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Original Research

Narrow Band Imaging in Laryngeal Lesions:A Valuable Tool in Decision Making

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Objective: To assess the efficacy of Narrow band Imaging (NBI) in detecting laryngeal malignancies by statistical analysis.

Methods: This prospective, observational study was conducted from 1st September 2022 to 31st December 2023. All patients above 18 years, who were scheduled to undergo nasopharyngolaryngoscopy with biopsy for laryngeal lesions, were included. Total 84 patients were included who were divided into two groups, Group A- with no previous treatment, Group B- with previous radiation to the larynx. They underwent routine white light endoscopy followed by NBI and grading was determined. Suspicious areas were biopsied and sent for histopathology. Based on the final report, the diagnostic accuracy was assessed using area under the curve (AUC) in ROC curve, sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and accuracy.

Results: Group A included 54 patients. Thirty-five had a clearly malignant lesion on WLE, however NBI showed Grade IV IPCL pattern in three. The final histopathology in them showed squamous cell carcinoma (p value 0.019). One patient had vocal cord leukoplakia on WLE which showed Grade IV NBI pattern. The histopathology showed early squamous cell carcinoma. The remaining 18 had equivocal lesions on WLE with six showing Grade V NBI pattern. The final histopathology showed squamous cell carcinoma in five and moderate dysplasia in one (p value 0.574). Statistical analysis in Group A showed WLE had a sensitivity of 80.49% whereas NBI had 82.93 %. Specificity of WLE was 71.43% and NBI was 69.23%. Group B included 30 patients. Nineteen had malignant lesions on WLE. Of them 2 had Grade IV NBI pattern and one of them showed squamous cell carcinoma in histopathology (p value 1.000). Eleven patients had equivocal lesions in WLE and NBI in 6 showed Grade V pattern. Of these, four showed squamous cell carcinoma on histopathology, one had sarcoma and one showed mild to moderate dysplasia (p value 0.261). Statistical analysis showed WLE had a sensitivity of 69.23% while NBI had 88%. Specificity of WLE was 75% while NBI had 80%.

Conclusion: We found that NBI in post irradiation setting, showed higher sensitivity and specificity. Hence it can aid in early detection of recurrent lesions that may otherwise be

masked by treatment related changes.

Introduction

The mucosal surface of the upper aerodigestive tract (UADT) is an onset site of several pathologies with varied etiopathogenesis and clinical presentations. Moreover, the epithelium in certain subsites, such as the nasal and oral mucosa as well as the subglottic larynx show pathological peculiarities, thus representing a challenging tract to explore [3]. Considering that benign and malignant lesions represent some of the most frequent pathologies examined by the otolaryngologist, in the last decades a lot of new techniques were developed to examine the UADT [3].

The visualization of these laryngeal and hypopharyngeal lesions has been significantly enhanced with the advent of technological advancements in endoscopes, lighting systems, and camera systems. Despite these advances, recognition of the exact pathology by non-invasive means, still remains a considerable challenge. Especially when the lesions are small, recurrent, or in post-treatment settings, the differentiation of benign versus malignant lesions presents a formidable challenge to clinicians [1].

In light of this, one of the most innovative and useful technologies that has helped in overcoming these difficulties is narrow-band imaging (NBI).

NBI is an optical image enhancement technology that enhances the vessels in the surface of the mucosa using light absorption characteristics of hemoglobin at a specific wavelength. This technique alleviates the need for any special dyes. In the NBI mode, an optical filter allows a narrow-band low-penetration blue light, centered at 415 nm (range, 400–430 nm), to penetrate only the superficial layer where it is absorbed by the capillary vessels in the surface layer of mucosa. In parallel, a narrowband deep penetration green light, centered at 540 nm (range, 525–555 nm), is applied, which penetrates deeper into the tissue and specifically illustrates the vessels in the submucosa. This results in contrast to the images obtained by the 415-nm light (brown) and 540-nm light (cyan) depicting tumor-specific neoangiogenesis [2]. With this technology the clinician can assess the differential vascularization of mucosal lesions, thereby increasing the diagnostic accuracy of traditional high-definition video laryngoscopy [3].

Ni et. al. have already described the usefulness of NBI in detecting early malignancies of the UADT in 2011, and have also proposed a classification based on the modification of mucosal vascularization observed with NBI allowing the in vivo differentiation of non-malignant and malignant laryngeal lesions [4] (Table 1).

Ni et. al. Grade [4]	Intrapapillary Capillary Loop (IPCL) Pattern
I	Thin, oblique and arborescent vessels are interconnected and IPCLs are almost invisible
II	Diameter of oblique and arborescent vessels is enlarged, and IPCLs are almost invisible
III	IPCLs are obscured by white mucosa
IV	IPCLs can be recognised as small dots
Va	IPCLs appear 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 irregular distribution, scattered onthe tumour surface

Table 1. Classification of Intrapapillary Capillary Loop (IPCL) Features Using Narrow Band Imaging [4].

Considering the aforementioned factors, the aim of our study is to assess the efficacy of NBI in detection of laryngeal malignancies.

Materials and Methods

After obtaining approval of the Institutional Ethics Committee, this prospective, observational study was carried out in the department of Head and Neck surgical oncology, from 1st September 2022 to 31st December 2023.

Inclusion criteria

All patients above the age of 18 years, who were scheduled to undergo asopharyngolaryngoscopy evaluation with biopsy after obtaining informed written consent.

Exclusion criteria

Characteristically benign appearing lesions, which would not warrant a biopsy evaluation.

A total of 84 patients were included in our study. These patients were further divided into two groups, i.e. Group A- patients with no previous history of irradiation for laryngeal/hypopharyngeal malignancies; and Group B- Patients who had prior irradiation to the larynx.

Procedure

- NBI equipment with a xenon light source with integrated NBI filter, a high-definition video endoscope and a video system unit was used. Switching between the conventional mode (white light) and NBI mode is achieved by pressing a button on the endoscope or at the unit.

- Conventional white light endoscopy (WLE) in the outpatient clinic under local anesthesia (using 10% lidocaine hydrochloride spray) in the supine position was done. In the WLE mode, suspicious lesions were identified by color change (leukoplakia, demarcated red lesions) and irregularity of mucosal surface (growth, bulging, and ulceration).

- NBI was performed immediately after WLE with the images of all examinations recorded and saved on a computer for further evaluation.

- NBI findings were classified into five types (I–V) according to IPCL features, as recommended by Ni et al.

- Type I–IV lesions were considered benign and V lesions as malignant.

- All biopsies were performed after obtaining NBI images. The pathologist was blinded to the results of WLE and NBI. The histopathologic results were then analyzed retrospectively with NBI and WLE images.

Statistical Analysis

The categorical variables were summarized using counts and percentages and continuous variables are presented using mean with standard deviation or median with interquartile range. The diagnostic accuracy has been assessed using area under the curve (AUC) in ROC curve, sensitivity,

specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and accuracy.

Results

A total of 84 patients were included in our study period from September 2022 till December 2023. We noted a male dominance in our study population with 81 males and only 3 females (male:female ratio of 27:1).

The age varied from 43 years to 81 years, with a mean age of 62.77 years. Of the total population, 44 patients had a history of smoking and only 11 had a history of alcohol abuse.

Among these 84 patients, 54 were in Group A (51 males and 3 females) and the remaining 30 came under Group B (29 males and 1 female). The various parameters observed in these groups have been described below.

GROUP A

The 54 patients included in this group were all evaluated with both WLE and narrow band imaging followed by biopsy evaluation.

- Among these, 35 patients had a clearly malignant lesion on WLE, however the NBI finding showed a Grade IV IPCL pattern in three of them. The final histopathology in these three as well showed evidence of squamous cell carcinoma.

- One patient had a leukoplakic patch on the vocal cord on WLE which showed only Grade IV changes on NBI. However even this patient’s histopathology showed evidence of early squamous cell carcinoma.

- The remaining 18 of the 54 patients had only equivocal lesions on WLE and six of these had Grade V changes on NBI. The final histopathology in these patients showed squamous cell carcinoma in five and moderate dysplasia in one.

The final histopathology results in the entire subset were as shown in Table 2.

Final HPR	No. of Patients (%)
Benign	4 (7.4)
Hyperplastic squamous epithelium	3 (5.5)
Dysplasia	6 (11.1)
Squamous cell carcinoma	40 (74.1)
Sarcoma	1 (1.8)

Table 2. Final Histopathology Report with Number of Patients in Each (Group A).

The various endoscopy findings and their corresponding histopathology reports have been summarised in Table 3 Figure 1 shows a comparison of WLE and NBI findings in two of our subjects.

		NBI Grade IV		
WLE Finding	Negative HPR	Positive HPR	Total	p Value (<0.05 significant)
Leukoplakia	0	1	1	0.019
Malignant	0	3	3	

Equivocal	9	3	12	
Total	9	7	16	
		NBI Grade V		
WLE Finding	Negative HPR	Positive HPR	Total	p Value (<0.05 significant)
Malignant	3	29	32	0.574
Suspicious	1	5	6	
Total	4	34	38	
		TOTAL (NBI Grade IV+V)		
WLE Finding	Negative HPR	Positive HPR	Total	p Value (<0.05 significant)
Leukoplakia	0	1	1	<0.001
Malignant	3	32	35	
Suspicious	10	8	18	
Total	13	41	54	

Table 3. WLE vs NBI with Final Histopathology (Group A).

Figure 1. Comparison of WLE and NBI Findings. Picture (a) shows left vocal cord lesion suggestive of malignancy on WLE and picture (b) shows NBI finding in the same case with typical dilated tortuous (Grade V) changes. Picture (c) shows Suspicious lesion at the posterior commissure and picture (d) shows NBI finding in the same case with no significant findings.

The sensitivity and specificity of WLE to efficiently detect possibly malignant lesions were 80.49% and 71.43% respectively. The positive and negative predictive values for the same were 89.19% and 55.56% respectively with an accuracy of 78.18%. In comparison to this, NBI showed a sensitivity and specificity of 82.93% and 69.23%, The PPV and NPV were 89.47% and 56.25% respectively with an accuracy of 79.63%. The same results are summarized in Table 4 and the ROC curve (Figure 2) summarizes the comparison between these two modes.

Statistics	White Light Endoscopy		Narrow Band Imaging	
	Value	95% CI	Value	95% CI
Sensitivity	80.49%	65.13%-91.18%	82.93%	67.94%-92.85%
Specificity	71.43%	41.90-91.61%	69.23%	38.57%-90.91%
PPV	89.19%	78.05%-95.04%	89.47%	78.80%-95.11%
NPV	55.56%	38.19%-71.66%	56.25%	37.41%-73.44%
Positive Likelihood Ratio	2.82	1.21-6.54	2.7	1.18-6.16
Negative Likelihood Ratio	0.27	0.14-0.55	0.25	0.11-0.53
Accuracy	78.18%	64.99%-88.19%	79.63%	66.47%-89.37%

Table 4. Statistical Comparison between WLE and NBI (Group A).

Figure 2. Receiver Operating Curve (ROC) of the Two Modalities Analyzed for Group A. (Pink reference line, Green NBI, Blue WLE).

GROUP B

Thirty of our patients had a previous history of irradiation for a laryngeal/hypopharyngeal

malignancy and all these patients were men.

- Nineteen patients had malignant appearing lesions on WLE among these 30. Of them two had Grade IV changes in NBI and one patient of the two had evidence of squamous cell carcinoma in histopathology and one had no evidence of malignancy.

- Eleven patients had equivocal lesions in WLE and on NBI evaluation six of these showed a Grade V pattern. Of these, four patients showed squamous cell carcinoma on histopathology, one had evidence of sarcoma and one showed mild to moderate dysplasia.

The final histopathology results in Group B patients were as shown in Table 5.

Final HPR	No. of patients (%)
Benign	3 (10)
Hyperplastic squamous epithelium	0 (0)
Dysplasia	2 (6.6)
Squamous cell carcinoma	24 (80)
Sarcoma	1 (3.3)

Table 5. Final Histopathology Report with Number of Patients in Each (Group B).

Table 6 describes the different endoscopy findings with their corresponding histopathology reports.

	NBI Grade IV			
WLE Finding	Negative HPR	Positive HPR	Total	p Value (<0.05 significant)
Malignant	1	1	2	1
Equivocal	3	2	5	
Total	4	3	7	
	NBI Grade V			
WLE Finding	Negative HPR	Positive HPR	Total	p Value (<0.05 significant)
Malignant	0	17	17	0.261
Suspicious	1	5	6	
Total	1	22	23	
	TOTAL (NBI Grade IV+V)			
WLE Finding	Negative HPR	Positive HPR	Total	p Value (<0.05 significant)
Malignant	1	18	19	0.047
Suspicious	4	7	11	
Total	5	25	30	

Table 6. WLE vs NBI with Final Histopathology (Group B).

Figure 3 shows the WLE and NBI findings in two subjects from group B.

Figure 3. Comparison of WLE and NBI Findings. Picture (a) shows suspicious lesion on right false cord on WLE and picture (b) shows no significant changes on NBI in the same patient. Picture (c) shows lesion suspicious of recurrence over the left vocal cord with picture (d) showing speckled appearance on NBI in the same case. However histopathology showed only dysplasia.

The sensitivity and specificity of WLE in detecting malignant lesions were 69.23% and 75%

respectively. The positive and negative predictive values for the same were 94.74% and 27.27% respectively with an accuracy of 70%. On the other hand, NBI showed a sensitivity and specificity of 88% and 80% respectively. The PPV and NPV were 95.65% and 57.14% respectively with an accuracy of 86.67%. These results are summarized in Table 7 and the ROC curve (Figure 4) summarizes the comparison between the two modes.

Statistics	White Light Endoscopy		Narrow Band Imaging	
	Value	95% CI	Value	95% CI
Sensitivity	69.23%	48.21%-85.67%	88.00%	68.78%-97.45%
Specificity	75.00%	19.41%-99.37%	80.00%	28.36%-99.49%
PPV	94.74%	76.38%-99.01%	95.65%	79.12%-99.22%
NPV	27.27%	14.32%-45.69%	57.14%	29.72%-80.79%
Positive Likelihood Ratio	2.77	0.50-15.41	4.4	0.76-25.55
Negative Likelihood Ratio	0.41	0.18-0.92	0.15	0.05-0.47
Accuracy	70.00%	50.60%-85.27%	86.67%	69.28%-96.24%

Table 7. Statistical Comparison between WLE and NBI (Group B).

Figure 4. Receiver Operating Curve (ROC) of the Two Modalities Analyzed for Group B. (Red reference line, Green NBI, Blue WLE).

Discussion

It is well known that early diagnosis and timely and appropriate treatment for laryngeal malignancies are vital in providing a favourable prognosis. Hence it is all the more important for the treating otolaryngologist to have a clear understanding of the clinical features of laryngeal premalignant and early malignant lesions [5]. Delayed diagnosis may lead to treatment choices that often cause mutilation or invalidism of patients and to unfavorable prognosis. Proper management of patients with cancers of the upper aerodigestive tract should always begin with accurate evaluation and subsequent biopsy [6].

Li et al., [7] evaluated the values of CT and MRI for the diagnosis of thyroid cartilage invasion by laryngeal and hypopharyngeal cancer. One hundred and ninety-seven patients with primary laryngeal cancer treated with surgery between January 2013 and December 2014 were included in their study. The sensitivity, specificity, positive predictive value and negative predictive value of CT for the detection of thyroid cartilage invasion were 57%, 86%, 65% and 81% respectively. However, these imaging modalities have an essential role in assessment of laryngeal cancer and its loco-regional spread, but do not allow us to identify superficial mucosal pathological patterns.

Allegra et al [8] in their study on early laryngeal cancers found MRI shows a sensitivity of 100% and a specificity of 97% in assessing areas such as paraglottic space, anterior commissure, thyroid, and arytenoid cartilages. However, the sensitivity of CT reaches lower values, 40%, but it has high specificity (100%). When comparing this with our findings, it can be noted that sensitivity and specificity of NBI in both the groups is less than 90%. However like already mentioned, imaging has a major role in detecting cartilage involvement and defining the extent of disease involvement. On the other hand, NBI is useful in early detection of malignancy in suspicious lesions.

White light fiberoptic nasolaryngoscopy or direct white light optical laryngoscopy still represent the standard pre-operative methods for diagnosis of precancerous lesions or early cancer of the larynx [9]. However, these techniques may not always be able to distinguish premalignant lesions from

malignant ones. Hence, newer diagnostic techniques were introduced to overcome these limitations. One among them is autofluorescence, which allows to analyse the reduction of the green fluorescence emission by the neoplastic cells, because of the lower concentration of the oxidized flavin mononucleotide (FMN), which is detected in the normal cells, when exposed to the blue light. Fostiropoulos et al. showed in their study of 152 patients with laryngeal lesions that autofluorescent imaging has a sensitivity of 98% vs. 88% and an accuracy of 97% vs. 90% compared with white-light endoscopy [10]. The other modality is contact endoscopy that consists of endoscopic examination of laryngeal mucosa after its staining by means of methylene blue 1%. This technique allows us to observe the cells, nuclei and cytoplasm and the grade of abnormality using specific contact endoscopes. Tarnawski et al. [11] performed CE on 54 patients with various laryngeal pathologies intraoperatively during microlaryngoscopy. Their results were based on computer-assisted analysis of all CE images for certain nuclear morphometric parameters. They reported, on computer-assisted analysis of CE images, 100% sensitivity and specificity for diagnosis of Squamous cell carcinoma and severe dysplasia but overall sensitivity and specificity for all lesions put together was only 91% and 81% respectively. Both these modalities have shown to have high sensitivity and specificity in early detection of laryngeal pre malignant and malignant lesions when compared to NBI. However, they are associated with the use of additional equipments leading to higher cost and need more technical expertise. This makes the use of NBI, that has no added tools and has a shorter learning curve, a more appropriate alternative.

The use of NBI represents a major evolution in the evaluation of patients suspected of preneoplastic or neoplastic lesions [12]. Muto et al. were the first to use a prototype NBI system for screening the oropharynx and hypopharynx for SCC and concluded that the NBI technique could significantly improve the efficacy of screening for, and surveillance of, lesions of the head and neck region, especially those at oropharyngeal and hypopharyngeal sites, during routine endoscopic examination [13] Watanabe et al. further investigated the efficacy of the NBI system in endoscopic screening of the oropharynx and hypopharynx in patients with oesophageal cancer and they too concluded that use of NBI system might improve the sensitivity by about two-fold over the conventional method [14].

Our study too showed improved diagnostic accuracy on adding NBI evaluation during routine WLE in both the groups (groups A and B). In group A, which included the treatment naive subjects, the sensitivity of NBI was 82.93% vs the 80.49% in WLE. However, the specificity for WLE was seen to be higher, 69.23% vs 71.43%. The PPV for WLE vs NBI was 89.19% and 89.47% respectively. The NPV for the two were 55.56% for WLE and 56.25 % for NBI. The results obtained in our group are in concordance with those reported in literature with a similar cohort of patients. Vilaseca et al. [15] showed that accuracy improved from 74.1% with WLE to 88.9% with NBI and demonstrated additionally, a better PPV (NBI: 89% vs. WLE: 74%). Additionally, Popek et al. [16] showed a PPV of 97.7% for NBI vs. 79.6% for WLE. Thus, from our findings in this group, it can be said that there surely is an added advantage of using NBI in aiding the identification of laryngeal pre malignant and malignant lesions, although the accuracy for both the modalities did not show a vast difference (accuracy 78.18% for WLE and 79.63% for NBI).

We can possibly infer from these findings that NBI in a primary treatment setting may be useful in helping the clinician identify any early changes in the larynx and also guide one in assessing the true extent of the mucosal involvement owing to its ability to demonstrate altered vascular patterns.

Also to be noted is the fact that of the 16 patients in this cohort that had an NBI Grade IV finding, more than half (56.2%) had a final negative histopathology. Considering this, whether such patients could have been kept on follow up thereby avoiding unnecessary biopsy, is a question to be looked into.

Coming to the Group B patients, i.e. those with history of prior irradiation to the larynx, our findings were more interesting. The sensitivity and specificity for WLE in these patients was

69.23% and 75% respectively, whereas the same in NBI was 88% and 80% respectively.

The PPV for WLE was 94.74% and that for NBI was 95.65%. The NPV for WLE and NBI were 27.27% and 57.14% respectively. This significant difference between the two modalities emphasises the importance of NBI as a vital tool in early identification of laryngeal lesions in a recurrent setting (accuracy of WLE 70% vs 86.67% for NBI). Here too, similar to the previous group, majority of the 7 patients with Grade IV NBI finding (57.2%) had a negative final histopathology. Hence whether this, along with a higher specificity in post radiation subjects (80%), can help us rule out the need for a biopsy evaluation. Piazza et al. in their studies comparing WLE and NBI with or without HDTV showed that NBI ± HDTV after chemoradiotherapy/radiotherapy or in post operative setting was of value in detecting tumor persistence, early recurrences, and metachronous tumors [17, 18]. Zabrodsky et al. in their study on role of NBI in detecting laryngeal lesions post chemoradiotherapy/radiotherapy found the accuracy, sensitivity, specificity, and positive and negative predictive value of the method to be very high (88%, 92%, 76%, 96%, and 91%, respectively) [19]. Among the limitations stated in Piazza et al.'s [18] studies was that they considered lesions without performing biopsy as "true negatives" despite the short duration of follow-up; in the second study [17] each patient, at least twice endoscopically evaluated, was considered true negative; however, this assumption could be insufficient to obtain reliable values of specificity and NPV. Zabrodsky et al. [19] considered persistently negative endoscopy, with an average follow-up duration of 10 months (range 5–24 months) as true negative. Based on these, we can definitely say that NBI not only has a role to play in early detection of recurrences and in guiding biopsy, but can also assist the surgeon in deciding when not to over evaluate a patient, thereby avoiding unnecessary mental stress to the patient, avoiding possible organ injury due to repeated biopsies (like strictures or chondronecrosis), as well as preventing the exhaustion of important resources, especially in a high volume center.

The strength of our study is division of our cohort in two groups considering previous radiotherapy treatment. Several studies reported similar results, for nasopharynx, hypopharynx or larynx [20-22]. With our results we can justify the use of NBI as a useful tool for daily clinical practice, in which we analyze mucosal lesions on different sites of the head and neck. Also, in the evaluation of any new method, it should be compared with the gold standard, which is the histopathological examination in this case. We included those cases who were already scheduled for an endoscopy and biopsy evaluation. Hence our study provides for a histological diagnosis of all cases included.

The limitations of our study need to be looked into as well. As mentioned earlier, only those cases were included in our study that were already scheduled for a biopsy. This means that typically benign appearing lesions could not be included, and therefore the value of NBI in accurately assessing such lesions could not be studied. Studies have shown that NBI allows a better differentiation between bamboo nodes and vocal fold cysts, early respiratory papilloma, venous ectasias, or small hemangiomas, thus helping in several therapeutic occasions such as intraoperative laser vaporization of early respiratory papilloma and microcoagulation of ectatic veins or small hemangiomas [23, 24]. Dippold et al. found that NBI in combination with WLE improves the detection rate of benign lesions of larynx, especially of vocal fold cysts [25, 26]. Also to confidently say that NBI evaluation alone can guide us when a lesion can be kept on follow up and when it needs to be biopsied, all grades of NBI along with their histopathology needs to be studied. And to prove its significance, a much higher sample may be required. Another factor to be addressed is the inability to assess NBI alone as it is done after WLE evaluation. Therefore, bias from initial WLE could not be ruled out. Muto et al. conducted a clinical trial in which 333 patients were randomly assigned to primary WLE followed by NBI and vice versa, thus controlling this problem. They demonstrated that when WLE was followed by NBI, the diagnostic accuracy was higher than in the alternative order and is unlikely to miss a mucosal lesion [13.] Another shortcoming is that those patients who had a biopsy showing no evidence of malignancy could not be adequately followed up due to time constraint. Zabrodsky et al. [19] considered persistently negative endoscopy, with an average follow-up duration of 10 months (range 5–24 months) as true negative. However it should be emphasised that to date there is no reliable indication regarding

adequate follow-up duration.

In conclusion, early diagnosis of laryngeal neoplasms remains a priority to the head and neck oncologist. Narrow band imaging is a technology that has proven its role in aiding the same without any added cost to the patient. It has also shown itself to be superior in identifying early recurrences in a post treatment setting. Not only in early identification of disease in these patients, but also the higher specificity can help guide us which lesions can be followed up thus conserving vital resources in high volume centres. With the findings of our study, we can surely justify the use of NBI as a routine parameter in the assessment of patients with suspected laryngeal lesions and also in their follow up evaluations.

Acknowledgments

Disclosure

This material has never been published and is not currently under evaluation in any other peer-reviewed publication.

Ethical approval

The permission was taken from the Institutional Ethics Committee prior to starting the project. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Conflicts of interest

There are no conflicts of interest.

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