Development of Image-enhanced Endoscopy of the Gastrointestinal Tract

A Review of History and Current Evidences

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Abstract: Endoscopy imaging of the gastrointestinal (GI) tract has evolved tremendously over the last few decades. Key milestones in the development of endoscopy imaging include the use of various dyes for chromoendoscopy, the introduction of optical magnification in endoscopy, the introduction of high-definition image capturing and display technology and the application of altered illuminating light to achieve vascular and surface enhancement. Aims of this review paper are to summarize the development and evolution of modern endoscopy imaging and in particular, image-enhanced endoscopy (IEE), to promote appropriate usage, and to guide future development of good endoscopy practice. A search of PubMed database was performed to identify articles related to IEE of the GI tract. Where appropriate, landmark trials and high-quality meta-analyses and systematic reviews were used in the discussion. In this review, the developments and evolutions in endoscopy imaging and in particular, IEE, were summarized into discernible eras and the literature evidence with regard to the strengths and weaknesses in term of their detection and characterization capability in each of these eras were discussed. It is in the authors' opinion that IEE is capable of fairly good detection and accurate characterization of various GI lesions but such benefits may not be readily reaped by those who are new in the field of luminal endoscopy. Exposure and training in making confident diagnoses using these endoscopy imaging technologies are required in tandem with these new developments in order to fully embrace and adopt the benefits.

Key Words: chromoendoscopy, endoscopy imaging, image-enhanced endoscopy, magnifying endoscopy, narrow band imaging

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Advancements in endoscopy imaging of the gastrointestinal (GI) tract have progressed by leaps and bounds over the last few decades. From the first introduction of rigid gastroscope lighted by turpentine oil in the early 19th century to the launch of flexible fibroscope in the 1960s; from the introduction of image sensor in the form of charge-coupled device in 1983 to the initiation of high-definition (HD) technology in the early 2000s and subsequently to the recent launch of 4K technology; from the dye-based image-enhanced endoscopy (IEE) or conventional chromoendoscopy (CE) in 1970s to the introduction of equipment-based IEE or optical-digital CE in 2005; new innovations are being continuously introduced which have changed GI endoscopy from a mere observational tool to a sophisticated real time diagnostic tool. We are witnessing a gradual but inevitable change in the world of GI endoscopy which is shaping the future landscape of endoscopy practice. Aims of this review paper are, therefore, to summarize the development and evolution of endoscopy imaging and in particular, IEE, to promote appropriate usage, and to guide future development of good endoscopy practice.

The cornerstone of a good diagnostic endoscopy entails good detection of various GI lesions followed by characterization of the detected lesions in terms of differentiation of such lesions into neoplastic and non-neoplastic types and delineation of their lateral (border) and vertical margin (depth).

The introduction of the fiber-optic endoscopy in 1963 ushered in a new era in GI endoscopy and started an unsurpassed period of technological advancement in the construction of scopes. It can be largely divided into 4 eras based on the innovation milestones and their clinical impacts in the field of GI endoscopy. Table 1 summarizes the characteristics (properties, enhancement effect, and clinical improvement) of each of these eras.

METHODS

A PubMed literature search was performed using keywords such as “chromoendoscopy,” “endoscopy imaging,” “image-enhanced endoscopy,” “magnifying endoscopy,” “narrow band imaging,” “autofluorescence imaging,” “i-Scan,” “flexible spectral imaging color enhancement,” “blue laser imaging,” and “linked color imaging.” Further articles were obtained through the review of the quoted references from the selected articles. In general, landmark trials of significant impact and conclusion from high quality meta-analyses and systematic reviews were used in the discussion. However, for new or emerging technology where the literature is scarce, articles with other study design were also included.