Chapter 45
NBI® and benign lesions of laryngeal mucosa

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Abstract

NBI® technology has only recently been applied to observe laryngeal pathology and it is being used predominantly when examining cases suspicious for malignancy or for RRP. However, many other pathological conditions in the larynx feature abnormal vascular components. This group of dysphonias includes benign laryngeal conditions. Hence, we report here on how NBI® exposes benign lesions of the laryngeal mucosa and leads to improved diagnosis and management of dysphonias.

Keywords: NBI®, VF, dysphonias, efficacy, WL, vascular blush, neovascularization, benign phonatory lesions, vascularity, B-nodes, vocal fatigue, CUG

Introduction

Modern optical technology is instrumental in providing improved visualization of the glottis. These improvements provide much needed gains in the diagnostic capabilities of both static and/or dynamic properties of the vocal folds (VF). These optical technologies include LVS, HSDP, and flexible transnasal distant chip endoscopy. These techniques are capable of enhanced exposure of various organic lesions of the VF and reveal more exact exposure of the kinematics of the glottis. Interpretation or diagnosis of some organic findings based solely on white light (WL) exposure may be unclear and subject to clinical experience and interpretive judgments of the endoscopy (phonoscopy) team [1]. Accurately defining what is actually being seen is now benefiting significantly from the new optical technology called NBI®. NBI® has even been referred to as an “optical biopsy” [2]. NBI® was introduced recently by Olympus Co., Japan (see Chapter 23 in Volume I). Such an “optical biopsy” is suggested possible because NBI® technology divides the WL into specific wavelengths—415 µm (blue light) and 525 µm (green light) frequency bands—that are absorbed preferentially by hemoglobin. Therefore, NBI® highlights vascular and/or neoangiogenic processes in the mucosa. The shorter wave (blue) appears as brownish-gray on NBI®, exposing superficial vascularizations, while the longer wave (green) shows as cyan, exposing deeper blood vessels.

Consequently, NBI® has been proven very useful in more accurately detecting vascular changes associated with malignant or viral changes in human tissues. Yet, NBI® applications to laryngeal mucosal changes are just beginning to emerge. By the year 2008, only two reports of NBI® applications regarding laryngeal applications were identified by us in the world literature [3-4]. Since then, the literature has steadily expanded and new applications are discussed. To better define the growing utility of NBI® in the larynx, we decided to examine all incoming consecutive voice cases in our clinical practice with both WL and NBI®. Our decision was based on our clinical observations that vascularization of the VF is present in many organic mucosal laryngeal conditions, not necessarily only in malignant or viral conditions.
Clinically we observed two types of change, which we refer to as neovascularization or vascular blush. Neovascularization refers to discretely visualized vessels that appear more numerous, dilated, or distorted than typical. Vascular blush refers to a diffuse, homogenous area of vascular change likely resulting from a fine web of vessels too small to resolve individual vessels. We think of these changes as analogous to vascular changes that can be observed in the sclera of the eyes (i.e., “bloodshot eye” being analogous to neovascularization and “pink eye” demonstrating vascular blush) as shown in Figure 1. For the purpose of keeping this chapter as brief as possible, we limited presentation of our NBI® findings to some very interesting, rare, or unusual organic non-malignant lesions of the laryngeal mucosa.

![Figure 1. “Bloodshot eye” (neovascularization) on the left and “pink eye” (vascular blush) on the right.](image)

**Methods**

All NBI® video recordings were made with an Olympus NBI® system (Center Valley, PA, USA): Model OTV-S190 processor and CLV-S190ENT light source. Visualizations were performed with either a distal chip flexible fiberoptic endoscope or a rigid transoral scope. The flexible scopes used were an ENF-VH scope, a 3.9mm OD 1080HD distal chip scope, or an ENF-V3 2.6mm OD high resolution distal chip scope. The rigid scope was a WA96100A 70° HD laryngoscope.

**Case 1: Hemorrhagic polyp (HeP)**

VF polyps can be either relatively avascular or vascular. Vascular polyps are referred to as hemorrhagic polyps (HeP). Not surprisingly, this VF (HeP) type is markedly highlighted by NBI® illumination compared to WL endoscopy (Figure 2).

![Figure 2. NBI® (left) and WL (right) view of a right TVF vascular polyp.](image)
Case 2: Vocal fold hemorrhage

Also not surprising, acute bleeds into the VF are well demonstrated on both WL and NBI® endoscopy (Figure 3).

Figure 3. WL (left) and NBI® (right) view of the right VF with nodular swelling and hemorrhage.

Case 3: Contact ulcer granuloma (CUG)

Contact ulcer granulomas (CUG) are benign lesions of the posterior VF that commonly occur spontaneously in men or as a result of post-intubation trauma in women. They can often persist or recur as long-term lesions. As such, these lesions can sometimes be bi-lobed and manifest a more long-term, less vascular, fibrotic component and a shorter term, more vascular, more acutely inflamed component. These two components can be suggested on WL endoscopy but are more readily apparent on NBI® endoscopy (Figure 4). Absence of NBI® findings for carcinoma (IPCLs and bizarre fragmented vascular supply) confirm the benign nature of these lesions.

Figure 4. WL (left) and NBI® (right) view of left arytenoid contact ulcer granuloma.
Case 4: “Bamboo” vocal folds

Bamboo vocal folds also known as “B-nodes” are a very rare laryngeal disorder thought to be of autoimmune etiology, though traumatic causation has also been postulated [5]. A detailed review of this condition is presented in Chapter 46 of this volume. The characteristic appearance is similar to that of a true bamboo node as illustrated in Figure 5. NBI® illumination clearly shows that the vascular components are not disturbed, bringing a strong case against the traumatic etiology of this condition.

In more detail, these lesion appear as bilateral, whitish, thin linear, submucosal deposits located in the superior surface of the VF mucosa, traversing the mucosa from lateral to medial edge. These bands are not located opposed to each other (i.e. like the so called “kissing nodes”) but are misaligned between each other on the right and the left VF on the anterior-posterior axis. These deposits divide the VF into anterior and posterior segments causing phonatory aperiodicity (Figure 6).

Case 5: Steroid-inhaler fungal laryngitis

Inhalation of steroid asthma medications can affect the laryngeal mucosa. These changes include mucosa swelling and hyper-vascularization associated with fungal infection. Such fungal inflammations are particularly associated with the corticosteroid/bronchodilator combination inhalers such as mometasone/formoterol or fluticasone/salmeterol. At times this problem presents with strikingly diffuse inflammatory blush of the tissues (Figure 7) and other cases are notable for the presence of thick white fungal debris and
crusting (Figure 8). Typically, this condition is self-limited with changing of inhalers and/or treatment with antifungal medication. With marked inflammatory changes, NBI® visualization appears to be helpful to evaluate laryngeal mucosa in these cases and is an excellent tool to monitor progress and recovery of the laryngeal mucosa in this condition.

![Figure 7. WL (left) and NBI® (right) view of fungal deposits.](image)

Cases 6 & 7: Vocal fold scar

Scars can be difficult to appreciate on WL endoscopy, although better appreciated on LVS. Scars tend to illuminate on NBI® as a faint vascular blush. Both of the following cases represent postoperative VF scarring after MDL surgery. Case 6 is a patient after excision of a VF cyst with long term persistent hoarseness. WL endoscopy shows a subtle left anterior VF whitish lesion along the vibratory edge while NBI® reveals a more diffuse area of scar highlighted by green (Figure 9).
Case seven is represented by a patient with recurrent respiratory papillomas (RRP) mainly involving the right anterior VF. This is known to be an incurably chronic, often relapsing condition. NBI® has been advocated as useful in evaluating these patients [7]. He has undergone five operative procedures for the excision of these recurrent lesions. He is a rock singer and notes a slight loss of upper range with his voice. WL endoscopy reveals a very subtle irregularity of the right anterior VF behind the anterior commissure. It is better appreciated on LVS and HSDI. NBI® demonstrates a faint vascular blush in the area behind the anterior commissure on the right side (Figure 10).

Figure 10. WL (left) and NBI® (right) view of VF scarring after RRP excision.

Case 8: Sulcus vocalis

VF sulcus can also be understood as another form of scar causing hoarseness as the epithelium is often abnormally adhered to the underlying VF ligament due to a defect of the superficial laminina propria [8]. Characteristically, it can be recognized as a depressed furrow below the free edge of the VF on WL endoscopy, but NBI® again often reveals a diffuse vascular blush in the depressed area of the sulcus scar (Figure 11).

Figure 9. WL (left) and NBI® (right) view of VF scarring after cyst excision.
Case 9: Post-laryngeal radiation therapy

Bizarre vessel fragmentation and IPCLs are associated with laryngeal squamous cell carcinoma [9]. However, other vascular changes can develop in the VF after radiation. Somewhat tortuous vessel dilatation can occur but these changes remain stable over a period of surveillance monitoring. Since these changes do involve the vascular supply of the VF, they are noticeable on WL endoscopy but strikingly more so with NBI® (Figure 12).

Case 10: Incipient VF nodules / Vocal fatigue

Vocal fatigue is a poorly understood clinical entity with heretofore nonspecific findings. Obviously, it tends to occur in patients with high vocal demands such as singers. It may often be found in association with muscle tension dysphonia and hypertrophic compensatory supraglottic muscular activity. Well-formed (keratotic) VF nodules are typically non-vascularized lesions that are equally recognizable by either white light or NBI® endoscopy. However, early VF nodules can be difficult to recognize clinically as they are associated with subtle findings of pre-nodular swelling or edema, and are often associated with complaints of vocal fatigue.
This classically trained singer in graduate voice studies complained of voice fatigue of an unrecognized source. Initial WL endoscopy was associated with little remarkable findings (Figure 13). However, sustained phonation revealed mucus collecting at less dynamic areas of the vibratory edge, suggesting pre-nodular swelling (Figure 14). These areas of swelling are accentuated by a focal vascular blush at the site of incipient nodules under NBI® scrutiny (Figure 15).

Figure 13. WL endoscopy was associated with little remarkable findings.

Figure 14. WL endoscopy post-sustained phonation suggesting pre-nodular swelling.

Figure 15. NBI® accentuating these areas of swelling by a focal vascular blush at the site of incipient nodules.
Case 11: Chronic laryngitis / Vocal fatigue

This pop singer complained of vocal fatigue with voice breaks after performing musical sets of more than 30-45 minutes. WL endoscopy is negative except for a suggestion of a slightly uneven, edematous vibratory VF edge. NBI® illumination highlights a vascular blush extending along both edges of the VF identifying the problematic area of inflammation (Figure 16).

Figure 16. WL (left) and NBI® (right) view of chronic laryngitis.

Case 12: Laryngopharyngeal reflux (LPR)

One of the more commonly reported findings associated with LPR is posterior commissure hypertrophy [10]. This is postulated to be an effect of local acid and/or pepsin irritation on the posterior larynx. As such, it should manifest an inflammatory component easily identifiable by NBI®. This professional, massively obese gospel singer with classic GERD symptoms has had problems with loss of her upper range. This is attributable to her evident VF nodules. But of interest is her posterior commissure hypertrophy consistent with LPR on WL endoscopy. NBI® demonstrates a diffuse intense vascular blush consistent with an inflammatory component (Figure 17). We suggest NBI® may have a future role in confirming and measuring response to therapy if such inflammatory changes are noted to change with treatment for LPR.

Figure 17. WL (left) and NBI® (right) view of LPR.
Case 13: Amyloid

Laryngeal amyloidosis (see Chapter 17 in this volume) is a rare entity in which submucosal deposits of “beta-sheet” proteins are noted. These deposits are most commonly seen in the supraglottic larynx, less frequently in the VF and subglottis [11]. These inert proteins cause little inflammation but do affect the voice by altering the vibratory compliance of the endolaryngeal tissues. These yellowish discrete deposits are evident on WL illumination. Since they do not provoke much of an inflammatory response, there is a lack of neovascularization or vascular blush but the vascular topography is highlighted on NBI® (Figure 18).

![Figure 18. WL (left) and NBI® (right) view of laryngeal amyloids.](image)

Case 14: Multiple laryngeal lesions

Occasionally patients with multiple laryngeal lesions will be encountered. Case 14 is a patient with a history of a T1 squamous cell carcinoma of the posterior left VF excised endoscopically. In Figure 19, a depressed scar area can be seen as darker pink on WL endoscopy, but is highlighted particularly as dark green on the NBI® image of that area. Anterior to the previous excision site, an area of leukoplakia can be easily appreciated with both WL and NBI® imaging. On the right mid-VF, a small polyp is noted, again highlighted on NBI® due to the hemorrhagic nature of the lesion. Finally, a right posterior VF contact ulcer granuloma can be identified with both WL and NBI® imaging. This case illustrates the variable utility of NBI®—very useful for defining the presence of some laryngeal lesions, but not all.

![Figure 19. WL (left) and NBI® (right) view of VF with multiple lesions.](image)
Summary

This short chapter constitutes a welcomed addition to the scarce world literature on benign mucosal lesions within the human larynx examined with the newly introduced NBI® technology and contrasted with the more commonly performed WL endoscopy. Our findings show that NBI® provides significant improvement in identification of specific lesions and their character within the laryngeal mucosa. Hence we feel that NBI® contributes significantly to the diagnosis and to the treatment efficacy of many laryngeal conditions causative of transient or chronic dysphonias.

References

4. Chapter 41 in this volume.