Review Article

Narrow band Imaging: Discerning the Unseen

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Abstract

The management of oral soft tissue lesions specially the potentially malignant and malignant lesions lead to both cosmetic and functional deficit to the patient and the confirmatory histopathology is a time-consuming process which may be a reason for a reduced follow up and compliance of the patient. This review aims to elaborate regarding narrow band imaging (NBI) and how it (NBI) serves both the above purposes in an expeditious and non-invasive manner and thereby improving the lifestyle of the patients. It can be a better non-invasive and time saving diagnostic tool in the management of potentially malignant and malignant oral lesions in its earlier period as well as a better visual guide for preoperative and intra operative assessment of oral and oropharyngeal cancer.[2025, 6(1): 25-31]

Keywords: Angiogenetic pattern, Narrow band imaging, Neovascularization, White light endoscopy.

Introduction

Narrow band imaging (NBI) is an endoscopic technique that enhances the mucosal surface texture, and mucosal and submucosal vascular morphology. It is a non-invasive, optical diagnostic technique that helps identify lesions at an earlier stage and thus stops the disease progression from causing additional functional and structural degeneration. Here, the white light is filtered to emit two 30nm narrow bands of blue (415nm) and green (540 nm) light simultaneously, the former becomes the main peak of absorption for haemoglobin, and the latter helps in visualising the vasculature of deeper mucosal and submucosal layers. Thus, this ability of narrow band imaging of picturizing angiogenetic patterns makes it an extremely promising technology for highlighting early neoplastic lesions that may not be clinically evident in the white light, as angiogenesis is an evident initial feature of carcinogenesis (1).

This review paper aims to explore the role of narrow band imaging as an early period diagnostic tool primarily for malignant transformation of Oral Potentially Malignant Disorders thus improving the prognosis of the oral diseases and the lifestyle of the patients.

History and development

Narrow Band Imaging a user friendly optical diagnostic tool which is a non-invasive, advanced endoscopic, non-staining technique that detects early epithelial changes using narrow band width of filtered visible white light.This Idea was first conceived for gastrointestinal endoscopy in May

1999. The first prototype was designed on December 1999. It was first launched in 2003 as First generation EXERA II then an improved version came on 2006 as First generation EVIS LUCERA SPECTRUM. These had a drawback of contrast of the imaging which was rectified in the year 2012 in Second generation EXERA III with High intensity discharge lamps (Fig 1) (2).
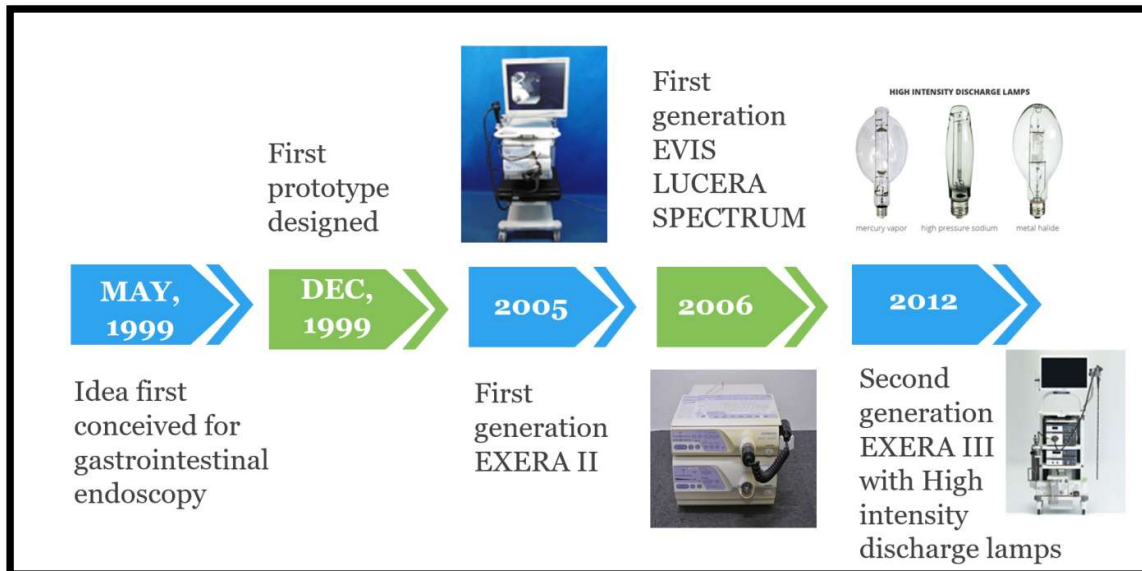

Fig 1: Evolution of the NBI device

Technology and Principle of NBI

The light technology of NBI consists of the light unit which has a high intensity xenon discharge lamp to compensate for the brightness attenuation, the narrow band filter to attenuate the wide bandwidth to narrow bandwidth (NB) (30nm) of visible light. The NB light is then passed on to the fitted RBG rotary filter which only filters the blue and green bands from the spectrum of white light.

Finally, the discharge unit focuses the filtered NB light onto the exposure area. The NB light interacts differently with the mucosal and submucosal surfaces. On the NBI image, the thin capillary network on the mucosal surface taken by blue light (415 nm) has a brownish appearance and thick blood vessels in the sub mucosal surface taken by green light (540 nm) have a cyan (blue) appearance (Fig 2). Thus, the mucosal and the angiogenetic pattern can be interpreted from the NBI image (1).
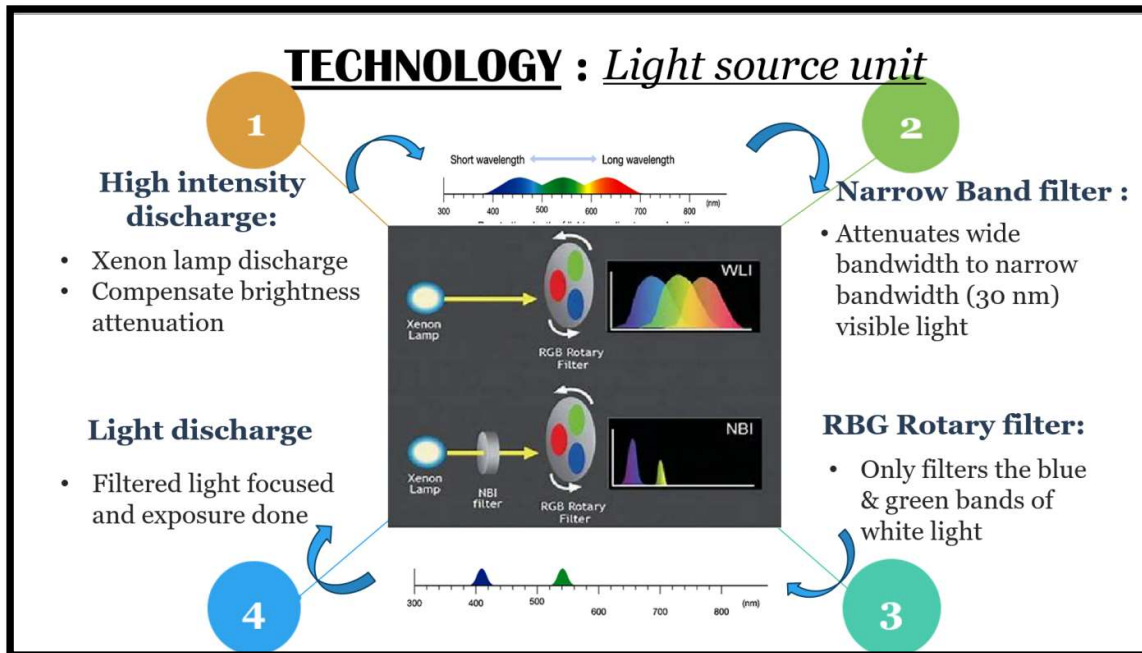
Fig 2:Technology followed by the light source unit of NBI device

Classification systems for NBI image

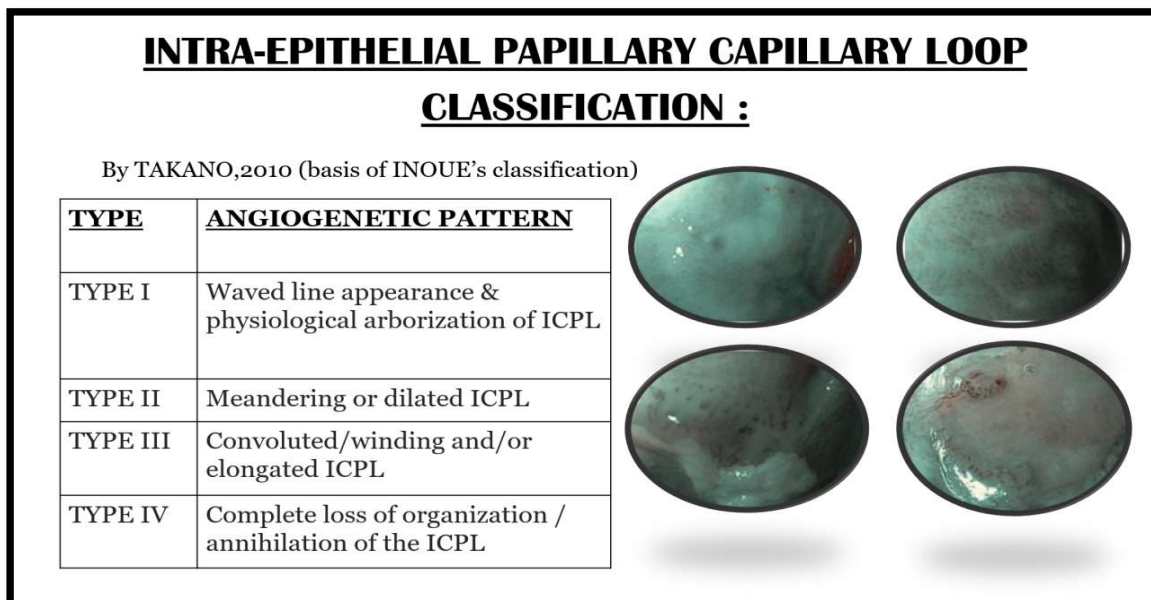Classification systems for NBI image are: (Fig 3,4,5 & 6) (3,4,5, 6)

Fig 3: Intra-Epithelial Papillary Capillary Loop classification by TAKANO (2010)

EPITHELIAL CLASSIFICATION : (by LIN et al. 2012)

	CELLS OF THE TISSUE	TYPES OF EPITHELIUM	THICKNESS
TYPE 1	STRATIFIED SQUAMOUS	KERATINIZED	THICK
TYPE 2a		NON KERATINIZED	THIN
TYPE 2b		NON KERATINIZED	VERY THICK
TYPE 3	CILIATED COLUMNAR	PSUEDO STRATIFIED	ANY TYPE

TYPE OF NBI	TYPE OF EPITHELIUM
NORMAL 1	TYPE 1
NORMAL 2a	TYPE 2a
NORMAL 2b	TYPE 2b
DYSPLASTIC 1-2a	TYPE 1 &2a
DYSPLASTIC 2b	TYPE 2b
NEOPLASTIC	

Fig 4: Epithelial classification of NBI by LIN et al. (2012)
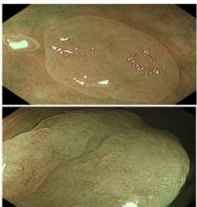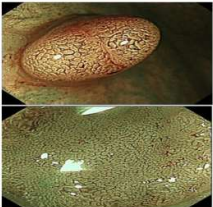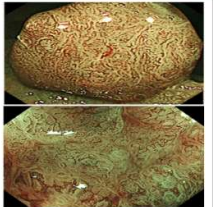
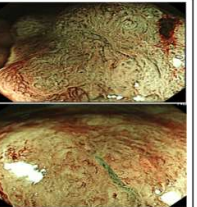## JAPAN NBI EXPERT TEAM CLASSIFICATION (JNET), 2016 :

|	TYPE 1	TYPE 2A	TYPE 2B	TYPE 3
Vessel Patterns	Invisible	Regular caliber &distribution	Variable caliber &distribution	Loose vessels , blanching interruption by thick vessels
Surface area	Regular dark or white spots (normal mucosal appearance)	Regular	Irregular or obscure	Amorphous area
Pathology	Hyperplastic polyp	Low grade intra-mucosal neoplasia	High grade intra-mucosal neoplasia	Deep submucosal invasive cancer
NBI				

Fig 5: JNET Classification (2016)
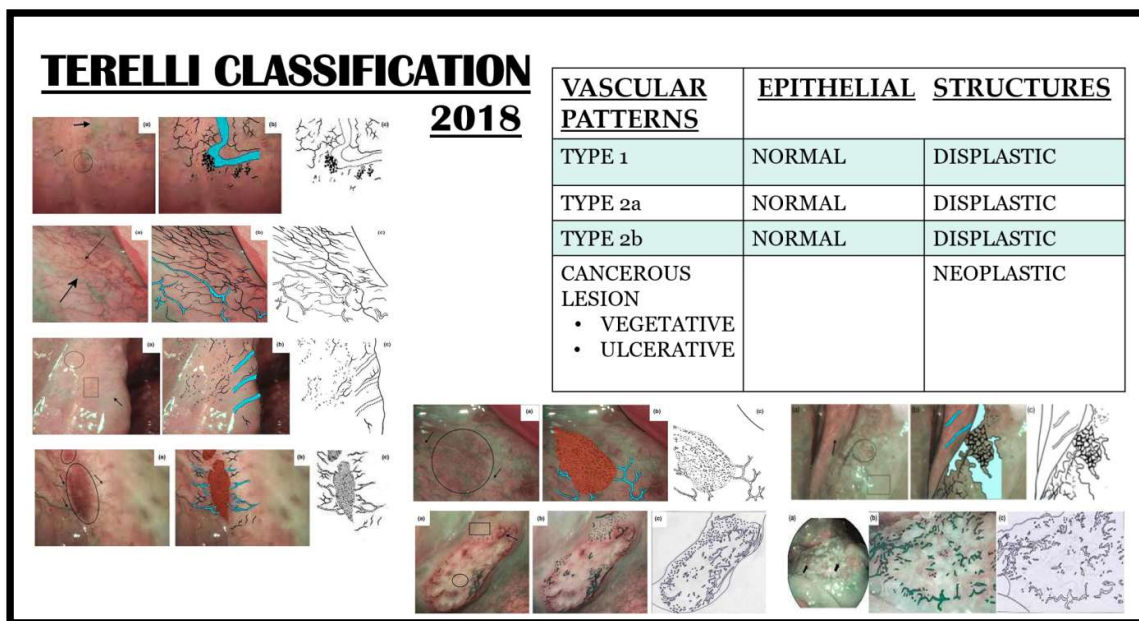
Fig 6: Terelli classification for NBI image (2018)

Applications of NBI in Oral Lesions

1. Effective and early diagnostic tool in diagnosis of oral potentially malignant land malignant lesions

A prospective cross-section study by A. Upadhyay et al (2019) of 38 patients of Indore was undertaken with suspicious lesions and subjected to endoscopic examination by both white light endoscopy (WLE) and NBI and samples were sent to histopathological examination for confirmation. Among 38 patients the study revealed 32 patients with neovascularization with the intra papillary capillary loop through NBI with type I (50%) and type II (31%) to be the most common pattern both correlated with the gold standard as low-grade histopathological finding whereas type III (19%) correlated with high grade histopathology. The sensitivity and specificity of WLE was found to be 75.75% and 76.43% respectively and of NBI to be 93.93% and 80% respectively according to the mentioned study. In finding malignant lesions, the diagnostic ability of NBI is almost equal to the histopathology and superior to WLE. Thus, NBI imaging is found to be an optical diagnostic tool in the diagnosis of the lesions at an earlier stage a preventing from further functional and structural deterioration by the disease progression. The study concludes that the NBI can be an optical confirmatory test for identifying lesions in their potentially malignant stage (1,7,8).

2. Used in pre-operative and intra-operative assessment of oral and oropharyngeal cancer

In the surgical management of head and neck squamous cell carcinoma, the identification of synchronous lesions, precancerous lesions around the main tumour, or the unknown primary in the case of neck metastasis is a problem, as these lesions may be invisible to the naked eye or with standard white light (WL) endoscopy. A study by Giancarlo Tirelli MD et al (2017) revealed that NBI helped the clinician to assess the pre-operative and intra-operative stages of management of oral and oropharyngeal cancers. According to this study, NBI was used preoperatively in 47 patients and intra operatively in 30 patients and the result of the study says pre operatively, the diagnosis gain of NBI was 8.5%, allowing identification of 3 synchronous tumors and 1 unknown primary tumor. Intra operatively, NBI improved the defination of tumor limits in 67.7% of cases, with resection enlargement showing dysplasia and carcinoma in 8 and 12 patients respectively (9).

3. Used for guided resection of oral cancer, decrease local recurrence and increase survival

The study by CS Farah(2018) concluded that resection guided by NBI defined the margins of Oral Squamous Cell Carcinoma (OSCC) more accurately and improved survival rates and decreased recurrence rate of OSCC compared to traditional methods. It can be used for determining mucosal surgical margins for oral cancer treatment (10-13).

4. To assess neoplastic transformation in a non-invasive manner in oral Erythroplakia

Yang et al. (2015) analyzed the use of NBI in detecting high grade dysplasia, carcinoma in situ and carcinoma in oral erythroplakia. According to the study, 72 patients were evaluated by NBI and the IPCL pattern was noted, and it was found that twisted, elongated and destructive patterns of IPCL of NBI image are indicators of high-grade dysplasia, carcinoma in situ and non-invasive carcinoma in oral Erythroplakia (11).

5. As a taste assessment tool

Taste examination is performed by observing fungiform papillae. Various new methods are developing for the same, NBI can also be used for assessment of taste function. According to Tetsuaki Shimada MD et al. (2013) NBI endoscopy can clearly detect not only fungiform papillae but also the vascular morphology. The numbers of papillae and the vascular morphology are related to each other and have significant inverse correlation with gustatory functions. In the affected side of the patients, the parameters were found to be lower in number than the unaffected side. Thus, the study reveals, NBI endoscopy is an easy, highly sensitive and reliable objective examination tool of taste function (12).

Advantages of NBI

Advantages of NBI are (1,7,8,9,10,11)

1. It is noninvasive and easy to interpret.

2. Detect small tumors in early stage.

3. Analyses tumor progression.

4. Effective in all kinds of mucosal patterns.

5. Patient compliance.

Disadvantages of NBI

Disadvantages of NBI are (13,14)

1. Not cost effective.

2. Limited use in stagnant saliva, sticky mucous and hyperkeratosis.

3. Post radiation edema gives false results.

4. Technique sensitive.

Conclusion

There has been a profound use of NBI in the field of gastroenterology, urology, ENT for years. But in the field of dentistry, it's just a new beginning with great potential to help diagnose the oral lesions in a very early and a non-invasive manner, thus more focus and exploration of NBI in dentistry is the need of the hour.

The present studies indeed reveal that NBI is a very promising diagnostic technology for multiple oral lesions in a very early stage specially in a country like India, being the oral cancer capital with a huge population of various oral deleterious habits but due to its high technique sensitivity and lack of cost effectiveness, the country wide use is limited.Perhaps, this can be overcome easily by the indigenous manufacturing and production of the NBI devices making it cost effective and feasible for the general Indian population.

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