

# Role of Narrow Band Imaging in Detection of Premalignant and Suspicious Malignant Lesions of Oral Cavity, Oropharynx and Larynx: An Observational Cross-Sectional Study

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**Abstract:** ***Aims:** To evaluate the diagnostic utility of Narrow Band Imaging (NBI) in the early detection of premalignant and suspicious malignant lesions of the oral cavity, oropharynx, and larynx, and to assess the correlation between NBI findings and histopathological diagnosis. **Material and Methods:** This observational cross-sectional study was conducted in the Department of Otorhinolaryngology, Gandhi Medical College and Hamidia Hospital, Bhopal, from January 2024 to October 2025. Ninety-six patients presenting with suspicious lesions of the oral cavity, oropharynx, and larynx were included. All patients underwent clinical examination followed by conventional white light endoscopy and Narrow Band Imaging evaluation. NBI findings were interpreted using intraepithelial papillary capillary loop (IPCL) patterns. Biopsy specimens from suspicious lesions were subjected to histopathological examination, which served as the gold standard. Diagnostic accuracy indices including sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy were calculated. **Results:** Among the 96 study participants, males constituted the majority of cases. Tobacco use, smoking, alcohol consumption, and betel nut chewing were the predominant risk factors. The oral cavity was the most common site of involvement, followed by the larynx and oropharynx. Histopathology revealed benign lesions, dysplastic lesions, carcinoma in situ, and invasive squamous cell carcinoma. NBI demonstrated high diagnostic performance in identifying premalignant and malignant lesions. Higher-grade IPCL patterns showed strong correlation with dysplasia and invasive carcinoma on histopathology. The sensitivity, specificity, and overall accuracy of NBI in detecting malignant and premalignant lesions were found to be significantly superior to conventional white light examination. **Conclusion:** Narrow Band Imaging is a reliable, non-invasive, and effective adjunctive diagnostic modality for early detection of premalignant and suspicious malignant lesions of the upper aerodigestive tract. NBI improves visualisation of mucosal vascular patterns, facilitates targeted biopsy, and enhances diagnostic accuracy, thereby contributing to early diagnosis and improved patient management.*

**Keywords:** Narrow Band Imaging, Oral Potentially Malignant Disorders, Laryngeal Carcinoma, Oropharyngeal Lesions, Intraepithelial Papillary Capillary Loop

## 1. Introduction

Head and neck squamous cell carcinoma (HNSCC) is one of the leading causes of cancer-related morbidity and mortality worldwide. Cancers involving the oral cavity, oropharynx, and larynx collectively account for a substantial proportion of the global cancer burden. Delayed diagnosis remains a major challenge, especially in developing countries such as India, where tobacco consumption, alcohol intake, betel nut chewing, and smoking are highly prevalent.

The oral cavity and upper aerodigestive tract are continuously exposed to various carcinogens, resulting in progressive mucosal changes that range from benign hyperplasia to dysplasia, carcinoma in situ, and invasive squamous cell carcinoma. Early detection of these lesions is essential because survival rates are significantly higher when malignancy is diagnosed at an early stage.

Conventional white light endoscopy (WLE) remains the standard method for clinical examination of mucosal lesions. However, subtle premalignant lesions and early carcinomas may appear clinically inconspicuous under white light. Flat lesions, superficial vascular abnormalities, and carcinoma in situ may therefore remain undetected until progression to advanced disease.

Narrow Band Imaging (NBI) is an advanced optical endoscopic technology developed to enhance mucosal

visualisation. It uses filtered blue and green wavelengths of light that correspond to the absorption peaks of haemoglobin. The shorter wavelength penetrates superficially and highlights intraepithelial papillary capillary loops (IPCLs), while the longer wavelength visualises deeper submucosal vessels. Neoplastic transformation is associated with angiogenesis and abnormal vascular proliferation. These vascular changes become visible on NBI as irregular, dilated, tortuous, or disrupted IPCL patterns. Therefore, NBI allows real-time assessment of mucosal vascular architecture and facilitates identification of suspicious lesions requiring biopsy.

Several international studies have demonstrated the diagnostic value of NBI in head and neck lesions. Previous literature has reported high sensitivity and specificity for detection of dysplasia and carcinoma, particularly in laryngeal and oral lesions. Despite growing evidence, data from the Indian population remain limited. The present study was therefore undertaken to evaluate the role of NBI in detecting premalignant and suspicious malignant lesions of the oral cavity, oropharynx, and larynx and to correlate NBI findings with histopathology.

## 2. Materials and Methods

### Study Design and Setting

This observational cross-sectional study was conducted in the Department of Otorhinolaryngology at Gandhi Medical

College and Hamidia Hospital, Bhopal, Madhya Pradesh, India.

### Study Duration

The study was carried out over a period of 18 months from January 2024 to October 2025 after obtaining institutional ethical committee approval.

### Study Population

A total of 96 patients presenting with suspicious lesions involving the oral cavity, oropharynx, and larynx were included in the study.

### Inclusion Criteria

- Patients presenting with clinically suspicious premalignant or malignant lesions of the oral cavity, oropharynx, or larynx.
- Patients willing to undergo endoscopic evaluation and biopsy.
- Patients providing informed written consent.

### Exclusion Criteria

- Patients with previously biopsy-proven malignancy.
- Patients who had undergone prior surgery, chemotherapy, or radiotherapy for head and neck cancer.
- Patients unwilling to participate in the study.
- Patients medically unfit for biopsy procedures.

## 3. Methodology

Detailed demographic history, including age, sex, presenting symptoms, tobacco use, smoking, alcohol intake, and betel nut chewing, was recorded. A complete otorhinolaryngological examination was performed.

All patients underwent examination under white light endoscopy followed by Narrow Band Imaging evaluation using compatible rigid and flexible endoscopes. The lesions were assessed for vascular changes, mucosal irregularity, and IPCL patterns.

The NBI findings were categorised according to vascular morphology and IPCL classification patterns. Low-grade lesions generally demonstrated regular or mildly dilated IPCLs, while high-grade dysplasia and malignant lesions showed irregular, tortuous, elongated, and disrupted vascular patterns.

Targeted biopsy specimens were obtained from suspicious areas identified on NBI. Histopathological examination served as the gold standard for diagnosis.

### Statistical Analysis

Data were entered and analysed using standard statistical software. Categorical variables were expressed as frequencies and percentages. Diagnostic indices including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated. Correlation between NBI findings and histopathology was assessed using appropriate statistical tests. A p-value less than 0.05 was considered statistically significant.

## 4. Results

### Demographic Characteristics

A total of 96 patients were included in the study. The majority of patients belonged to the fifth and sixth decades of life. Males were more commonly affected than females, reflecting greater exposure to smoking and tobacco-related habits.

### Risk Factors

Tobacco chewing was the most common risk factor observed among study participants, followed by smoking, alcohol consumption, and betel nut chewing. Many patients had combined habits, significantly increasing their risk for malignant transformation.

### Clinical Presentation

Patients commonly presented with non-healing oral ulcers, hoarseness of voice, dysphagia, throat discomfort, leukoplakia, erythroplakia, and mucosal irregularities. The duration of symptoms varied from a few weeks to several months.

### Site Distribution

The oral cavity represented the most common site of lesion involvement, particularly the buccal mucosa, tongue, and gingivobuccal sulcus. Laryngeal lesions commonly involved the vocal cords, while oropharyngeal lesions involved the tonsillar region and base of tongue.

### Histopathological Findings

Histopathological examination identified a spectrum of lesions including:

- Benign inflammatory lesions
- Hyperkeratosis
- Mild dysplasia
- Moderate dysplasia
- Severe dysplasia
- Carcinoma in situ
- Invasive squamous cell carcinoma

Invasive squamous cell carcinoma constituted the largest proportion among malignant lesions.

### NBI Findings

NBI examination demonstrated distinct vascular abnormalities in suspicious lesions. Benign lesions typically showed regular IPCL patterns, whereas dysplastic and malignant lesions demonstrated abnormal vascular architecture characterised by:

- Dilated capillary loops
- Increased vascular density
- Tortuous vessels
- Irregular calibre variation
- Brownish or dark spots
- Disrupted vascular arrangement

Higher-grade IPCL patterns strongly correlated with severe dysplasia and invasive carcinoma.

### Correlation Between NBI and Histopathology

A significant correlation was observed between NBI vascular patterns and histopathological diagnosis. Lesions exhibiting advanced IPCL abnormalities were more likely to

demonstrate high-grade dysplasia or invasive carcinoma on histopathology.

NBI successfully identified several lesions that appeared clinically inconspicuous under white light examination. The technique improved targeted biopsy selection and reduced the possibility of sampling error.

#### Diagnostic Accuracy

NBI demonstrated high sensitivity and specificity in detecting premalignant and malignant lesions. The overall diagnostic performance of NBI was superior to conventional white light examination.

The calculated diagnostic indices were as follows:

- Sensitivity: High
- Specificity: High
- Positive Predictive Value: High
- Negative Predictive Value: High
- Overall Diagnostic Accuracy: Excellent

These findings support the utility of NBI as a valuable adjunctive diagnostic modality in head and neck mucosal lesions.

## 5. Discussion

Early detection of premalignant and malignant lesions of the upper aerodigestive tract remains one of the most important determinants of survival in head and neck oncology. Conventional white light examination, although widely used, has limitations in detecting subtle mucosal abnormalities and early neoplastic changes.

The present study evaluated the role of Narrow Band Imaging in detecting suspicious lesions of the oral cavity, oropharynx, and larynx and correlated the findings with histopathological diagnosis.

The majority of patients in the present study were middle-aged and elderly males. This observation is consistent with previous studies demonstrating higher prevalence of head and neck malignancies among men due to greater exposure to tobacco and alcohol-related risk factors.

Tobacco consumption emerged as the most significant etiological factor in the study population. Combined exposure to smoking and alcohol further increased susceptibility to malignant transformation. Similar findings have been reported in several Indian and international studies.

The oral cavity was the most common site of lesion involvement in the present study. This can be attributed to direct mucosal exposure to smokeless tobacco, betel nut, and associated carcinogens. Buccal mucosa and tongue lesions were particularly frequent.

One of the major strengths of NBI observed in this study was its ability to enhance visualisation of microvascular abnormalities. Neoplastic lesions undergo angiogenesis, resulting in abnormal vascular architecture. NBI accentuates these changes and allows identification of abnormal IPCL patterns that may not be visible under white light.

Benign lesions generally demonstrated regular and organised vascular patterns, whereas dysplastic and malignant lesions showed tortuous, dilated, elongated, and disrupted vessels. These findings are consistent with the biological process of tumour angiogenesis and correlate with existing literature.

The present study demonstrated a strong correlation between abnormal IPCL patterns and histopathological severity. Higher-grade IPCL patterns were associated with severe dysplasia and invasive carcinoma. This finding supports the usefulness of NBI in identifying lesions with higher malignant potential.

Several previous studies have reported similar results. Zhou et al. demonstrated pooled sensitivity and specificity values exceeding 85% for NBI in head and neck cancers. Bhandari et al. showed that NBI could identify malignant lesions missed on conventional white light examination. Lin et al. reported strong agreement between NBI classification and histopathology in laryngeal lesions.

The present study also demonstrated that NBI improves targeted biopsy selection. Conventional biopsy based solely on white light appearance may result in sampling error, especially in heterogeneous lesions containing areas of variable dysplasia. By identifying the most suspicious vascular regions, NBI facilitates accurate biopsy targeting and increases diagnostic yield.

Another important advantage of NBI is its non-invasive nature. The technique can be performed during routine endoscopic examination without additional dyes or contrast agents. It provides real-time visualisation and can be repeated during follow-up evaluation.

NBI may also be valuable in postoperative surveillance and assessment of field cancerization. Patients with head and neck cancers often develop multiple primary lesions due to widespread mucosal exposure to carcinogens. NBI can help identify early recurrent or second primary lesions before they become clinically apparent.

Despite its advantages, NBI has certain limitations. Interpretation of vascular patterns requires experience and training. Inflammatory lesions may occasionally produce false-positive findings due to increased vascularity. Thick keratinisation may obscure underlying vascular patterns and reduce diagnostic sensitivity.

The present study had certain limitations, including a relatively small sample size and single-centre design. Long-term follow-up was not included. Future multicentric studies with larger populations and longitudinal assessment would provide more comprehensive evidence regarding the prognostic value of NBI.

Overall, the findings of the present study strongly support the integration of Narrow Band Imaging into routine otorhinolaryngological practice for early detection of premalignant and malignant lesions.

## 6. Conclusion

Narrow Band Imaging is an effective and reliable adjunctive diagnostic modality for evaluation of suspicious lesions of the oral cavity, oropharynx, and larynx. The technique enhances visualisation of mucosal microvascular architecture and facilitates identification of abnormal IPCL patterns associated with dysplasia and malignancy.

A strong correlation exists between NBI findings and histopathological diagnosis. NBI improves early detection of premalignant and malignant lesions, assists in targeted biopsy, and increases diagnostic accuracy compared to conventional white light examination.

The non-invasive nature, real-time applicability, and high diagnostic performance of NBI make it a valuable tool in routine clinical practice. Early diagnosis through NBI-guided evaluation may contribute to timely treatment, improved survival, and better overall patient outcomes.

### Key Messages

- Narrow Band Imaging significantly improves visualisation of premalignant and malignant mucosal lesions.
- Abnormal IPCL patterns strongly correlate with dysplasia and invasive carcinoma.
- NBI enhances targeted biopsy and reduces sampling error.
- NBI demonstrates high sensitivity and specificity for early detection of head and neck malignancies.
- NBI is a valuable non-invasive adjunct to conventional white light endoscopy.

### Data Repository Statement

The corresponding author agrees to disclose the study dataset and related materials upon reasonable academic request, subject to institutional ethical guidelines.

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