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Original Research Article

Narrow Band Imaging as a Diagnostic Tool in Laryngeal Pathology

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Abstract:

Background: Narrow band imaging (NBI) is an innovative biological endoscopic technology designed to enhance the diagnostic precision by visualization of tumor-specific neo-angiogenesis. Currently available evidence indicates that narrow band imaging is a promising approach in the diagnosis of laryngeal cancer

Methods: The descriptive study was conducted at the ENT outpatient department of Government Medical College, Ernakulam and Dept of Surgical Oncology at Cochin cancer Research Centre for a period of 6 months from August 2021 to January 2022 among 45 patients. The objective of current study was to assess the validity of narrow band imaging as a diagnostic and follow up tool in the diagnosis of laryngeal lesions and to study the epidemiological profile of different laryngeal pathologies.

The findings in NBI i.e., type of vascular pattern was compared with histopathology findings.

Results: Out of all the lesions, 33 (73.3%) were malignant and the location were glottis (40%), supraglottis (26.6%) and immediate subglottis (6.6%). White light endoscopy (WLE) was able to pick up only 27 cases as true positive, NBI alone was able to pick 32 cases as true positive while NBI with WLE was able to detect 33 true positive cases. At 95% confidence interval sensitivity of WLE was 81.8 % , NBI was 96.9% and of WLE with NBI was 100%. Specificity of WLE was 71.2%, NBI was 72.1% and WLE+NBI was 72.3%. PPV of WLE was 90.7%, NBI was 91.5% and of WLE+NBI was 92.6%. Negative predictive value of WLE was 55.3%, NBI was 78.9% and of WLE+NBI was 100%

Conclusion: The integration of Narrow Band Imaging (NBI) with White Light Endoscopy (WLE) enhances the sensitivity for detecting laryngeal malignancy and its precursor lesions. NBI is also beneficial for follow up in premalignant lesions, certain benign lesions and irradiated larynx.

Keywords: Endoscopy, Diagnosis, Intraepithelial Papillary Capillary Loop, Laryngeal Pathology, Narrow Band Imaging, White Light Examination.

Introduction

The visualization of laryngeal and hypopharyngeal lesions has markedly improved due to developments in endoscopic technology. However, the precise identification of underlying pathology by non-invasive methods has nonetheless posed a significant barrier. The identification of small lesions, those lesions in post-treatment contexts, as well as the distinction between benign and pre malignant lesions in certain scenarios, creates significant hurdles for the clinician. [1]

In recent years, one of the most innovative and beneficial technologies in the field of endoscopy is narrow-band imaging (NBI). NBI is an endoscopic optical imaging modality that enhances the contrast of mucosal surface texture and visualizes mucosal and submucosal vasculature, thereby augmenting diagnostic sensitivity for surface lesions or neoangiogenic patterns that are undetectable by conventional white light endoscopy (WLE) [2]. In rigid or flexible scopes incorporated with NBI, it can be easily enabled by pressing a button. NBI relies on the distinct light-absorbing characteristics of blood and mucosa; to this end, NBI filters emit solely blue light (415 nm wavelength) and green light (540 nm wavelength), which illuminate the mucosa at varying depths, rendering superficial and submucosal vessels brown respectively. This method enables clinicians to evaluate the vascularization of mucosal lesions, hence enhancing the diagnostic precision of conventional high-definition video laryngoscopy. Narrow Band Imaging (NBI) has demonstrated its efficacy in the early diagnosis of neoplastic lesions of the upper aerodigestive tract [3-6]. In 2011, Ni et al. [7] introduced a classification system based on the alterations in mucosal vascularization observed through NBI, based on intrapapillary capillary loops (IPCL) in five types (types I–V) facilitating

the in vivo differentiation between non-malignant and malignant lesions.

The distinctive morphological alterations of intraepithelial papillary capillary loops (IPCL) in the superficial mucosa of normal, inflammatory, precancerous, and cancerous tissues have been thoroughly investigated using narrow-band imaging (NBI). [7] IPCL alterations indicative of malignancy include dilation, tortuosity, caliber fluctuation, and irregularity in vascular morphology. [8] The European Laryngological Society (ELS) suggested a simpler way to classify glottic vascular changes using NBI. They propose dividing these changes into two categories—longitudinal (which is not suspicious) and perpendicular (which is suspicious). [9]

Table 1: Ni's classification (2011)

Type I	Thin, oblique, and arborescent vessels are interconnected and IPCLs are almost invisible
Type II	Diameter of oblique and arborescent vessels is enlarged, and IPCLs are almost invisible
Type III	IPCLs are obscured by white mucosa
Type IV	IPCLs are recognized as small dots
Type V	Va—IPCL appears as solid or hollow, with a brownish, speckled pattern and various shapes Vb—IPCLs appear as irregular, tortuous, line-like shapes Vc—IPCLs appear as brownish speckles or tortuous, line-like shapes with an irregular distribution, scattered on the tumor surface

Table 2: European Laryngological Society classification (2016)

Longitudinal vascular pattern	Benign lesions
Perpendicular vascular pattern	Papillomatosis, SIN, and malignant lesions

Material and methods

This prospective diagnostic study was conducted at the outpatient department of ENT, Government Medical College, Ernakulam and Dept of Surgical Oncology at Cochin cancer Research Centre from August 2021 to January 2022. Ethical clearance was taken from Institutional ethics committee.

Sample size was calculated using the Burderers formula. Taking specificity as 90% and prevalence of 30% with precision level taken as 9%, the estimated sample size was taken as 45. Patients were selected on the basis of inclusion and exclusion criteria.

Inclusion Criteria

1. All patients above the age of 18 years with laryngeal lesions detected on indirect laryngoscopy.

Exclusion Criteria

1. Patients diagnosed to have bilateral vocal nodule, which usually doesn't require surgical excision.

After history taking, all patients with laryngeal symptoms underwent indirect laryngoscopy. This was done with the patient in sitting position using indirect laryngoscopic mirror with 10% xylocaine spray. Those detected to have any laryngeal lesion underwent a high-definition flexible video laryngoscopy with narrow band imaging after getting an informed consent. We used VISERA ELITEII OTV-S200 (Olympus Medical Systems, Tokyo, Japan), which can provide images both in NBI and white light modes. All endoscopies were performed by the same endoscopist. The entire larynx was initially visualised with standard white light, followed by visualisation using the narrow band imaging mode. The anatomical location of each patient's laryngeal lesion(s) was documented as follows: supraglottis, glottis or subglottic region. Representative images were recorded for analysis. The vascular pattern was then assessed and subsequently graded using Ni's classification published in 2011 by a single observer to avoid inter observer variability. All patients underwent microlaryngoscopy and biopsy under general anaesthesia as indicated by the standard clinical guidelines and the tissue was sent for histopathology examination. The histopathology results were then analyzed.

Statistical Analysis

Results were analysed using SPSS version 25.0. The findings in NBI i.e., type of vascular pattern was compared with histopathology findings. The true positives, true negatives and false positives and negative results were recorded. The positive predictive value and negative predictive value were also calculated. The sensitivity and specificity of NBI in the diagnosis of different laryngeal lesions was calculated taking histopathology as the gold standard.

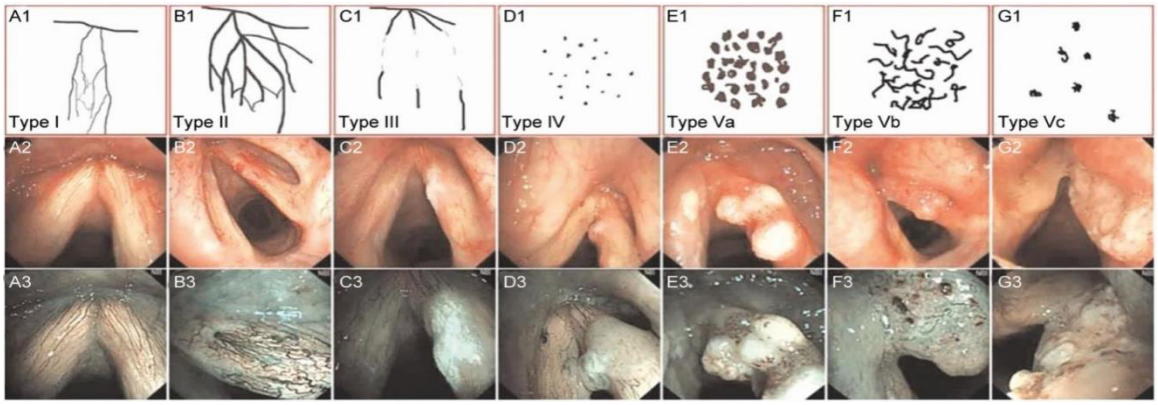

Figure 1: Diagram of microvascular and endoscopic view of vocal cords in white light and NBI (adapted from Ni's 2011 classification)

Results

The mean age of patients was 45.87± years and number of female patients was 15.5% and number of male patients was 84.5% as shown in figure 1.

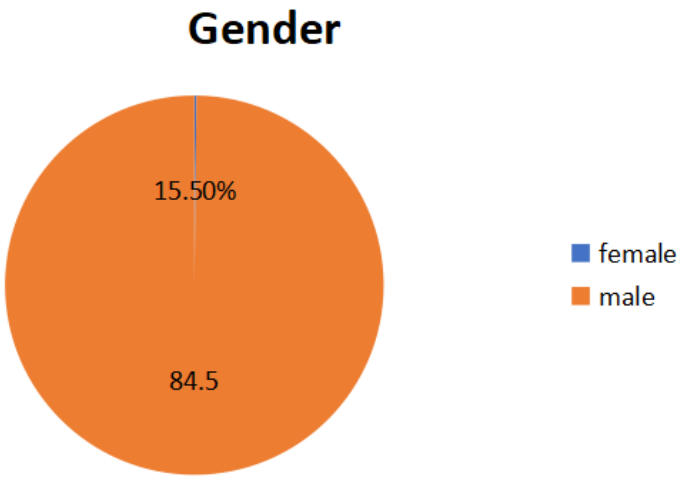

Figure 2: Gender distribution of patients

Out of all the tumors 33 (73.3%) were malignant and the location were glottis (40%), supraglottis (26.6%) and immediate subglottis (6.6%). Pre malignant lesions were 5 (11.1%) and benign lesions were 7 (15.5%). Only 2 (4.4%) had taken prior treatment as shown in table 1b.

Table 3: Clinical characteristics of patients (WLE+NBI)

	Clinical characteristics		N	Total N (%)
1	Proliferative lesions s/o malignancy			33
	Glottis	cT1	7	18 (40)
		cT2	4	
		cT3	4	
		cT4	3	
	Supraglottis	cT1	5	12 (26.6)
		cT2	3	
		cT3	3	
		cT4	1	
	Immediate subglottis	cT3	3	3 (6.6)
2	Pre- malignant lesions (leukoplakia)		5	5 (11.1)
3	Benign lesions	Vocal cord papilloma	3	7 (15.5)
		Vocal cord polyp	2	
		Vocal cord cyst	2	

Table 3b:

Prior treatment(excision)	Yes	2 (4.4)
	No	43 (95.6)

Out of 33 malignant lesions 19 were of type V, 14 of type IV). Out of 5 pre-malignant lesions 2 were of type V, 2 was of type IV and 1 was of type III. Out of 7 benign lesion 5 were of type III a 1 was of typeII and1 was of type II as shown in table 2.

Table 4: Correlation between histopathology and NBI findings according to ICPL patterns

Histopathology	Type I	Type II	Type III	Type IV	Type V	Total
Squamous cell carcinoma and Ca in situ	0	0	0	14	19	33
Moderate -High grade dysplasia	0	0	0	2	2	4
Mild dysplasia	0	0	1	0	0	1
Benign lesions(cyst,papilloma)	1	1	5	0	0	7

WLE was able to pick up only 27 cases as true positive, NBI alone was able to pick 32 cases as true positive while NBI with WLE was able to detect 33 true positive cases. Thus, combining NBI with WLE increased the diagnostic sensitivity to 100% for identification of malignant lesions.

Table 5: Comparison of WLE,NBI and WLE+NBI (at 95% confidence interval)

Parameters	WLE	NBI	WLE+NBI
Sensitivity	81.8%	96.9%	100%
Specificity	71.2%	72.1%	72.3%
Positive predictive value	90.7%	91.5%	92.6%
Negative predictive value	55.3%	78.9%	100%

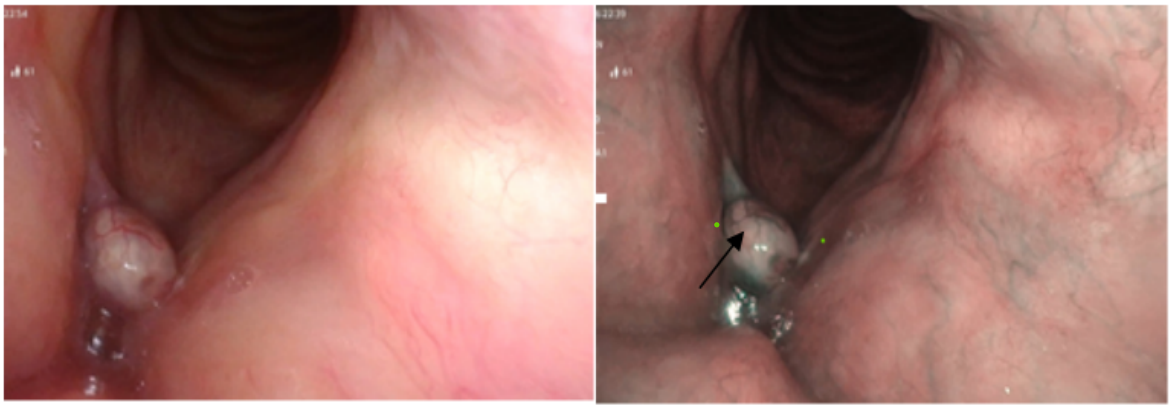

Figure 3: Type 1 vascularity

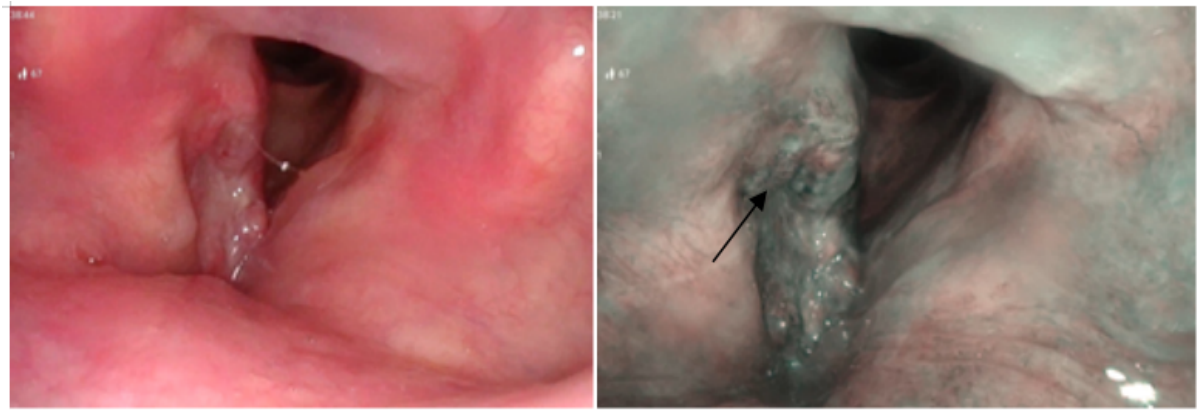

Figure 4: Type V vascularity

Discussion

Given that early malignant laryngeal disease has a favorable prognosis, it is essential for the treating otolaryngologist to possess a comprehensive awareness of the clinical characteristics of premalignant and early malignant alterations in the larynx. [10] The present availability of thin high-definition video endoscopes renders NBI feasible for outpatient use. Since no medication is necessary (apart from local anesthetic spray), one should not worry about side effects or consequences. Additional advantages of endoscopes with NBI include the ease of handling, superior image quality, and effective photo recording. [11,12] Moreover, this technique can be executed using rigid endoscopes as well during micro-laryngoscopy. [13]

Though various studies have been done on Indian population, ours is the first study from Kerala done in a Government Medical College. In our study most of the lesions were malignant and most common location was the glottis. The sensitivity of NBI alone was 96.9% and in combination with WLE it shows 100% sensitivity. Specificity of WLE with NBI was 72.3% which is similar to most Indian studies.[14,1]PPV and NPV of combined approach was 89% and 100% respectively which is also better than other Indian studies. [15]

Borders of lesions are frequently difficult to discern, particularly when the adjacent mucosa is aberrant, as seen in post-radiotherapy patients, widespread leukoplakia, and tissue necrosis. NBI is beneficial in cases of recurrent disease following surgery or radiotherapy, since accurate identification of IPCL patterns aids in distinguishing them from post-therapy alterations. [16] While NBI offers minimal advantage in detecting advanced tumours that are easily visible with WLE, it accurately delineates their extent, infiltration into adjacent structures, and aids in determining the biopsy location [1]. NBI can also be incorporated into rigid endoscopes during microlaryngoscopy where identification of margins prior to resection plays a crucial role [17] but we did not have that facility.

Chang et al. recommended that office-based NBI-guided flexible laryngoscopic biopsy is an effective and efficient method, achieving a diagnostic accuracy of 98.9%, with sensitivity and specificity rates of 97.2% and 100%, respectively. The accuracy of their study remained unaffected by tumour size, location, learning curves, or prior history of head and neck cancer, suggesting that NBI can provide targeted biopsies at specific sites. [11]

Any diagnostic method should be assessed against the gold standard, which is histological diagnosis for laryngeal lesions. We incorporated patients already scheduled for microlaryngoscopy, therefore including several malignant lesions in our analysis. This study design facilitates histologic diagnosis of all lesions, a requirement unmet by several prior investigations. [9,10]

Since NBI was conducted after WLE in all instances, our findings do not represent the results of NBI in isolation. Muto et al. executed a clinical experiment with 333 patients who were randomly allocated to have primary white light endoscopy (WLE) followed by narrow band imaging (NBI) and vice versa, thereby addressing this issue. This study indicated that when WLE was succeeded by NBI, the diagnostic accuracy surpassed that of the alternative sequence and is improbable to overlook a mucosal lesion.

NBI demonstrates superior negative predictive values for the detection of initial and recurrent tumours, as well as carcinoma of uncertain primary origin, offering significant clinical reassurance for patients following negative endoscopic results. [18] Although direct laryngoscopy under general anesthesia and biopsy remains to be the gold standard to rule out laryngeal malignancy, it is invasive, and it is not feasible to repeat this procedure at every follow-up visit in dysplastic lesions. NBI endoscopy seems to be a very promising diagnostic tool in the diagnosis of laryngeal malignant disease and follow up of dysplastic lesions which are biopsied once. [19]

Despite the numerous advantages of NBI, several challenges may arise. To accurately evaluate the vasculature, the videoendoscope has to be positioned near the lesion, namely behind the epiglottis deep into the larynx, which might be challenging in individuals with a pronounced gag reflex. [3] NBI can be conducted in such individuals following the administration of regional blocks or under general anaesthesia. The presence of secretions can sometimes obscure the vascular pattern of NBI. The expense of the equipment and the inability to evaluate the vertical extent of the lesion are additional notable drawbacks of NBI. [5]

Limitations

The sample size is insufficient to reliably assess the diagnostic accuracy of NBI in identifying and grading laryngeal dysplasia. Due to the prevalence of malignancy patients at our centre, only a limited number of benign cases were scheduled for videolaryngoscopy and microlaryngoscopy biopsy, resulting in fewer benign cases included in the study. Increased number of clinically malignant lesions in the study population may have affected the results obtained.

Conclusion

The distinction between benign,premalignant and malignant lesions is essential for the decision about

further management. The advancement of technology enables the acquisition of supplementary information regarding biological traits for lesion diagnosis, which is unattainable by conventional approaches. The elevated NPV indicates that NBI technology, which provides a comprehensive topographical delineation of lesions by enhancing the visualization of microvascular anomalies can serve as a dependable tool in pre malignant lesions on follow up and irradiated patients.

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