Magnifying Endoscopy and Chromoendoscopy of the Upper Gastrointestinal Tract

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Abstract

Magnifying endoscopy has been developed to visualize the microstructure of gastrointestinal surface mucosa and mucosal vascularity. Magnifying endoscopy is starting to play an important role in the diagnosis of upper gastrointestinal diseases: Barrett’s esophagus, atrophic gastritis, Helicobacter pylori-induced gastritis, gastric neoplasm. Chromoendoscopy in conjunction with magnifying endoscopy improves diagnostic accuracy and allows the early detection of premalignant and malignant lesions. Standardization of the procedural methodology and consensus terminology of the mucosal patterns are crucial.

Key words

Magnifying endoscopy – chromoendoscopy – malignant and pre-malignant lesions.

Introduction

The early detection of upper gastrointestinal cancers improves the rate of survival in patients presenting with such lesions. This can be achieved using conventional endoscopy combining multiple biopsy sampling from suspicious areas of mucosa with “blind” biopsy sampling of normal-appearing mucosa. Although this method is considered to be the gold standard for the surveillance of premalignant conditions of the upper gastrointestinal tract, it entails significant resource utilization for both the gastroenterology and morphopathology departments.

The development of new endoscopic techniques has improved the detection of dysplasia and early stage cancers, providing the opportunity for reduced morbidity and mortality for patients presenting with these lesions. These techniques enhance the accuracy of diagnostic endoscopy, most particularly with regard to analyzing lesion extension, which is critical for assessing the potential for endoscopic mucosal resection.

Basic principles

Magnifying endoscopy enhances the visualization of mucosal details by enlarging the image. Magnifying endoscopes have an optical zooming mechanism composed of a movable motor-driven lens in the tip of the scope. By controlling the focal distance, the scope can approach the mucosal surface extremely closely, thereby providing a magnified image of up to 200x. The resulting image produces detailed visualization of the fine structures of the mucosa.

A short transparent cap placed at the tip of the endoscope helps to fix the position of the tip near to the mucosal surface. The procedure is time consuming because of the difficulty in maintaining the tip of the endoscope at a fixed and short distance from the mucosa, which is constantly moving due to respiratory effort, cardiac function, esophageal contractions and gastric motility [1].

Magnifying endoscopy by itself can demonstrate the fine details of the mucosa, but the mucosal pattern can be enhanced by the addition of contrast agents.

The development of magnifying endoscopes has increased interest in chromoendoscopy. Surface analysis allows the differentiation of different staining patterns.

Agents used for chromoendoscopy are categorized according to their working principles [2]. Vital stains such as methylene blue are absorbed into the cells. Methylene blue selectively stains specialized columnar epithelium in Barrett’s esophagus with high accuracy. Contrast stains such as indigo carmine accumulate in the pits and valleys between the cells, highlighting the mucosal architecture.

Acetic acid, a weak acid and the smallest of the fatty acids, interacts with the glycoprotein layer which covers the mucosa and breaks disulphide bonds resulting in a higher contrast of the surface epithelium. The concentration of glacial acetic acid solution that should be used is freshly...
1.5% with a pH range of 2.5-3.0 [3]. Acetic acid testing helps in assessing the pit pattern of the columnar epithelium. Elective indications include exploration of the epithelial junction at the cardia and analysis of columnar metaplasia in Barrett’s esophagus. Other applications include the analysis of intestinal metaplasia in the stomach [3].

Clinical applications

Barrett’s esophagus

Strategies for an improved survival rate among patients with adenocarcinoma of the esophagus focus on improving the diagnosis of Barrett’s esophagus, on better identification of dysplasia and on detection of cancer at earlier and potentially curable stages.

Methylene blue selectively stains specialized columnar epithelium in Barrett’s esophagus with high accuracy. Intestinal metaplasia typically stains uniformly blue, while lighter intensity staining and increased heterogeneity in the staining pattern predicts high grade dysplasia or malignancy [2].

For methylene blue the application of a mucolytic agent (N-acetylcysteine) is required prior to staining. The examination technique consists of the application of N-acetylcysteine via a spray catheter followed by 20 ml of 0.5% methylene blue. After waiting 4 minutes, which is required to permit the absorption of methylene blue, the excess dye is washed off with 200-300 ml water (Fig. 1). The mucosal pattern is then analyzed using the magnifying technique (Fig. 2). Methylene blue staining assists in identifying areas most at risk for developing cancer and allows biopsies to be obtained from these areas.

Magnification coupled with the application of methylene blue is capable of distinguishing between areas of intestinal metaplasia and areas with a fundic or cardial type of metaplasia.

Endo and colleagues have introduced a surface-pattern classification for Barrett’s esophagus after methylene blue staining [4]. These authors showed that a villous and a tubular staining pattern was consistently associated with the presence of Barrett’s esophagus (Fig. 2), whereas small round and straight pits were indicative of the gastric type of epithelium.

Gastritis

Magnifying endoscopy is used to visualize the microstructure and microvascular architecture of gastric surface mucosa. Microsurface structure of the mucosa is named pit pattern. Mucosal microvasculature represents the capillary loops surrounding the necks of gastric pits and collecting venules, which drain in the submucosa [5].

The normal gastric body mucosal pattern consists of regular, round pits, a honeycomb shaped sub-epithelial capillary network (SECN), and collecting venules, all arranged in a regular configuration [6].

In normal antral mucosa the SECN is coil-shaped. Collecting venules lie in a deeper layer and cannot be seen. Figs. 3 and 4 show images of normal gastric mucosa pattern.

Many studies have found an increased cumulative risk of gastric cancer and precancerous conditions in individuals with Helicobacter Pylori (HP) infection. The gastric mucosa undergoes progressive phenotypical changes, from chronic active gastritis to gastric atrophy, intestinal metaplasia and gastric dysplasia. Each of these morphological alterations is associated with an increased risk for gastric cancer.

Magnified views of the corpus of the normal stomach without HP infection show a characteristic structure, while the HP infected stomach has an entirely different structural pattern. In HP-associated gastritis there is either loss of collecting venules with honeycomb type SECN and regular, round pits, or there is loss of the normal SECN and collecting venules with enlarged white pits surrounded by erythema [7]. Neither collecting venules, nor capillaries can be seen in Fig.5, corresponding to HP-associated gastritis. The loss of collecting venules has a sensitivity and specificity up to 100% for the presence of HP infection, according to British and Japanese investigators [6, 7].

In gastric atrophy (Fig.6), there is a loss of normal SECN and round pits, with irregular arrangement of the collecting venules [7].

The identification of HP induced gastritis and atrophic gastritis could increase the detection of early malignant changes in the mucosa. The changes in the morphology of the gastric mucosa can be monitored before and after
eradication of HP through the comparison of magnified views with histological findings [8].

**Gastric polyps**

Perfect agreement regarding the endoscopic appearance of different gastric polyps does not exist. Hyperplastic polyps may show a reddish, coarse pattern on magnifying endoscopy, which reflects the enlargement of pits caused by congestion and edema of the interstitium. Gastric adenomas may exhibit a white, minute, and regular mucosal pattern on magnification, which reflects the flat surface structure composed of compact and regular pits [9]. Figs. 7 and 8 show images of gastric polyps.

**Gastric cancer**

Chromoendoscopy in conjunction with magnifying endoscopy is used for the early detection of malignant lesions. A volume of 10 ml of freshly prepared acetic acid solution (1-3%) is instilled through a spray catheter introduced into the working channel of the endoscope. Magnification endoscopy with acetic acid has two objectives: identification of areas of intestinal metaplasia and the identification of dysplasia and superficial cancer within these areas. Selective biopsies from areas with a suspicious mucosal architecture or vascular pattern allow correlation between endoscopic appearances and histological findings.

Japanese studies show irregularity and destruction of the minute surface pattern, which is recognized as being specific...
to cancerous lesions \[6, 10\]. For early gastric cancer, the disappearance of the SECN, accompanied by proliferating microvessels in an irregular pattern has been described \[11, 12\]. The proliferating vessels vary in size, shape and distribution \[5, 13\]. In Fig. 9 areas with hypervascularisation and irregular or absent surface pattern correspond to high grade intraepithelial neoplasia (HGIEN). The biopsy specimen reveals the presence of HGIEN.

In conclusion, magnifying endoscopy offers a new standard for investigation of gastrointestinal mucosa. Optical magnification increases the yield of information on the mucosal surface and magnified images are comparable with images obtained using the dissecting microscope. The application of chromoendoscopy and magnifying endoscopy in the upper gastrointestinal tract requires further study through large prospective trials in order to determine intra- and inter-observer variability. Additionally, standardization of the procedural methodology as well as standardization of the descriptive terminology of the distinct mucosal patterns are imperative \[14\]. With these improvements, magnifying endoscopy and chromoendoscopy have the potential to improve significantly both diagnostic accuracy and patient outcome.

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Conflicts of interest

Nothing to declare.

References


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Fig 9. High grade intraepithelial neoplasia: conventional endoscopy (a); magnifying endoscopy – irregular pattern (b,c) and hypervascularization (d); histologic findings – biopsy (e), resected specimen (f)
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