottal pressure peak, airflow, and RB) across /pa/ syllable trains for the following groups of subjects: spasmodic dysphonia (SD), benign vocal fold lesions, primary muscle tension dysphonia (MTD-1), secondary muscle tension dysphonia with an identifiable primary benign vocal fold lesion (MTD-2), unilateral vocal fold paresis or paralysis (VFP), and normal nondysphonic patients (control).

METHODS

Sixty adult subjects were enrolled on an ongoing basis at a single institution's voice clinic and categorized into one of six equal groups based on a diagnosis by a single fellowship-trained laryngologist. Subjects were enrolled until 10 subjects were collected for each of the following groups: group 1 (AdSD,

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TABLE 1.
Patient Demographics

Group	No. of Subjects	Sex (n)	Mean Age (y) (Range)	Specific Diagnosis (n)
1	10	Female (10)	73.1 (64–89)	AdSD (9) AdSD with tremor (1)
2	10	Female (9) Male (1)	40.2 (21–59)	Nodules (4) Polyp (4) Cyst (2)
3	10	Female (9) Male (1)	60.8 (43–75)	MTD-1 (10)
4	10	Female (9) Male (1)	42.4 (17–55)	MTD-2 with nodules (6) MTD-2 with Polyp (4)
5	10	Female (9) Male (1)	68.4 (51–89)	Unilateral paralysis (10)
6	10	Female (9) Male (1)	36.4 (31–55)	Normal (10)

Abbreviations: AdSD, adductory spasmodic dysphonia; MTD-1, primary muscle tension dysphonia; MTD-2, secondary muscle tension dysphonia with an identifiable primary benign vocal fold lesion.

N = 10), group 2 (benign vocal fold lesion, N = 10), group 3 (MTD-1, N = 10), group 4 (MTD-2, N = 10), and group 5 (VFP, N = 10). Subjects were compared to group 6 (control subjects), who were considered to be normal and denied current dysphonia (N = 10). Subject demographics are available in Table 1.

Aerodynamic measures obtained were part of the normal voice evaluation protocol during the voice clinic. Aerodynamic measures were analyzed for repeated /pa/ syllable trains among 50 dysphonic subjects and 10 control subjects. Control subjects denied any current dysphonia and denied knowledge of laryngeal pathology.

Aerodynamic signals were captured and analyzed using *Pentax Medical Phonatory Aerodynamic System*, model 2 (Pentax Medical, Montvale, NJ). A tight-fitting pneumotachograph mask was held against the subject's face, covering the oral and nasal cavities. A pressure tube was positioned into the oral cavity, avoiding contact with the tongue, and in accordance with manufacturer specifications. All subjects were assessed for aerodynamics during onset-offset for the /papapapapa/ task in a modal voice. Subjects repeated /pa/ syllable trains at ~2 /pa/ segments per second for a total of five to seven syllables on a single breath flow using a steady, comfortable pitch and comfortable volume, consistent with their conversational speaking voice. A minimum of three /pa/ syllable train tokens were obtained for analysis. Recordings were made before any treatment.

Although measures of pressure, airflow, intensity, and fundamental frequency were obtained, only data related to pressure and airflow were presented in this study.

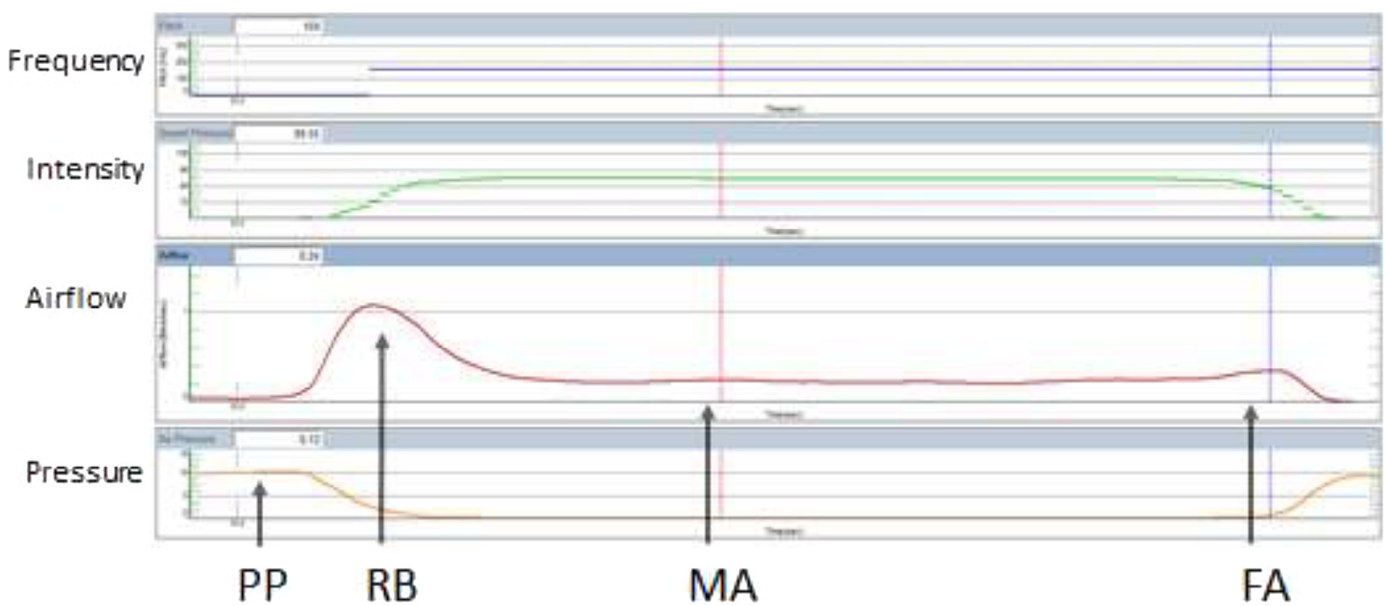

FIGURE 1. Graphic representation of the PP of the first syllable [p], the highest airflow during the RB for that [p] production, the airflow at the MA, and the FA measured immediately before pressure increase for the subsequent [p] in a control subject. FA, final airflow for the [a] segment; MA, middle of the [a] segment; PP, pressure peak; RB, release burst.