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ACOUSTIC AND PERCEPTUAL MEASURES OF VOICE PRE AND POST PHONOMICROSURGERY AND COMPARISON WITH STROBOSCOPIC FINDINGS

Objective:
To evaluate acoustic and perceptual outcomes of voice pre and post phonomicrosurgery for vocal fold polyp. To evaluate and compare the videostroboscopic measurements with that of acoustic and perceptual analysis of voice

Material & Methods:
A total of seven (Male=4, Female=3) subjects who were diagnosed to have vocal cord polyp were taken for the study at Dr. Chandrasekhar Institute of Speech and Hearing, Bangalore, India from January 2012 to June 2012. The study was carried out in three phases. In the first phase pre-operative measures were taken, 2-4 days before surgery, which involved detailed case history, videostroboscopic evaluation, acoustic evaluation using PRAAT software and perceptual evaluation using GRBAS scale. The second phase involved the surgical excision of the vocal polyp under general anaesthesia. The third phase involved the post-operative measures taken after 2 weeks of surgery which involved videostroboscopic evaluation, acoustic evaluation, perceptual evaluation and patient self rating scale.

Results & Conclusion:
The acoustic and perceptual parameters of voice showed improvement at 2 weeks post-surgery. There was tremendous improvement in glottic closure, mucosal wave, regularity of the vocal folds, periodicity of the vocal folds, vocal fold edge and the amplitude of the vocal folds post-operatively in all the subjects of our study.

Key words: Vocal polyp, Phonomicrosurgery, Videostroboscopy, Acoustic

INTRODUCTION:

Vocal polyps are extensions of the epithelium that appear on the free margin of the vocal folds secondary to vocal fold trauma. They can be bilateral or unilateral and can be caused by long term vocal abuse or single traumatic event to the vocal folds[1]. It is usually larger and softer than a nodule in appearance. Vocal polyp may be small or large, sessile or pedunculated, reddish or whitish in colour[2]. In localized polyp, it appears as, sessile or broad based polyps which can involve varying extents of the vocal folds closely adhering to mucosa. Pedunculated polyps is attached to the vocal fold only by a slim stalk of tissue. Hemorrhagic polyp has a appearance of a blood blister. A common vocal characteristic associated with the presence of polyp is diplophonia, which is the audible perception of two distinct pitches during phonation. This is caused by the increased mass the polyp adds to one vocal fold. Sudden voice breaks are also common in patients with pedunculated polyps. These breaks occur because the polypoid stalk bends easily and thus the polyp falls between the folds. This sudden insertion of the polyp body between the folds disrupts the pattern of vocal fold vibration and results in sudden voice breaks. Patients with sessile polyps show hoarse and breathy vocal qualities because of the mass the polyp adds to the vocal folds. Airway obstruction occasionally occurs when the polyp enlarges sufficiently.

MATERIAL AND METHODS:

A total of 7 (Male=4, Female=3) subjects of age range 35-53 years, who were diagnosed to have vocal cord polyp were taken for the study at Dr. Chandrasekhar Institute of Speech and Hearing, Bangalore, India from January 2012 to June 2012. Complete medical evaluation and status of vocal fold was seen before the surgery. The study was carried out in three phases. In the first phase; pre-operative measures were taken 2-4 days before surgery, which involved detailed case history, videostroboscopic evaluation, acoustic evaluation using PRAAT software and perceptual evaluation of voice using GRBAS scale. The second phase involved the surgical excision of the vocal polyp under general anaesthesia. All the surgical interventions were performed by the same Phonosurgeon. The benign vocal fold pathology were removed by making an excision from the sub-epithelial space of the vocal folds disrupting only minimal tissue surrounding vocal fold pathology. After Phonosurgery, maximal vocal rest was recommended for first 7 postoperative days. The third phase involved the post-operative measures taken after 2 weeks of surgery, which involved videostroboscopic evaluation, acoustic evaluation, perceptual evaluation and 3-point self rating scale. The videostroboscpy was done with 8 mm 90 degree rigid stroboscpe using Ecleris Strobo light. All the recordings were done in the sound treated room. The subjects were asked to sit comfortably and sustain the production of vowel /a/ three times at the comfortable pitch and the intensity as steadily as possible. The recorded sample was evaluated using PRAAT software (Version 5.0.17). Maximum Phonation Duration and s/z ratio was assessed to perceptually evaluate their voice. Subjects were asked to read "Grandfather passage" and the quality of voice was analysed using GRBAS scale by three judges (2 experienced listeners and 1 naive listener).

The extracted parameters were subjected to Wilcoxon Signed Ranks test to find the Mean, Standard Deviation and Significance of differences across pre-operative and post operative voice measures in vocal polyp at 0.05 significance level.

RESULTS:

The results indicated variation in perturbation parameters post operatively compared to pre operative values. Jitter and shimmer values decreased along with decreased Degree of Voice Breaks (DUV), showed marked improvement in cycle to cycle movement during vocal cord vibration. The fundamental frequency (F0) showed improvement in the post- operative evaluation. The values of Noise to Harmonic Ratio have shown considerable decrement in post-operative evaluation with Harmonic to Noise Ratio (HNR) being increased post-operatively suggesting a normal glottis closure after phonosurgery in both male and female subjects with Vocal Cord Polyp. The findings of Perceptual Voice Evaluation of subjects with vocal cord polyp using GRBAS (G=Grade; R=Roughness; B=Breathiness; A=Asthenic; S=Strained) scale indicated decreased values of ratings in all the analysed parameters after surgery. The pre-operative voice was rated to be affected by Moderate-Severe degree in terms of its Hoarseness, Roughness, Breathiness and Asthenic. However, after the surgery, it was perceived to be normal or affected to mild degree. Videostroboscopic findings showed tremendous improvement in glottis closure, mucosal wave, regularity, periodicity of the vocal folds, vocal fold edge and the amplitude of the vocal folds post-operatively in all the subjects. A 3 point self rating scale (0=dissatisfied, 1=improved voice quality compared to pre-operative status, 2=satisfied with voice quality) showed that 5 patients were satisfied with voice quality and

Tab: 1. Comparison of values frequency, perturbation &noise parameters between Pre and Post operative conditions in Male and Female subjects with Vocal cord polyp using Wilcoxon Signed Ranks Test

Gender	Parameters	Pre-operative		Post-operative		p-value
		Mean	SD	Mean	SD	
Male (n =3)	Mean F0	145.64	2.32	117.02	3.39	0.109
	Min F0	120.63	9.30	113.39	2.62	0.285
	Max F0	173.40	13.45	122.65	2.53	0.109
	Jitter	3.83	4.55	0.43	0.09	0.109
	Shimmer	18.00	6.10	10.01	2.73	0.109
	NHR	0.27	0.25	0.03	0.01	0.109
	HNR	6.89	4.75	14.78	1.86	0.109
	DUV	15.17	13.18	0.00	0.00	0.109
Female (n =4)	Mean F0	205.27	58.78	238.00	72.99	0.068*
	Min F0	161.24	80.57	184.83	72.99	0.465
	Max F0	255.28	36.68	277.18	79.41	0.715
	Jitter	2.44	1.18	0.47	0.10	0.068*
	Shimmer	15.91	2.50	11.01	1.74	0.068*
	NHR	0.41	0.19	0.04	0.02	0.068*
	HNR	5.40	2.64	14.14	1.93	0.068*
	DUV	8.35	6.72	0.00	0.00	0.109*

Tab: 2. Comparison of MPD and S/Z Ratio between Pre and Post operative conditions in Male and Female subjects with Vocal cord polyp using Wilcoxon Signed Ranks Test

Gender	n	Parameters	Pre-operative		Post-operative		p-value
			Mean	SD	Mean	SD	
Male	3	MPD	8.00	2.65	13.81	8.28	0.285
		S/Z	2.28	0.72	1.27	0.47	0.109
Female	4	MPD	3.00	0.82	6.75	1.71	0.059*
		S/Z	2.16	0.29	1.23	0.22	0.068*

Tab: 3. Perceptual Voice Evaluation using GRBAS scale before and after Phonosurgery

Group	n	Pre-operative				Post-operative			
		0 Absent	1 Slight	2 Moderate	3 Severe	0 Absent	1 Slight	2 Moderate	3 Severe
Vocal polyp	7	0	0	2	5	3	3	1	0
		0	2	5	0	6	1	0	0
		1	3	1	2	5	2	0	0
		1	1	5	0	7	0	0	0
		3	4	0	0	7	0	0	0

Tab: 4. Comparison of Videostroboscopic findings before and after Phonosurgery in subjects with Vocal cord Polyp

Stroboscopic Parameters	Pre-operative	Post-operative
Glottic closure	incompiete	Compiete
Vertical Level VF Approx	Affected	Normal
Periodicity (Regularity)	Irregular	Regular
Ventricular folds (Symmetry)	Symmetry	Symmetry
Arytenoids (Symmetry)	Symmetry	Symmetry
Vocal fold Edge	Vocal cord polyp	Normal
Phase symmetry	Affected	Normal
Hyperfunction	Absent	Absent
Mucosal wave	Absent	Present
Amplitude of vibration	Decreased	Improved

Fig:1. Videostroboscopic evaluation in a subject diagnosed to have vocal cord polyp during pre-operative evaluation

Fig:2. Videostroboscopic evaluation in a subject after excision of vocal polyp during post-operative evaluation

2 of them reported it to be improved compared to pre-operative status.

The results of acoustic, perceptual, GRBAS scale and videostroboscopic data are shown in table:1, table:2, table:3, table:4 respectively.

DISCUSSION:

Jitter is a cycle to cycle variation in fundamental frequency of the voice. Even a subtle micro instability in the vocal fold vibration will show changes in the jitter, which is true in the cases of vocal polyps[3]. The similar finding was seen in the both male and female subjects with vocal cord polyp in pre-operative condition. Post-operatively, there was a significant ($p<0.05$) decrement in Jitter values in female suggesting marked improvement in cycle-to cycle variation in vocal fold movement. Several studies reported the similar findings[4,5]. However, the present study did not show statistically significant difference in male subjects in pre and post operative conditions. Shimmer refers to a cycle-to cycle variation of amplitude which occurs during phonation. These changes reflect the slightest difference in mass, tension, bio-chemical characteristics of vocal folds. The Shimmer value increases due to poor and inconsistent contact of vocal fold edges as occurs in vocal cord polyps[1]. The increased values of Shimmer in both male and female subjects in post-operative conditions suggest the poor glottic closure during phonation. Post-operatively, there was a significant ($p<0.05$) decrement in the Shimmer values in female subjects suggesting that the removal of polyp after Phonomicrosurgery helped to maintain a consistent contact of vocal fold edges. However, the results of male subjects did not show statistically significant difference.

Noise parameters are another indicator to quantify the quality of voice. The increased NHR values and decreased HNR values indicate the presence of turbulence noise in the voice signal due to incomplete glottis closure. The present study showed the decreased level of Noise and improved signal following phonosurgery in the both male and female subjects with vocal cord polyp. Stanjner et al[6], reported similar findings in a longitudinal study in subjects with vocal cord polyp.

It is observed that F0 after Phonosurgery in males with vocal polyps is lower and improvement is seen when compared to preoperative values. Pre operatively they had high pitch but after surgery their pitch reduced and reached to near normal values. Baken[7] also stated that male voice with benign mass are higher (133.1cps) in comparison to normal voices (121.9 cps). We found significant improvement ($p<0.05$) in female's fundamental frequency during post operative evaluation which is around 238 Hz, indicating that Phonosurgery has helped them not only in removal of growth but also to improve their pitch. The added mass of polyp showed decrement in F0 in pre-operative condition. Post-operatively, the excision of this benign growth has helped them to bring back their original pitch[8].

Pre-operative Videostroboscopic findings in the present study revealed an incomplete glottic closure, irregularity in vocal folds, absent mucosal wave, decreased amplitude of vibration and vocal polyp present in the vocal fold edge in all the seven subjects included in the study. Colton et al[1] reported the similar Videostroboscopic findings in 24 patients with vocal cord polyp. Durand[9] and Thomas et al[10] reported the normal vocal folds, return of mucosal wave, and improved amplitude of vibration with a complete glottic closure after phonosurgery in subjects with vocal cord polyp.

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CONCLUSION:

There was a remarkable improvement in acoustic and perceptual measures of voice post-operatively in all the cases of vocal polyp and the findings were correlated with videostroboscopic findings.

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