



Original Article

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Diagnostic Accuracy of Magnifying Endoscopy with Narrow Band Imaging for Differentiating Benign and Malignant Gastric Lesions: A Prospective Observational Study with Histopathological Correlation

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ABSTRACT

Background: Gastric cancer is the leading cause of cancer related mortality worldwide and early diagnosis is essential. Common white light endoscopy (WLE) is inadequate to detect subtle changes in mucosal structure and function. Magnifying endoscopy with narrow band imaging (ME-NBI) is a promising tool for better visualisation of mucosal microstructure and microvascular structure and can also improve diagnostic accuracy in gastric lesions.

Objectives: To evaluate the diagnostic accuracy of ME-NBI in distinguishing benign from malignant gastric lesions based on histopathological examination (HPE) as the gold standard.

Methods: The single-centre prospective diagnostic accuracy study was performed at a tertiary care centre for 12 months (July 2017 to June 2018). We evaluated 86 patients with gastric lesions (malignant lesions = 10) using ME-NBI (OLYMPUS EVIS EXERA II). Based on mucosal surface and microvascular patterns, lesions were classified as benign or malignant. Targeted biopsies were performed and HPE served as the gold standard and diagnostic accuracy metrics such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and overall accuracy were evaluated.

Results: The average age of all patients was 47.9 years and female dominance (54.7%). The most common type of lesion was gastric erosion (37.2%), while the most common site was the antrum (57.0%). Of 86 lesions, 76 (88.4%) were benign and 10 (11.6%) malignant on HPE. ME-NBI achieved sensitivity of 90.00%, specificity of 98.68%, PPV of 90.00%, NPV of 98.68% and overall accuracy of 97.67%. There was one false positive and one false negative case.

Conclusion: ME-NBI provides good diagnostic accuracy for gastric lesions characterisation, with high specificity and sensitivity. In addition to conventional WLE, it is a good adjunct for real time differentiation and biopsy guidance. More multicentre studies are needed for wide clinical adoption.

Keywords: Narrow band imaging; Magnifying endoscopy; Gastric lesions; Gastric carcinoma; Adenocarcinoma; Histopathology; Diagnostic accuracy.

INTRODUCTION

Gastric diseases are one of the leading causes of morbidity and mortality in the world. Gastric cancer is the fifth most common cancer and the fourth most common cause of cancer-related death.^{1,2} Adenocarcinoma accounts for more than 90% of gastric malignancies and early diagnosis of this disease significantly improves survival.³ Despite advancements in diagnostic techniques, many gastric cancers are diagnosed at advanced stages, especially in poorer regions with limited screening. This only serves to highlight the need for better diagnostic techniques that detect gastric lesions early on.

The classical white light endoscopy (WLE) is still the most common surgical procedure to evaluate gastric malignancies. However, WLE is limited in detecting subtle changes in mucosal structure, flat lesions and early tumours that may not have clear morphological properties.⁴ Olympus Medical Systems introduced NBI technology for gastrointestinal endoscopy and has made it a reality. NBI uses optical filters to isolate two wavelengths of light: 415 nm blue light (brownish) and 540 nm green light (cyan) to visualize deeper submucosal vessels.^{5,6} ME-NBI also allows detailed images of mucosal microstructure and microvascular structure.

The VS classification system was developed by Yao and colleagues.⁷ These characteristics are standardized for gastric lesions with ME-NBI and according to the system - cancerous and non-cancerous mucosa (DL) and irregular microvascular pattern (IMVP) and/or irregular microsurface pattern (IMSP) are found in the lesion.^{7,8} The low-cost and easy diagnostic approach of ME-NBI simplifies the diagnosis for early gastric cancer and can be applied at the point of care.⁹

ME-NBI has been well tested in East Asian populations, including Japan and China, but there are few studies in the Indian population.¹⁰⁻¹² And because gastric pathology is ethnic and epidemiological in nature and a wide range of patient types, we need to validate the findings in various settings. Furthermore, most studies have focused on gastric lesions but not gastric disease.

Thus, we aimed at the diagnostic accuracy of ME-NBI by diagnosing benign as well as malignant gastric lesions. The study used histopathological examination as the gold standard at a tertiary care centre in Northeast India.

MATERIALS AND METHODS

Study design and content: This prospective observational study was performed in the Department of General Surgery, Assam Medical College and Hospital, Dibrugarh, Assam, India. The duration of the study was 12 months, from July 2017 to June 2018.

Ethical considerations: The study was approved by the Institutional Ethics Committee. Before it was enrolled, written informed consent from participants was obtained. Based on the Declaration of Helsinki, we conducted the study as per the guidelines of the study and the results of the study had been reported in the journal.

Study Population: All patients who had gastric lesions in the upper gastrointestinal region were considered to be eligible to be included in the study. The criteria for inclusion are: (i) gastric lesions on the endoscopic examination, (ii) age 12 years or older and (iii) informed consent. The eligibility criteria for exclusion were: (i) age below 12 years, (ii) not consenting, (iii) gastric varices, (iv) moribund patients and (v) altered coagulopathy. For this gastric-specific analysis, oesophageal and duodenal lesions from the parent study were excluded.

Equipment: Endoscopic examinations were performed with the OLYMPUS EVIS EXERA II Gastro-videoscope (GIF-Q180) with CV-180 Video Processor with NBI and CLV-180 Xenon Light Source. The equipment consisted of field of view 140 degrees, depth of field 3-100 mm, outer diameter 8.8 mm, electronic magnification 1.2x to 1.5x, working length 1030 mm and channel width 2.8 mm.

Procedure: Patients were prepared with 8 hours of fasting and placed in the left lateral decubitus position to conduct a detailed examination of all gastric regions (fundus, body, antrum and pylorus). Initial assessment was done via white light endoscopy and NBI mode was activated for suspicious areas. Lesions were examined for mucosal surface patterns (regular or irregular) and microvascular patterns (regular or irregular with IMVP or IMSP). The presence of a demarcation line (DL) was observed. The lesions were classified as benign lesion (BL) or malignant lesion (ML). Biopsies were performed from all lesions.

Histopathological Analysis: Biopsy samples were fixed in 10% buffered formalin, processed using standard tissue processing techniques, embedded in paraffin and stained with haematoxylin and eosin (H&E). The pathologist was blinded to ME-NBI results and performed a histopathological analysis. Lesions were classified as benign (inflammatory cells, hyperplastic polyps) or malignant (adenocarcinoma). Adenocarcinomas were also classified as well differentiated (WD) or moderately differentiated (MD). A lesion was considered malignant on ME-NBI when a demarcation line with irregular microsurface pattern and/or irregular microvascular pattern was present based on the VS classification system.

Statistical Analysis: We calculated all statistics from mean, standard deviation and frequencies. Diagnostic accuracy was measured using histopathological evaluation as the gold standard. Sensitivity was calculated as $TP/(TP+FN)$, specificity as $TN/(TN+FP)$, positive predictive value (PPV) as $TP/(TP+FP)$, negative predictive value (NPV) as $TN/(TN+FN)$ and overall accuracy as $(TP+TN)/Total$ where TP = true positive, TN = true negative, FP = false positive and FN = false negative. A 2x2 contingency table was constructed for analysis.

RESULTS

Demographics: A total of 86 patients with gastric lesions were analysed. The mean age was 47.9 ± 16.2 years, with an age range of 19 to 102 years. There was a female predominance, with 47 females (54.7%) and 39 males (45.3%), yielding a male-to-female ratio of 0.83:1. The baseline characteristics are presented in Table 1.

Table 1: Baseline characteristics of the study population (n=86)

Parameter	Value
Total patients	86
Age (years), Mean $\pm$ SD	47.9 ± 16.2
Age range (years)	19 – 102
Male, n (%)	39 (45.3%)
Female, n (%)	47 (54.7%)
Male:Female ratio	0.83:1

SD = Standard Deviation

Lesion Distribution: The distribution of gastric lesions by type showed gastric erosion as the most common lesion (32 cases, 37.2%), followed by gastric ulcer (24 cases, 27.9%), gastritis (15 cases, 17.4%), carcinoma stomach (10 cases, 11.6%) and gastric polyp (5 cases, 5.8%). Regarding anatomical site distribution, the antrum was the most common location (49 cases, 57.0%), followed by body (18 cases, 20.9%), fundus (12 cases, 14.0%) and pylorus (7 cases, 8.1%). The detailed distribution is presented in Table 2.

Table 2: Distribution of gastric lesions by type and anatomical site

Lesion Type	n	%
Gastric Erosion	32	37.2
Gastric Ulcer	24	27.9
Gastritis	15	17.4
Carcinoma Stomach	10	11.6
Gastric Polyp	5	5.8
Total	86	100.0
Anatomical Site	n	%
Antrum	49	57.0
Body	18	20.9

Fundus	12	14.0
Pylorus	7	8.1
Total	86	100.0

ME-NBI and Histopathological Findings: On ME-NBI examination, 76 lesions (88.4%) were classified as benign and 10 lesions (11.6%) as malignant. Benign lesions typically demonstrated regular surface patterns, regular microvascular patterns and absence of a demarcation line. Malignant lesions showed irregular patterns (IMVP and/or IMSP) with the presence of a demarcation line.

On histopathological examination, 76 lesions were confirmed as benign, comprising inflammatory cells in 71 cases (82.6%) and hyperplastic/inflammatory polyps in 5 cases (5.8%). Ten lesions were confirmed as malignant, all being adenocarcinomas: 6 cases (7.0%) were moderately-differentiated and 4 cases (4.7%) were well-differentiated.

The correlation between ME-NBI findings and HPE results is presented in Table 3. Two discordant cases were identified: one false positive (Case #110), where ME-NBI diagnosed carcinoma stomach but HPE revealed inflammatory cells; and one false negative (Case #144), where ME-NBI diagnosed gastric ulcer but HPE confirmed well-differentiated adenocarcinoma.

Table 3: Correlation between ME-NBI findings and histopathological examination (2×2 contingency table)

	HPE Positive	HPE Negative	Total
ME-NBI Positive	9 (TP)	1 (FP)	10
ME-NBI Negative	1 (FN)	75 (TN)	76
Total	10	76	86

HPE = Histopathological Examination; TP = True Positive; TN = True Negative; FP = False Positive; FN = False Negative

Diagnostic Accuracy: The diagnostic accuracy metrics of ME-NBI for gastric lesions are presented in Table 4. ME-NBI demonstrated a sensitivity of 90.00% (95% CI 55.5-99.7), specificity of 98.68% (95% CI 92.9-100.0), PPV of 90.00% (95% CI 55.5-99.7), NPV of 98.68% (95% CI 92.9-100.0) and overall accuracy of 97.67% (95% CI 91.9-99.7). Agreement between ME-NBI and histopathological examination was excellent (Cohen's kappa = 0.887). The small number of malignant lesions resulted in relatively wide confidence intervals for sensitivity and PPV which may imply limited precision of these estimates.

Table 4: Diagnostic accuracy of ME-NBI for gastric lesions

Parameter	Value (%)	95% CI
Sensitivity	90.00	55.5 - 99.7
Specificity	98.68	92.9 - 100.0
Positive Predictive Value (PPV)	90.00	55.5 - 99.7
Negative Predictive Value (NPV)	98.68	92.9 - 100.0
Overall Accuracy	97.67	91.9 - 99.7

The overall flowchart of the study, its outcomes and our findings are illustrated in Figure 6.

DISCUSSION

Here is the below text split into paragraphs at the same points as the original, with the reference numbering placed in the corresponding locations and no wording changes other than preserving those citations in the matching contexts:

In this study we demonstrated that ME-NBI is a very accurate diagnostic for gastric lesion diagnosis with an overall accuracy of 97.67%. The high specificity (98.68%) indicates a good ability to identify benign lesions and hence reduce unnecessary biopsies. The sensitivity of 90.00% indicates that it is a good diagnostic method for detecting malignant lesions

although the single false negative case shows that biopsy should be taken with such low threshold of risk in cases of suspicious ulcerative lesions.

The demographic profile of our study population was 47.9 years old and similar to other Asian studies, Yu and colleagues reported a median age of 56 years for 3,675 gastric lesions in their study.¹³ The female predominance in our study (M:F ratio 0.83:1) is quite different from the male predominance in Li and colleagues (M:F ratio 1.51:1) that may be due to geographical variation in gastric pathology epidemiology.¹⁴

The antral prevalence (57.0%) in our study is also consistent with published studies. At 89.4% of cases, Yu and colleagues found antral involvement while Li and colleagues found 58.5% antral lesions.^{13,14} Tao and colleagues also found antrum as the most common site (69%)¹⁵ which has implications in endoscopic technique and therefore the need for thorough antral examination is important.

The diagnostic accuracy of our study is in line with international literature (Table 5). Gong and colleagues had a sensitivity of 91.67% and specificity of 95.45%.¹⁰ Yu and colleagues had a sensitivity of 87.2% and specificity of 98.6% and accuracy of 97.8% in a large study of 3,675 lesions.¹³ Yamada and colleagues had 95%, specificity of 96.8% and accuracy of 96.6%.¹⁶ Li and colleagues have a sensitivity of 97.3%, specificity of 84.4% and accuracy of 90.2%.¹⁴ Uedo and colleagues have a sensitivity of 89%, specificity of 93% and accuracy of 91%¹⁷ and our results are at the higher end of the published data (98.68% and 97.67%) which shows that ME-NBI is accurate even in situations outside East Asia.

Table 5: Comparison of diagnostic accuracy with published literature

Study	Year	n	Sens (%)	Spec (%)	Acc (%)
Present study	2018	86	90.00	98.68	97.67
Gong S et al.	2015	—	91.67	95.45	93.55
Yu H et al.	2015	3675	87.2	98.6	97.8
Yamada et al.	2014	—	95.0	96.8	96.6
Tao G et al.	2014	—	85.4	98.5	95.5
Li H et al.	2012	164	97.3	84.4	90.2
Uedo N et al.	2006	—	89.0	93.0	91.0

Sens = Sensitivity; Spec = Specificity; Acc = Accuracy

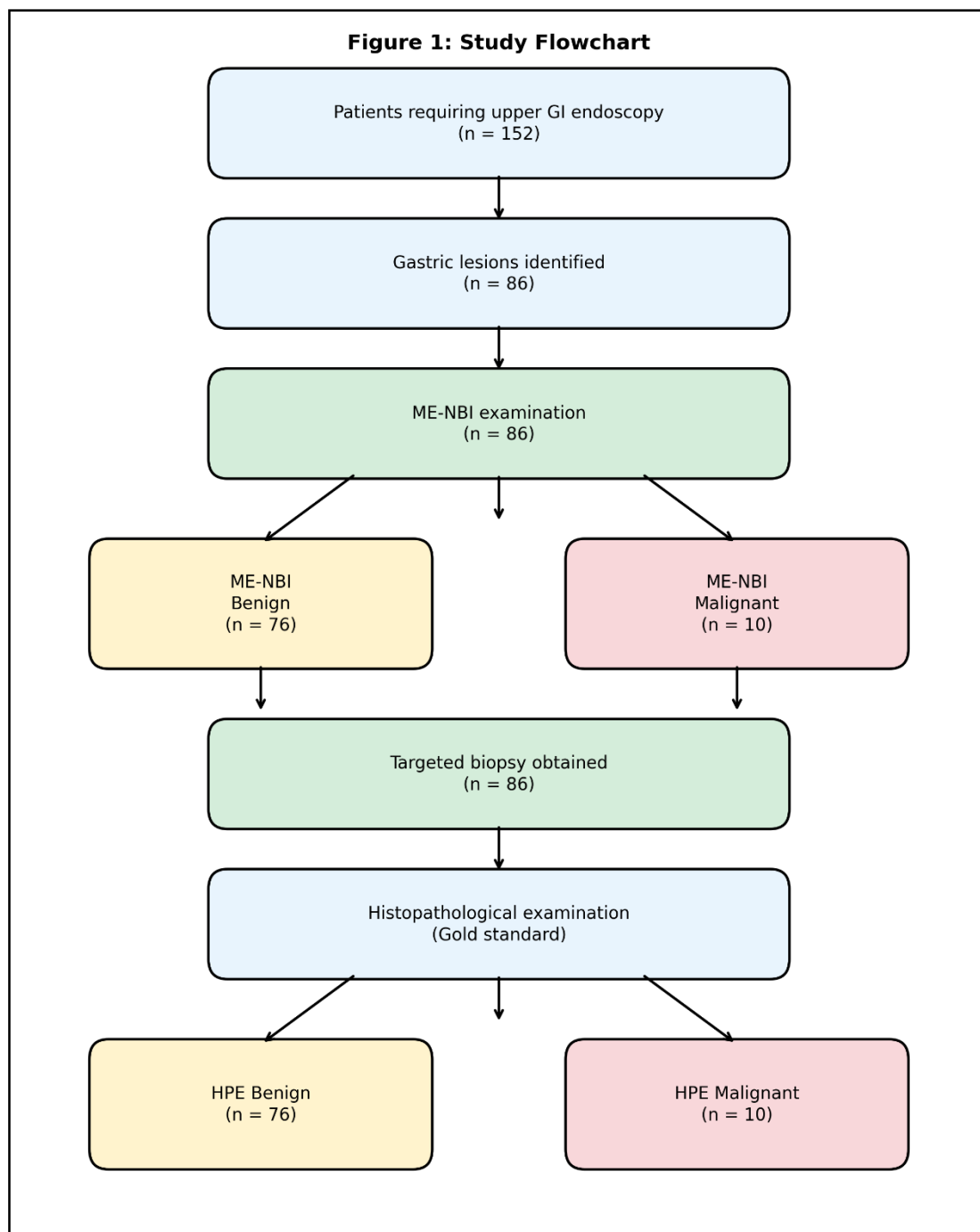


Figure 1: Study flowchart showing patient selection and diagnostic pathway. A total of 86 patients with gastric lesions underwent ME-NBI examination followed by targeted biopsy. Histopathological examination served as the gold standard for diagnostic accuracy calculation.

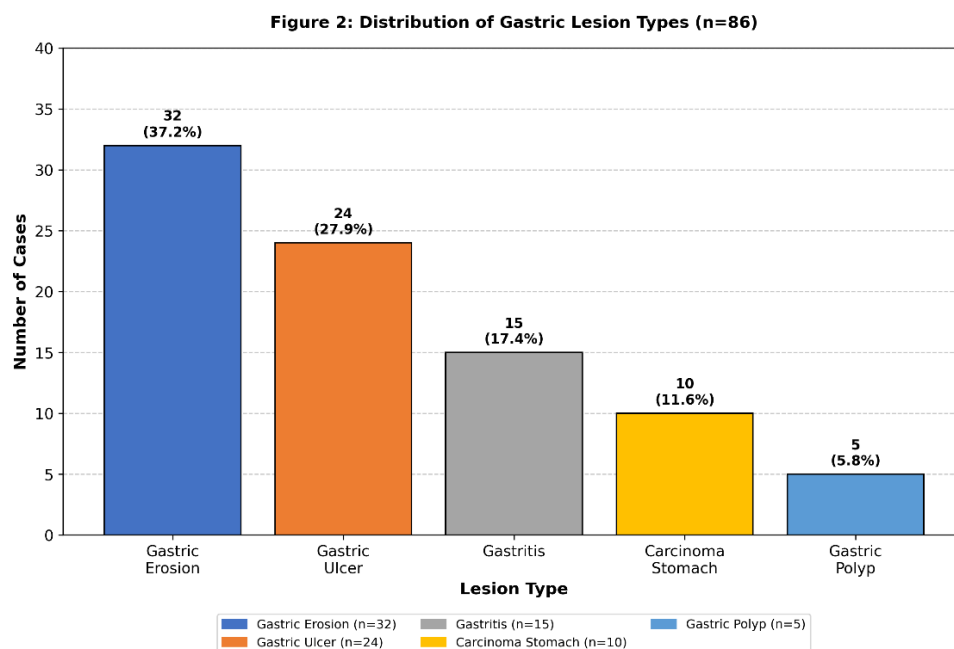


Figure 2: Distribution of gastric lesion types. Gastric erosion was the most common lesion (37.2%), followed by gastric ulcer (27.9%), gastritis (17.4%), carcinoma (11.6%) and polyp (5.8%). Legend is displayed below the x-axis.

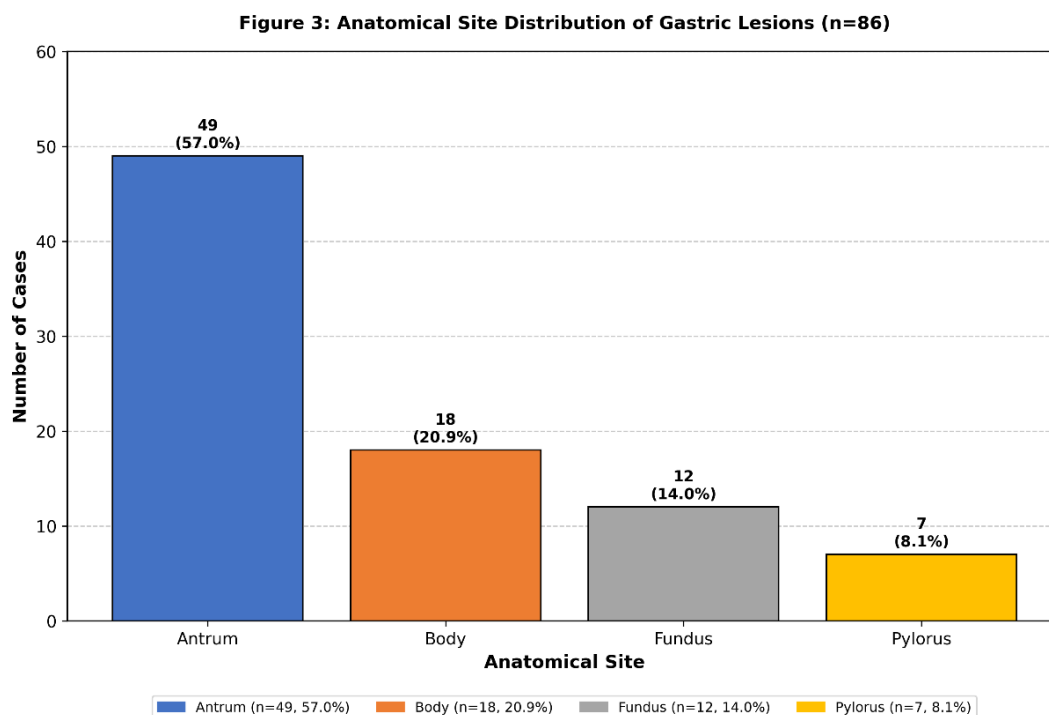


Figure 3: Anatomical site distribution of gastric lesions. The antrum was the most common site (57.0%), followed by body (20.9%), fundus (14.0%) and pylorus (8.1%). Legend is displayed below the x-axis.

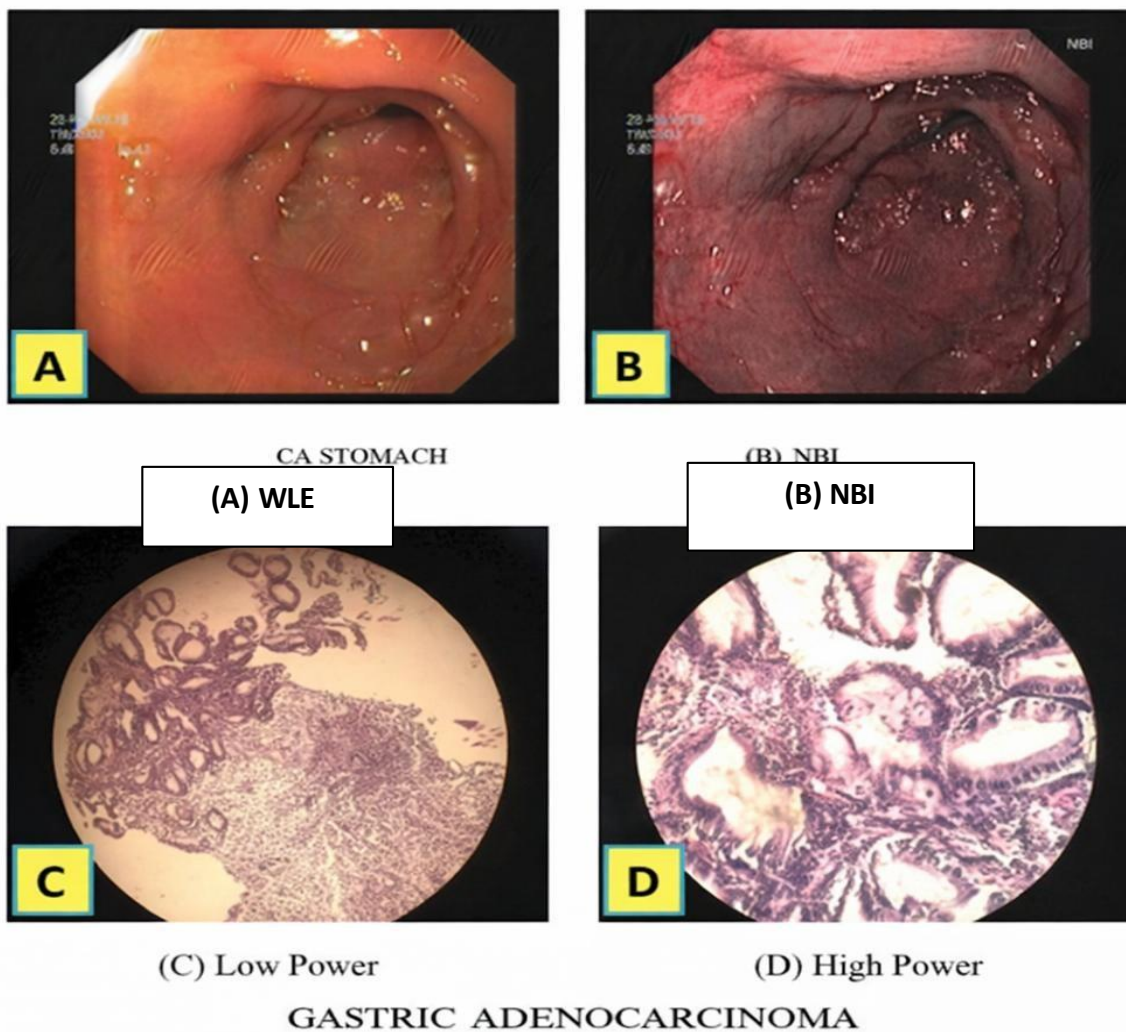


Figure 4: Representative endoscopic and histopathological images. (A) Gastric carcinoma on white light endoscopy showing ulcerated lesion. (B) Same lesion on narrow band imaging demonstrating enhanced visualisation of irregular microvascular pattern and demarcation line. (C) Histopathology at low power magnification showing adenocarcinoma. (D) Histopathology at high power magnification confirming moderately-differentiated adenocarcinoma.



Figure 5. OLYMPUS EVIS EXERA II GASTROVIDEOSCOPE WITH NBI

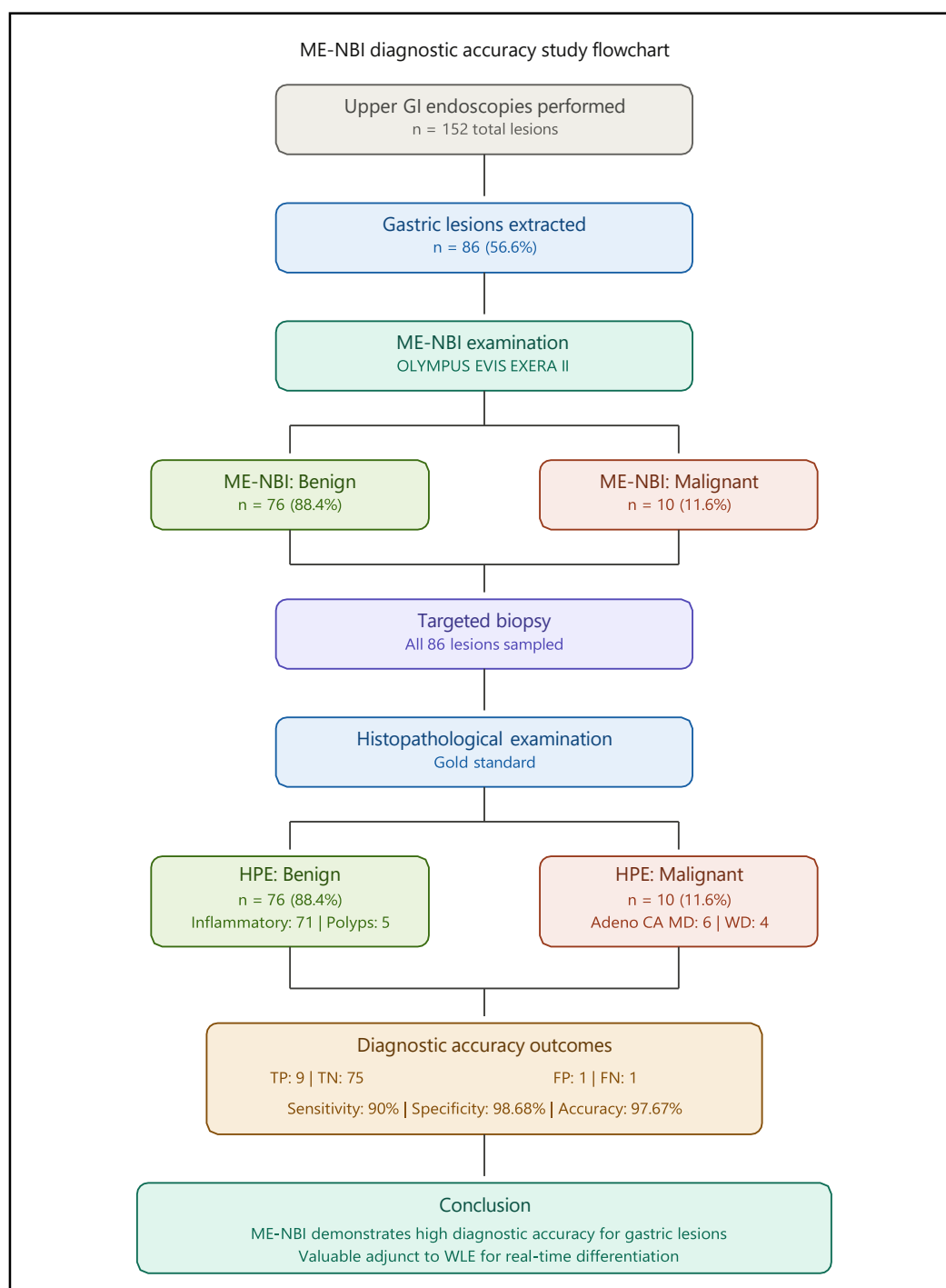


Figure 6 – Shows the overall flowchart of the study with results, findings, diagnostic outcomes and conclusions.

The main reason for the high diagnostic accuracy of ME-NBI is that it is able to better visualize mucosal microstructure and microvascular architecture. 415 nm blue light is absorbed by haemoglobin in the superficial capillaries and appears brownish on NBI; 540 nm green light is able to penetrate deeper to reveal submucosal vessels which appear cyan.^{5,6} Malignant transformation is linked to neoangiogenesis and architectural distortion (manifesting as irregular microvascular pattern (IMVP) and irregular microsurface pattern (IMSP) on ME-NBI).^{7,8} In addition, the demarcation line (DL) of normal and abnormal mucosa is also a good indication for cancer and non-cancerous tumours. On the VS classification system, if IMVP or IMSP are present in the DL, 97% of early gastric carcinomas can be diagnosed at the moment of diagnosis.⁷

This is particularly relevant in resource-limited settings where histopathological services may be constrained. The specificity suggests that ME-NBI could potentially reduce unnecessary biopsies in clearly benign lesions, but clinical judgment should be exercised in equivocal cases. ME-NBI could also play an important role in surveillance of high-risk patients, such as those with *Helicobacter pylori* infection or intestinal metaplasia.

The advantages of this study are its prospective design, the gold standard HPE for all lesions, single-centre approach to technique and interpretation, and specific focus on gastric lesions. Furthermore, the study provides validation for a neglected population in Northeast India.

There are several limitations to the study. (A) the study was a single-centre study, which limits generalisability. (B) due to the small sample size (n=10) for the malignant lesions, analysis of the subgroups is not statistically strong. (C) we have a single endoscopist who conducts the tests, so we cannot distinguish variables in the interobserver variation. (D) we did not follow up on the benign cases for years to avoid false negatives. (E) the operator-dependent nature of ME-NBI and its learning curve may affect reproducibility in non-expert hands. The high cost of ME-NBI equipment may also be a barrier to widespread adoption in resource-constrained circumstances.

Future work would need to include multicentre validation with larger sample sizes, assessment of interobserver variability, long-term outcome studies, and artificial intelligence integration for automated pattern recognition. Cost-effectiveness analyses comparing ME-NBI with conventional WLE and random biopsy strategies would also be useful.

CONCLUSION

Magnifying endoscopy with narrow band imaging demonstrates high diagnostic accuracy (97.67%) for gastric lesion characterisation, with excellent specificity (98.68%) and good sensitivity (90.00%). These results are comparable to international literature, validating the applicability of ME-NBI in the Indian population. The antrum was identified as the most common site for gastric pathology and adenocarcinoma was the predominant gastric malignancy. ME-NBI enables real-time differentiation of benign from malignant gastric lesions at the point of care, facilitating targeted biopsy guidance and potentially reducing sampling errors. It is a valuable adjunct to conventional white light endoscopy in clinical practice. Further multicentre studies with larger sample sizes are warranted for widespread clinical adoption and integration with artificial intelligence holds promise for enhancing diagnostic capabilities.

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