NARROW BAND IMAGING- A PARADIGM SHIFT IN EARLY DETECTION OF ORAL CANCER

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ABSTRACT:

Oral cancer ranks the sixth most common cancer globally with incidence of 127,000 deaths per year. This highlights the importance of continued surveillance of such population as to diagnose at the earliest stage of development.

A novel optical imaging technique- Narrow Band Imaging (NBI)was introduced as a non invasive imaging modality that answers these clinical challenges. It is a type of endoscopy that helps the clinician to visualize the superficial vasculature and changes in the soft tissue using blue spectrum of the visible light, the wavelength (415nm) of which corresponds to the peak absorption spectrum of hemoglobin. Changes in the microvasculature, thus, made visible will help to identify dysplastic changes in the earliest stage of disease progression. This article provides an insight to NBI that facilitates early detection of malignant and potentially malignant disorders.

Key Wors: Oral Cancer, Narrow Band Imaging, Hemoglobin, Malignant disorders.

INTRODUCTION:

Oral Cancer ranks the sixth most common cancer globally with incidence of 127,000 deaths per year. The most common head and neck malignancy is squamous cell carcinoma. It is well recognized that these tumours may arise in multiple sites, either synchronously or metachronously.

Although the locoregional control of head and neck squamous cell carcinoma (HNSCC) has improved inthe past decades, only minimal improvement in survival has been achieved because of the development of distant metastasis and second primary malignancies. In early-stage cancer, second primary malignancy is still the main cause of treatment failure.[1,2] Therefore, prevention and early diagnosis of second primary malignancy has become essential to improving survival after treatment.

Efforts to achieve the earliest detection of potentially malignant disorders have led to the development of new endoscopic examination methods. Lesions few millimetres in diameter are in most cases impossible to detect using conventional white light endoscopy. This, eventually, led to the introduction of special endoscopic methods that allowed detection of these lesions of fewmillimetre dimensions.

Narrow Band Imaging (NBI) is a novel optical technique that enhances the diagnostic sensitivity of endoscopes for characterizing tissues by using narrow bandwidth filters in a sequential red-green-blue illumination system.This technique has been proven effective in detecting early malignancies in the gastrointestinal (GI) tract.[3-5] It is also useful for identifying early lesions in the oropharynx and hypopharynx.[6-8] However, very little research has been focused on the oral cavity.[9]

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NARROW BAND IMAGING

Narrow band imaging (NBI) is a simple endoscopicmethod that uses 2 narrow bands of light, the first at 400to 430 nm and the second at 525 to 555 nm to only minimallypenetrate the superficial mucosa and enhance theearlyabnormal angiogenesis seen in premalignant andmalignant lesions.[10] NBI has been reported to improvethe sensitivity, diagnostic accuracy, and negative predictivevalue for the detection of early head and neck squamouscell carcinomas (SCCs) compared with white light inspection.[11–14] It has also been shown to be effective indetecting second primary cancers in patients with previous oral SCCs.[15]

PRINCIPLE

The NBI system was developed as a part of the joint research between Japanese National Cancer Center Hospital East and Olympus Corporation (Tokyo, Japan) by support of Grant for Scientific Research Expenses for Health and Welfare Program since 1999. Sano et al were the first to report the clinical utility of NBI in the gastrointestinal tract.[18]The conventional red/ green/ blue (RGB) medical video endoscope system (EVIS 240; Olympus Co Ltd) has a xenon lamp and rotation disk with 3 broadband optical filters covering all spectra of the visible wavelength that ranges approximately from 400 to 800 nm (Figure 1). The NBI is a novel system using narrow band illumination created with 3 optical interference filters (Figure 1*B*). The bandwidths are spectrally narrowed. The NBI filter sets (415 _ 30 nm, 445 _30 nm, 500 _ 30 nm) were selected to obtain fine images of the microvascular structure (Figure 1*B*). Because the 415-nm is the hemoglobin absorption band, the thin blood vessels such as capillaries on the mucosal surface can be seen most clearly on this wavelength.[16,17]

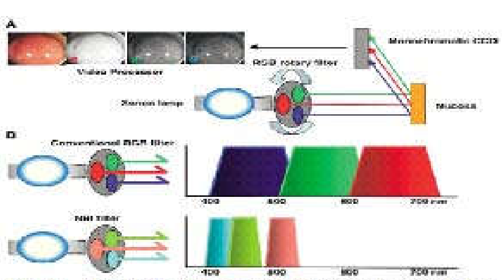

Figure 1. Conventional medical video endoscope system with the RGR sequential illumination method and the NBI system. (*A*) The conventional system has a xenon lamp and rotation disk with 3 RGB optical filters. The rotary filter and monochromatic charge-coupled device (CCD) are synchronized, and 3 band images are generated sequentially. Color images can be synthesized by using 3 band images by the video processor. (*B*) The NBI is a novel system using narrow banding filters instead of conventional RGB broadband filters. The center wavelengths of 3 NBI filters using this study were 415, 445, and 500 nm, respectively.

NBI shows differences in epithelium quality and changes of mucosal vascularization. NBI system consists of the same components as conventional videoendoscopic systems - light source, camera unit and camera head or chip equipped videoendoscope. (Figure 2) In addition, NBI system contains a special image processor and a lighting unit with special filters that narrow frequency range of emitted light to 400-430 nm (centered at 415 nm) and 525-555 nm (centered at 540 nm) bands. It relies on the principle of depth of light penetration. In contrast to red light, 415 nm wavelength light has less penetration and less scattering thus enhancing image resolution. The blue filter is designed to correspond to the peak absorption spectrum of haemoglobin to enhance the image of capillary vessels (IPCL - Intraepithelial Papillary Capillary Loops) on mucosal surface. 540 nm wavelength light penetrates deeper and highlights the submucosal vascular plexus. The reflection is captured by a charge coupled device chip (CCD), and an image processor creates a composite pseudocolour image, which is displayed on a monitor, enabling NBI to enhance mucosal contrast without the use of dyes. (Figure 3).

Fig 2 [illegible]

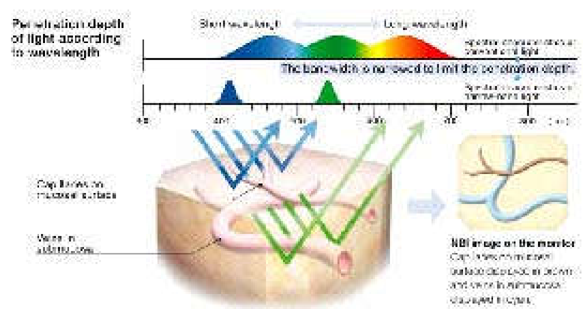

Fig. 3: Principle of NBI based on penetration depth of light

Typical suspect finding in NBI image is defined as well demarcated brownish area, exhibiting scattered brown dots within this area on close view. Brown dots are caused by expansion of IPCL, which is due to neoangiogenesis in tumour growth. The finding of brown dots, spread freely in the mucosa of without boundary line of altered epithelium, must be carefully distinguished.(Figure 4)

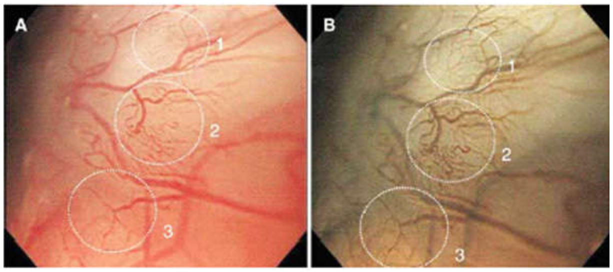

Figure 4: Vascular network of the squamous epithelium at the mucosa of the oropharynx and the hypopharynx. (A) Conventional image with magnification. (B) NBI image with magnification. Fine microvascular network can be easily identified by NBI, when compared for each dotted circle.

ANALYSIS OF THE ORGANIZATION OF THE MICROVASCULAR PATTERN

Five different IPCL patterns have been described in association with different esophageal features, from normal mucosa to modified mucosa due to inflammation, dysplasia or cancer: type I corresponds to normal mucosa (Figure 5), type II to inflammation (Figure 6), type III corresponds to borderline lesions(Figure 7), often related to low-grade intraepithelial neoplasia, type IV and V corresponds to high-grade intraepithelial neoplasia (HGIN) or carcinoma (Figure 8).[19] Dilation, tortuosity, irregularity in vessels caliber and form, destruction of IPCLs and replacement with tumor vessels are vascular features associated with esophageal carcinoma. The assessment of IPCLs and submucosal vascularity allows the detection of superficial squamous carcinoma and also the prediction of the depth of invasion. The utility of the estimation of submucosal invasion in clinical practice influences the decision of performing endoscopic therapy.

Figure 5: Type I:brownish spots and demarcation line with irregular microvascular patterns.

Figure 6: Type II: well-demarcated brownish area with thick dark spots and/or winding vessels.

Figure 7: Type III: IPCL pattern elongation and meandering.

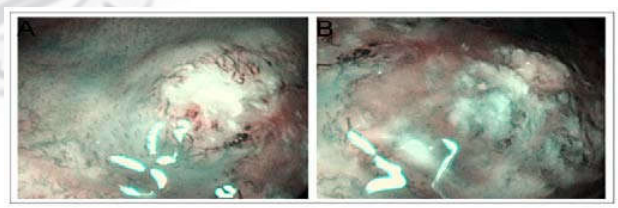

Figure 8: Type IV& V: IPCL pattern destruction and angiogenesis following a sequence ofcarcinogenesis progression.

INDICATIONS

- NBI can be used for diagnosis of oral, oropharyngeal, hypopharyngeal, nasopharyngeal and laryngeal pathologies.
- NBI can be used for screening and for follow up after chemotherapy and radiotherapy treatment of head and neck SCC.
- Some authors also used NBI intraoperatively to perform targeted biopsies of most suspect areas and also to determine the safe limits of resection margins

CASE STUDIES CONDUCTED IN ORAL CAVITY

Yang et al[20] conducted a retrospective case-control study to investigate the diagnostic accuracy of the established patterns of intraepithelial microvasculature of NBI for detecting high grade dysplasia, carcinoma in situ and oral leukoplakia based on IPCL pattern destruction.The study observed NBI findingsof twisted elongation of IPCL and IPCL pattern destruction as indicators of high grade dysplasia or carcinomatous lesions in oral leukoplakia.(Figure 9)

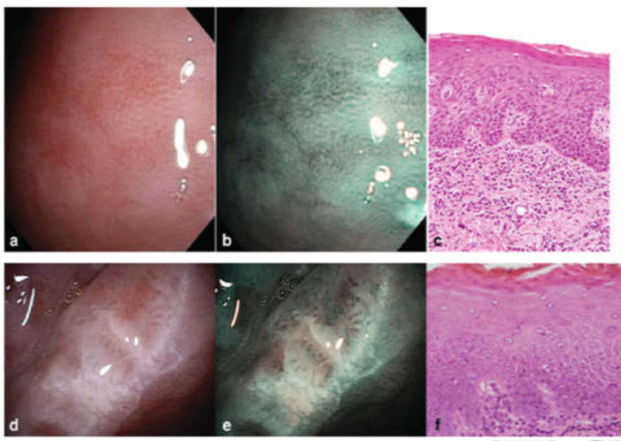

Figure 9: (a) Endoscopic examination of buccal leukoplakia with conventional broadband white light. (b) NBI image from a. The pathological report showed low-grade dysplasia(c). (d) Endoscopic examination of lower gum leukoplakia with conventional broadband white light. (e) NBI image from c. Well-demarcated brownish epithelium was demonstrated in lower gum leukoplakia. The pathological report showed intermediate-grade dysplasia(f).

Another retrospective case control study was conducted by Chang C[21] et al to analyze the clinical application of endoscope with NBI system in detecting high-grade dysplasia, carcinoma in situ and oral erythroplakia. They observed twisted, elongated, and destructive patterns of intraepithelial papillary capillary loop of NBI images are indicators for high-grade dysplasia, carcinoma in situ, and invasive carcinoma in oral erythroplakia.

Figure 10: Endoscopic examination of the left buccal oral erythroplakia of a 45-year-old male patient with conventional broadband white light. **b** NBI image. Regularly distributed intraepithelial papillary capillary loop was demonstrated on the reddish patch, or IPCL type I, was shown by NBI; the pathological report revealed squamous hyperplasia.

LIMITATIONS

- Since NBI is an optical method based on observation of the mucosal surface, conditions that prevent a direct view of the clear mucous membrane may limit or completely baffle the examination. Most often this is due to stagnant saliva or sticky mucus, especially in patients with a history of oncology treatment.
- Lesions that are characterized by a high layer of hyperkeratosis prevent visualization of mucosal vascularization eg. verrucous carcinomas
- Chronic inûammation arising from dental irritation or postoperative radiation may result in a false-positive ûnding. Coloration or staining of the oral mucosa from betel nut chewing or other food materials may also interfere with the diagnostic judgment.

CONCLUSION

Early Detection is the key as early detection can save lives. Therefore, dentists can benefit from the use of this imaging technique that offers new perspectives to early detection of potentially malignant disorders which can hold great promise for the management of target specific treatment of dental tissues.

REFERENCES:

1. Cooper JS, Pajak TF, Rubin P, et al. Second malignancies in patients who have head and neck cancer: incidence, effect on survival and implications based on the RTOG experience. Int J RadiatOncol Biol Phys 1989;17:449–456.
2. Lippman SM, Hong WK. Second malignant tumors in head and neck squamous cell carcinoma: the overshadowing threat for patients with early-stage disease. Int J Radiat Oncol Biol Phys1989;17:691–694.

3. Uedo N, Ishihara R, Iishi H, et al. A new method of diagnosing gastric intestinal metaplasia: narrow-band imaging with magnifying endoscopy. Endoscopy 2006;38:819–824.
4. Machida H, Sano Y, Hamamoto Y, et al. Narrow-band imaging in the diagnosis of colorectal mucosal lesions: a pilot study. Endoscopy 2004;36:1094–1098.
5. Hamamoto Y, Endo T, Nosho K, Arimura Y, Sato M, Imai K. Usefulness of narrow-band imaging endoscopy for diagnosis of Barrett's esophagus. J Gastroenterol 2004;39: 14–20.
6. Ugumori T, Muto M, Hayashi R, Hayashi T, Kishimoto S. Prospective study of early detection of pharyngeal superficial carcinoma with the narrowband imaging laryngoscope. Head Neck 2009;31:189–194.
7. Watanabe A, Tsujie H, Taniguchi M, Hosokawa M, Fujita M, Sasaki S. Laryngoscopic detection of pharyngeal carcinoma in situ with narrowband imaging. Laryngoscope 2006;116:650–654.
8. Muto M, Nakane M, Katada C, et al. Squamous cell carcinoma in situ at oropharyngeal and hypopharyngeal mucosal sites. Cancer 2004;101:1375–1381.
9. Katada C, Nakayama M, Tanabe S, et al. Narrow band imaging for detecting superficial oral squamous cell carcinoma: a report of two cases. Laryngoscope 2007;117:1596–1599.
10. Uedo N, Ishihara R, Iishi H, et al. A new method of diagnosing gastric intestinal metaplasia: narrow-band imaging with magnifying endoscopy. Endoscopy 2006;38:819–824.
11. Muto M, Minashi K, Yano T, et al. Early detection of superficial squamous cell carcinoma in the head and neck region and esophagus by narrow band imaging: a multicenter randomized controlled trial. J Clin Oncol 2010;28: 1566–1572.
12. Katada C, Tanabe S, Koizumi W, et al. Narrow band imaging for detecting superficial squamous cell carcinoma of the head and neck in patients with esophageal squamous cell carcinoma. Endoscopy 2010;42: 185–190.
13. Watanabe A, Taniguchi M, Tsujie H, Hosokawa M, Fujita M, Sasaki S. The value of narrow band imaging for early detection of laryngeal cancer. Eur Arch Otorhinolaryngol 2009;266:1017–1023.
14. Tan NC, Herd MK, Brennan PA, Puxeddu R. The role of narrow band imaging in early detection of head and neck cancer. Br J Oral Maxillofac Surg 2012;50:132–136.
15. Chu PY, Tsai TL, Tai SK, Chang SY. Effectiveness of narrow band imaging in patients with oral squamous cell carcinoma after treatment. Head Neck 2012;34:155–161.
16. Gono K, Yamazaki K, Doguchi N, et al. Endoscopic obseravation of tissue by narrow band illumination. Opt Rev 2003;10:1–5.
17. Gono K, Obi T, Yamaguchi M, et al. Appearance of enhanced tissue feature in narrow-band endocopic imaging. J Biomed Opt 2004;9:568–577.
18. Japan Society for Head and Neck Cancer. General rules for clinical studies on head and neck cancer. Tokyo: Kanehara Syuppan, 2001.
19. Yoshida T, Inoue H, Usui S, Satodate H, Fukami N, Kudo SE. Narrow-band imaging system with magnifying endoscopy for superficial esophageal lesions. Gastrointest Endosc. 2004;59:288–295
20. Yang, Shih Wei, et al. Diagnostic significance of narrow band imaging for detecting high grade dysplasia, carcinoma in situ, and carcinoma in oral leukoplakia. The laryngoscope 2012;122(12): 2754-2761.

Chang LC, Hwang CC, Chen TA et al. Clinical characteristics of narrow-band imaging of oral erythroplakia and its correlation with pathology. BMC Cancer 2015;15(1):1-8