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Enteroscopy: Advances in diagnostic imaging

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Routine endoscopic imaging of the small bowel is performed with videoendoscopic white light technology. However, currently there are many new methods that improve our visual acuity when evaluating the small bowel mucosa. These methods are collectively called “advanced endoscopic imaging”. These imaging methods include high-definition white light endoscopy, standard and dye-less or “virtual” chromoendoscopy, magnification endoscopy and confocal laser endomicroscopy. Regardless of the method used to image the small bowel the endosocopist needs to pay attention to detail and focus on three essential aspects: a) the shape of the lesion, b) the superficial mucosal detail (i.e. “pit pattern”) and c) the submucosal vascular pattern. This review describes advances in the endoscopic imaging methods to study the small bowel.

Introduction

The main aim of endoscopic visualisation of the luminal gastrointestinal tract is to detect mucosal pathologies by studying the composition and distribution of folds, studying the mucosal detail (i.e. appearance of the villi) and viewing of the submucosal vascular pattern [1–3]. All endoscopic imaging techniques further increase our ability to describe, delineate and characterise abnormal structures and lesions in great detail [3–5]. Standard white light endoscopes permit gross examination of the small bowel mucosa permitting the recognition of minor and major defects such as erosions, ulcers,

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lymphangiectasias or abnormal duodenal folds. The water immersion technique increases our ability to inspect the small bowel villi by magnifying the view as well as providing a soluble medium where the villi and other superficial structures appear bigger and "move" inside the water [6–8]. This technique can be very helpful when investigating conditions associated with villous atrophy such as celiac disease and other malabsorption syndromes [6,7]. Magnification or zoom endoscopy further increases our ability to analyse the mucosal detail [9,10]. By applying dyes and magnifying the mucosa (magnification chromoendoscopy) further architectural detail of the mucosa can be elucidated [10,11]. New dyeless or virtual chromoendoscopy techniques such as narrow band imaging (NBI), i-scan and Fujinon intelligent color enhancement (FICE) have further enhanced our optical capabilities for the evaluation of enteric mucosal and submucosal lesions [5,12–14]. Endocytoscopy and confocal laser endomicroscopy are currently the most advanced endoscopic techniques [3,15–18]. When using confocal laser endoscopy the targeted structure is magnified in such a way that a virtual histology image ("*in vivo* histology") is achieved [16–18]. We believe that in the near future confocal endomicroscopy may further help characterise and diagnose diseases affecting the small bowel such as celiac disease, Crohn's disease, infections, vasculitis, mesenteric ischaemia and angiodysplasias, among others. Table 1 shows a list of diseases resulting in destruction of the mucosa and submucosa of the small bowel. This review describes advances in the endoscopic imaging methods to study the small bowel.

Principles of endoscopic inspection

The basic concept behind endoscopic imaging is the visualisation and characterisation of the lesion's shape and its mucosal and submucosal architecture [1,2]. All benign or malignant mucosal and submucosal lesions will "stand out" from its surroundings by virtue of various characteristics such as growth, excavation, protrusion, villous destruction, villous flattening and submucosal vessel architecture [2].

Mucosal analysis

In the small bowel the main "player" is the villus, of which there exist several billion (Fig. 1A and B). Each villus is a unique "unit" that has a layer or coat of various types of cells, which have different functions and degrees of maturation from base to tip. Inside the villi there is a fine venocapillary and lymphatic network that is responsible for homeostasis, bringing oxygen to the cells and transporting absorbed elements (Fig. 2). During inflammatory, neoplastic, angiogenetic and infiltrative porcesses this minute vessels become deranged and this can be observed at varying degrees with existing endoscopic imaging methods. In addition, any mucosal or submucosal lesion will have a superficial epithelial "pattern" (e.g. "pit pattern") and characteristic borders which result from absorbance,

Table 1
Examples of various diseases resulting in small bowel mucosal and submucosal abnormalities.

Luminal or mucosal destruction
Ulcerative, inflammatory and/or autoimmune diseases
Crohn's disease
Ulcerative jejunitis
Eosinophilic gastroenteritis
Vasculitis: Churg-Strauss, polyarteritis nodosa
Celiac disease
Tropical sprue
Giardia lamblia
Strongyloides stecoralis
Infiltrative or submucosal destruction
Mastocytosis
Whipple's disease
Neoplastic or proliferative (lymphoma, metastasis)
Adenomas
Peutz–Jeghers syndrome
Cronkhite Canada syndrome