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ORIGINAL ARTICLE

Higher net change of index of hemoglobin values between colon polyp and nonpolyp mucosa correlates with the presence of an advanced colon adenoma

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KEYWORDS
Advanced colon lesion;
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Summary *Background:* The index of hemoglobin (IHb) has not been applied in colonoscopy to correlate the histological features of colon polyps. This study tested whether the net change of IHb values between polyp and normal mucosa correlates with the pathological features of colon polyps.
Patients and methods: This study consecutively enrolled patients who underwent colonoscopy during September 2011–August 2012 in a single tertiary referral colorectal unit. Endoscopic pictures and IHb values of each part of the colon were taken at the levels of cecum, ascending colon, transverse colon, sigmoid colon, and rectum. The net change of IHb values was calculated as follows: IHb value of colon polyp minus that of the surrounding mucosa.
Results: A total of 117 patients (32 with hyperplastic polyp, 5 with sessile serrated adenoma, 53 with tubular adenoma, 10 with villotubular adenoma, and 3 with adenocarcinoma) were recruited. The net change of IHb values increased in following order: hyperplastic polyp, tubular adenoma, sessile serrated adenoma, villotubular adenoma, and adenocarcinoma (-3.8 ± 6.3, -1.2 ± 1.7, -1.2 ± 5.7, 2.9 ± 8.1, and 12.7 ± 9.3, respectively; $p < 0.001$). Alcohol drinking and serum hemoglobin level were two independent factors related to the IHb values of nonpolyp colon mucosa. Using a cutoff value of 2.4 for the net change of IHb values, selected based on the receiver operating characteristic curve analysis, the optimal sensitivity (52.9%)

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and specificity (75.6%) could be achieved for defining the polyp histology as an advanced colon lesion.
Conclusion: The net change of IHb values between colon polyp and nonpolyp mucosa can correlate with the pathological features of colon polyps. A positive net change of IHb values may indicate a more adverse histological pattern with a higher malignant potential.
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Introduction

Colorectal cancer is the third leading cause of cancer death in Taiwan [1]. An early screening with colonoscopy offers benefits such as interruption of the adenoma—carcinoma sequence of colorectal cancer [2,3]. Endoscopic diagnosis of the colorectal disease is based on the observation of the color tone and the structure of lesion mucosa to predict the underlying pathological change. Despite the color change of the lesion being important for diagnosis, only subjective and descriptive terms can be provided in the endoscopic report. Thus, a more objective and quantitative measurement is really needed to define the exact degree of mucosal change or even to implicate the clinical—pathological significance.

The index of hemoglobin (IHb) can be used objectively to evaluate the hemoglobin (Hb) content in gastrointestinal mucosa instantly during endoscopy. It was designed based on the detection of the peak absorption of light by Hb, to objectively measure the mucosal redness [4]. The IHb assessed during gastrointestinal endoscopy can detect the gastric *Helicobacter pylori* infection [5,6], predict the treatment response to erosive reflux esophagitis [7], and facilitate the detection of malignant gastric or colonic lesions [8,9]. The study further determined whether the IHb modality in colonoscopy can be correlated with the adenoma carcinoma sequence and can predict the malignant risk of colon polyp instantly during colonoscopy.

Materials and methods

Patients and demographic background

The study consecutively enrolled patients who underwent colonoscopy during September 2011 to August 2012, in the Endoscopy Room of National Cheng Kung University Hospital, a tertiary referral medical center in southern Taiwan. All elective colonoscopies performed during the study period were screened for eligibility. Patients with poor bowel preparation, failure of cecal intubation, contraindication for biopsy or polypectomy, previous operation with altered vasculature at colorectal area, previous malignant diseases with a systemic chemotherapy history, and a history of inflammatory bowel disease, and those under 18 years of age were excluded. In addition, patients who declined to be a part of the study were also excluded. Prior to data collection, approval was obtained from the Institutional Review Board of National Cheng Kung University Hospital, Tainan, Taiwan.

Data on smoking, alcohol consumption, antihypertension medication, aspirin or clopidogrel use, body weight, body height, and body mass index were collected from the medical records. Laboratory data including those on blood Hb and creatinine levels were recorded.

Colonoscopy and IHb value acquisition

In this study, lower gastrointestinal electronic endoscopes (CF-Q260AL; Olympus Optical, Tokyo, Japan) were used as the standard equipment in all procedures. An endoscopic image database system (EVIS-NET) was used to take white light pictures and the IHb images on a personal computer equipped with a 24-bit color image capture board. During colonoscopy study, cecal intubation was achieved first and the adequacy of colon preparation was recorded. Endoscopic pictures were taken at normal mucosa of each part of the colon, including cecum, ascending colon, transverse colon, sigmoid colon, and rectum. IHb values were instantaneously measured by endoscopy image system on the frozen image and stored for further analysis. During measurement of IHb values of normal mucosa, endoscopists would make sure that there were no other lesions (such as arteriovenous malformation or diverticulum) in the field to avoid interference. Both white light pictures and IHb chart pictures with IHb values were recorded. The IHb value of each part of the colon is defined as the mean of two measurements on frozen endoscopic images when the endoscopic tip is placed at each level with 2 cm distance from normal mucosa.

For the area of detected polyps during screening colonoscopy, the white light images and the IHb chart with IHb values over the polyp and the adjacent normal mucosa were taken and recorded in pairs to obtain the net change of IHb values, defined as the difference between the IHb value of colon polyp and that of the adjacent nonpolyp mucosa. The size of each polyp was documented, and the final pathology would also be retrieved for analysis after complete removal of the polyp.

Statistical analysis

We first examined the clinical characteristics associated with IHb values of normal colon mucosa. Pearson's correlation was used to determine the correlation between blood Hb and mucosal IHb value. Next, we calculated the

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