

## Original Research Article

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# Assessment of pre and postoperative voice quality in cases of vocal fold polyp

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## ABSTRACT

**Background:** Benign vocal fold lesions comprise of a wide range of conditions resulting from vocal misuse or abuse (vocal nodules, polyps, cysts etc.), acute and chronic inflammatory changes, congenital vocal fold anomalies, vocal fold trauma and benign tumours. It results in significant impairment of vocal communication with major psychosocial impact.

**Methods:** The prospective study was conducted in Department of Otolaryngology, Vivekananda Institute of Medical Sciences, Kolkata from January 2016 to January 2018. All forty patients diagnosed with vocal fold polyp underwent phonomicrosurgery using micro-flap technique followed by voice therapy. Detailed pre-operative and post-operative (3 weeks, 6 weeks, 12 weeks follow up) voice assessment including fibre optic laryngoscopy and laryngovideostroboscopic findings were recorded.

**Results:** Voice quality of the 40 patients with vocal fold polyps who underwent cold steel phonomicrosurgery had a statistically significant improvement at each follow up visit (3 weeks, 6 weeks and 12 weeks) as assessed by the subjective variables of voice handicap index score, visual analogue scale score and grade, roughness, breathiness, asthenia, strain score and objective variables of jitter, shimmer, harmonic-to-noise ratio, maximum phonation time and fiberoptic laryngoscopy and videolaryngostroboscopic findings. Fundamental frequency in females had statistically improved results but in males, though there was an improvement, the values were not statistically significant.

**Conclusions:** Cold steel microlaryngeal surgery using micro-flap technique offers excellent results in patients with vocal fold polyps. Perceptual, aerodynamic, acoustic, self-analysis and videolaryngostroboscopic parameters together allow multidimensional assessment of voice characteristics.

**Keywords:** Vocal fold polyp, Phonomicrosurgery, Voice quality, Stroboscopy

## INTRODUCTION

Voice production is a complex phenomenon requiring a controlled integration of respiratory, phonatory and resonatory functions. A disturbance in any of these functions can result in a voice disorder.

The subjective and objective parameters of voice have made it possible to evaluate the therapeutic efficacy of

different modes of treatment. After Hirano's original description of the layered microstructure of the human vocal fold in 1981, increasingly sophisticated diagnostic and surgical techniques have evolved to more precisely address and preserve vocal production.<sup>1</sup>

In 1997, Jacobson et al developed the voice handicap index (VHI) which is a quality-of-life questionnaire specific to voice disorders, and has excellent reliability and

reproducibility.<sup>2</sup> Rosen et al have introduced an abridged version composed of ten questions, the VHI-10.<sup>3</sup> Hirano et al proposed the GRBAS (grade, roughness, breathiness, asthenia, strain) scale which is a widely used perceptual rating instrument used by speech pathologists and laryngologists for the evaluation of voice quality in clinical settings.<sup>4</sup>

An exhaustive review of recent literature confirms the value of acoustic variables (fundamental frequency F0, jitter, shimmer, harmonic-to-noise ratio, degree of voice breaks), aerodynamic and perceptual parameters in voice assessment.<sup>5</sup>

Videostroboscopy has evolved as the most practical and useful technique for the clinical evaluation of the visco-elastic properties of the phonatory mucosa.

Von Leden and Godfrey Arnold introduced the term “Phonosurgery” in 1963.<sup>6</sup> This is elective, precise surgery aimed to improve vocal function based on principles of vocal fold physiology. The aim of the microflap technique, which was developed by Sataloff, is conservative removal of submucosal pathology with preservation of overlying normal epithelium and superficial lamina propria which allows healing by primary intention and optimal voice quality after surgery.<sup>7</sup>

A multidisciplinary approach is required to adequately treat a patient of vocal polyp. Successful outcome depends upon the surgeon’s skill, voice therapy, improvement of vocal efficiency, vocal hygiene, elimination of vocal abuse and misuse combined with medical therapy that addresses reflux, allergy and hydration to eradicate these lesions.

No universally agreed protocol exists about the management of vocal fold polyps due to lack of comprehensive study of voice quality after different modes of treatment. It was hence proposed to study both objective and subjective parameters before and after phonomicrosurgery to assess its efficacy and role in management of vocal fold polyps.

## METHODS

The study was performed in the Department of Otolaryngology, Vivekananda Institute of Medical Sciences (VIMS), Kolkata from January 2016 to January 2018. A total of 40 cases of vocal fold polyps were included in the study. A proforma was made and the details of each case were recorded.

Detailed voice assessment findings and relevant investigations including pre and post-operative fibre optic laryngoscopy and laryngovideostroboscopic findings were recorded.

All patients underwent phonomicrosurgery (micro-flap technique) under general anaesthesia and were advised voice therapy postoperatively. They were followed up in

the ENT OPD after 3 weeks, 6 weeks and 12 weeks. Post-operative rigid laryngoscopy and voice assessment was done on every visit. Videostroboscopy was done only after 12 weeks.

## Inclusion criteria

Adult (over 18 years) patients presenting in the outpatient clinic of ENT and Head and Neck Surgery, VIMS and diagnosed with vocal fold polyp were included.

## Exclusion criteria

Patients with any other non neoplastic lesions such as keratosis, vocal cysts, vocal nodules etc., patients with neoplastic growths over the vocal cords, patients having comorbidities obviating surgery under GA, subjects under 18 years of age and patients with associated neurological affection of larynx were excluded.

## Surgical procedure

### *Micro-laryngoscopic cold steel surgery (phonomicrosurgery)*

Infiltration of the subepithelial space with 1 cc of 1:10,000 of adrenaline in saline was given just lateral to the proposed incision on the vocal fold. The center of the polyp was grasped with Bouchayer laryngeal heart-shaped microforceps and pulled medially toward the opposite cord. An incision was made using a sickle knife, just lateral to the polyp. A mucosal flap was created by dissecting the polyp away from the vocal ligament. The polyp was then excised with maximal preservation of normal mucosa. The flap was repositioned back on to the vocal fold. The superficial lamina propria (SLP) layer is vital for production of the mucosal wave and cannot regenerate; therefore, care was taken to handle this layer with care while preserving as much normal epithelium as possible (Figure 6).

## Voice assessment technique

**Self-analysis:** Patient’s own acceptability of his/her voice was assessed by asking the patient to rate his/her quality of voice on a visual analogue scale (VAS) of 1 to 10 ranging from totally normal or acceptable (1) totally abnormal/unacceptable (10). Subjective evaluation was performed by using (VHI-10) questionnaire, filled in by the patients.

**Perceptual voice evaluation:** This was done using the GRBAS scale which consists of five parameters. Overall GRBAS was rated on a 4-point scale of 0 to 3, by the sole speech and language pathologist of the department.

**Aerodynamic analysis:** Maximum phonation time (MPT) was noted in each case. A patient was asked to take a deep breath and then to sustain the vowel sound “a” for as long as possible at a comfortable pitch and loudness on one exhalation and without straining and the time was

recorded. The procedure was repeated for a total of three attempts, and the MPT was calculated as the average of these phonation times.

**Rigid fibre optic laryngoscopy:** Rigid fibre optic laryngoscopy (FOL) with a 70 degree Hopkins rod endoscope (Karl Storz) was performed in all 40 patients. The nature and location of the lesion, glottic closure pattern and associated laryngopharyngeal reflux were noted (Figure 3).

**Videostroboscopic evaluation:** Videostroboscopic evaluation was done in all patients using 8 mm rigid FOL with a 70 degree Hopkins rod endoscope (Karl Storz) along with CPT 31579 Atmos videostroboscope. Various parameters examined were mucosal wave pattern, amplitude, vocal fold edge, glottic closure, symmetry and periodicity (Figure 4).

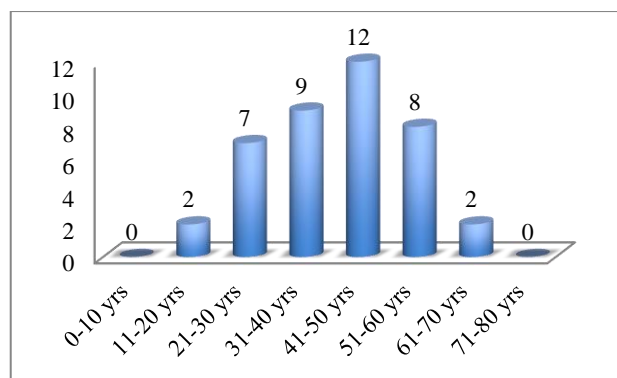
**Acoustic analysis:** The patient's voice sample was recorded during sustained phonation of steady vowel /a/. A microphone (attached to a computer) placed off-axis at a distance of 5 cm from the speaker's lip was used to record and store the voice sample. Acoustic analysis of these voice samples was done using PRAAT software version 5.3.68. Acoustic voice signal data was measured for mean fundamental frequency, frequency perturbation called jitter, amplitude perturbation called shimmer, and harmonic to noise ratio (HNR) (Figure 5).

Data was analyzed statistically using IBM SPSS 20.0 and Microsoft office® 2010 and result was depicted by graph, pie chart and bar diagrams. The mean, standard deviation and p value (paired T Test) was calculated. The statistic correlation and significance of the variables was noted.

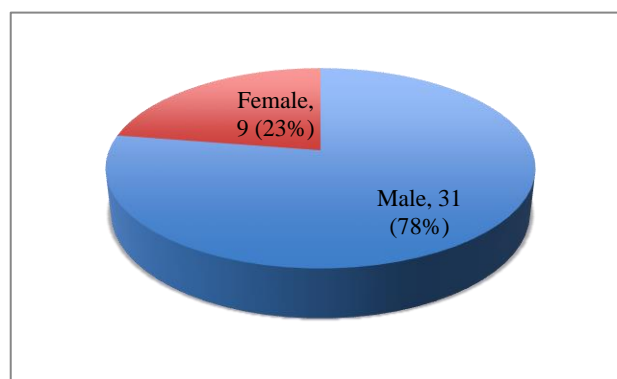
## RESULTS

The results showed a substantial postoperative improvement of vocal function with increased efficiency of phonation in all patients. We noted that majority of study population belonged to age group 41-50 yrs (Figure 1). The mean age of study population was  $41.175 \pm 12.018$  yrs. The sex distribution of the population showed that majority were males (78%) (Figure 2). It was observed that majority of the vocal fold polyps were on the right side (65%) and were of the sessile type (95%).

The mean VAS preoperatively was  $2.05 \pm 0.78$  and postoperatively was  $7.73 \pm 1.01$ ,  $8.10 \pm 1.08$  and  $9.35 \pm 0.77$  at 3 weeks, 6 weeks and 12 weeks respectively. We observed a significant improvement in VHI-10 score from  $18.775 \pm 7.39$  preoperatively to  $3.68 \pm 1.77$  at 3 months postoperatively ( $p < 0.05$ ). The mean GRBAS Score was  $11.85 \pm 1.12$  preoperatively and  $10.43 \pm 1.20$ ,  $9.05 \pm 1.24$  and  $6.80 \pm 1.59$  postoperatively at 3 weeks, 6 weeks and 12 weeks respectively.



**Figure 1: Distribution of study population according to age (n=40).**



**Figure 2: Distribution of study population according to sex (n=40).**

The mean MPT was  $8.73 \pm 1.72$  preoperatively and was  $10.88 \pm 1.80$ ,  $11.60 \pm 1.96$  and  $13.85 \pm 2.70$  postoperatively at 3 weeks, 6 weeks and 12 weeks respectively (Table 1).

The fundamental frequency of voice was analysed separately for males and females. We found that there was a statistically significant difference (improvement) of fundamental frequency (F0) in the female population after surgery at 3 weeks, 6 weeks and 12 weeks follow up ( $p < 0.05$ ), but no statistically significant difference (improvement) of fundamental frequency (F0) in male population ( $n=31$ ) after surgery at 3 weeks ( $p=0.0902$ ), 6 weeks ( $p=0.0640$ ) and 12 weeks ( $p=0.0604$ ) follow up. We noted a statistically significant difference (improvement) of Jitter, Shimmer, and HNR after surgery at 3 weeks, 6 weeks and 12 weeks follow up ( $p < 0.05$ ) (Table 1).

Videostroboscopic evaluation showed all 40 patients had diminished mucosal wave on the affected side preoperatively (Figure 7). Majority of the population (92%) had incomplete glottal closure preoperatively and 3 cases (8%) with small sessile polyps had inconsistent glottal closure. All patients had complete glottal closure postoperatively except 1 patient with large pedunculated polyp who had an inconsistent glottal closure (Figure 8). All had normal mucosal pattern postoperatively at 12 weeks.



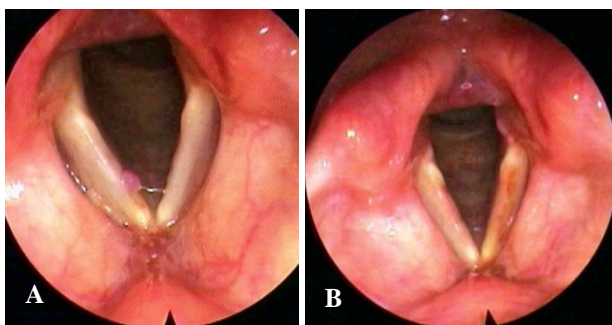
**Table 1: Comparison of preoperative and post-operative voice assessment parameters of the study population (n=40).**

Parameters	Preoperative score	Postoperative score			P value
		3 weeks	6 weeks	12 weeks	
<b>VHI-10</b>	18.775±7.39	13.58±5.7	8.95±3.57	3.68±1.77	<0.0001
<b>VAS</b>	7.95±0.78	2.27±1.01	1.90±1.08	0.65±0.77	<0.0001
<b>GRBAS score</b>	11.85±1.12	10.43±1.20	9.05±1.24	6.80±1.59	<0.0001
<b>MPT</b>	8.73±1.72	10.88±1.80	11.60±1.96	13.85±2.70	<0.0001
<b>Fundamental frequency in females (n=9)</b>	186.33±12.12	222.11±12.56	228.67±16.19	233.22±17.91	<0.0001
<b>Fundamental frequency in males (n=31)</b>	104.29±11.43	105.61±8.98	105.77±12.19	105.81±11.91	>0.05
<b>HNR</b>	8.210±1.21	13.188±0.744	13.803±0.603	14.298±0.475	<0.0001
<b>Jitter</b>	2.193±0.540	1.575±0.589	1.318±0.501	1.105±0.482	<0.0001
<b>Shimmer</b>	5.203±0.741	4.890±0.693	4.585±0.645	4.133±0.684	<0.0001

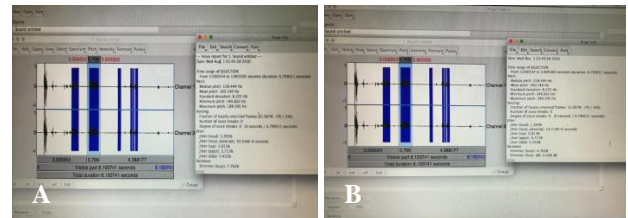


**Figure 3: Rigid FOL in the OPD.**

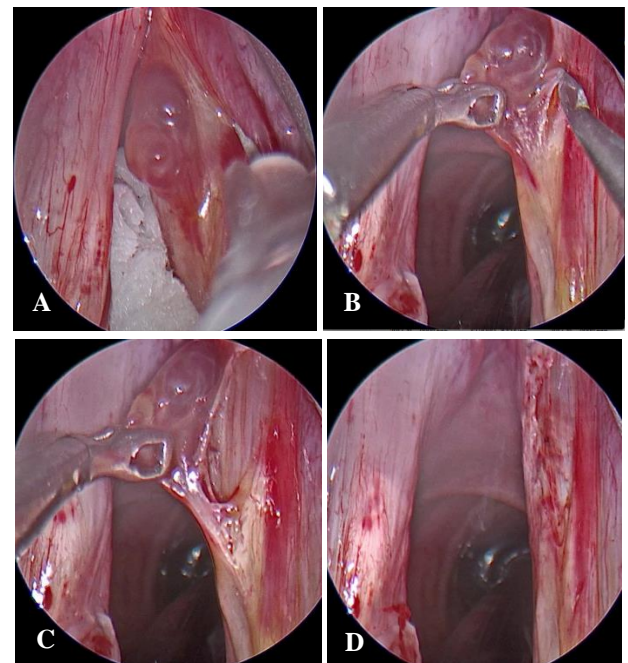
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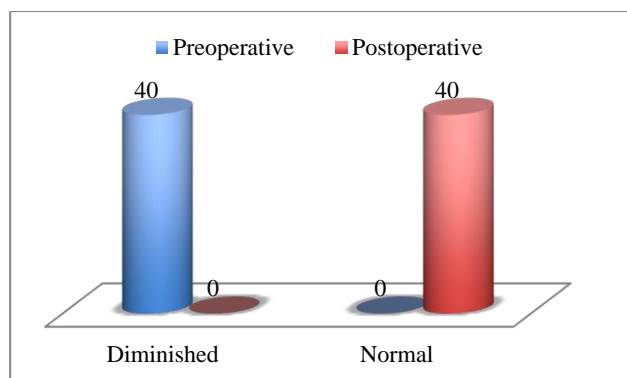
**Figure 4 (A and B): Pre and postoperative videolaryngostroboscopic findings in a case of vocal fold polyp.**



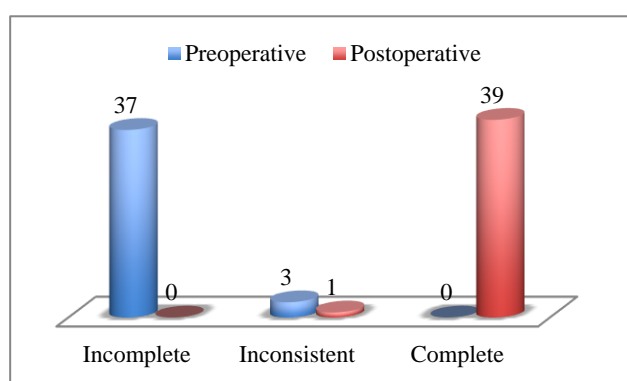
**Figure 5 (A and B): Pre and postoperative acoustic analysis screenshots using PRAAT software in a case of vocal fold polyp.**



**Figure 6 (A-D): Microlaryngeal surgery using micro-flap technique (OT of VIMS).**



**Figure 7: Comparison of the videostroboscopy findings of mucosal wave pre and postoperatively (n=40).**



**Figure 8: Comparison of the videostroboscopy findings of degree of glottal closure pre and postoperatively (n=40).**

## DISCUSSION

A vocal polyp is a benign swelling of greater than 3 mm that arises from the free edge of the vocal fold.<sup>8</sup> In the opinion of Rosen et al, it is a pathologic process of the lamina propria that involves typically an exophytic or pedunculated lesion of the mid membranous vocal fold that can be unilateral or bilateral.<sup>9</sup> It occurs predominantly on the anterior or middle third of the fold, where the mechanical forces of vibration are more marked.

### Role of demographic parameter

Age at presentation of vocal fold polyps has been extensively studied in the literature Nagata et al, Lin et al, Schindler et al and Salmen et al have revealed a common age of presentation of vocal fold polyps which is in the range of 40 to 50 yrs.<sup>10-13</sup> In our study, we found the mean age of presentation to be  $41.175 \pm 12.018$  years which is similar. However, regarding sex distribution there were some varied results. Though studies by Nagata et al stated equal distribution in both sexes, Schindler et al and Salmen et al revealed a female preponderance.<sup>10,12,13</sup> Lin et al in his study mentioned that majority of the study population were males which was in concordance with our study.<sup>11</sup>

### Role of assessment of voice

Subjective and objective assessments of voice are critical to the analysis of outcome of patients with dysphonia. Self-assessment measures like VHI and VAS provide us with the information on the impact of dysphonia on the quality of life. Our results were in agreement with other studies of Akbulut et al, Schindt et al, Rosen et al, Salmen et al and Thomas et al who demonstrated a reduction in the total scores of VHI.<sup>13-15,17</sup> VAS score improvement was in agreement with the studies of Ragab et al, Stainer-Katusic et al, Virmani et al and Uloza et al.<sup>16,18-20</sup>

Perceptual scoring of voice by a speech and language pathologist also provides us with important information about the efficacy of the treatment. We used the internationally approved GRBAS score for voice assessment and found a statistically significant improvement from  $11.85 \pm 1.12$  preoperatively to  $6.80 \pm 1.59$  postoperatively at 3 months ( $p < 0.05$ ). Studies by Ragab et al, Petrovic-Lazic et al, Virmani et al, Uloza et al and Phaniendra et al have also shown similar improvements.<sup>18-22</sup> In the study by Virmani et al, GRBAS improved from  $7.5 \pm 0.82$  in the pretreatment stage to  $2.3 \pm 1.17$  at 6 months.<sup>19</sup>

The acoustic variables have shown varied results in the literature. Ragab et al in a randomized controlled trial on 50 patients with benign vocal fold lesions observed that both "jitter" and "shimmer" decreased significantly after surgery in both cold knife and radiosurgical group ( $p < 0.001$ ).<sup>18</sup> Uloza et al observed that while there was a statistically significant improvement in mean jitter, shimmer and normalized noise energy postoperatively, the mean of F0 did not show statistically significant improvement.<sup>20</sup>

Toran et al, Stajner-Katusic et al, Virmani et al and Petrovic-Lazic et al, showed improvement in jitter, shimmer, HNR and F0 investigated after surgery.<sup>16,19,21,23</sup> Thomas in his study on 30 patients with benign vocal fold lesions concluded that while jitter, shimmer and HNR showed a trend towards improvement but the values were not statistically significant.<sup>17</sup>

Toran et al analysed objective measures of voice pre and post-surgery in 23 patients of vocal polyps and demonstrated significantly decreased shimmer, HNR and F0; jitter though reduced was not statistically significant ( $p = 0.694$ ).<sup>23</sup> In our study all the objective measures of voice i.e. jitter, shimmer, fundamental frequency and noise-to-harmonic ratio showed statistically improved results ( $p < 0.05$ ). In our study, we found a statistically significant improvement of fundamental frequency (F0) in the female population after surgery, but in males, though it improved, it was not statistically significant (at 3 weeks ( $p = 0.0902$ ), 6 weeks ( $p = 0.0640$ ) and 12 weeks ( $p = 0.0604$ ) follow up).

Pneumatic parameters like maximum phonation time also showed statistically significant improvement from  $8.73 \pm 1.72$  preoperatively to  $13.85 \pm 2.70$  postoperatively ( $p < 0.05$ ). It is in accordance to the study by Virmani et al where MPT showed significant improvement from  $9.43 \pm 1.89$  to  $14.16 \pm 1.7$  at 3 months postoperatively.<sup>19</sup> Stainer-Katusic et al, Salmen et al and Zeitels et al also demonstrated significant improvement in the acoustic parameters after surgery.<sup>13,16,24</sup>

Salmen et al concluded that the lesions were more common on the left side with the preponderance of sessile or broad based polyps in the study population.<sup>13</sup> In our study we had a preponderance of sessile polyps (95%) mostly located on the right vocal fold (65%).

### **Efficacy of different modes of treatment**

The role of voice therapy in the treatment for vocal fold polyps is still under study. In our study we provided the patients with voice therapy both preoperatively and postoperatively by our sole speech and language pathologist. This was done to undo any additional factors causing dysphonia as a result of inefficient manner of phonation. Voice therapy as a single modality of treatment of vocal fold polyps is not recommended. In a study by Cohen, he stated that voice therapy was effective in improving patients' voices but the difference was not statistically significant.<sup>25</sup> In our case, all patients had incomplete glottic closure preoperatively and voice therapy as a single modality of treatment was not advocated for. More detailed assessment in this regard is warranted for.

Phonomicrosurgery has yielded excellent results in the treatment of vocal fold polyps. Studies by Salmen et al, Akbulut et al, Stainer-katusic et al, Virmani et al, Uloza et al, Toran et al, Zeitels et al and Jensen et al and Rasmussen et al reiterated the importance of phonomicrosurgery in treatment of vocal fold polyps by demonstrating statistically significant improvement in most of the variables studied.<sup>13,14,16,19,20,23,24,26</sup> In our study also, we observed a significant improvement of voice postoperatively in all the variables studied.

The treatment of vocal fold polyps is basically surgical and regardless of the modalities and techniques used, a multidisciplinary team is required for successful treatment.<sup>6</sup> The physician should make the diagnosis and assess the best treatment approach for each patient depending on individual characteristics.

Above all, patients' awareness about the limitations of treatment and also about partial recovery of normal vocal pattern is important considerations to avoid misinterpretation and false expectations.

## **CONCLUSION**

Cold steel microlaryngeal surgery using microflap technique offers excellent results in patients with vocal fold polyps.

Perceptual, aerodynamic, acoustic, self-analysis and videolaryngostroboscopic parameters together allow multidimensional assessment of voice characteristics. Such an assessment allows a researcher or a clinician to successfully measure voice outcome both subjectively and objectively.

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