Research Article

Variations in stroboscopic patterns in perceptually phononormic individuals

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Abstract

The present study was intended to examine the stroboscopic parameters with regard to the extent and type of deviancies or variations from normalcy in perceptually phononormic individuals. Fifty perceptually phononormic individuals who served as the participants for the study were made to undergo Videostroboscopic examinations by an experienced Otolaryngologist. Later, all the recordings were examined, and under glottal activity majority of the parameters inclined towards normalcy but for certain deviations noticed for glottis closure and amplitude. Under supraglottal activity variations were noticed mainly under the structure and functioning of epiglottis, ventricular folds and arytenoids. These findings of the current study advocate that the presence of slight anatomically deviant parameters (probable normal variations) alone without any related presenting complaints do not serve as diagnostic hallmarks, mainly in cases of Functional or Non organic dysphonia and serves to caution in exercising just the theoretical framework in diagnosis of primarily functional dysphonia.

Introduction

Instrumental voice evaluation specifically utilizing glottal visualization techniques is one of the gold standard methods for the assessment of varied voice disorders and for chalking out the subsequent line of intervention. Visualization of the larynx has been an important feature of the examination of voice disorders for >100 years (Colton, Woo, Brewer, Griffin & Casper, 1995).One such resourceful glottal visualization technique is the Videostroboscopy. Stroboscopy is as useful to the clinician as indirect laryngoscopy or laryngeal endoscopy as it allows for evaluation of the dynamic aspects of vocalfold vibrations. Stroboscopic examination of the vocal folds provides quick and precise information for Phoniatric diagnosis that is useful for medical,functional, or surgical treatment, as well as for follow-up (Faure & Muller, 1992).

The working principles underlying the Videostroboscopy can be put forth in the following manner. Laryngeal stroboscopy creates an apparent slow motion view of periodic vocal fold vibrations by sampling effectively successive phases of the movement across successive vocal fold cycles. This is an excellent instrumental technique that provides a magnified and slow motion view of the vocal cords in action. This technique endows for an accurate diagnosis of conditions and diseases of the vocal folds and certain supra glottal structures including mass lesions, deviancies of vocal cord motion or mobility, inflammatory conditions, arterial or blood supply discrepancies, scarring lesions and other conditions.

Characteristic phenomena to be observed from the video stroboscopic recording include the glottis closure patterns, mucosal wave generation and its vibratory amplitude, which provides insight into the flexibility of the mucosa and its freedom from the underlying body of the vocal fold. In addition, the system allows for observation and documentation of actions of other supraglottic structures namely the epiglottis, ventricular folds, arytenoids etc. The addition of the strobe light during laryngoscopy paves way for the assessment of fine and discrete parameters of vocal fold vibration and results in both quantitative and qualitative information about laryngeal structure and function.

Interpreting the stroboscopic examination involves systematic judgment and subsequently describing the diverse vibratory pattern characteristics and signs. Different researchers opine and emphasize upon different parameters and characteristics to be observed and rated in the stroboscopic recording. Hirano and Bless (1993) included the fundamental frequency and periodicity, amplitude of horizontal excursion, glottal closure, and symmetry of bilateral movement,mucosal wave, and non-vibrating portions of the vocal fold.Faure and

Muller (1992) opine the characteristic phenomena to be observed from the Videostroboscopy evaluation to include the vibratory amplitude of the glottic wave, which provides insight into the flexibility of the mucosa and its freedom from the underlying body of the vocal fold. Mucosal flexibility is associated with a clear voice and rich resonance. Specific aspects of importance are amplitude of the opening phase; amplitude of the closing phase; bilateral symmetry of these amplitudes; diminution of the opening phase; diminution of the closing phase; variability with phonatory frequency or intensity; and phase delay of wave activity when comparing the two folds. Bless, Hirano and Feder (1987) reported certain vital stroboscopic features to be observed and inferred upon. A few of these are: Amplitude of Vibration, Mucosal Wave, Symmetry,Periodicity, Glottic Closure Patterns (Phase of glottic closure, Configuration of glottic closure),and Non-Vibrating Portions and Ventricular vibrations.

Ample of reports on Videostroboscopy cited in the literature concern some or the other laryngeal pathological conditions and discuss varied deviant stroboscopic patterns. Reports in the literature addressing deviant stroboscopic patterns even in phononormic individuals are present (Shaw & Deliyski, 2006; Djukic, Milovanovic, Jotic & Vukasinovic, 2014) but are relatively sparse. All phononormic individuals who appear so on a perceptual basis when examined through direct visualization techniques may exhibit some form of laryngeal deviancy, or certain variations that may be normal variations or indicative of an impending disorder. In addition, expanding the current knowledge on stroboscopic parameters that could be slightly deviant or normal variations, could add on to the existing theoretical database in evaluating persons presenting with voice complaints. Hence, the present study was intended to examine perceptually phononormic individuals through Videostroboscopy, compile the various stroboscopic parameters and to analyze them with regard to the extent and type of variations or deviancies form normalcy.

Method

Participants: Fifty individuals in the age range of 20-40 years with a perceptually normal voice were recruited as the subjects for the current study. To ensure the presence of normal voice, the phonation samples of all these individuals was recorded and later rated by 2 SLPs having expertise in using CAPE-V (The Consensus Auditory perceptual Evaluation of Voice, ASHA, 2002). A score of less than 10/100 (less than 10% deviancy in voice) on all the parameters of roughness, breathiness, strain, pitch and loudness was obtained for all the individuals thus qualifying to be phononormic individuals. It was observed that 19 participants out of 50 had a perceptual rating of 7-10/100 mainly on parameters of roughness, strain and pitch. Rest 31 participants received a score 0/100 (suggesting 0% deviancy from normal voice) on all the parameters, All the participants were ensured to be devoid of any voice complaints and upper respiratory tract infections on the day of testing. It was also ensured that none of the participants were involved in any form of active vocal loading at the time of testing and 2 days prior to.

Procedural Protocol

As a part of routine examination, all the participants enrolled for the study were made to undergo Videostroboscopic examination. Videostroboscopy was performed by an experienced otolaryngologist through the DIVAS Xion EndostrobeVideostroboscopy system. During the recording procedure, the participants were asked to protrude their tongue and sustain phonation of the phoneme /i/ in their comfortable habitual pitch and loudness. Meanwhile, the otolaryngologist with the grip of the participant's protruded tongue introduced the rigid strobe into the individual's oral cavity, to capture the laryngeal movements.

Evaluation of the Stroboscopic Recordings: Once the stroboscopic recordings of all the participants were obtained,these were evaluated or examined by two specialists (one Speech Language Pathologist and an Otolaryngologist) having expertisein the area of voice pathology. The entire stroboscopic examinations were viewed repeatedly, evaluated and a consensus on the final evaluation or opinion for each parameter was attained. A Video stroboscopic report form developed by The Voice Clinic, All India Institute of Speech and Hearing, Mysore was utilized to evaluate and record the varied parameters. Glottal parameters (Glottis closure, Vertical level of Vocal fold approximation, Periodicity, Vocal fold edge, Amplitude, Mucosal Wave, Phase symmetry, Phase Closure and Vibratory Behaviour) and Supraglottal parameters (Epiglottis, Aryepiglottic folds, Ventricular folds, Arytenoids appearance and Arytenoids symmetry) were mainly targeted upon and evaluated. Once the evaluation was completed for all the recordings, using descriptive statistics, the overall percent frequency of each of the parameters mentioned abovewas calculated separately.

Results

Descriptive statistics was applied to obtain the overall percent mean frequency of each of the parameters under glottal and supraglottal activity separately. Under glottal activity, the following

results were obtained for the mentioned parameters.

Glottis closure: Four different types of glottis closure patterns were observed from the total corpus of 50 perceptually phononormic recordings. These were complete closure (30/50), Posterior Glottis chink (15/50), Hour glass type of glottis chink (4/50) and Irregular Glottisclosure patterns (3/50). 60% of the total recordings exhibited complete glottal closure, 30% exhibited Posterior Glottis chink, 4% exhibited Hour glass type of glottic chink and 6% exhibited Irregular closure patterns.

Vertical level of approximation: 100% of the recordings demonstrated the presence of on plane vertical level of approximation.

Periodicity of vibrations and vocal fold edges were noticed to be normal in all the recordings.

Amplitude: 96% (48/50) of the recordings exhibited normal vibratory amplitude, while 4% (2/50) exhibited reduced amplitude of vibrations on either right /left vocal cord.

Mucosal wave: All the recordings exhibited normal mucosal wave patterns.

Phase symmetry: Phase closure and Vibratory behaviour were found to be normal in all the recordings.

Epiglottis: Normal epiglottis structure (16/50), Omega shaped (7/50) epiglottis and Posterior falling epiglottis (27/50) were observed in the recordings, their percent mean frequencies accounting to 32%, 14% and 54% respectively. Two varied forms of Posterior falling epiglottis was observed: 20% (10/50) of the participants showing it as an anatomical variant and the rest 34% (17/50) participants showing it as a functional compensation resulting in an anterior posterior compression of the laryngeal mechanism. This functional anterior posterior compression of the posterior falling epiglottis wasthe maximally seen feature indicating a trend towards the theoretical pattern of a subtype of Muscle Tension dysphonia. Aryepiglottic folds functioning and Ventricular folds symmetry was observed to be normal in all the participants recordings.

Ventricular folds movement: 66% (33/50) of the participants were found to exhibit normal ventricular folds movements and 34% (17/50) were observed to exhibit hypertrophied ventricular folds movements indicating lateral medial compressions and subtypes of Muscle tension dysphonia during laryngeal vibrations.

Arytenoids appearance: 72% (36/50) of the participants exhibited normal appearance of arytenoids, the remaining 28% (14/50) of the participants showed reddened appearance of arytenoids.

Arytenoids symmetry: 76% (38/50) of the participants exhibited symmetrical arytenoids movements whereas the remaining 24% (12/50) of the participants exhibited asymmetrical arytenoids movements.

Discussion

The current study revealed various minor deviations in at least a few glottal as well as supraglottal parameters in majority of the participants (perceptually phononormic individuals). There are a few reports in literature that concern deviant stroboscopic patterns even in perceptually normal voices. With regard to glottis closure patterns, majority of the participants exhibited near normal or complete closure pattern, which is a much anticipated finding concerning phononormic individuals. Posterior glottic chink pattern was evident in 32% of the participants. This finding is in consonance with the findings of previous studies which report a predominance of posterior glottis chink patterns even in normal subjects, more evidently in females, which they further opine to be regardless of any pathology and to be a normative variation (Biever & Bless, 1988; 1989). Incomplete or irregular glottic chink was also observed in 6% of the participants. This is possibly due to the presence of arytenoids asymmetry in a few participants which could create an imbalance in accurate vocal fold vibration (Bonilha, O'shields, Gerlach & Deliyski, 2009). Another reason could be the presence of excess mucous secretions at the time of phonation, or the internal state of tension the participant was facing on the intrusion of the strobe. Emerging hour glass type of glottic chink pattern was also observed in 4 participants, which could be another normative variation as it is asymptomatic in these perceptually phononormic individuals.Another key feature to be noted is that though there was the presence of minor glottic chink patterns in 40% of the participants, on perceptual rating none of them were rated as having even slight deviancy on the breathiness parameter of CAPE-V.

Another parameter showing slight deviation was the amplitude of vibration. 96% of the participants were found to present with normal amplitude of vibrations while 4% of the participants demonstrated reduced amplitudes either on the right/left vocal cords. This could be attributed to individualistic anatomical variations, wherein one vocal cord could be bulkier or slightly weaker than the other, thus reducing the amplitude on the weaker side.

Table 1: Mean percentage of glottis and supraglottic parameters of all the participants

Parameter (Glottal activity)		Mean Percentage
Glottis closure	Complete (Normal)	60%
	Posterior glottis chink	30%
	Irregular/ Incomplete	6%
	Hour glass type	4%
Vertical level of approximation	On plane	100%
Periodicity	Appropriate	100%
Vocal fold edge	Smooth	100%
Amplitude	Normal	96%
	Reduced on right/left	4%
Mucosal wave	Normal	100%
Phase symmetry	Symmetrical	100%
Phase closure	Normal	100%
Vibratory behaviour	Normal	100%
Parameter (Supraglottal activity)		**Mean Percentage**
Epiglottis	Normal	32%
	Omega shaped	14%
	Posterior falling (Anatomical variance)	20%
	Posterior falling (Functional compensation/Anterior posterior compression)	34%
Aryepiglottic folds	Normal	100%
Ventricular folds	Normal (Symmetrical)	100%
Ventricular folds (movement)	Normal	66%
	Hypertrophied	34%
Arytenoids appearance	Normal	72%
	Reddened	28%
Arytenoids symmetry	Symmetrical	76%
	Asymmetrical	24%

All the other parameters under the glottal activity were found to be normal or as anticipated for phononormics in all the participants.

Under the supraglottal activity, various parameters were found to be deviant in most of the participants. The structure and movement of epiglottis was found to be normal in just 32% of the participants.14% confirmed the presence of omega shaped epiglottis or an infantile epiglottis appearance which could be attributed to the individualistic anatomical maturation differences. Rest 54% of the participants revealed the presence of Posterior falling epiglottis as either an anatomical deviance (20%) or functional compensation (34%). This was ensured by observing the epiglottis mainly during inhalation and rest. If the epiglottis was falling posterior on inhalation and at rest, it was thought of as an anatomical deviation from normalcy. If on inhalation epiglottis would stay in place and allow for visualization of vocal folds and only during phonation would fall posterior, this was thought of as a functional compensation of tension in laryngeal musculo-skeletal structures and signal Muscle tension dysphonia. Type III (Morrison &Rammage, 1993)Ventricular folds movement during phonation was observed to be normal in 66%, with the remaining 34% exhibiting hypertrophied ventricular movements during phonation.

Posterior falling epiglottis and hypertrophied ventricular movements during or on phonation alone indicate anterior-posterior and latero-medial compression of the laryngeal mechanism, which attributes to hallmark features of the Nonorganic dysphonia or the Muscle Tension Dysphonia (Morrison & Rammage, 1993; Behrman, Dahl, Abramson &Schutte, 2003). Stager, Bielamowicz, Regnell, Gupta and Barkmeier (2000, 2001) reported the presence of latero- medial compression even in normals and further reported it to be a normal dynamic laryngeal gesture in comparison to anterior-posterior compression which was a static or abnormal laryngeal posture that might lead to dysphonic features. Behrman, Dahl, Abramson and Schutte, (2003) reported a certain amount of overlap in the measure of anterior posterior compression across the two groups of normal and dysphonics,

further relatively lesser degree ofanterior-posterior compression in normals was reported. These authors too opined latero-medial compression to be a largely normal articulatory posture rather than being suggestive of some form of dysfunction. Further, these authors opine that the protruded tongue posture and elevated larynx required with these invasive procedures yield hyperfunctional supraglottal behaviours that are examination artefacts. 19 participants rated as 7-10/100 (7-10% deviancy from normalcy) on parameters of strain and pitch were found to exhibit MTD II features, revealing hypertrophied ventricular movements and posterior falling epiglottis as a functional deviancy.

Arytenoid appearance was found to be normal in 72% of the participants whilein the remaining 28% of the participants, reddened arytenoids appearance was observed. This is possibly due to increased acidic secretions in the arytenoids regions owing to a symptomatic susceptibility to the Laryngopharyngeal reflux disorder.76% of the participants were found to comprise symmetrical arytenoids movements whereas the remaining 24% revealed asymmetric arytenoids movements. This finding can be augmented by the reports of Bonilha et al. (2009) who opine 70% of persons with normal voices to have arytenoid adduction asymmetries, which confounds the examiner in diagnostic decisions in cases where, the arytenoid adduction asymmetries visualized in persons with voice disorders might have no influence on their presenting complaints.

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Conclusions

The present study was a preliminary attempt to examine various stroboscopic patterns (normal or deviant) in 50 perceptually phononormic individuals. To summarize, findings of the present study reveal that just the presence of slight glottis closure variations, anterior posterior compression, latero-medial compression, reddened or asymmetrical arytenoids etc. during phonation do not account solely as diagnostic markers for Non organic or Functional dysphonia. These could occur as normal individualistic variations or due to certain examination artefacts. The findings of the current study advocate that the presence of certain deviant parameters alone without any related presenting complaints do not serve as diagnostic hallmarks, mainly in cases of functional or non organic dysphonia. The present study serves to caution in exercising just the theoretical framework based only upon the anatomical features in diagnosis of mainly functional dysphonia. Variations noticed in the current study advocate that the presence of slight anatomically deviant parameters (which could be normal variations) alone without any related presenting complaints do not serve as diagnostic hallmarks, mainly in cases of functional or non organic dysphonia. More empirical studies in future are crucial for establishing the diagnostic significance of normal variations or deviancies, in cases of Functional or Non organic Dysphonia.

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