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Dysphagia

"Wet Voice" as a Predictor of Penetration and Aspiration in Oropharyngeal Dysphagia

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Abstract. This article describes the results of a study that investigated how well wet phonation can predict penetration and/or aspiration of ingested material in dysphagic patients. Voice samples of 23 subjects with neurologic oropharyngeal dysphagia were collected immediately after each subject had swallowed nine different boluses on videofluoroscopy. The boluses were graded according to three different consistencies and three different sizes. The presence of wetness in the voice was analyzed in relation to any ingested material that remained in the larynx or trachea after each bolus was swallowed. Results showed that there was no association between the presence of a wet voice and penetration or aspiration of prandial material after a swallow. The importance of detecting wet phonation by itself was therefore not considered diagnostic in detecting prandial penetration/aspiration by the bedside, but a wet voice may still be useful in identifying those with dysphagia who may have laryngeal dysfunction and therefore may be at risk of penetrating/aspirating any type of material, not just prandial material.

Key words: Dysphagia, evaluation — Aspiration — Bedside evaluation — Deglutition — Deglutition disorders.

Early and accurate assessment of those with oropharyngeal dysphagia is essential because of the life-threatening nature of the disorder. Invasive techniques used for the assessment of the effectiveness of the swallow such as the videofluoroscopy are well known but are expensive and may involve some risk for the patient.

The accuracy of noninvasive assessments of dysphagia, including the detection of aspiration, is crucial, particularly when invasive or instrumental procedures are not suitable or readily available. Invasive techniques may not be suitable for those patients who have to have their swallowing status reviewed daily. Patients who have to be reviewed daily may include those with an acute medical condition whose dysphagic symptoms may change rapidly [1]. Since 1983, several noninvasive techniques designed to assess oropharyngeal dysphagia have been described. These range from procedures that assess features associated with the swallow such as evaluating respiratory patterns [2–4], cough reflex [5], measuring the audible sounds of swallow [6], pulse oximetry [7] to those that assess the physiology of the swallow itself such as ultrasonography [8] and magnetic resonance imaging [9]. Although highly innovative, these techniques are still not widespread or used frequently in the clinical field because of the expense or limitations in the application of the techniques themselves (such as ultrasonography being restricted to diagnosing only certain sections of pharyngeal motility).

The clinical bedside evaluation of dysphagia is still the most common method of assessing oropharyngeal dysphagia. However, the accuracy of the clinical evaluation has been a controversial issue in both the literature and clinical practice.

This controversy has concerned primarily the detection of aspiration [5,10–16]. For instance, in a previous study [14], the incidence for the detection of aspiration was 40% lower in clinical bedside evaluations as compared with that of aspiration as detected on videofluoroscopy. Therefore, it would follow that improving the validity and reliability of clinical tests of swallowing is of paramount importance in the detection of aspiration of dysphagia [5].

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Several clinical features have been nominated as being associated with dysphagia. Of these, the presence of a "wet" voice is often mentioned [6,14–20]. The term *wet* in relation to voice quality has also been described as *gurgly* or *liquid sounding* [21] and is generally presumed to be due to the voice being produced through moisture [21]. This moisture can be due to an accumulation of body secretions (e.g., saliva) or to ingested material in the pyriform sinuses or on the vocal cords themselves [11,14,16,18–20]. Although it has been suggested that "poor pharyngeal clearance can lead to a wet quality of the voice … from overflow aspiration" (p. 133 [19]), wetness and aspiration have rarely been studied simultaneously.

Even though hoarseness or dysphonia has been mentioned as being associated with dysphagia, the relation between specifically "wet" phonation to penetration and aspiration has yet to be studied in depth. Most studies examining the presence of coughing after swallowing and/or disorders of phonation such as "hoarseness" have shown that a variety of voice and laryngeal disorders can be positively related to penetration/aspiration [6,11,15–19].

The aim of the present study was to determine the predictive value of the perceptual rating of wet phonation on the presence of penetrated or aspirated material after a swallow: *penetration* being where material is located on or above the vocal cords within the laryngeal inlet and *aspiration* being where material is located below the vocal cords in the trachea [22]. We hypothesized that wetness would be associated with the presence of ingested material in the larynx and/or trachea (as opposed to being associated with material in the oral and pharyngeal cavities) as identified on videofluoroscopy. This hypothesis is based on previous research that has shown that a variety of voice and laryngeal disorders (such as wet voice or poor cough) are associated with penetration and aspiration [15–17] but that "wet" phonation specifically is the sound of material on the vocal cords. In a patient with dysphagia, this moisture may be indicative of ingested material or secretions that have been aspirated and/or penetrated [18].

Materials and Methods

Subjects

The study participants included 23 consecutive patients (18 males, seven females; median age = 66.6 years, range = 20–84 years) who had been referred for videofluoroscopic evaluation. The subjects were inpatients of an acute-care city hospital. All were referred for dysphagia evaluation by their medical officers. The patients were considered dysphagic if they reported one or more of the following [23]: (a) they could not eat or drink normally, (b) they complained of food often being lodged in their mouth or throat, and (c) they coughed during or after swallowing. Subjects were excluded from the study if they had a history of laryngeal pathology and/or surgery, had a tracheostomy tube in situ, or were on a respirator.

Table 1. Summary of characteristics of subjects

Subjects	Age	Sex	Medical diagnosis	Time post-onset	Diet
1	82	F	Right CVA	21 days	Puree
2	23	M	HBD	84 days	NPO
3	70	F	MND	21 days	Puree
4	80	M	Right CVA	28 days	Puree
5	72	M	Left CVA	7 days	NPO
6	77	M	Right CVA	2 days	NPO
7	62	F	Idiopathic	365 days	Minced
8	75	F	MND	14 days	Soft
9	75	M	Right CVA	14 days	NPO
10	72	F	EMD	56 days	Normal
11	76	F	Right CVA	21 days	NPO
12	80	M	PD	7 days	Soft
13	92	M	Idiopathic	2 days	Soft
14	60	M	Right CVA	28 days	Soft
15	80	M	Ependymoma	1 day	Minced
16	71	F	Idiopathic	365 days	Normal
17	48	M	MS	365 days	Normal
18	69	M	Right CVA	21 days	Minced
19	74	M	Left CVA	3 days	NPO
20	87	F	Idiopathic	6 days	Puree
21	80	F	Left CVA	6 months	Puree
22	22	F	Right CVA	2 days	Minced
23	67	M	Idiopathic	3 months	Soft

CVA, cerebrovascular accident; EMD, esophageal motility disorders; HBD, hypoxic brain damage; MND, motor neuron disorders; MS, multiple sclerosis; NPO, nil per orally; PD, Parkinson's disease.

The etiologies of the swallowing disorders were as follows: 17 with neurologic disorder, five with idiopathic etiology for the dysphagia, and one with idiopathic etiology plus the presence of esophageal motility disorder. Time since onset of the subjects' dysphagia ranged from 1 week to 2 years. All but six were on oral feeding regimens at the time of the study. Details about the subjects are listed in Table 1.

Procedure

Each subject underwent two testing procedures. The first one was a standard videofluoroscopy, and the second was a recording of a sample of the subject's voice that was conducted after each subject had swallowed each bolus during the videofluoroscopy. The purpose of audiotaping the voice was for determining interjudge reliability ratings, which were done afterward (see below).

Videofluoroscopy

Each subject was required to swallow a standard set of nine bolus sizes and consistencies: 2.5, 5, and 10 ml of thin fluid (milk consistency), thick fluid (thick-shake consistency), and pudding (mousse consistency). Contrast material to be swallowed was Quick C, a barium sulphate 98% (w/w), mixed with White Wings Instant Pudding Mix (for taste and bulk) and water. Test boluses were at room temperature. All swallows were done with the subject in the erect position and

videorecorded in the lateral plane with a Siemens fluoroscopy tube, an Akai videorecorder, and a 3M television chain monitor.

Voice Sample

Immediately after subjects had completed swallowing each different bolus (as determined by subjects demonstrating no further attempts at initiating a swallow), which was recorded on videofluoroscopy, a sample of each subject's voice was recorded with a Sony DAT recorder TCD 1050. Voice sampling involved prolongation of the sound *ah* for at least 3 sec and counting from 1 to 5. The order of these two conditions was alternated at random.

Ratings

Videofluoroscopy

Three speech-language pathologists, each with extensive experience in the diagnosis and management of dysphagia, reviewed each videotape in the manner described previously [23]. The judges rated each tape concurrently frame by frame, using slow motion to determine both the location and the amount of ingested material remaining after the swallow at several cervical sites. This occurred when subjects no longer attempted to initiate a swallow. In those instances when there was a disagreement, the tape was reviewed until consensus was reached [23].

Oropharyngeal/laryngeal site for material was noted at the following anatomic sites: oral cavity, valleculae, pyriform sinuses, pharynx (excluding valleculae and pyriform sinuses), larynx (above true vocal cords, i.e., penetration) and trachea (below true vocal cords, i.e., aspiration).

To rate the amount of ingested material remaining after the each bolus was swallowed, a two-point scale was used: 0 = no material visible, 1 = any amount of material visible (including coating). Material left behind from any preceding bolus was included in the rating. The material that passed through the folds and into the trachea was regarded as aspiration for the purposes of the study.

Voice Sample

A voice sample (prolonging the sound *ah* and counting from 1 to 5) collected after each bolus was swallowed was rated as to whether wetness was present or absent. Three speech-language pathologists with extensive experience in dysphagia evaluation and management were asked to independently judge each condition in this manner. This was to reflect a common clinical practice of perceptually evaluating the presence of wet phonation in the voice of dysphagic clients as an indicator of aspiration risk. For instance, it has been recommended that part of the bedside evaluation for dysphagia should include an evaluation of voice quality by perceptual means (see [20], but also see p. 112 in [12] and p. 68 in [19] for descriptions). These judges heard an audiotape of a sample of a subject with wet phonation before making judgements about other subjects' wet voices.

The presence of wetness was determined if at least two of the judges were in agreement on this variable for either of the voice sampling conditions. Interjudge reliability resulted in high levels of agreement in the ratings of wetness ($r = 0.85$). The judges were blinded to the identity of the subjects and their medical etiologies.

Nine boluses (three consistencies for each of three different bolus sizes) were presented to each of the 23 subjects. The presence or absence of wetness in the voice for either of the voice conditions was assessed against the site of ingested material (seen on the videorecording) remaining after each bolus was swallowed.

Results

There were 1,242 measurements of ingested material remaining after the swallow (23 subjects swallowing nine boluses with residue measurements taken at six cervical sites).

Initial scanning of the data showed that on 57% (i.e., 708) of occasions, ingested material remained in the cervical region after the swallow was completed. Separate analyses of the two dimensions of consistency and bolus size and their effects on penetration/aspiration were conducted. A two-factor analysis of variance showed that pudding was aspirated/penetrated more often [24] ($H = 45.2$, $df = 8$, $p < 0.0001$) than the other two consistencies, but there was no main effect for bolus size [24]. Data on the ingested material that remained in the cervical region after the swallow was completed by each subject were then examined to determine whether there was an association with the presence of wetness. Results showed that of the 708 occasions when ingested material remained after a swallow, only 6.6% (i.e., 47 occasions) of the time was wetness also judged to be present in the voice after the swallow.

These data on residual material that occurred in the presence of wetness (i.e., 47 occasions that wet voice was judged to be present) were then divided further by where this remaining ingested material might be located. The data were divided into two regions: larynx/tracheal area versus the oral and pharyngeal areas (Table 2). This analysis showed that a wet voice was associated with material in either the larynx or trachea in only 17.5% (i.e., 7 out of 47) of occasions. Interestingly, most material was identified as being located in the oral cavity and pharyngeal areas (i.e., 87.5% of the time, or 40 out of 47 occasions). Interestingly, none of the patients in this sample were observed to cough or clear their throats after penetrating/aspirating, indicative of silent aspiration/penetration.

Absence of wetness was also associated with residue in the oropharyngeal area (i.e., 87.7% of the time, or 580 occasions) rather than with material in the larynx or trachea (i.e., 12.3% of the time, or 81 occasions).

Fisher's exact test [24] was then computed on the data to determine which region (larynx and/or trachea vs. oropharyngeal area) was associated with a wet voice. A significant association was found ($p = 0.0016$, $n = 708$). In other words, a wet voice was not associated with residue in the larynx or trachea or with ingested material in the oropharyngeal area.

Discussion

The main finding from this study was that our initial hypothesis, that wetness would be associated with in-

Table 2. Ingested material and wetness

Wetness	No. occasions		Total
	In the larynx or trachea	In the oropharyngeal region	
Present	7	40	47
Absent	81	580	661
Total	88	620	708

gested material in the larynx and/or trachea, was not supported. These results showed that identifying the presence of a wet voice as a symptom of laryngeal penetration/aspiration by itself does not conclusively indicate whether ingested material has been penetrated or aspirated. Thus, the present results contradict those that have found that a wet voice is associated with aspiration of prandial material [11,14].

The detection of wetness in the voice has long been considered as one of many critical clinical signs of aspiration, particularly in patients with cerebrovascular accident [11]. The finding that wet phonation in this study was not sensitive enough to detect aspiration or penetration of ingested material as a clinical sign by itself is consistent with studies that have found that clinical signs lack sensitivity in detecting aspiration [5,14,15,25]. This should alert clinicians not to rely soley on wetness to predict prandial aspiration or penetration. Although many clinicians may rely on clusters of clinical characteristics to detect dysphagia itself [12], clusters of clinical signs may be all that can alert clinicians to the risk of penetration/aspiration [1,13]. However, the present results do not entirely contraindicate the notion that wet phonation is important. It may be an indicator of a patient who is at risk of aspirating any material remaining in the cervical region. This remaining material obviously still poses a risk to the health of the patient [20]. Therefore, its usefulness in the evaluation of dysphagia is still valued.

If wetness in the voice is not an indication of penetration or aspiration, the question still remains as to what physiological conditions may be causing the sound of "wetness" to occur in the voice. A wet voice may be more predictive of saliva and/or mucoid secretions in the airway rather than indicative of prandial material in the airway. Only prandial material was examined in this study. This supports the findings of Murray et al. [26] who showed that an "accumulation of secretions within the laryngeal vestibule produces a wet dysphonic voice quality" (p. 103 [26]). Therefore, even if there was only a trace of barium residue on the vocal cords, the patient's voice may have still sounded "wet" by virtue of secretions in situ. There is often increased saliva production after neurologic damage due to the neurologic deficits, iatrogenic effects, an inability to swallow, and/or inability to detect pooling saliva in the oropharyngeal area. A high incidence of aspiration has been shown in those patients whose secretions are visible endoscopically [26]. Secretions originating in the lungs may collect in the airway, also causing the sound of a "wet" voice.

Another interesting finding in this study was that none of the patients in this sample coughed or cleared their throats after penetrating/aspirating, which is consistent with findings of Garon et al. [27] who found a significant incidence of silent aspiration on videofluoroscopy on dysphagic patients, in particular those who were found to aspirate.

The results of our study may have also been influenced by the fact that our subjects were not gross aspirators. Those subjects who were likely to aspirate significantly on videofluoroscopy were excluded from the study for safety reasons. Those with significant aspiration are a difficult group to study on videofluoroscopy for both ethical and safety reasons [25]. Wetness may also be an indicator of prandial aspiration only if large amounts are aspirated, a notion that warrants further investigation.

Conclusion

The present results showed that the clinical feature of the wet voice is not associated with ingested material being penetrated or aspirated into the airway. Although this study examined wetness as a feature in isolation from other clinical dysphagic signs, the present findings support those that point to a conglomeration of clinical features to attempt to identify those who are at risk of aspirating [11,15–20,25], and wet voice may be one of these [15,19,20]. Further research would be beneficial to observe whether wetness and another sign can improve the sensitivity of the clinical identification of aspiration in dysphagia.

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