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Review

Efficacy of narrow band imaging for detection and surveillance of potentially malignant and malignant lesions in the oral cavity and oropharynx: A systematic review

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SUMMARY

Objective: Narrow band imaging (NBI) is an endoscopic technique that enhances the mucosal surface texture, and mucosal and submucosal vascular morphology. This paper systematically reviews the available literature regarding the efficacy of NBI for the detection and monitoring of potentially malignant and malignant lesions in the oral cavity and oropharynx.
Methods: Databases searched included PubMed, EMBASE, Web of Science and Scopus (to September 2013). Additional articles were found by conducting an author publication search using PubMed and by scanning the reference lists of relevant articles. Only trials that investigated and evaluated the effectiveness of both white light (WL) and NBI for aiding the detection of only oral potentially malignant lesions, oral squamous cell carcinomas and/or oropharyngeal squamous cell carcinomas were considered for this review. Two reviewers (ANV and CSF) independently assessed retrieved articles against the criteria, and included articles underwent data extraction and risk of bias assessment.
Results: Two studies, one retrospective and one prospective, met the inclusion criteria. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy for WL ranged between 56–96%, 60–100%, 33–100%, 87–99% and 66–89% respectively, whereas it was 87–96%, 94–98%, 73–96%, 97–98% and 92–97% respectively for NBI.
Conclusion: While more research is required to determine the full value of NBI, it has great potential in accurately aiding the detection and assessment of neoplastic lesions, and influencing how these lesions are managed.

Introduction

Oral and pharyngeal cancers combined rank within the top ten most common malignancies in the world for men, with an estimated global incidence of oral cancer alone at approximately 275,000 [1]. Over 90% of oral cancers affecting the lips, gingiva, tongue, buccal mucosa, floor of mouth and hard palate arise from the squamous epithelium and are thus termed oral squamous cell carcinomas (OSCCs) [2,3]. Conversely, neoplasms originating from the epithelial lining of oropharynx are called oropharyngeal squamous cell carcinomas (OPSCCs) [1]. Patients with OSCCs are typically males over 40 years of age with a history of regular exposure to aetiological risk factors such as tobacco products, alcohol, betel quid or micronutrient deficiency [2,4]; however, younger patients with lower cumulative tobacco or alcohol exposure are increasingly presenting with OSCC or OPSCC [2]. These early-onset OSCCs or OPSCCs are often located in the base of the tongue, tonsils and oropharynx, and are associated with the human papillomavirus infection [1,2,5,6].

Despite advances in the treatment of OSCC over the past 30 years, the five year survival rate has remained at around 50% but can be as low as 15% when patients present with advanced cancers that have metastasized to the cervical lymph nodes [2]. The presence of synchronous or metachronous OSCCs due to the field cancerisation effect further reduces prognosis [7–9]. Early detection of OSCCs at the dysplasia or carcinoma in situ (CIS) stages improves morbidity and mortality as there is a very low risk of metastasis [10–12]. Consequently, painful, invasive and disfiguring treatment that often results in loss of function and reduced quality of life can be avoided [12,13]. However, it can be difficult to detect OSCC in the early stages as they are not only relatively

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asymptomatic, but can also have very subtle changes in the epithelium that make them difficult to visualise with standard visualisation techniques using white light (WL) inspection [12,14]. These mucosal changes may appear as patches of white, red, or speckled red-white, and are called leukoplakia, erythroplakia or erythroleukoplakia (speckled erythroplakia) respectively when there is no clinical or histopathological diagnosis [2]. Therefore, research into technology and techniques that can enhance visualisation has resulted in the development of several visualisation methods – one of which is narrow band imaging (NBI).

NBI (Olympus Medical Systems Corporation, Tokyo, Japan) is an endoscopic technique that provides real-time on-demand optical image enhancement of the mucosal and submucosal vascular morphology and mucosal surface texture. The technology utilises the concept that the wavelength of light determines the depth of penetration [15,16]. In NBI mode, two optical filters placed in front of WL select two narrow bands of light in the blue and green spectrum. Blue light between 400 and 430 nm (centred at 415 nm) corresponds to the peak absorption spectrum of haemoglobin, and can therefore highlight the capillary bed and intrapapillary capillary loop (IPCL) pattern in the superficial mucosa by making them appear brown. Thicker blood vessels in the deeper mucosa and submucosa are enhanced by green light between 525 and 555 nm (centred at 540 nm), and appear cyan [15–18]. A charge coupled device (CCD) at the tip of the endoscope captures the reflected light, which is then reconstructed to produce a coloured NBI image that is displayed on a monitor. Switching between WL mode and NBI mode simply involves pressing a button on the videoendoscope, video camera or monitor console [10]. Magnifying endoscopy, which can enhance morphological and colour changes in the mucosa and allow for clearer visualisation of microvascular structures, is also possible with the two commercially available NBI systems [15,19]. The red-green-blue sequential NBI endoscopes (Evis Lucera 260 Spectrum) can optically magnify images up to 80 times and is considered to give clearer images, whereas the colour CCD endoscopes (Evis Exera II and Evis Exera III) are coupled with digital zoom at 1.2 and 1.5 times magnification. Both are capable of maintaining excellent resolution even when the endoscope tip is as close as 2 mm from the mucosal surface due to their physical zoom property [19].

As angiogenesis occurs early in the carcinogenesis continuum, the distinct microvasculature architecture associated with potentially malignant and malignant lesions can be used to differentiate these lesions from normal mucosa [13,14,20]. Areas of neoplasia are typically characterised by well-demarcated brownish areas with scattered spots, whereas inflammatory lesions have ill-demarcated borders [17,21]. However, NBI has been designed to enhance microvascular morphology, and can therefore be used to detect vascular changes such as the degree of dilation, meandering, tortuosity and calibre of IPCLs [13,20]. Typically, a separate IPCL classification for oral mucosa is used for oral lesions [21]. This classification is a simplified version of Inoue's IPCL classification for oesophageal mucosa [20]. Normal mucosa has IPCL type I, and is characterised by regular brown dots when loops are perpendicular to the surface of the mucosa, or waved lines when parallel. Non-neoplastic lesions are either type II, which has a dilated and crossing IPCL pattern, or type III, which demonstrates an elongated and meandering IPCL pattern. Neoplastic lesions have type IV, which is characterised by large vessels, IPCL pattern destruction and the presence of angiogenesis. For all these classifications, the most advanced IPCL pattern determines the type of lesion when more than one pattern is present [20–22].

Although NBI is commonly used in the gastrointestinal, aerodigestive and urinary tracts, the use of this technology in the oral cavity to screen for oral potentially malignant lesions (OPMLs) and OSCC has only been a fairly recent development. Consequently, the literature regarding the use of NBI as a visualisation adjunct for screening potentially malignant and malignant lesions in the oral cavity and oropharynx is still limited. Nonetheless, NBI has demonstrated high sensitivity and specificity for aiding the detection of dysplasia and neoplasia elsewhere in the head and neck [23]. In order to determine the benefits of NBI over traditional WL oral and oropharyngeal examination, this paper aims to systematically review the literature relating to the efficacy of NBI for the detection and surveillance of OPMLs, OSCCs and/or OPSCCs in patients who have or are at risk of having these types of lesions.

Methods

Criteria for considering studies for this review

Types of studies

Retrospective and prospective trials that investigated and evaluated the effectiveness of both WL and NBI for aiding the detection of only OPMLs, OSCCs and/or OPSCCs were included for this review. Studies had to have values for sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy for both lights, or had enough data reported that these could be calculated. Although publications had to be in English, there were no restrictions on publication date or publication status.

Types of participants

Participants who underwent examination with both conventional broadband WL and NBI, and had at least one detectable OPML, OSCC and/or OPSCC were included.

Types of interventions

Studies considered for inclusion had to have a WL comparison to NBI view, and this was typically the conventional broadband WL view of the NBI system. Lesions deemed suspicious for dysplasia, CIS, or carcinoma required histopathological assessment; however, this was not a requirement for non-suspicious lesions due to the ethical implications and feasibility regarding random biopsy sampling in every patient with negative clinical results.

Types of outcome measures

Although the primary outcome considered for this review was the efficacy of WL and NBI for aiding the detection and surveillance of OPMLs, OSCCs and/or OPSCCs, other outcome measures also considered included the effectiveness of the criteria used for determining the presence of dysplasia or neoplasia with NBI, correlations between IPCL patterns and diagnoses, advantages of using NBI in the oral cavity and oropharynx, and limitations of the use of NBI in the oral cavity and oropharynx.

Search strategy

In order to retrieve relevant published English language studies, detailed search strategies were developed for each electronic database used (Figs. 1 and 2). Databases searched included PubMed (to 18 September 2013), EMBASE (to 18 September 2013), Web of Science (to 20 September 2013) and Scopus (to 30 September 2013). In addition, PubMed was used to conduct an author publication search of all authors who contributed to articles that were potentially relevant. The reference lists of all relevant articles retrieved from the databases and from the author publication search were checked to identify other studies (see Fig. 3).