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TEXTURE DEPENDENT VOLUNTARY COUGH – WHAT DOES IT TELL ABOUT QUALITY OF SWALLOW

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ABSTRACT

Modification of texture has become the most common methods for intervention in individuals with dysphagia, and has been considered vital for promoting efficient and safe swallow. However, till date, there is no protocol to describe levels of liquid thickening or food texture modifications for clinical use. Frequently bedside swallowing evaluation is used as a diagnostic indicator for aspiration which assesses the voice quality by using the water swallow test. However, the wet voice quality may not be constantly perceived by the clinicians therefore leading to high degree of interrater variability for perceptual judgement for wetness. Similarly, eliciting phonation or speech may not be possible among the disordered. Therefore, the present study focuses on adding objectivity with perceptual findings in analysing the quality of swallow using cough with varying textures in normal individuals. The aim of the study was to determine the effect of food texture on voluntary cough in normal adult females. Cough samples of 30 normal female adults were taken and the individuals where asked to voluntarily cough post swallow for three different food textures. The analysis of cough was perceptually carried out by two experienced speech pathologists and objectively it was analysed using the Mel-Frequency Cepstral Coefficients (MFCC). Result: The study showed a difference in cough analysis for the three consistencies, the energy spectrum distribution was observed to be dispersed across the frequencies among the different consistencies. Conclusion: The present study infers the need of constant consistencies during the preliminary assessment to determine the quality of swallow.Keywords: Texture modification, cough, MFCC.

INTRODUCTION

Individuals with suspected swallowing disorders, especially who show a change in voice quality, are often described as demonstrating a wet or "gurgly" voice (Logemann 1998, Murray et al., 1996, Warms and Richards, 2000). This phenomenon is often associated with risk of aspiration. Material in the larynx during phonation may result in multiple voice quality perceptions, and even experienced clinicians may not be adept at identifying the perceptual consequences of this. There are several studies that have attempted to address these phenomena objectively. Observation of laryngeal physiology during voicing when material is in the larynx using imaging techniques can improve reliability in the identification of wet vocal quality (Wright, Boyce & Kelchner, 2010). Groves Wright (2007) evidenced that foreign materials in the lungs can also induce acoustical changes in the phonation. Further, stated that the acoustical characteristics of phonation may provide a clinical marker of swallowing dysfunction. Santos et al. (2015) conducted a study to verify the use of perceptual analysis of voice using phonation sample to detect oropharyngeal dysphagia. The sample was recorded post swallow with different consistencies (pasty, liquid and solid). The voice was evaluated using GRBAS rating scale. The results showed individuals with dysphagia showed significant decrease in grade of voice and asthenia and increase in strain after swallowing pasty substances, differing from individuals without dysphagia who showed no modification of the parameters after swallowing. The study concluded that decrease in grade and asthenia and increased strain are indicative of a swallowing disorder, indicating increased vocal strain to clean the vocal tract of food. The variation of voice production post swallowing proved to be a reliable source in detection of swallowing problems. However, in real, it might be difficult sometimes to obtain speech or phonation sample especially from individuals suffering stroke and could be replaced from other vocal behaviours such as throat clearing or cough.

Cough has been of recent interest in evaluating and management of Dysphagia (Plowman, et al; 2016). Recent Research highlights that cough airflow measures may serve as a valuable physiologic metric to index airway defence capabilities in at risk individuals. It is equally important for us to objectively quantify in order to avoid bias. Testing with both liquids and foods with different consistencies would provide useful information about the swallowing adaptation and could better guide the successful introduction of oral nutrition during this phase even in patients with dysphagia.

Mel Frequency Cepstral Coefficients (MFCC) basically gives the energy distribution in various speech frequency bands. These energies are computed in logarithmic frequency scales (Mel scale) and this energy distribution resembles the human auditory perception. MFCC parameters have been successfully used in voice pathology detection and proved to be good parameters to quantify the voice quality.

NEED FOR THE STUDY:

Typically, the bedside swallow evaluation includes the water swallow test which assesses the voice quality and is considered as diagnostic indicator for aspiration. However, the wet voice quality may not be reliably perceived by clinicians and there could be a high degree of interrater

variability for perceptual judgments of wetness. Also, eliciting speech or phonation may not be possible always especially among the disordered. Hence the present study focuses on adding objectivity with perceptual in analysing the quality of swallow using cough with varying texture in normal individuals.

AIM OF THE STUDY:

The aim of the study was to determine the effect of food texture on voluntary cough in normal female adults.

OBJECTIVE OF THE STUDY:

To investigate the effect of food texture on voluntary cough

To correlate between perceptual and objective analysis of cough across the food textures.

Secondary Objectives:

To compare the cough pattern between the different textures

METHOD

PARTICIPANTS:

30 female participants aged between 18 to 25 years were enrolled in the study. Participants enrolled were normal healthy individuals with no vocal complaint and without past history of any vocal, respiratory and neurological problems. The participants were explained about the purpose and the procedure involved in the study. Informed consent was obtained from all the participants.

Instrumentation:

The sample was recorded using AHUJA UTP-30 microphone using PRAAT software installed in Lenovo Ideapad 360 Laptop.

Procedure:

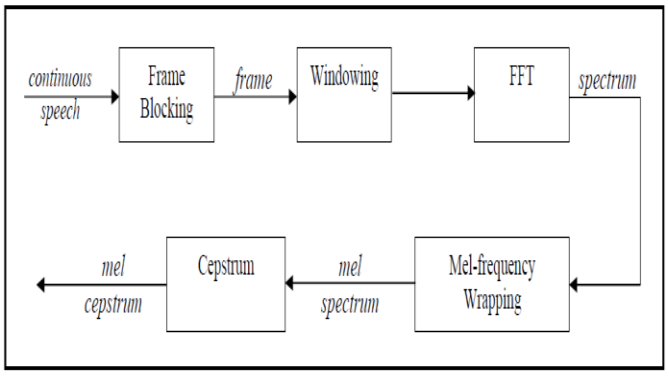
The participants were made to sit in upright posture. They were instructed as "You will be given three different textures to swallow at a time. The first one would be liquid consistency (water), followed by semisolid consistency (biscuit dipped in water) and lastly solid consistency (biscuit). You have to cough voluntarily post swallow for three different textures". The second food texture was given immediately after the participant produced voluntary cough for the first texture. The cough was recorded using microphone at a distance of 10cm from the participant's mouth in a quiet room.

Analysis:

The perceptual analysis was done by two experienced speech pathologists by evaluating the cough as strong or weak for the different consistencies. The cough was objectively analysed using Mel-Frequency Cepstral Coefficients (MFCC).

MFCC analysis:

Figure 1: MFCC computation steps



Mel frequency cepstral parameters have been extensively used in quantification of

speech signal for variety of applications. MFCC parameters are successfully used in the detection of voice pathology (Kumara Shama, Ananthakrishna, and Niranjan U.Cholayya; 2007). Hence in the present study MFCC are explored and *figure 1* shows the method of obtaining MFCC from speech signal.

In the first step, the speech signal is divided into frames of 20msec duration (frame blocking step). For each frame, spectrum is obtained by taking fast fourier transform (FFT). Spectrum is nothing but frequency domain representation of the signal. It gives the information about the frequency components present in the input speech signal. However human hearing is not equally sensitive at all frequency bands. The Mel filter bank based on Mel scale is used to model this property.

The *figure 2* shows schematic representation of frequency bands in the Mel filter bank.

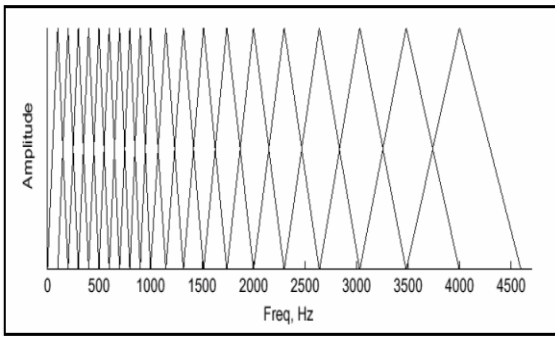


Figure 2. Graphical representation of Mel Filter bank.

RESULTS AND DISCUSSIONS:

In the present study, the perceptual analysis was done. The speech pathologist rated the strength of the cough as strong or weak. In the study, all the participants cough strength was perceived to be stronger. The results revealed increased strain in the cough post swallowing solid consistency among few of the participants. This could be probably attributed to the attempt to clear the minimal food residue in the airway. This is also in consonance with the objective evaluation of cough, wherein the differences were observed between liquid and semisolid/ solid consistencies using Mel frequency Cepstral Coefficients (MFCC) plots. The bolus volume and viscosity have been found to systematically vary some measures of oropharyngeal swallow physiology in normal individuals (Jacob, Kahrilas, Logemann, 1989; Cook, & Lang, 1990). The variations in consistencies are hypothesized to lead to physiological changes in swallowing including changes in lingual, submental and hyolaryngeal activity and duration of hyolaryngeal closure (Robbins 2008). Cough for different consistency can be effectively quantified by the MFCC parameters. It can be observed that cough sound in an individual varies based on the post swallow consistencies. The post liquid or solid consistencies would increase the total mass of the vocal folds and food molecules may be partly deposited on the walls of vocal tract. This would greatly influence on the cough sound perception. The cough sound quality can be quantified by the Mel frequency cepstral parameters (MFCC).

Figure shows the plot of MFCC for three different consistencies in one of the participant.

Figure 3 - The plot of MFCC

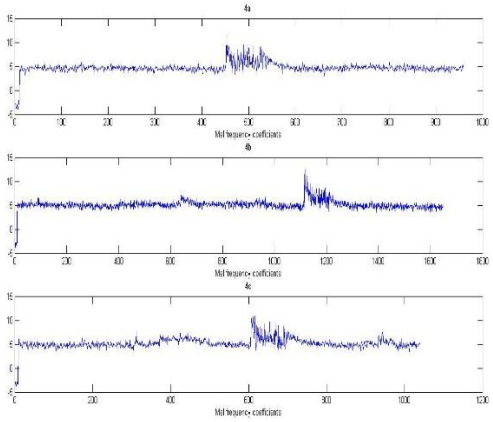


Figure 3 - The plot of MFCC

The energy spectrum distribution is observed to be dispersed across the frequencies among the different consistencies. In the present study, it was observed that the energy distribution for liquid consistency was in the lower frequency range as compared to the semisolid or the solid consistency among all the participants. However there was no precision observed between the semisolid or solid consistency.

SUMMARY & CONCLUSION:

The present study infers the need to consider the texture modification in evaluation of dysphagia, as it elicits different patterns in quality of swallow based on the texture. The different response pattern observed for the varied texture can further probe information on the location and extent of residue in the airway. This would also guide the clinician to necessitate for further investigations if required. From the present study, it can be concluded that cough can be used objectively as a quick screening tool in the evaluation of dysphagia. It also concludes that cough to be analysed by varying textures as it could serve as a confounding variable on voluntary cough analysis.

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