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MAIN ARTICLE

Use of narrow-band imaging in detection of nasopharyngeal carcinoma

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Abstract

Aim: To compare narrow-band images of nasopharyngeal carcinoma with those of normal adenoidal tissue.

Method: Patients with a nasopharyngeal mass were evaluated using both conventional white light and narrow-band light. Biopsies were performed and Epstein–Barr viral serology was tested for all patients.

Results: Thirty consecutive patients were recruited. Twenty-one patients had normal adenoidal tissue and seven had nasopharyngeal carcinoma. One patient with papillary adenocarcinoma was excluded. The features of narrow-band imaging in normal adenoidal tissue were: (1) a regularly arranged follicular pattern, and (2) each 'follicle' comprising a pale centre with surrounding dark periphery. The features of narrow-band imaging in nasopharyngeal carcinoma were: (1) absence of surface patterns ($n = 7$), and/or (2) 'reverse', haphazard follicular pattern comprising a dark brown centre and pale periphery ($n = 3$).

Conclusion: Narrow-band imaging of the surface of adenoidal tissue and nasopharyngeal carcinoma appears to identify distinct, characteristic features as described. Narrow-band imaging may be a useful adjunct in differentiating normal adenoidal tissue from malignancy. Further studies are needed to evaluate its diagnostic accuracy.

Key words: Nasopharynx; Endoscopy; Adenoids; Imaging, Diagnostic; Nasopharyngeal Carcinoma; Diagnosis

Introduction

Nasopharyngeal cancer is common amongst the Chinese population in South-East Asia. In Singapore, its prevalence is estimated at 10.8 per 100 000, and it is the sixth commonest cancer affecting males.[1] Patients frequently present late with advanced tumour. The commonest presentation is neck swelling from lymph node metastasis. Early tumours are often asymptomatic and discovered incidentally. Targeted examination of the postnasal space is performed in patients with a suspicious clinical history. Large tumours are easy to identify with conventional white light endoscopy. Early tumours, however, may appear similar to adenoidal tissue or even normal nasopharyngeal mucosa.

The efficacy of narrow-band imaging via video-endoscopy in the early detection of pre-malignant and malignant lesions has been shown in regions such as the lung and gastrointestinal tract.[2,3] Studies on applications of narrow-band imaging in the head and neck region are scarce in comparison. There have been five publications to date on the use of narrow-band imaging in the nasopharynx for the detection of primary or recurrent nasopharyngeal carcinoma.[4–8] The criteria for suspicion of nasopharyngeal carcinoma vary between reports and are not yet clearly defined.

In this study, nasopharyngeal masses were examined using both white light and narrow-band imaging. The features of both white light and narrow-band imaging as regards to normal adenoidal tissue and nasopharyngeal carcinoma were then compared.

Method

Ethics approval was sought and obtained from the institutional review body (DSRB Domain D/10/267).

Patients attending the ENT clinic who required nasopharyngeal examination due to their presenting complaint, and who were found to have a postnasal mass, were invited to participate in this prospective study. Informed consent was obtained.

Patients underwent nasendoscopic evaluation using both conventional white light and narrow-band light. Photodocumentation of the nasopharynx was performed. Biopsies of the nasopharyngeal mass were taken for histological confirmation of diagnosis. Serological analysis for Epstein–Barr virus, a tumour marker for nasopharyngeal carcinoma, was performed for all patients.

Exclusion criteria included an age younger than 21 years, pregnancy, lack of consent, cognitive

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TABLE I
PATIENT CHARACTERISTICS AND RESULTS

Age (y)	Sex	Presenting complaint	Family NPC Hx?	Imaging appearance		Histology	EBV titres	
				White light	Narrow band		VCA	Ea
21	M	Sore throat, fever	No	Large, craggy, central PNS mass	Regular follicular pattern with small, dark brown areas	Lymphoid hyperplasia	1:40	1:<5
22	M	Epistaxis	No	Central PNS mass	Regular follicular pattern	No evidence of malignancy, chronic inflammatory infiltration	1:40	1:<5
27	M	Snoring	No	Large, central PNS mass	Regular follicular pattern	Reactive lymphoid hyperplasia	1:40	1:<5
29	M	Sore throat, fever, blood-stained saliva	No	Large, smooth, central PNS mass	Regular follicular pattern with widespread brown speckling	Reactive lymphoid hyperplasia	1:40	1:<5
29	M	Snoring	No	Large, central PNS mass	Regular follicular pattern	No evidence of malignancy	1:10	1:<5
31	M	Haemoptysis	No	Central PNS mass	Regular follicular pattern	Lymphoid tissue	1:160	1:<5
33	M	Epistaxis after sneezing	Yes	Slight fullness L FOR	Regular follicular pattern	Reactive lymphoid tissue	1:10	1:<5
43	M	Submandibular mass	No	Central PNS mass	Regular follicular pattern	Lymphoid tissue	1:10	1:<5
53	M	Snoring	No	Central PNS mass	Regular follicular pattern	Reactive lymphoid tissue	1:<5	1:<5
44	M	Otorrhoea	No	R PNS mass	Regular follicular pattern with widespread brown speckling	No evidence of malignancy	1:40	1:<5
57	M	Bilateral hearing loss	No	Central PNS mass	Regular follicular pattern	Reactive lymphoid hyperplasia	1:<5	1:<5
57	M	Dry throat	No	Central PNS mass	Regular follicular pattern	Chronic inflammation	1:10	1:<5
71	M	Blocked nose	No	Central PNS mass	Regular follicular pattern	No evidence of malignancy	1:10	1:<5
25	F	Cough, purulent sputum	No	Smooth, central PNS mass	Regular follicular pattern with scattered brown speckling	Reactive lymphoid hyperplasia	1:<5	1:<5
33	F	Blood-stained saliva	No	Central, upper PNS mass	Regular follicular pattern	Reactive lymphoid hyperplasia	1:5	1:<5
42	F	R neck swelling	No	L FOR fullness	Regular follicular pattern	Reactive lymphoid hyperplasia	1:5	1:<5
43	F	Blocked nose, blood-stained sputum	No	Central PNS mass with surrounding hypervascularity	Regular follicular pattern with widespread brown speckling	No evidence of malignancy	1:10	1:<5
47	F	L conductive hearing loss	No	Central, upper PNS mass	Regular follicular pattern	No evidence of malignancy	1:40	1:<5
47	F	Globus sensation	No	Central PNS mass	Regular follicular pattern	No evidence of malignancy	1:10	1:<5
57	F	Giddiness	No	Central PNS mass	Regular follicular pattern	Reactive lymphoid hyperplasia	1:5	1:<5
69	F	Blocked nose, R conductive hearing loss	No	R PNS mass	Regular follicular pattern	Reactive lymphoid hyperplasia	1:<5	1:<5
52	M	L neck mass	No	L FOR mass	No patterns on surface	Non-keratinising carcinoma	1:>640	1:40
52	M	Globus sensation	No	L PNS mass	'Reverse', haphazard follicular pattern	Undifferentiated carcinoma	1:40	1:<5
58	M	Blood-stained nasal discharge	No	L FOR mass with bleeding spots	No patterns on surface, scattered brown speckling	Non-keratinising, undifferentiated carcinoma	1:160	1:10
60	M	R neck swelling	No	Central, friable PNS mass	No patterns on surface; irregular, dark brown areas; 'reverse', haphazard follicular pattern	Undifferentiated carcinoma	1:>640	1:160

Continued

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Table I *Continued*

Age (y)	Sex	Presenting complaint	Family NPC Hx?	Imaging appearance		Histology	EBV titres	
				White light	Narrow band		VCA	Ea
69	M	L neck mass	No	Smooth L FOR mass	No patterns on surface	Non-keratinising, differentiated carcinoma	1:>640	1:>640
47	M	R neck swelling	No	Pale, yellow, sloughy, L FOR mass	No patterns on surface	Undifferentiated carcinoma	1:>640	1:40
60	F	L tinnitus & hearing loss	No	Craggy, friable L PNS mass	No patterns on surface	Non-keratinising, undifferentiated carcinoma	1:160	1:40
62	F	Blood-stained sputum	No	Centre-R, friable PNS mass	No patterns on surface; areas of widespread brown speckling; 'reverse', haphazard follicular pattern	Non-keratinising, undifferentiated carcinoma	1:>640	1:>640

Y = years; NPC Hx = history of nasopharyngeal carcinoma; EBV = Epstein–Barr virus serology; VCA = viral capsid antigen (immunoglobulin (Ig) A); Ea = early antigen (IgA); M = male; PNS = postnasal space; L = left; FOR = fossa of Rosenmuller; R = right; F = female

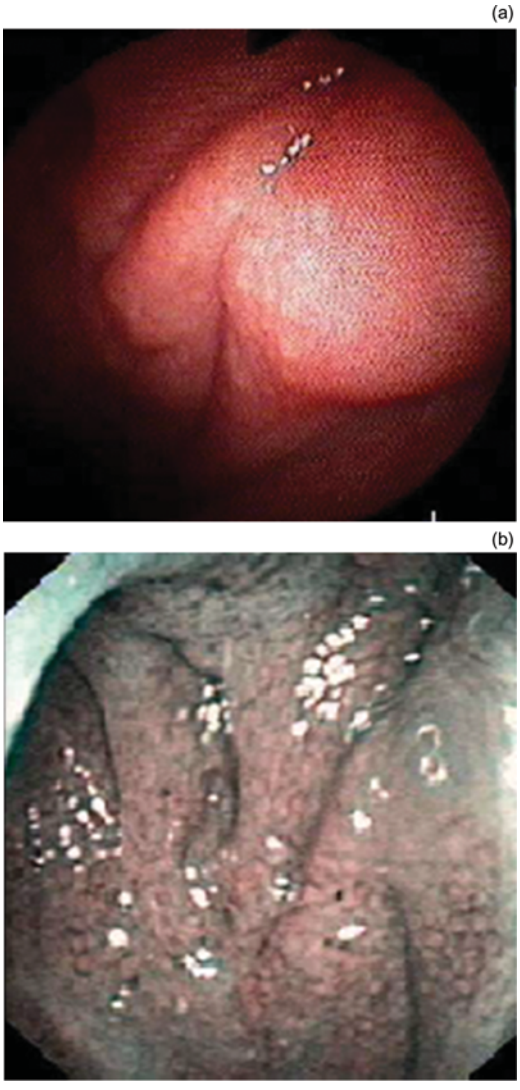

FIG. 1

Endoscopic appearance of normal nasopharynx, comparing (a) conventional white light and (b) narrow-band light. Regularly arranged follicular patterns with pale-centred follicles and dark peripheries are clearly visualised with narrow-band imaging.

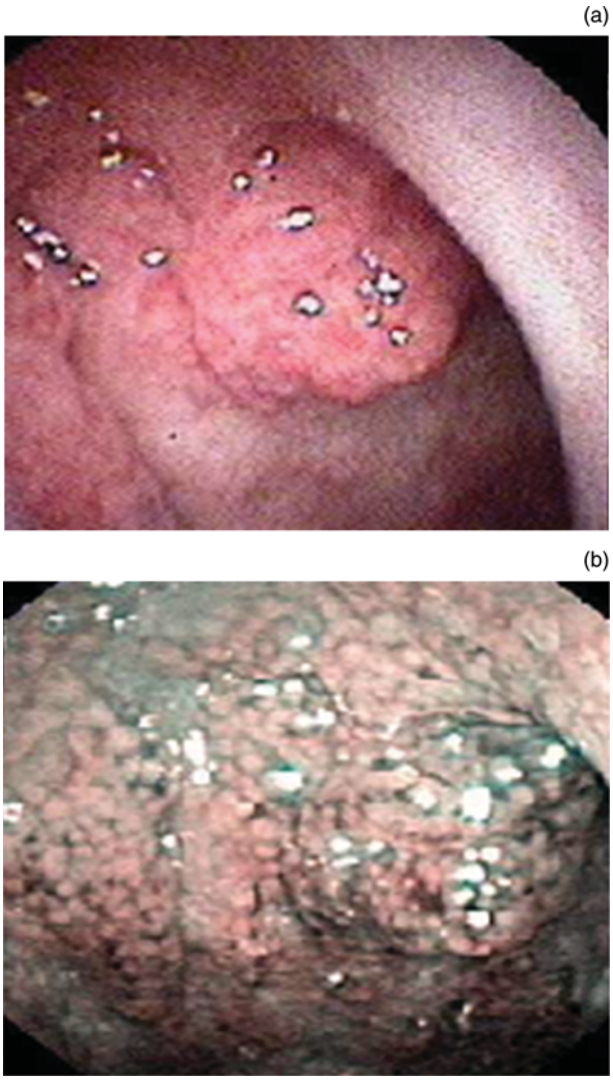

FIG. 2

Endoscopic appearance of adenoidal tissue, comparing (a) conventional white light and (b) narrow-band light.

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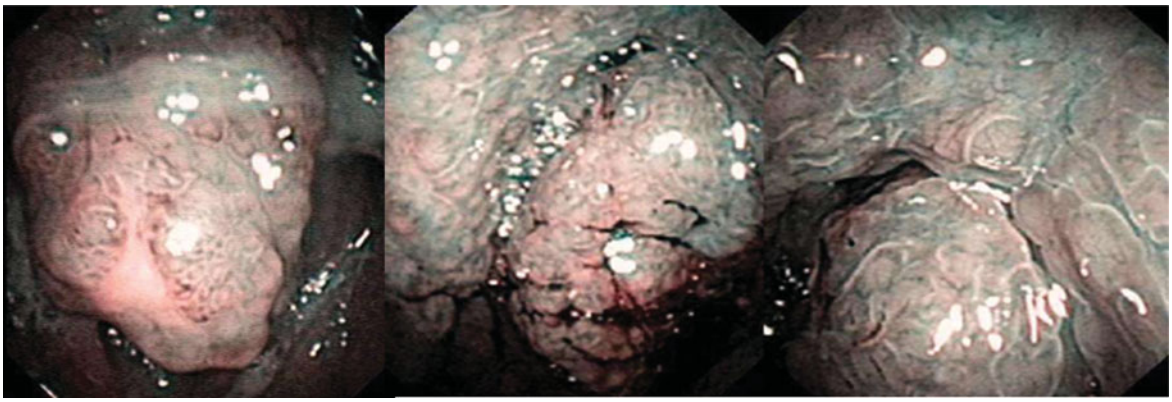

FIG. 3
Endoscopic appearance of adenoidal tissue seen with narrow-band light.

impairment, coagulopathy and previous Epstein–Barr virus serological analysis.

Results

We recruited 30 consecutive patients who were found to have a nasopharyngeal mass on routine nasendoscopic examination and who consented to participate in the study. Patients' symptoms and examination findings for white light and narrow-band imaging are shown in Table I. Twenty-one of the 30 patients had no evidence of malignancy on either histological or serological testing. Eight patients had nasopharyngeal carcinoma. One patient with papillary adenocarcinoma of the nasopharynx was excluded, as our aim was to compare nasopharyngeal carcinoma with non-neoplastic nasopharyngeal tissue.

Of the 21 patients with normal adenoidal tissue, 17 were found to have a central nasopharyngeal mass, 2 had a unilateral nasopharyngeal mass and 2 had fullness at the fossa of Rosenmuller. Narrow-band imaging features identified in all these patients were as follows: (1) a regularly arranged, follicular pattern, and (2) each 'follicle' being composed of a pale centre with a surrounding dark periphery (Figures 1 to 3).

Of the eight patients with nasopharyngeal carcinoma, one presented with a central nasopharyngeal mass, three had a unilateral nasopharyngeal mass and four had a mass at the fossa of Rosenmuller. The features of narrow-band imaging of these cases of nasopharyngeal carcinoma were as follows: (1) absence of surface patterns ($n = 7$), and/or (2) 'reverse', haphazard follicular patterns, with each follicle being composed of a dark brown centre with a surrounding pale periphery ($n = 3$) (Figures 4 to 6). Brown speckling was seen both in patients with adenoids and those with nasopharyngeal carcinoma (19 per cent of adenoids cases, 25 per cent of nasopharyngeal carcinoma cases).

Discussion

Narrow-band imaging via video-endoscopy is an innovative technology which uses optical interference filters to create narrow-band light capable of highlighting superficial mucosal microvasculature, an important characteristic which has been proposed to differentiate neoplastic and non-neoplastic lesions.[1] Narrow-band imaging is available in many recent video-endoscope models, activated from the monitor console or the endoscope itself. This imaging modality has been increasingly recognised as a highly sensitive and accurate tool for the early detection of superficial mucosal neoplastic lesions. Much work has been done evaluating the diagnostic precision of narrow-band imaging versus conventional white light imaging, for the detection of early tumours in regions such as the lung and gastrointestinal tract.[2,3]

Studies on applications of narrow-band imaging in the head and neck region are scarce by comparison. In a recently published, multi-centre, randomised, controlled trial from Japan assessing narrow-band imaging in the early detection of synchronous and metachronous superficial oropharyngeal and hypopharyngeal squamous cell carcinoma in patients with oesophageal cancer, the sensitivity of narrow-band imaging was reported to be 100 per cent, compared with 8 per cent for conventional white light endoscopic imaging.[9] Kumagai *et al.* have proposed criteria for narrow-band imaging features suspicious of malignancy in regions other than the nasopharynx, as follows: (1) a well demarcated, brown lesion, with (2) scattered, brown dots within the lesion.[2] Brown speckling represents microvascular proliferation, which is reported to be a characteristic feature of neoplastic and pre-neoplastic lesions on narrow-band imaging.

To date, there have been five publications on the use of narrow-band imaging in the nasopharynx for the detection of primary or recurrent nasopharyngeal carcinoma, and the criteria for suspicion of malignancy in this region have not yet been clearly defined.[4–8]

Lin *et al.* reported the successful detection of early nasopharyngeal carcinoma recurrence using narrow-band imaging, following the criteria proposed by Kumagai *et al.*[4] A well demarcated, brownish area

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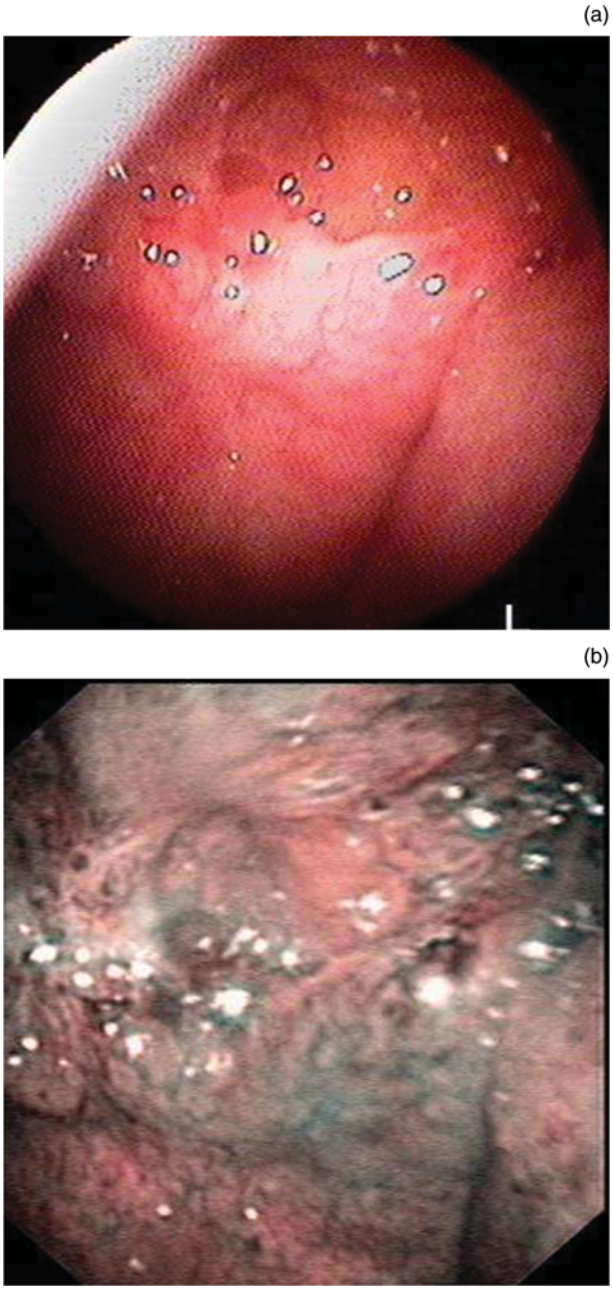

FIG. 4

Endoscopic appearance of nasopharyngeal carcinoma, comparing (a) conventional white light and (b) narrow-band light. The latter clearly shows haphazardly arranged follicular patterns and an increase in brown areas on the surface of the suspicious lesion.

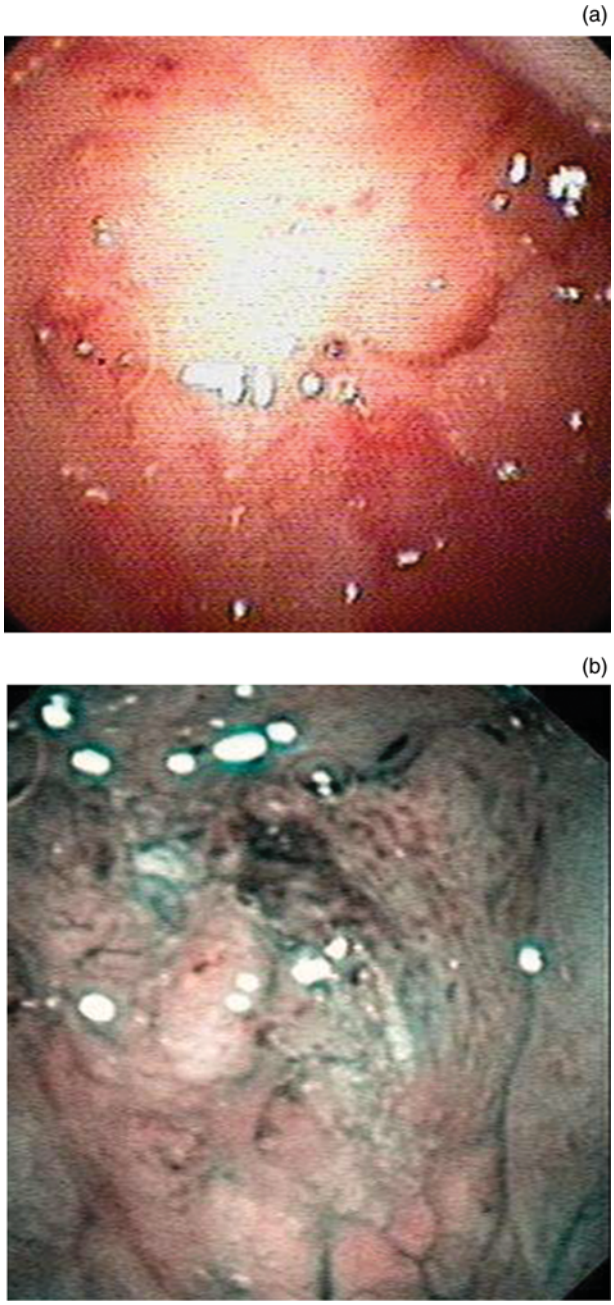

FIG. 5

Endoscopic appearance of nasopharyngeal carcinoma, comparing (a) conventional white light and (b) narrow-band light. The latter shows irregular follicular patterns with reversal of the usual follicular pattern, i.e. showing a dark brown centre with a pale periphery.

with brownish spots was found in an area of the nasopharynx otherwise noted to be smooth and symmetrical when viewed with conventional endoscopy.

Vlantis *et al.*, on the other hand, did not notice these features in their patient with nasopharyngeal carcinoma.[5] They observed that, in adults, mucosal lymphoid tissue had a regular follicular pattern on narrow-band imaging, with pale follicles surrounded by a thin, dark border, and a ratio of pale follicle to dark border ('pale-to-dark' ratio) of roughly 90 per cent.[5] In their patient with nasopharyngeal carcinoma, they described a reversal in the pale-to-dark ratio of the follicles. Therefore, they concluded that this abnormal vascular pattern may signal an early event in the evolution of nasopharyngeal carcinoma.[5]

Ho *et al.* examined narrow-band imaging appearances in nasopharyngeal carcinoma and benign nasopharyngeal lesions.[7] They too observed that benign lymphoid hyperplasia demonstrated a regular, cobblestone appearance on narrow-band imaging. Irregular, engorged vascular patterns and/or microvascular proliferative patterns were seen in 32 of 41 nasopharyngeal carcinoma cases (78 per cent) in their study.

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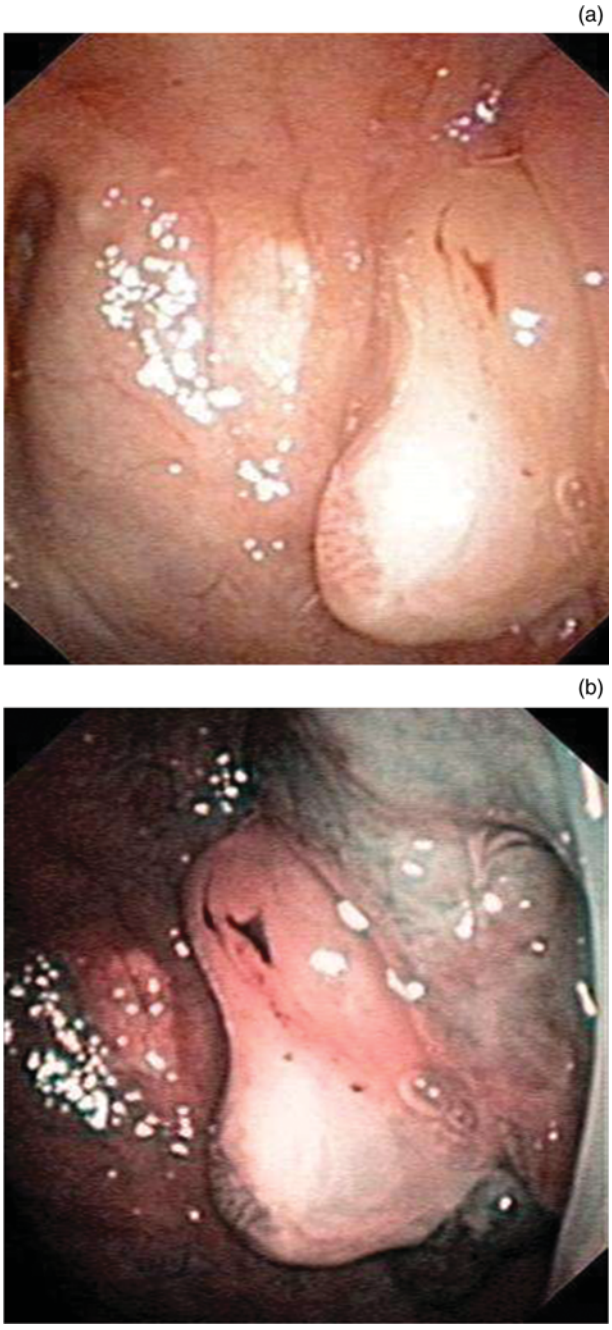

FIG. 6
Endoscopic appearance of nasopharyngeal carcinoma, comparing (a) conventional white light and (b) narrow-band light. The latter shows absence of surface patterns.

In our study, narrow-band imaging of normal adenoids revealed features consistent with descriptions given by other authors. Regularly arranged follicular patterns, with each follicle having a pale centre and surrounding dark periphery, were seen in all patients with normal adenoidal tissue. In patients with nasopharyngeal carcinoma, regularly arranged follicular patterns were not seen. Patterns were either absent (88 per cent) or, if present, tended to be haphazard and irregular (38 per cent) with reversal of the follicular pattern described by Vlantis *et al.*[5] Increased microvascularity, presenting as brown speckling on narrow-band imaging, was seen in 19 per cent of our patients with benign adenoidal tissue and in 25 per cent of our patients with nasopharyngeal carcinoma.

- **Endoscopic narrow-band imaging can detect early pre-malignant and malignant lesions in the lung and gastrointestinal tract**
- **Nasopharyngeal applicability is poorly researched, and diagnostic criteria are ill-defined**
- **This study reports narrow-band imaging characteristics of normal adenoids and nasopharyngeal carcinoma**
- **This modality may enable earlier, more accurate detection of nasopharyngeal malignancy**

Wang *et al.* found that scattered brown spots were seen in recurrent nasopharyngeal carcinoma post-irradiation, as well as in the nasopharynx of patients with no recurrence, presumably due to non-specific inflammatory changes due to irradiation.[8] Studies not involving the head and neck region have reported that increased microvascular density due to inflammation can mimic the narrow-band imaging appearance of dysplasia and carcinoma; indeed, narrow-band imaging has been reported to have a high incidence of false positive results in patients with colitis.[10] Brown speckling, a criteria proposed by Kumagai *et al.*,[4] may therefore not be as specific a finding in the nasopharynx as the other features described.

Conclusion

This study found that normal adenoidal tissue consistently demonstrated narrow-band imaging features previously described by other authors. Nasopharyngeal carcinoma, on the other hand, may vary widely in appearance; however, our study found that loss or irregularity of follicular patterns, and reversal of follicular patterns, were characteristic features.

From the limited literature thus far, narrow-band imaging appears to be a promising and useful adjunct enabling earlier and more accurate detection of malignancy in the nasopharynx. However, much work remains to be done. Further studies into the diagnostic precision of narrow-band imaging are in progress.

Acknowledgement

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References

1 Seow A, Koh WP, Chia KS, Shi L, Lee HP, Shanmugaratnam K. Trends and incidences of cancer in Singapore 1968–2002. In: Ministry of Health. *Singapore Cancer Registry Report No. 6*. Singapore: Ministry of Health, 2004;88–9

https://doi.org/10.1017/S0022215112002940 Published online by Cambridge University Press

2 Kumagai Y, Inoue H, Nagai K, Kawano T, Iwai T. Magnifying endoscopy, stereoscopic microscopy, and the microvascular architecture of superficial oesophageal carcinoma. *Endoscopy* 2002;**34**:369–75
3 East JE, Tan EK, Bergman JJ, Saunders BP, Tekkis PP. Meta-analysis: narrow band imaging for lesion characterization in the colon, oesophagus, duodenal ampulla and lung. *Aliment Pharmacol Ther* 2008;**28**:854–67
4 Lin YC, Wang WH. Narrow band imaging for detecting early recurrent nasopharyngeal carcinoma. *Head Neck* 2011;**33**: 591–4
5 Vlantis AC, Chan ABW, Chan HS, Woo JKS, Tong MCF, van Hasselt CA. Reversal of pale-to-dark nasopharyngeal follicle ratio on narrow-band imaging. *Hong Kong Med J* 2010;**16**: 307–9
6 Wang WH, Lin YC, Chen WC, Chen MF, Chen CC, Lee KF. Detection of mucosal recurrent nasopharyngeal carcinomas after radiotherapy with narrow-band imaging endoscopy. *Int J Radiat Oncol Biol Phys* 2012;**83**:1213–19
7 Ho CY, Lee YL, Chu PY. Use of narrow band imaging in evaluation of possible nasopharyngeal carcinoma. *Am J Rhinol Allergy* 2011;**25**:107–11
8 Wang WH, Lin YC, Lee KF, Weng HH. Nasopharyngeal carcinoma detected by narrow-band imaging endoscopy. *Oral Oncol* 2011;**47**:736–41
9 Muto M, Minashi K, Yano T, Saito Y, Oda I, Nonaka S *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**:1566–72
10 Dekker E, van den Broek FJ, Reitsma JB, Hardwick JC, Offerhaus GJ, van Deventer SJ *et al*. Narrow-band imaging compared with conventional colonoscopy for the detection of dysplasia in patients with longstanding ulcerative colitis. *Endoscopy* 2007;**39**:216–21

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