Main Article

Voice Quality Measurement as an Indicator of Efficiency of Treatment in Laryngopharyngeal Reflux Disease

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ABSTRACT

Introduction

Laryngopharyngeal reflux disease can alter the structural and functional integrity of the vocal fold. Objectives of the study was to determine the effect of Laryngopharyngeal Reflux Disease (LPRD) on selected Acoustic, Aerodynamic and perceptual parameters of voice and to establish its effectiveness in therapeutic outcome.

Materials and Methods

The number of patients enrolled for this prospective observational study was 65, all with Reflux symptom index (RSI) more than 13. Quality of life was evaluated using voice handicap index (VHI). Perceptual evaluation of voice done by Grade Roughness Breathiness Asthenia Strain score (GRBAS) followed by acoustic and aerodynamic analysis. Patients were started on a once daily proton pump inhibitor therapy for 3 months along with vocal hygiene measures and RSI, VHI and voice analysis repeated after the treatment.

Results

There was significant improvement in the RSI score after treatment. Percent jitter and shimmer showed significant improvement in males post treatment (p value:<0.05). Harmonic to noise ratio improved 3 months post treatment in both sexes. Improvement noted in Maximum phonation time and GRBAS score except asthenia and strain post treatment.

Conclusion

Measurement of voice quality can be used as an effective tool to monitor the efficiency of treatment of LPRD.

Keywords

Laryngopharyngeal Reflux; Quality of Life; Voice Quality

Laryngopharyngeal reflux disease (LPRD) is an inflammatory condition of the upper aero digestive tract which results from the direct and indirect effects of reflux of the gastroduodenal contents. These reflux contents bring about morphological changes in the mucosa of upper aero digestive tract.[1] The posterior glottis and inter arytenoid area acts as a gutter for the upper aerodigestive tract secretions. Retrograde flow of gastroduodenal contents exposes the sensitive laryngeal mucosa to acid and pepsin.[2] As pepsin reduces the mucin and bicarbonate secretion it leads to excessive production of dry sticky mucus which is responsible for most of the symptoms of LPRD.[1] LPRD is one of the chronic inflammatory conditions of the larynx which we come across in routine otolaryngology practice and can be attributed as a cause for hoarseness persisting for more than 3 months.[3,4]

The objective of our study was to analyze voice quality through various objective and subjective measures among the individuals with LPRD and establish its usefulness in therapeutic outcome. LPR requires more aggressive and long duration treatment than GERD along with vocal

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hygiene measures and lifestyle modifications.[5]

Materials and Methods

Subject characteristics and study design:

From June 2019 to June 2020, we prospectively recruited 65 outpatients with LPRD-related symptoms at the Otolaryngology Department of our institution. All patients with symptoms suggestive of laryngopharyngeal reflux disease (LPRD) such as hoarseness, dysphagia, globus sensation in the throat, chronic throat clearing, chronic cough, or excessive throat mucus were included. A detailed patient information sheet was provided to all participants and written & informed consent was obtained. Our study was given ethical clearance by the ethical committee with approval number 2019/150.

All participants were requested to complete a survey questionnaire containing the RSI (Reflux symptoms index).[6] The scale for each individual item ranges from 0 (no problem) to 5 (severe problem), with a maximum total score of 45. Patients with total RSI score > 13 were included in the study as this indicates presence of LPRD.

The participants with any history of vocal abuse, neurological disease affecting voice, upper respiratory tract infection within last month, an antacid treatment, previous history of neck surgery/radio therapy, chemical or mechanical trauma to larynx, vocal cord paralysis, benign or malignant vocal fold lesions were excluded from the study.

Instruments:

Videolaryngoscopy was performed in all patients with Karl Storz 70-degree rigid endoscope and the findings were recorded.

Quality of life measure:

A standardized questionnaire (Voice Handicap Index – VHI)7 was used to assess the quality of life. It was self-administered questionnaire containing 30 items which were broadly grouped under physical, functional and emotional aspects.

Perceptual voice evaluation:

Perceptual evaluation of voice was done by GBAS scale, a clinically feasible version adopted by the UK Royal college of speech and language therapist.[8] It assesses G(Grade) – the overall degree of voice abnormality, R(Roughness), B (breathiness), asthenia (voice weakness), and strain. Under this each parameter is quantified on a 4-point scale, where 0= normal, 1 = mild, 2 = moderate, and 3 = severe. Participants were asked to read a few sentences of a phonetically balanced passage in a comfortable loudness and pitch and the voice samples were recorded. Perceptual evaluation was done by a trained speech pathologist, an ENT surgeon and the principle investigator.

For Acoustic and Aerodynamic Measurements:

A segment of 2 second duration of vowel /a/ was recorded for acoustic analysis. For aerodynamic measurements patients were asked to take a deep breath and sustain the vowel /a/ for as long as possible on one exhalation. Both were recorded at habitual pitch and loudness in a sound proof 2.5 x 1.5 m room through the microphone placed at 10 cm distance from the mouth coupled to a digitized recorder. Voice samples were assessed by using Vaghmi Voice & Speech Systems (VSS, Bangalore).

Sample size:

Sample size was 65 at the prevalence rate of laryngopharyngeal reflux disease as 60 % at 10% level of significance and 10 % of marginal error, sampling technique was convenient sampling method. Statistical analysis was done by IBM SPSS version 23, mean, standard deviation and paired t test was performed. P value <0.05 was considered significant.

Participants were treated by diet modifications, life style changes, vocal hygiene measures and once daily proton pump inhibitor therapy (pantoprazole 40 mg) for 3 months. The vocal hygiene measures included adequate voice rest, good hydration, reduction of laryngeal irritants and chronic cough. Life style changes included quitting smoking and alcohol, smaller meals, reduction of coffee, tea and spicy food.

After a period of 3 months RSI, VHI and voice

Table I: Age wise distribution of LPRD

	AGE	LPRD DURATION
Mean	41.19	4.83
Median	42.5	4
Std. Deviation	10.38	2.43

analysis were repeated. Pre and post treatment variables were analysed statistically.

Results

This is a prospective observational study done in patients with symptoms suggestive of laryngopharyngeal reflux disease. 65 subjects were identified for this study, of these majority were females 37 (57%) and 28 (43 %) were males. Mean age of the subjects was 41.19 with SD of 10.38. Mean duration of reflux symptoms was 4.83 weeks with SD OF 2.43(Table I).

Table III: VLS findings

VLS FINDINGS	FREQUENCY AND PERCENTAGE
Arytenoid congestion	42(64%)
Vocal cord edema	25(38.4%)
Early nodular changes	18(27.6%)
Vocal cord granuloma	2(3%)
Posterior commissure hypertrophy	7(10%)

RSI:

Reflux symptom index (RSI) is the most commonly used validated tool for the reflux related symptoms. The mean and standard deviation of RSI pre and post treatment is given in Table II.

Paired "t" test was used to compare reflux symptom index before and after the interventions. There was a significant change in most variables except post nasal drip, dysphagia and breathing difficulty in pre and post

Table II : Reflux symptom index comparison in pre and post treatment

(N = 65)	PRE		POST		"T"	P VALUE
	MEAN	S.D.	MEAN	S.D.		
Hoarseness	1.6	0.79	0.79	0.48	7.483	< 0.001
Throat clearing	1.78	0.99	0.95	0.42	6.034	< 0.001
Post nasal drip	2.1	1.06	1.81	0.59	1.833	0.072
Dysphagia	1.43	1	1.54	1.01	-0.604	0.548
Coughing post eating	1.54	0.96	1.13	0.85	2.793	0.007
Breathing difficulty	0.67	0.67	0.63	0.58	0.375	0.709
Troublesome cough	1.67	0.9	1.29	0.97	2.303	0.025
Globus pharyngeus	1.92	0.83	1.62	0.83	2.173	0.034
Heart burn	2.06	0.84	1.54	0.76	3.667	0.001

Table IV: Comparison of VHI pre and post treatment

(N = 65)	PRE		POST		"T"	P VALUE
	MEAN	S.D.	MEAN	S.D.		
VHI	33.86	6.05	33.35	4.28	0.677	0.501
Part I-Functional	10.91	2.36	10.89	2.49	0.037	0.971
Part II-Physical	10.88	2.47	11.42	2.47	-1.5	0.139
Part III-Emotional	12.08	3.41	11.08	2.38	2.038	0.046

treatment period.

Videolaryngoscopic findings were recorded and the frequency and percentage given in table III. We noted that arytenoid congestion was the most common finding (64%).

Voice Handicap Index:

Comparison of 3 domains of VHI –functional, physical and emotional in pre and post treatment showed significant improvement in emotional component (p value – 0.033). For all other comparisons the obtained p values were > 0.05 and hence there was no difference in functional and physical domains. Paired "t" test was used to compare VHI before and after the interventions. There was no change in VHI (p = 0.514) before and after the treatments. (Table IV).

Acoustic Parameters:

Paired "t" test was used to compare the acoustic variables of voice before and after the interventions in both male and females. In females there was no significant difference in pre and post treatment values in

Table V: Comparison of acoustic parameters in pre and post treatment in females

PARAMETERS	PRE		POST		"T"	P VALUE
	MEAN	S.D.	MEAN	S.D.		
F0	208.66	26.92	208.9	26.79	-0.495	0.624
Min F0	210.79	37.15	211.1	36.98	-0.672	0.506
Max F0	211.82	23.99	212.64	24.39	-1.601	0.119
Int I0	110.6	4.68	111.27	6.04	-1.229	0.228
Min I0	109.11	6.55	110.07	8.09	-1.904	0.065
Max I0	110.23	4.48	109.96	6.3	-0.516	0.609
Jitter	6.17	2.37	3.17	1.23	- 0.221	0.381
Shimmer	9.25	1.09	2.01	2.58	-1.392	0.021
AVI	2.35	3.03	2.35	3.03	-0.211	0.231
HNR in dB	16.47	1.4	25.31	1.4	-0.574	0.005

Table VI : Acoustic measurements in males.

PARAMETERS	PRE		POST		"T"	P VALUE
	MEAN	S.D.	MEAN	S.D.		
F0	208.66	26.92	208.9	26.79	-0.495	0.624
Min F0	210.79	37.15	211.1	36.98	-0.672	0.506
Max F0	211.82	23.99	212.64	24.39	-1.601	0.119
Int I0	110.6	4.68	111.27	6.04	-1.229	0.228
Min I0	109.11	6.55	110.07	8.09	-1.904	0.065
Max I0	110.23	4.48	109.96	6.3	-0.516	0.609
Jitter	6.17	2.37	3.17	1.23	- 0.221	0.381
Shimmer	9.25	1.09	2.01	2.58	-1.392	0.021
AVI	2.35	3.03	2.35	3.03	-0.211	0.231
HNR in dB	16.47	1.4	25.31	1.4	-0.574	0.005

all acoustic parameters except for HNR (p value <0.05). Comparison of acoustic parameters in males showed significant difference in frequency perturbation measure (jitter), intensity perturbation (shimmer) and HNR as given in Table V, VI

Aerodynamic Parameters:

The values of maximum phonation times (MPT) showed improvement in post medication conditions for phoneme /a/ as given in table VII.

Perceptual evaluation:

It was done by GRBAS score. Paired sample test and correlation given in Table VIII. Paired t test showed a statistical significant improvement in the pre and post treatment condition (p value 0.000) in all variables except asthenia and strain (table VIII).

Discussion

Laryngopharyngeal reflux disease is believed to be an etiological factor associated with longstanding hoarseness. The pathophysiological mechanism underlying the hoarseness related to LPRD is still unclear. The aim of PPI therapy in LPRD is to prevent activation of pepsin. However, for LPRD unlike GERD symptomatic improvement may take longer time. So a treatment trial of 2 – 3 months is recommended which can be extended to 6 months in treatment responders.9

In our study there was a significant improvement in mean RSI score at the end of 3 months (p value < 0.001). This correlates with the findings by large number of studies in which they found that the mean RSI improved after

Table VII: Aerodynamic Parameters

(N = 65)	PRE		POST		"T"	P VALUE
	MEAN	S.D.	MEAN	S.D.		
MPT	10.98	0.33	14.95	0.28	-81.207	< 0.001

Table VIII: GRBAS score

S. NO.	PARAMETERS	PRE-TREATMENT MEAN AND SD	POST TREATMENT MEAN AND SD	PRE AND POST TREATMENT	SIG.
1	Grade	1.369+-0.71	0.646+-0.570	0.779	0
2	Roughness	1.369+-0.71	0.585+-0.527	0.781	0
3	Breathiness	0.492+_0.56	0.031+_0.174	0.481	0
4	Asthenia	0.292+_0.45	0.000+_0.00	**	**
5	Strain	0.369+-0.48	0.046_+0.21	0.136	0.282

treatment.[10,11,12,1] However certain individual parameters like post nasal drip, difficulty in swallowing and choking episodes did not show any improvement post treatment, the latter two could be because only a small number of patients exhibited these symptoms even at the baseline. The reason post nasal drip persisted could be because allergic rhinitis patients were also included in this study.

Regarding the evolution of subjective voice quality, which is assessed by using voice handicap index (VHI), we found that there was no overall improvement in the VHI. It is in contrast to other studies which showed a significant improvement in all the components of VHI.[13,14] Our patients may not have noticed subtle changes in their voice and its impact on their day to day activities over the short period of study. However, we noted an improvement in the emotional component. A special attention has to be paid to the patient's mental health status when interpreting the results.

GRBAS scale was the tool used for perceptual evaluation of voice. Paired t test shows a statistical significant improvement in the grade, roughness, breathiness components in pre and post treatment condition (p value 0.000). However, asthenia and strain did not show significant changes after treatment, the reason being there was no significant finding in these 2 parameters even before treatment. In a systematic review of 1483 patients it was found that perceptual analysis was done only in a few studies and they found that there was improvement in all parameters except for strain. The possible explanation for strain could be due to excess laryngeal muscle constriction and breathiness due to abnormalities in the cord adduction. So they emphasized the importance of speech therapy along with PPI.[15,16]

Acoustic parameters are an effective tool to identify subtle changes in voice. Our study has done gender based comparison of acoustic parameters. There are limited studies in literature where gender based assessment was done like study by Lechien et al.[17] They have reported significant improvement in various acoustic measures including jitter and shimmer in males compared to females which is partly consistent with our study. There was a latency in response in females which can be explained by difference in the anatomical, histological and functional properties in the female vocal folds. Female vocal fold mucosa is thinner and shorter which makes them more susceptible to injury.[18] In addition, smaller Reinke's space and decreased hyaluronic acid in females can aggravate this dryness and delay the healing process.[19,20,21] There was an improvement in HNR in both sexes in our study. Pepsin mediated damage to the vocal folds can alter the periodicity and intensity of the vibratory pattern which brings about variations in HNR.[2,19]

Regarding the aerodynamic parameters maximum phonation time showed significant improvement at the end of follow up. It is suggested that MPT is affected in LPR disease in two ways: bronchial irritation caused by LPR and due to incomplete adduction of the vocal cords resulting from the inflammatory reaction.[22] A study was conducted where only aerodynamic analysis of voice in LPRD patients was assessed and they found an improvement in MPT and phonation quotient.[23]

The highlight of our study is that we have done a

detailed analysis of voice which includes subjective, perceptual as well as objective parameters. A few of the limitations of our study was the small sample size and the duration of study. We have done post treatment evaluation at 3 months however we advised the patients to continue treatment for a period of 6 months along with lifestyle modifications.

Conclusion

Measurement of voice quality can be used as an effective tool to monitor the efficiency of treatment of LPRD. The treatment should include medical management along with lifestyle and dietary modifications. Long term studies with larger cohort is required for further research in this field.

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