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Original Article

NARROW BAND IMAGING-INSIGHT INTO THE INTERIORS

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Abstract :
Narrow Band Imaging (NBI) is a recent method of imaging which can be used as an adjunctive diagnostic device along with standard diagnostic protocol. This technology will improve clinicians' ability to detect early changes in inflammatory and dysplastic tissues. Recently there has been a rapid progression in its use in patients with head and neck cancer. NBI system is based on the principle of producing blue light which penetrates less deeply into the tissues of precancerous and cancerous lesions when compared to that of conventional white light and thus helps clinicians' to get a much better view of superficial structures.

Keywords : Narrow band imaging, squamous cell carcinoma, oral mucosa

Introduction :

Detection of changes in the oral mucosa and jaws that represent serious threats to health is an important component of dental practice.[1] Squamous cell carcinomas (SCCs) of the head and neck are usually found as advanced disease at initial diagnosis. These are associated with poor prognosis. [2] Oral cancer also is a major life threatening disease because survival rates have improved only marginally during the past 50 years. One of the difficulties associated with the clinical assessment of patients who could be at risk for oral cancer is that, until very recently, the only diagnostic method available has been visual and tactile examination of the oral mucosa. It cannot detect cellular changes that have not evolved enough to be visible to the unaided eye[1]. Thus the value of performing endoscopic screening for patients with SCC of the esophagus or head and neck has always been emphasized to detect second malignancies at an earlier stage.[2]

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Narrow Band Imaging (NBI) is a recent method of imaging which has the potential to improve the diagnostic capability of standard white light endoscopy. It was initially developed for use in the gastrointestinal tract, but is now commonly used to image other areas. Recently there has been a rapid development in its use for screening and examining patients for mucosal squamous cell carcinoma (SCC) in the head and neck.[3] It is an endoscopic technique based on the use of special optical filters that narrow the light bandwidth to enhance the visualization of the mucosa surface and microvasculature.[4,5] This technique increases tissue contrast by specifically identifying superficial capillaries and neo angiogenesis in abnormal mucosa. No special dyes are required and it allows for easy inspection of the superficial vascular bed. Thus the mucosal abnormalities detectable by NBI may result in an accurate endoscopic tool that will help to target biopsy examination to the areas with suspicious superficial vascular morphology, or enable excision biopsies to be more accurate[3]. The purpose of this article is to highlight the uses, benefits and importance of this novel optical technique.

Technology :

NBI technology is based on a modification of the standard white light spectrum by using optical filters that narrow the bandwidth of transmitted light through an endoscope[6] (CV-260SL processor and CLV-260SL light source, Olympus

Optical Co. Ltd., Tokyo, Japan [Fig 1])[7]. The filter which is applied within the optical light source absorbs the transmission of all but two wavelength bands. One band between 400 and 430 nm (centred at 415 nm) penetrates the superficial mucosa and highlights sub mucosal capillaries as brown in colour. The second band between 525 and 555 nm (centred at 540 nm) passes through to the sub mucosal layer and identifies prominent vessels as cyan.[3] A blue light is produced by the NBI endoscopy that penetrates less deeply into tissue and therefore gives the operator a much better resolution of superficial structures [Fig 2].[8] NBI relies on the principle of depth of light penetration. In contrast to red light, blue light has less penetration and less scattering thus enhancing image resolution[9]. The blue filter is designed to correspond to the peak absorption spectrum of haemoglobin to enhance the image of capillary vessels on surface mucosa. The reflection is increased by a monochromatic charge coupled device, and an image processor creates a composite pseudocolour image, which is displayed on a high definition video screen, enabling NBI to enhance mucosal contrast without the use of dyes. Thus, superficial mucosal lesions that would previously have been missed by regular white light during endoscopy would be identified by the blue light of NBI, based on the increased vascularity and neoangiogenesis of the tumour.[10]

NBI identifies normal mucosa in the oral cavity with clear branching vessels in the subepithelial layer which is visualised as cyan or green in colour. This is because 540 nm of light penetrates through to the sub mucosa and is reflected [Fig 3].[3] The 415 nm centred light does not penetrate any further than the epithelial layer and is in the peak absorption band of haemoglobin,[6,8] which means that blood vessels in the most superficial tissues are brown in colour.[3]

Fig 1 : NBI comprising monitor, NBI light source, image processor, conventional light source and keyboard

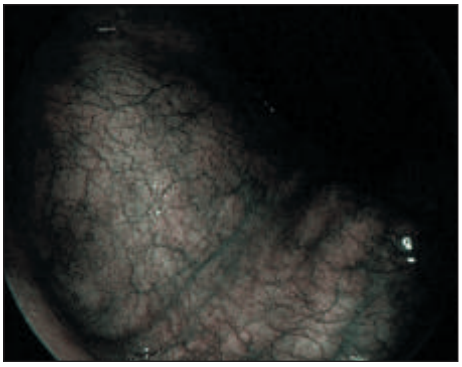

Fig 3 : Narrow band image of normal capillary bed in the right floor of mouth

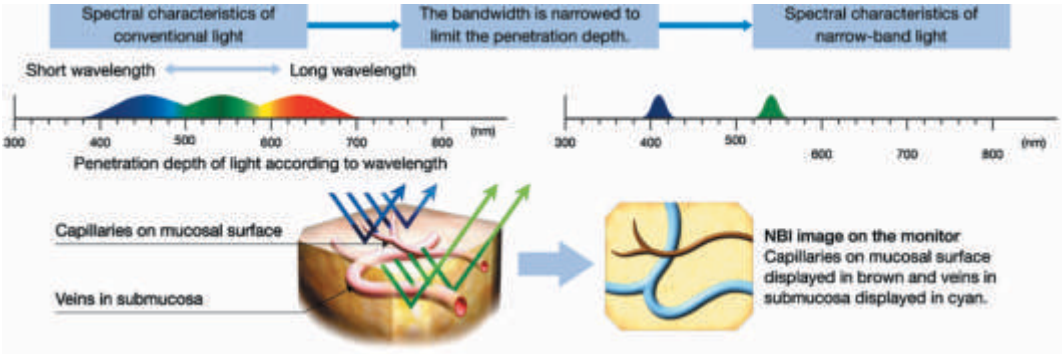

Fig 2 : Diagram of narrow band filtration of light highlighting improved contrast of superficial and submucosal vessels (Image courtesy of Olympus Keymed Group Companies)

The characteristic feature of the tissue is that it has undergone severe dysplasia to show substantial neo-angiogenesis.[11-13] Neo-angiogenesis is a prerequisite for the development of invasive SCC[3]. The abnormal vasculature that occurs within the subepithelial layer is seen as brownish dots with extension, dilatation, weaving, and differing shapes in NBI.[6] The usual branching arrangement seen in normal capillary beds is lost. Changes in the micro surface such as irregularities in the margin seen in early cancerous lesions which are also consistent with severe dysplasia or SCC can readily be seen with NBI and magnifying endoscopy.[3]

Discussion :

The hypopharynx was the first area to undergo detailed investigation with NBI. Muto et al studied 18 patients with 34 superficial mucosal lesions using NBI with magnifying endoscopy to highlight areas of abnormal mucosa (well demarcated, brownish, scattered, dot like lesions that indicate neo-angiogenesis and loss of the typical pattern of capillary vessels). All these areas were biopsied and all 34 lesions were diagnosed as SCC.[3,5]

Watanabe et al studied 217 consecutive patients with oesophageal cancer who underwent initial clinical examination and nasoendoscopy screening for oropharyngeal cancer. All patients initially had conventional white light imaging (WLI) nasoendoscopy after topical anaesthesia of the nasal cavity and clearance of oropharyngeal mucosal secretions by drinking a cup of water. NBI examination was then done. Any abnormal areas were noted and subsequently excised. The authors reported that the NBI system was roughly twice as sensitive as conventional endoscopy. They also reported that the early detection of lesions under 5 mm (seen on NBI but not by conventional nasoendoscopy in their study) would clearly be of benefit to patients.[3,14]

With an additional two years of follow up, Watanabe et al calculated sensitivity, specificity, accuracy, and positive or negative predictive values. NBI detected 44/45 cancers (a sensitivity of 97.7%), compared with 23/45 (51.5% sensitivity) by conventional examination, a significant benefit over conventional techniques. The specificities (indicating false positive results) in the detection of early cancer were 98.9% for NBI and 99.7% for conventional examination, with no statistical difference between the two groups. This study shows a clear benefit in the sensitivity of NBI in detecting early mucosal cancer.[2,3]

Katada et al reported the use of NBI in the surveillance of cancer of the head and neck after treatment. They reported two cases of metachronous superficial SCC in patients who had previously undergone chemoradiotherapy. Asymptomatic mucosal lesions in the oropharynx or hypopharynx that were more visible under magnified NBI were found in both patients.[3,15]

A study by Ugumori et al added further evidence on the advantages of NBI in the assessment of superficial oropharyngeal carcinomas. The authors investigated 51 superficial lesions in 29 patients who had a lesion that was initially identifiable using a standard white light GI endoscope. They did flexible nasoendoscopy using both WLI and NBI and digitally recorded all lesions. Two experienced surgeons evaluated the microvascular pattern and demarcation of the lesions, and graded the quality of the image as poor, good, or excellent, for each technique. The authors found that NBI significantly improved ($p < 0.05$) visualisation of the irregular microvascular pattern and the margins. One criticism of the study was that it assessed lesions after they had been clinically identified, and this could be perceived as a source of bias. Nevertheless, it does suggest that there is a potential diagnostic gain from the use of NBI.[3,16]

The most recent NBI study relating to head and neck SCC was published by Muto et al. This multicentre, prospective, randomised controlled trial also included patients with known oesophageal SCC, and it assessed the use of NBI in screening for synchronous oropharyngeal or hypopharyngeal superficial cancers. The study randomised subjects into both primary conventional examination and nasoendoscopy followed by NBI (162 subjects), or primary NBI followed by conventional examination (158 subjects) done back to back. NBI detected superficial cancer more

often than conventional techniques both in the head and neck, and the oesophagus, and it was concluded that it could be the standard examination technique for the early detection of superficial cancer in these areas.[3,17]

Until recently only a limited number of papers relating to the use of NBI in the oral cavity had been published.[7,10,18,19] Piazza et al investigated whether high definition television (HD-TV) NBI could provide a diagnostic advantage over standard white light examination. They included 96 patients; 35 with a recent diagnosis of oral or oropharyngeal SCC who were awaiting definitive treatment, and 61 who had already completed treatment. In their first group 14/35 patients (40%) showed additional findings with HD-TV NBI compared with standard white light examination. In the second group who were undergoing surveillance, 12/61 (20%) showed positive findings on NBI that were not identifiable using conventional methods. Overall, 26/96 patients (27%) had a diagnostic advantage when HD-TV NBI was used for screening endoscopy when compared with conventional white light examination.[3,20]

A recent study has also reported the value of NBI in detecting head and neck SCC in patients with oesophageal SCC. Using NBI, 15/112 patients (13%) with oesophageal SCC were also found to have small head and neck SCCs and it was concluded that NBI was useful for diagnosing these tumours.[3,21]

Only one study has been published that states the use of NBI in the assessment of patients who present with an unknown primary SCC of the head and neck with cervical lymph node metastases. Hayashi et al reported 46 patients with SCC cervical lymph node metastases. Standard clinical examination and white light nasoendoscopy was not able to detect a lesion in any of the patients. All subsequently underwent NBI with magnifying endoscopy and 26 suspicious lesions were found. All underwent biopsy examination and 16 were found to be SCC. Of these, 10 were in the hypopharynx and six in the oropharynx. Although the study was not blinded or randomised, the authors concluded that NBI has a clear diagnostic value for patients presenting with an unknown primary.[22]

Conclusion :

The use of narrow band imaging in the head and neck region is rapidly gaining interest. This novel imaging technology can be used as an adjunctive diagnostic technique along with the standard diagnostic protocol. This technology could increase the clinicians' ability to detect the initial changes in the dysplastic tissues and aid in the better judgement of the progression of the lesions. It is a technique that is easily learned, and has the potential to assist the general dental practitioners in assessment and decision- making related to mucosal tissues and lesions.

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