

# Subepithelial hydrodissection improves voice outcome of microflap surgery for vocal cord cyst

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## Objective

The aim was to evaluate voice outcomes of microflap surgery with subepithelial infiltration for vocal fold cysts and to compare voice outcomes of microsurgery with and without subepithelial infiltration for vocal fold cysts.

## Patients and methods

This study was conducted on patients with vocal folds cysts. Patients who met selection criteria were divided into two groups: group A was operated by microflap surgery with subepithelial infiltration, and group B was operated by microflap surgery without subepithelial infiltration.

## Results

Within the included 24 patients (12 in each group), a significant improvement of average fundamental frequency/fundamental frequency, jitter, shimmer, noise-to-harmonic ratio, maximal phonation time (MPT), and dysphonia was detected postoperatively in group A (with subepithelial infiltration), with 58.3% of patients resorted to grade 0 dysphonia. Statistically significant improvement of MPT and dysphonia was registered after intervention in group B (without hydrodissection). However, average fundamental frequency/fundamental frequency, jitter, shimmer, and harmonic to noise ratio (HNR) showed nonsignificant improvement after intervention. It was clear that dysphonia improved significantly more in hydrodissection group than nonhydrodissection group ( $P=0.0063$ ). However, there was no significant difference in postoperative MPT ( $P=0.3138$ ).

## Conclusion

Subepithelial infiltration is beneficial during microflap surgery for vocal fold cysts, with statistically significant better voice results. Therefore, we recommend using this technique during microflap surgery to enhance vocal outcomes; however, further studies are needed on a large number of patients and for a prolonged period of follow-up.

## Keywords:

cyst recurrence, dysphonia, hydrodissection, microflap dissection, subepithelial infiltration, vocal fold cyst, voice

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## Introduction

Subepithelial vocal fold cysts were first described in the 19th century as epithelium-lined sacs within the lamina propria. They exist in the superficial lamina propria [1]. The vocal folds are the second most common site of laryngeal cysts after the epiglottis [2]. The most frequent cysts of the vocal fold are epidermoid cysts, and retention cysts are next in frequency. Cysts are not precancerous or cancerous lesions. They are important purely because of their effect on the voice, as hoarseness of voice is the most common symptom of vocal fold cysts [3].

Simple excision may lead to overresection of the normal mucosa and extracellular matrix proteins [4]. Surgeons may be reluctant to excise vocal fold cyst because of the technical difficulty in complete cyst resection, occasionally resulting in suboptimal vocal function or cyst recurrence [1].

It was proved that microflap techniques permit cyst resection with less likelihood of overresection of normal mucosa and extracellular matrix proteins by enabling the phonosurgeon to identify areas of gross histological change [4,5].

Subepithelial infusion technique with microflap dissection was presumed to help in complete cyst removal with good voice results [1]. This study was designed to evaluate voice outcomes of microflap surgery with subepithelial infiltration for vocal fold cysts and to compare voice outcomes of microflap

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surgery with and without subepithelial infiltration for vocal fold cysts.

### Patients and methods

The present prospective study was conducted on adult patients who had vocal folds cyst at Otorhinolaryngology Department in University Hospitals over the period from July 2016 up to December 2017. Patients younger than 18 years or having undergone previous laryngeal surgery were excluded. The study was approved by the Institutional Review Board, and informed consent was signed by all included patients. Included patients were randomly divided into two groups: group A included 12 patients who were operated by microflap surgery with subepithelial infiltration and group B included 12 patients who were operated by microflap surgery without subepithelial infiltration.

Voice assessment protocol [6,7] was applied preoperatively and two months postoperatively passing through three levels:

- (1) Elementary diagnostic procedures: this included thorough history taking and auditory perceptual assessment of the patient's voice with careful otorhinolaryngology examination.
- (2) Clinical diagnostic aids: this level includes documentation of laryngeal examination by videolaryngoscopy using either flexible nasofibroscope or rigid 70° telescope, from Xion Medicals (Storz, Germany), connected to a camera in association with stroboscopic light. Then documentation of the auditory perceptual assessment was done by means of high-fidelity voice recording. The recordings were done in a sound-treated room to minimize environmental noise. The recorded materials for all patients were rated using the modified GRBAS scale, which was confirmed by three experienced phoniatricians. This scale comprised a four-point scale (0–3) [8] (0 for normal, 1 for mild, 2 for moderate, and 3 for severe dysphonia) for determining the following items: overall grade of dysphonia and character of voice including GRBAS scale consisting of G (Grade), R (Roughness), B (Breathiness), A (Asthenia), and S (Strain).
- (3) Additional instrumental measures: this level of assessment included acoustic analysis of voice using the Vocal Assessment Software from Dr Speech 4.5. The patient was asked to pronounce a prolonged /α/ in front of a microphone as long as he or she can, after taking deep inspiration. The

following parameters were analyzed automatically: average fundamental frequency (AFF), AFF/fundamental frequency (AFF.F0), jitter%, shimmer%, and noise-to-harmonic ratio. Maximal phonation time (MPT) could be measured simultaneously during the same task, done by asking the patient to pronounce a sustained A for three times and the average is measured.

### Surgery

In all patients, following general anesthesia and oral intubation using small-sized cuffed endotracheal tube, an appropriate-size laryngoscope was inserted and suspended to expose the larynx. The larynx was then sprayed with xylocaine, 4%, solution. A surgical microscope (Zeiss, Jena, Germany Carl Zeiss Microscope) with 400-mm lens was used to properly visualize the vocal cords. After the larynx was explored, under high magnification, a surgical cottonoid moistened with norepinephrine 1 : 200 000 was used as local surface decongestant. In group A only, a local subepithelial infiltration of 1 : 10 000 (norepinephrine in saline) was injected into Reinke's space of the vocal fold. In all patients, an incision was made on the upper surface of the vocal fold lateral to the cyst and flap was elevated followed by dissection of the wall of the cyst from the surface mucosa and the vocal ligament. Then the cyst was removed and the mucosal flap was redraped (Fig. 1).

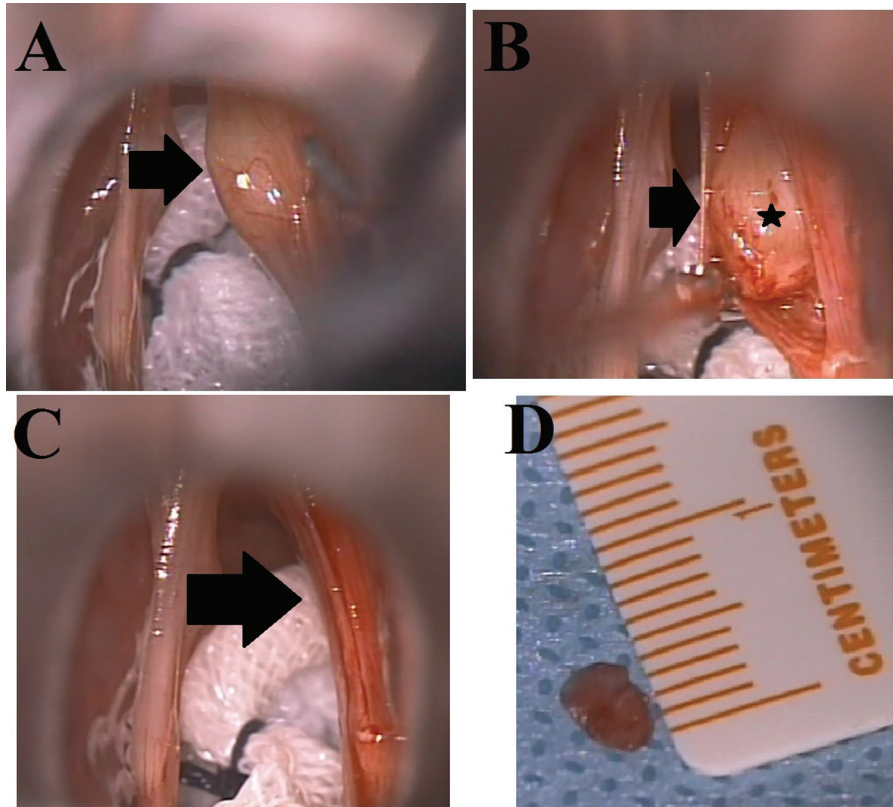
Data were collected and analyzed using the statistic package SPSS V12 (SPSS Inc., Chicago, Illinois, USA). *P* value less than 0.05 was considered as statistically significant.

### Results

Twenty four patients, with 14 males and 10 females, were included. Their age ranged between 18 and 52 years. Twelve patients presented with right vocal fold cysts and the others presented with left vocal fold cysts. Hydrodissection group (seven males and five females) had a mean age of 36±10.198 years, whereas the mean age in nonhydrodissection group was 36.8±10.32 years (seven males and five females). So both groups were matched regarding sex and age (*P*=0.8503, *t*=0.1910).

Significant improvement of AFF.F0, jitter, shimmer, harmonic to noise ratio (HNR), and MPT was detected postoperatively in group A (with subepithelial infiltration) (Table 1). In addition, dysphonia was significantly improved postoperatively in hydrodissection group (*P*= 0.003) with seven

Figure 1



(a) Endoscopic view of right vocal cord cyst (arrow) with local subepithelial infiltration into Reinke's space. (b) Incision on upper surface of the vocal fold lateral to the cyst (\*) and flap was elevated followed by dissection of the wall of the cyst from the surface mucosa (arrow) and the vocal ligament. (c) Cyst was removed and the mucosal flap (arrow) was redraped. (d) Cyst after removal.

**Table 1 Comparing acoustic parameters (average fundamental frequency/fundamental frequency, jitter, and shimmer) before and after surgery in group A (with subepithelial infiltration)**

Variables	Preintervention (mean±SD) [median (range)]	Postintervention (mean±SD) [median (range)]	t-Test	P value
AFF.F0	208.9±67.5	193.6±66.7	2.5	0.03 (S)
	215.5 (123–302.8)	207 (110.7–294.2)		
Jitter	1.04±0.7	0.25±0.03	2.8	0.01 (S)
	0.48 (0.22–2.5)	0.26 (0.21–0.29)		
Shimmer	4.3±1.4	1.6±0.5	2.7	0.01 (S)
	2.5 (1.35–10.5)	1.5 (1.04–2.4)		
HNR	19.6±6.2	26.1±3.1	3.1	0.01 (S)
	23.4 (9.2–25.6)	25.9 (21.1–30)		
MPT	11.7±3.7	21.6±7	4.4	0.001 (S)
	9 (5–25)	23 (6.25–30)		

AFF.F0, average fundamental frequency/fundamental frequency; HNR, harmonic to noise ratio; MPT, maximal phonation time; S, statistically significant difference.

(58.3%) patients resorted to grade 0, four (33.3%) patients resorted to grade I, and one (8.3) patients resorted to grade II (Table 2).

Statistically significant improvement of MPT was registered after intervention in group B (without hydrodissection). However, AFF.F0, jitter, shimmer, and HNR showed nonsignificant improvement after intervention (Table 3). Dysphonia also was significantly improved

postoperatively in nonhydrodissection group ( $P=0.009$ ) with eight (66.7%) patients resorted to grade I and four (33.3%) patients resorted to grade II (Table 4).

It was clear that dysphonia improved significantly more in hydrodissection group than nonhydrodissection group ( $P=0.0063$ ,  $\chi^2=10.133$ ). However, there was no significant difference in postoperative MPT ( $t=1.0309$ ,  $P=0.3138$ ).

**Table 2 Comparing dysphonia before and after surgery in case (with infiltration) group**

Variables	Preintervention		Postintervention		Wilcoxon signed-rank test	P value
	F(12)	%	F(12)	%		
Dysphonia grade						
0	0	0.0	7	58.3	2.9	0.003 (S)
I	1	8.3	4	33.3		
II	2	16.7	1	8.3		
III	9	75	0	0.0		

S, statistically significant.

**Table 3 Comparing acoustic parameters before and after surgery in group B (without subepithelial infiltration)**

Variables	Preintervention (mean±SD) [median (range)]	Postintervention (mean±SD) [median (range)]	t-Test	P value
AFF.F0	195.6±45.1 209 (123–262)	182.3±53.6 207 (120–245)	1.6	0.1 (NS)
Jitter	0.7±0.1 0.4 (0.18–2.45)	0.24±0.06 0.2 (0.13–0.33)	2.1	0.06 (NS)
Shimmer	3.5±1.8 2.57 (0.08–10.5)	2.1±0.09 1.6 (1.27–5.18)	1.5	0.2 (NS)
HNR	19.5±5.1 19.73 (9.2–25.6)	23.5±4.9 24.4 (12.9–30)	2	0.07 (NS)
MPT	10.3±3.7 7.9 (1.3–25)	18.3±8.6 22.5 (5–30)	3.8	0.003 (S)

AFF.F0, average fundamental frequency/fundamental frequency; HNR, harmonic to noise ratio; MPT, maximal phonation time; S statistically significant.

**Table 4 Comparing dysphonia before and after surgery in group B (without subepithelial infiltration)**

Variables	Preintervention		Postintervention		Wilcoxon signed-rank test	P value
	F(12)	%	F(12)	%		
Dysphonia grade						
I	1	8.3	8	66.7	2.5	0.009 (S)
II	2	16.7	4	33.3		
III	9	75	0	0.0		

S, statistically significant.

## Discussion

Within lamina propria, delicate extracellular matrix protein arrangement allows passive epithelial movement over the body creating the mucosal wave when air crosses through the glottis as a release of building subglottic pressure. Subepithelial vocal cord cysts exist in the superficial layer of the lamina propria, superficial to the vocal ligament and thyroarytenoid muscle [9].

Technical difficulty in complete cyst removal that could lead to suboptimal voice outcome and/or cyst rupture or recurrence increases the use of microflap dissection aiming to achieve complete removal of the cyst wall, but still difficulty in delicate noninjurious submucosal dissection is a challenge taking into consideration that the main aim of surgery is voice restoration.

Volume expansion and hydrodissection with subepithelial infusion of 1 : 10 000 adrenalin/saline solution of the superficial lamina propria (Reinke's space) has been

considered as an effective maneuver during phonosurgery, since its application in 1991 [9,10].

In the current work, a prospective detailed comparative study of this microflap technique for cyst removal with and without hydrodissection was conducted. We found that hydrodissection improved dysphonia significantly more than without hydrodissection for microflap vocal fold cyst removal. In addition, with hydrodissection, 58.3% of patients resorted to no dysphonia, a result that could not be achieved in any of the patients without hydrodissection. Moreover, significant improvement of acoustic parameters (AFF.F0, jitter, shimmer, and HNR) was detected with hydrodissection, whereas nonsignificant changes were reported without hydrodissection.

Subepithelial infusion of vocal fold as an aid to phonosurgical management of vocal fold lesions has been more refined to assume its place in managing vocal fold lesions [11].



Subepithelial infiltration of 1 : 10 000 saline adrenaline solution is proposed to offer various advantages over the conventional microflap technique, because by placing the pliable epithelium under greater tension and improving the exposure for perimeter incisions around the lesions, precision is enhanced. Norepinephrine solution causes vasoconstriction of the microvasculature, which aids in proper hemostasis and visualization. Norepinephrine infiltration causes hydrodissection of the superficial lamina propria. Owing to the increased depth of the superficial lamina propria, minimal damage occurred in the deeper layers of the superficial lamina propria.

As there is minimal loss of epithelium, healing is by primary intention with minimal postoperative scar formation over the vocal folds. Postoperative voice is therefore restored to near normal. Subepithelial infiltration helps in differentiating whether the lesion is arising only from the epithelium and superficial lamina propria or if there is underlying invasion of the vocal ligament by producing the 'doughnut effect' [12]. Volume expansion diminishes the amount of dissection necessary within the superficial lamina propria, thereby facilitating its preservation with easier dissection of cyst walls and cyst excision. Therefore, hydrodissection of the loosely attached vocal fold mucous membrane from the underlying vocal ligament reflects the underlying premise that an optimal postoperative voice will be achieved if there is maximal preservation of the vocal folds layered microstructure. Because of the minimal propensity of the superficial lamina propria to regenerate, it is greatly important to maximally preserve it. On this principle, microflap surgery of the vocal fold with subepithelial infiltration is based. The proposed disadvantage of subepithelial infiltration is possible confusion of the surgical planes following infiltration and hydrodissection of the normal basement membrane from the superficial layer of the lamina propria [12]. In contrary, in the current study, it was found that dissection was easier with hydrodissection.

Thus, hydrodissection by subepithelial diluted norepinephrine infiltration gave significant better voice results in microflap surgery for vocal fold cysts.

However, further studies on a large numbers of patients and for a long follow-up periods are needed.

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## Conclusion

Subepithelial infiltration is beneficial in microflap surgery for vocal fold cysts with statistically significant better voice results. Therefore, we recommend using this technique during microflap surgery to enhance vocal outcomes; however, further studies are needed on a large number of patients and for a prolonged time of follow-up.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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