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NBI – A Novel Diagnostic Tool For Early And Accurate Diagnosis Of Oral Cancer – A Cross-Sectional Study

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Abstract:

Introduction

Narrow band imaging (NBI) is a powerful tool that allows visualization of the mucosal and submucosal vasculature. Among the available diagnostic techniques, NBI is one of the most valid for early detection of oral squamous cell carcinoma (OSCC).

Material and methods:

A cross-sectional study of 100 patients presenting in the department of dentistry, Dr SCGMC Nanded with Oral Potentially Malignant Disorders (OPMD) and malignant lesions were selected and subjected to NBI examination and sample were sent to histopathological examinations for confirmation. The intrapapillary capillary loop were indentified through NBI and the most common pattern were then correlated with histopathological findings.

Result

The use of NBI examination in the oral cavity revealed higher specificity, sensitivity, positive and negative predictive values and accuracy for the early diagnosis of oral squamous cell cancer (OSCC).

Conclusion

NBI is found to be an excellent optical diagnostic tool in diagnosis of early stage and preventing from diseased progression. NBI has proved great utility in detecting malignancy features in oral pre-malignant lesions.

Keywords

Narrow band imaging, oral squamous cell carcinoma, Oral Potentially Malignant Disorders.

I. INTRODUCTION

Oral cancers are a vast group of cancer type that manifests in different areas of the oral cavity and Oral squamous cell carcinoma (OSCC) is one of the most common types of oral cancer and its incidence typically increases with age. Tobacco and alcohol are major risk factors for the development of oral cancers, other risk factors included in the etiology human papillomavirus (HPV) , chewing betel nuts or radiation exposure.It is almost always preceded by Oral Potentially Malignant Disorders (OPMD) .

In recent years so many new non-invasive technologies have been introduced for the diagnosis of oral cancers. Among these, the Narrow–Band Imaging (NBI) has shown excellent results in the identification of superficial mucosal lesions of oral mucosa.[1]

NBI was first conceived for the detection of gastrointestinal tumors, subsequently, used in identifying early stage mucosal SCC of oral cavity, head and neck.[2, 3, 4]Muto et al[5] underlined the importance of NBI for early diagnosis of oropharyngeal and hypopharyngeal cancer, validating its use for such a purpose.

NBI technique based on the use of special optical filters with magnification facility with narrow light bandwidth enhances the visualization of the mucosa and its microvasculature.[6]

NBI uses two narrow bands of light (blue and green), the former at 400-430 nm and the latter at 525-555 nm, to penetrate superficial mucosa and to enhance the visualization of the mucosal surface and the capillary pattern of the superficial layer, in particular the intraepithelial papillary capillary loops (IPCLs) [7].Different IPCL pattern classifications have been used in the various fields of NBI application Takano et al [8] with modified Inoue's classification created for esophageal mucosal lesions. . In particular, the Takano's classification is currently the most used for the oral cavity.

Takano summarized a new IPCL classification of oral mucosa on the basis of Inoue's classification, and divided it into 4 types (I to IV). The morphology of the IPCL varies in each type.

Type I appears as a waved line with both waved arms. Type II is dilated and is similar to type I, but has a much larger caliber than those far from the lesion. Type III displays generally elongated IPCLs that are accompanied by dilation. They can appear as long lines or as tangled lines due to a severe increase in length. Type IV is in the progression of carcinogenesis, the terminal branch loops dilate, elongate, and eventually destruct. Considering the histology, type I occurs in the normal mucosa, types II and III occur in non-neoplastic lesions with predominance of the latter, and types III and IV occur in neoplastic lesions.[8]

IPCL types I and II are typically present in non-neoplastic lesions while patterns III and particularly pattern IV can be predictive of High-Grade Dysplasia (HGD), carcinoma in situ (CIS) and OSCC. [9]

NBI represent an important tool for the clinician to identify the OPMDs and malignant mucosal lesion. Moreover, the use of this device, especially in recent years, along with magnification has been extended to the intraoperative margin assessment in oral cancer surgeries. [10]

Thus, aim of this study to achieve the earliest detection of the malignant changes in OPMD lesions and has led to the invention of the newer endoscopic technique like narrow band imaging (NBI). and the purpose of the study was to analyze and describe the features of IPCL from early oral neoplastic lesion by using NBI.

Principles of NBI

Based on wave particle duality

Propagation of light is through tissue based on wavelength

Blue light diffuses a short distance due to longer wavelength

Red light diffuses widely due to shorter wavelength

color of mucosa depends on Hb. scattered light absorbed by Hb

mucosal capillary has brownish color

deeper vessels appear as cyan color.

Materials –

This cross-sectional study was for a period of one year (february2024 to February 2025) and was held in the

Department of Dentistry at Dr.SCGMC and Hospital, vishnupuri, Nanded.

Inclusion criteria –

1. Age of patient group – 20 to 60 year
2. Patients with clinically visible oral potentially malignant disorder and malignant lesions
3. Patients who are willing to give consent for this study

Exclusion criteria –

1. age group below 20 years and above 60 years
2. patients with systemic diseases
3. patients not consenting for study

In this study 100 patients consented for the study, clinical history and informed consent was taken and then they were subjected to NBI examination. Olympus-H190 with a magnification of 500X was used for NBI examination.

Biopsy was taken from the suggestive area as per IPCL classification and sample sent for histopathological confirmation. Final histopathological study and NBI analyses were then corelated.

Fig-1–Olympus H-190 NBI endoscopic set

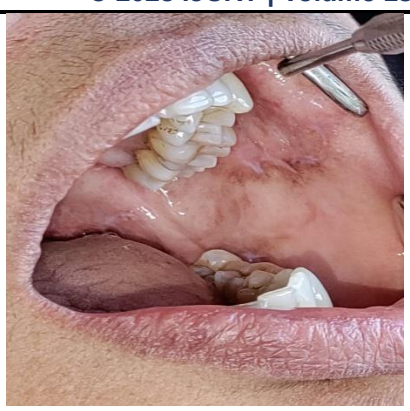


Fig 2 – clinically Type 2 IPCL

Fig 3 – clinically Type 4 IPCL

Fig 4 – clinically Type 3 IPCL

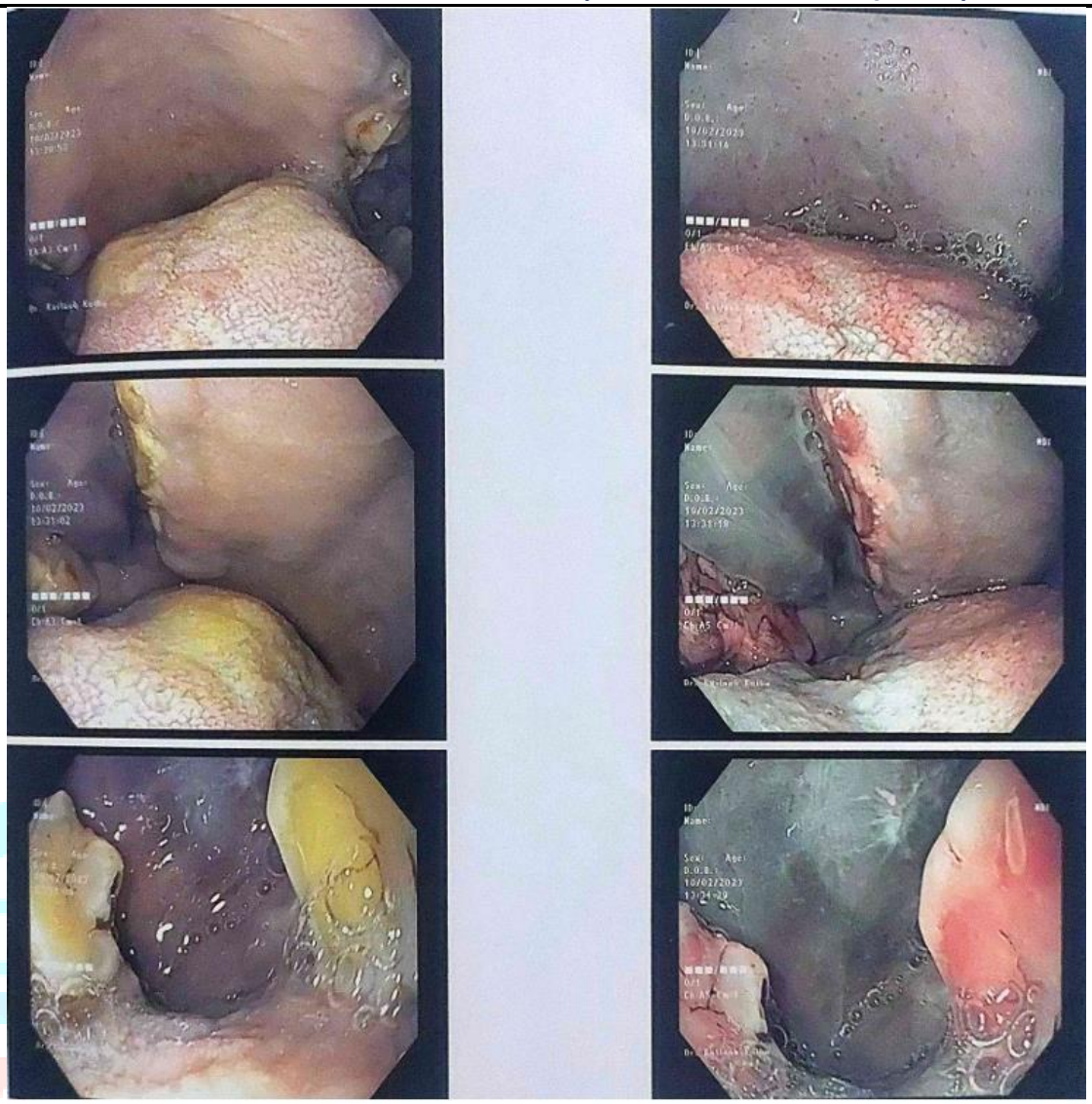


Fig 5 - showing NBI images Type 2, Type 4, Type 3 of IPCL respectively

Methods –

Statistical analysis

SPSS version 21 (IBM, New York) was used for analysis. Considering the biopsy report as the reference standard; the sensitivity, specificity, positive predictive value, and negative predictive value of NBI was calculated. For statistical analysis, patients were divided into two groups, considering Type I/ II pattern as non-malignant/pre-malignant lesions and type III/IV pattern as malignant lesions. Positive predictive value and Negative predictive value was calculated using following formulas

PPV = 100 * (Prevalence * Sensitivity) / (Prevalence * Sensitivity + ((1 - Prevalence) * (1 - Specificity)))

NPV = 100 * ((1 - Prevalence) * Specificity) / ((1-Prevalence) * Specificity + (Prevalence * (1 - Sensitivity)))

Results –

The mean age of study sample was 44.42+-15.25 years, with 78% males and 22% females. The majority of participants were diagnosed with OSMF (26%), followed by OLP (18%), Leukoplakia (14%), well-differentiated carcinoma 16%, and moderately differentiated carcinoma 14% and poorly differentiated carcinoma 12%. Majority of participants showed IPCL type II (48%). (Table 1).5 lesions had both IPCL type II and IPCL type III presentation in a single lesion and were then considered under higher classification i.e IPCL type III lesion.

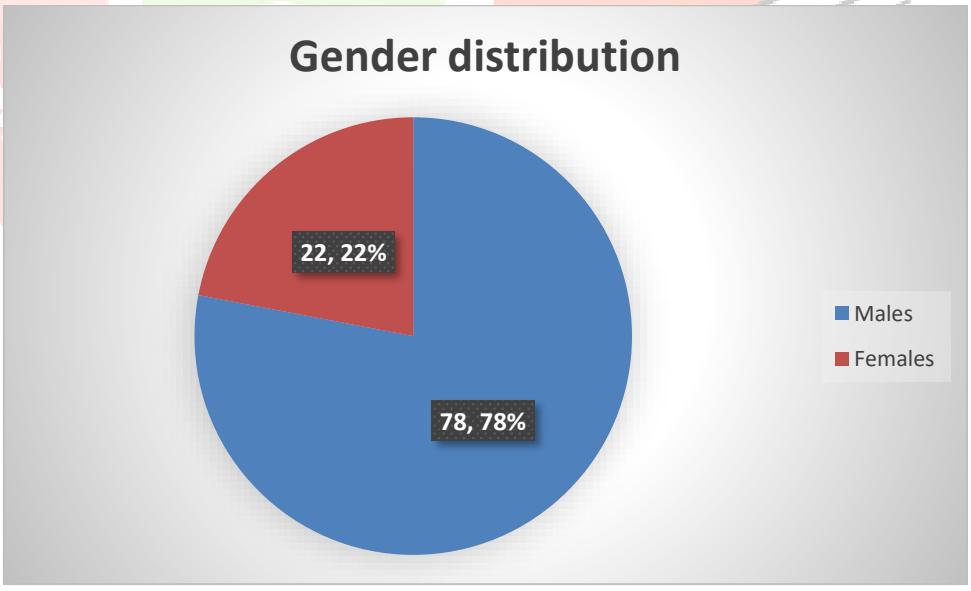
The correlation between IPCL type and histological diagnosis (Table 2) revealed that Well-differentiated carcinoma was detected as Type II IPCL in 11 cases, moderately differentiated

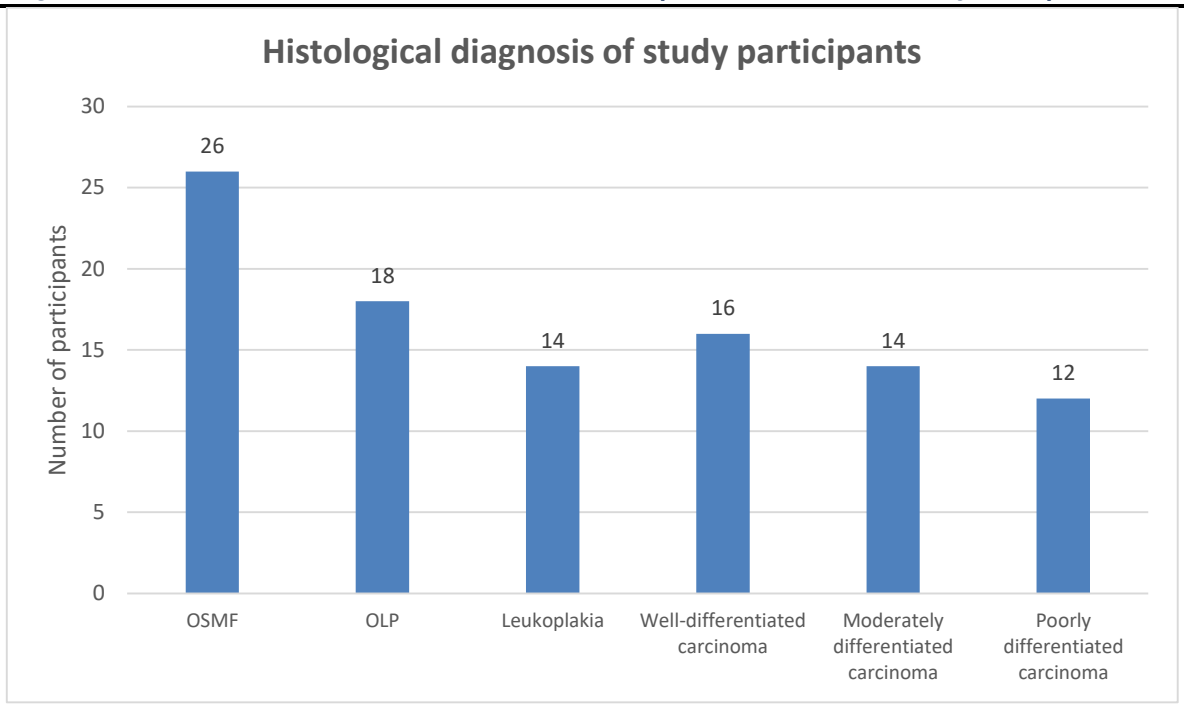
carcinoma was detected as Type II IPCL in 4 cases and poorly differentiated carcinoma was detected as Type II IPCL in 1 case.

In comparison to histological examination, the NBI resulted in 78.4% sensitivity, 83.3% specificity, 61.72% positive predictive value and 91.48% negative predictive value.

Table 1: Demographics

Number of participants (n)	100
Age Mean (SD)	44.42 (15.25)
Gender	
Males n(%)	78(78)
Females n(%)	22(22)
Histological diagnosis	
OSMF	26 (26)
OLP	18 (18)
Leukoplakia	14 (14)
Well-differentiated carcinoma	16 (16)
Moderately differentiated carcinoma	14 (14)
Poorly differentiated carcinoma	12 (12)
IPCL Types	
Type I	26 (26)
Type II	48 (48)
Type III	14 (14)
Type IV	12 (12)




Histological diagnosis of study participants
Number of participants
30
25
20
15
10
5
0
26
18
14
16
14
12
OSMF
OLP
Leukoplakia
Well-differentiated carcinoma
Moderately differentiated carcinoma
Poorly differentiated carcinoma

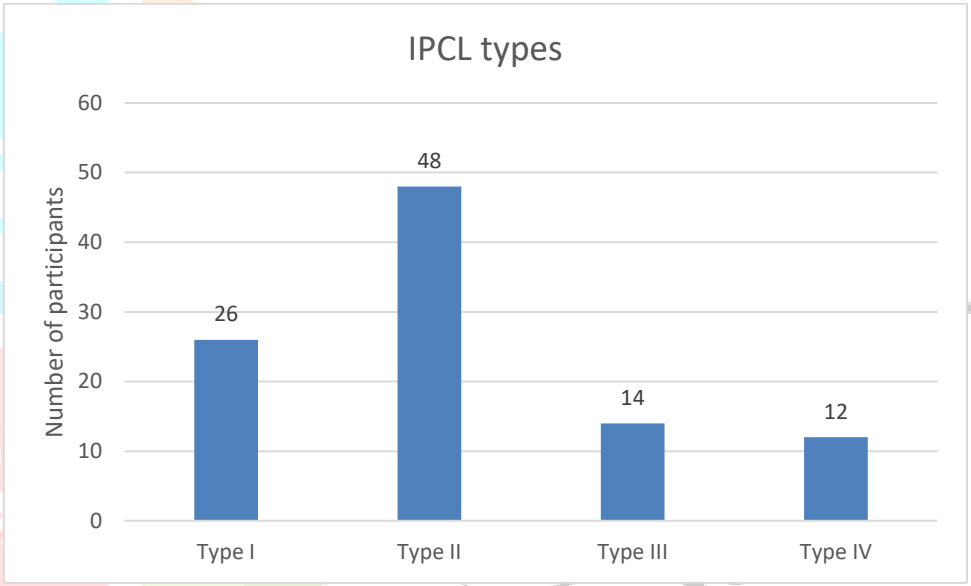

IPCL types
Number of participants
60
50
40
30
20
10
0
26
48
14
12
Type I
Type II
Type III
Type IV

Table 2: Correlation between IPCL type and histological diagnosis

Histological diagnosis	IPCL type			
	Type I	Type II	Type III	Type IV
OSMF	13	13	0	0
OLP	3	15	0	0
Leukoplakia	10	4	0	0
Well-differentiated carcinoma	0	11	5	0
Moderately differentiated carcinoma	0	4	9	1
Poorly differentiated carcinoma	0	1	0	11
Total	26	48	14	12

Table 3: Accuracy parameters of NBI as compared to histological examination

Sensitivity	78.4%
Specificity	83.3%
Positive predictive value	61.72%
Negative predictive value	91.48%

Discussion -

In this study we found that most common age group is affected is 5th decade followed by 6th decade.

One of study by Akilesh et al.[11] also found most of the squamous cell carcinoma common in 50 to 60 years which is consistent in this study too.

When correlating with Aroquinadase et al.[12] study we found the 78% of male and 22% female were seen. The male predominance is due to more prevalence of habits of tobacco chewing,betel nut chewing and smoking among them.

In this study we also found the most common site is buccal mucosa, and same result seen in the study by Kandhat et al.[13].

NBI observes surface layer lesion very well, OLP is frequently observed in this study on buccal mucosa and lower lip, OLP is the only recognized as a lesion when visualization is possible.[14] OLP is a immunological inflammatory reaction that affects larger area. Considering principles of NBI lesion may spread diffusely. That's why wide range of inflammation in OLP implies that one of the characteristics of OSCC arising in OLP lesion is their tendency to be multifocal according to field of cancerization. [15] and they may have under diagnosed, therefore NBI is more powerful tools for the diagnose the spread of OLP.

Regarding the IPCL analysis, Well-differentiated carcinoma was detected as Type II IPCL in 11 cases, moderately differentiated carcinoma was detected as Type II IPCL in 4 cases and poorly differentiated carcinoma was detected as Type II IPCL in 1 case in our study. The presence of type 3 and type 4 IPCL lesion indicates the possibility of malignancy. NBI can guide for the clinicians for selecting best biopsy site based on the area with most severe IPCL pattern for the minimising multiple biopsies.[16] as well as determine the time of biopsy taking .05 lesions had both IPCL type II and IPCL type III presentation in a single lesion and were then considered under higher classification i.e. IPCL type III lesion.

Limitations of NBI study which were reduced to a great extent in this study were firstly in case of thick keratinised mucosa, blood vessel cannot be seen using NBI this is clear limitations of the instruments but this was significantly reduced owing to high magnification (500X). Secondly result could have been affected by the Endoscopist skill which increase the rate of false positive but in this study the endoscopist had an experience of more than 10 years and lastly the study can be present sampling error considering not all the lesion were subjected to a total excision but only to simple biopsy.

Conclusion –

NBI is a powerful tool for the early detection of the oral cancerous lesion moreover high grade IPCL is the useful marker for the detection of OSCC. However, interpretation of the images is more important for the understanding the principles of instrumentation. In the field of dentistry NBI is at rudimentary level and this study sincerely done to open the gates to initiate its utility in dentistry.

For the future NBI can be more routinely can be used for detecting malignant changes in the OPMD lesions even before any change is clinically seen. It decreases the mortality and morbidity of our patients by preventing the progression of the disease and also preventing structural and functional deformity of our patient due to early diagnosis.

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