Basal Indentation Due to a Function of Geometry on CT Air-Contrast Enema for Sessile Colorectal Polyps: Quantitative Evaluation using Cross-Sectional Multiplanar Reconstruction

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Abstract

Objective: Basal Indentation (BI) on CT air-contrast enema (CT enema) for colorectal cancer consists essentially of the both factors of a function of geometry and a tumor invasion. This study was conducted to investigate the feasibility of quantitative evaluation of the basal indentation due to a function of geometry (BI-G) on CT enema for colorectal polyps using Cross-Sectional Multiplanar Reconstruction (CS-MPR) images.

Materials and Methods: The study group consisted of 21 patients with 37 sessile colorectal polyps that were pathologically confirmed as restricted to the mucosa. We calculated the maximal depth of BI-G (max BI-G) on CT enema for colorectal polyps, and compared the max BI-G with the estimated max BI-G (e-max BI-G), which was calculated using the CS-MPR images.

Results: A strong positive correlation was found between e-max BI-G and max BI-G ($R^2=0.91$, $P<0.0001$), although there was a significant difference in the mean values between e-max BI-G and max BI-G (0.64 ± 0.52 mm and 0.51 ± 0.73 mm, respectively; $P<0.05$).

Conclusion: CS-MPR is effective for quantitative evaluation of BI-G on CT enema for sessile colorectal polyps. Such evaluation may lead to improvement of the diagnostic accuracy of the invasion depth of colorectal cancers.

INTRODUCTION

Basal Indentation (BI), an intestinal deformity in the profile view of a barium enema for colorectal cancer, consists essentially of the both factors of a function of geometry and a tumor invasion [1-6]. Maruyama et al. demonstrated that BI is one of the most important indicators for the diagnosis of Colorectal Cancer (CRC) by barium enema [3]. On the other hand, Ament et al. demonstrated that BI due to a Geometric function (BI-G) was seen for all polyps by barium enema in both patients and colon phantoms [1]. According to the theorem of Pythagoras, the max depth of BI-G (max BI-G) depends on both the diameter of the intestine and the size of the colorectal polyp at the cross-sectional view of the intestine [1].

CT Colonography (CTC) is generally useful as a preoperative or screening examination for CRC [7-10]. CT air-contrast enema (CT enema), also known as “virtual barium enema,” is a three-
central thickness 1 mm, reconstruction interval 1 mm. Intravenous parameters: 120 kV, 200-300 mA, beam collimation 1 mm, slice (Toshiba Medical Systems Corporation) with the following systems corporation, tokyo) or a 64-slice MDCT (Aquilion64; toshiba medical systems corporation) with the following tomography (MDCT) scanner (Aquilion 16; toshiba medical systems corporation). Performed using either a 16-slice multi-detector-row computed tomography (CT) procedure. If the dilatation of the large intestine on a scout image was inadequate, additional room air was injected. CTCs were performed using a 64-slice MDCT (Aquilion64; toshiba medical systems corporation) with the following parameters: 120 kV, 200-300 mA, beam collimation 1 mm, slice thickness 1 mm, reconstruction interval 1 mm. Intravenous (IV) contrast media was used for 15 of the 21 patients. The IV contrast media could not be used in the remaining 6 patients due to contraindications.

All patients underwent both supine and prone scans. In patients for whom IV contrast media were used, CT images were obtained 40 s, 70 s and 240 s after the IV administration of 100 mL nonionic iodine contrast media (iopamiron 300; Bayer Health Care, Osaka, Japan) at a rate of 3 mL/s in the supine position (40 s and 70 s) and in the prone position (240 s). The MDCT data sets were loaded onto a workstation (Synapse Vincent, Fujifilm Medical, Tokyo). After all image data sets were transferred to the workstation, they were converted into 2D images of Multiplanar Reformation (MPR) and 3D images (i.e., CT enema images and virtual endoscopic images) using onboard software.

Image analysis

First, the colorectal polyps were identified using MPR images, virtual endoscopic images and CT enema images. Subsequently, CT enema images in the location of the colorectal polyps were extracted using the best distended series in the supine or prone position, and the max BI-G on the CT enema in the colorectal polyps was calculated based on the consensus of two gastrointestinal radiologists who had 13 years and 14 years of experience. Additionally, CS-MPR images that were equivalent to the short-axis view of the intestine were obtained at the level of the polyps, and the estimated max BI-G (e-max BI-G) was calculated based on the consensus of the two gastrointestinal radiologists using the CS-MPR images with the theorem of Pythagoras as follows: e-max BI-G = D/2 √(D/2)^2 - (L/2)^2; D, the diameter of the intestine; L, the size of the lesion (Figure 1).

Finally, we compared the max BI-G with the e-max BI-G.

Statistical analysis

All data are presented as the mean ± SD. Differences between the mean values of the max BI-G and e-max BI-G were assessed using the paired t-test. We also examined the correlation between the max BI-G and e-max BI-G with a Pearson correlation analysis. All statistical analyses were performed using JMP software (JMP version 9.0.2; sas institute inc., Cary, NC). P-values < 0.05 were considered significant.

Results

The characteristics of colorectal polyps are summarized in Table 1. The average size of the polyps was 9.8 ± 4.1 mm (range 5-22 mm). BI-G was detected in 21 (57%) of the 37 polyps, and was not detected in the other 16 (43%) polyps. There was a significant difference in the mean values between e-max BI-G in the polyps in which BI-G was detected and those in which BI-G was not detected (0.97 ± 0.85 mm and 0.24 ± 0.09 mm, respectively; P < 0.05). Moreover, a strong positive correlation was found between max BI-G and e-max BI-G (R^2 = 0.91, P < 0.0001) (Figure 2), although there was a significant difference in the mean values between e-max BI-G and max BI-G (0.64 ± 0.52 mm and 0.51 ± 0.73 mm, respectively; P < 0.05).

Discussion

When using the profile view of a barium enema or CT enema to diagnosis the depth of CRC, BI-G is of the same importance as...
Miyasaka et al. (2013)

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Figure 1 Methods to calculate max BI and e-max BI (52-year-old man with rectal polyp). Optical (a) and virtual (b) endoscopic images show sessile rectal polyp. The max BI-G (double-headed arrow, d; d is the magnification of panel c) was defined as length from the line joining both sides of the bottom of the polyp (arrow, c) to the top of the BI at the profile view on a CT enema image (c). The diameter of the intestine and the size of the lesion needed to calculate the e-max BI-G were measured with a CS-MPR image in the short-axis view of the intestine in which the polyps existed (e). D, diameter of intestine; L, size of lesion. Diagram and calculating formula (f) show the method used to calculate the e-max BI-G using the theorem of Pythagoras in panel e.

BI due to tumor invasion. Ament et al. and Kayashima et al. have shown that BI-G was detectable for all elevated lesions on barium enema and CT enema images using colon phantoms [2,13]. According to the theorem of Pythagoras, the max BI-G depends on both the diameter of the intestine at the polyp’s location and the diameter of polyps at the basement on a cross-sectional view. Namely, the larger the diameter of the polyp in the basement, the larger the max BI-G. In contrast, the smaller the diameter of the intestine, the larger the max BI-G. Although BI due to a tumor invasion is considered to occur in colorectal cancers of the submucosa or deeper, it is difficult to differentiate BI-G from BI due to a tumor invasion on CT enema for invasive CRC.

One of the biggest advantages of CTC is that it permits the evaluation of not only BI on CT enema but also e-max BI-G, which is theoretically equivalent to max BI-G, using CS-MPR. In the present study, a strong positive correlation was found between max BI-G and e-max BI-G for the colorectal intramucosal tumor lacking BI due to tumor invasion. Our results suggested that it was possible to quantitatively evaluate BI-G on CT enema using CS-MPR for colorectal tumors. The quantitative evaluation of BI-G on CT enema may lead to improvement of the depth diagnostic

CONCLUSION

CS-MPR is effective for the quantitative evaluation of BI-G on CT enema for sessile colorectal polyps. Such evaluation may be useful in the depth diagnosis by BI on CT enema in patients with early CRC.

ACKNOWLEDGEMENT

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REFERENCES


Table 1: Characteristics of the colorectal polyps examined.

<table>
<thead>
<tr>
<th>Polyp Location</th>
<th>Number of lesions (n=37)</th>
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<tbody>
<tr>
<td>Cecum</td>
<td>0 (0%)</td>
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<tr>
<td>Ascending colon</td>
<td>4 (10.8%)</td>
</tr>
<tr>
<td>Transverse colon</td>
<td>3 (8.1%)</td>
</tr>
<tr>
<td>Descending colon</td>
<td>4 (10.8%)</td>
</tr>
<tr>
<td>Sigmoid colon</td>
<td>20 (54.1%)</td>
</tr>
<tr>
<td>Rectum</td>
<td>6 (16.2%)</td>
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<tr>
<td>Polyp size</td>
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</tr>
<tr>
<td>≤ 9mm</td>
<td>21 (56.8%)</td>
</tr>
<tr>
<td>10-19mm</td>
<td>14 (37.8%)</td>
</tr>
<tr>
<td>≥ 20mm</td>
<td>2 (5.4%)</td>
</tr>
<tr>
<td>Histological classification</td>
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<tr>
<td>Adenoma (tubular)</td>
<td>31 (83.8%)</td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>4 (10.8%)</td>
</tr>
<tr>
<td>Inflammatory polyp</td>
<td>2 (5.4%)</td>
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