Colorectal carcinoma with stenosis: Findings on three-dimensional helical CT using air contrast

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The aim of this study was to determine whether helical CT provides useful additional information in patients with obstructive colorectal tumors. To visualize lesions in a hollow viscus and their three-dimensional extent, helical CT was performed using air as the contrast medium. In six colorectal cancer patients with bowel stricture or obstruction, helical CT demonstrated the three-dimensional extent of the lesion proximal to the tumor site, which could not have been visualized by ordinary barium enema or colonoscopy. Using air as the contrast medium, helical CT can be effective for detecting co-existing abnormalities of the colon and rectum proximal to the site of stricture or obstruction by a tumor.

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With the recent development of slip-ring computed tomography (helical CT), three-dimensional images of the liver, pancreas, lungs or skeleton have proved to significantly enhance the diagnostic accuracy for lesions of such parenchymal organs^{1,2}. Proper selection of the contrast medium and the timing of image acquisition also contributed to the detection of such lesions^{3,4}. Concerning lesions within a hollow viscus like the colorectum or small intestine, accurate information has traditionally been barium enema or colonoscopy with CT being utilized as an adjuvant diagnostic modality mainly to detect distant metastasis. In the case of bowel obstruction or stenosis, however, accurate information on the entire bowel is necessary for proper treatment, but the diagnostic potential of colonoscopy or barium enema is somewhat limited.

The aim of this study was to investigate the value of helical CT for obtaining more precise information on the bowel oral to the site of stenosis in colorectal cancer patients.

Materials and methods

From January to December 1995, 6 patients with colorectal carcinoma who presented with obvious signs of either bowel stenosis or obstruction were enrolled in this study (Table 1). One patient had ascending colon cancer, one had sigmoid colon cancer, and the other 4 patients had rectal carcinoma. There were 2 men and 4 women

aged from 46 to 78 years (median: 65 years). In these patients, colonoscopy and/or barium enema images were of poor quality and did not provide sufficient information about the intestines oral to the site of stenosis, so they were considered eligible for helical CT studies.

After routine lower bowel lavage, 300–600 ml of air was infused through a transanal catheter under continuous radiologic monitoring. After confirming that sufficient air had safely reached the oral side of the stenosis, 3-dimensional images were taken utilizing the infused air as the contrast medium. All studies were performed on a GE Highspeed Advantage Scanner with a 4th generation slip ring. Helical scans were acquired at 250–300 mA, 120 KV and a 20 to 30 second exposure time. Scans were successfully obtained in all patients with a single breath-holding. A 3–5 mm beam was used with a pitch of 1.0. After checking the region of interest, scans were again performed with a 1.5–2.5 beam in order to assess the lesion in detail and then images were reconstructed. To visualize the wall of the bowel, threshold selection from –600 to –200 HU was employed. This threshold was based on prior phantom studies that compared images obtained by colonoscopy.

Results

Case No. 1 had a rectosigmoid carcinoma causing circumferential stenosis of the bowel. Passage of a colonoscope was impossible no detailed information oral to the tumor was available (Fig. 1). By utilizing helical CT scanning, visualization of the entire tumor was possible, including information with regard to tumor infiltration at the oral margin (Fig. 2). Taking this additional data in

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Table 1 Patient characteristics

Case No.	Age	Sex	Disease	Borrmann type	Location	Tumor size (cm)	Histology	lq.med. [#]	Passage of coloscope
1.	60	M	Rectal cancer	II	Rectum (Rs)	4.5 × 3.7	Moderate*	(-)	(-)
2.	78	F	Colon cancer	II	Ascending colon	3.0 × 2.5	Well†	(-)	(-)
3.	47	F	Colon cancer	III	Sigmoid colon	4.0 × 4.0	Well†	(-)	(-)
4.	51	F	Rectal cancer	II	Rectum (Ra)	4.0 × 3.0	Well†	(+)	(-)
5.	70	F	Rectal cancer	II	Rectum (Rb)	4.3 × 3.5	Well†	(+)	(-)
6.	46	M	Rectal cancer	0(IIa)	Rectum (Ra)	1.5 × 1.0	Carcinoma® in adenoma	(+)	(-)

Abbreviations : * Moderate, moderately differentiated tubular adenocarcinoma

† Well, well differentiated tubular adenocarcinoma

® Carcinoma in adenoma, carcinoma in villous adenoma

liquid contrast medium

Fig. 1 Colonoscopic picture from case No. 1, showing complete obstruction of the large bowel due to rectosigmoid adenocarcinoma.

Fig. 3 Appearance of the resected specimen in case No. 1, demonstrating an adenocarcinoma of the rectosigmoid region.

Fig. 2 Three-dimensional helical CT image from the anal side (left) and cross section of the tumor (right) in Case No. 1, demonstrating both the oral and anal sides of the obstructing rectosigmoid adenocarcinoma.

Fig. 4 Conventional CT image of an ascending colon carcinoma in Case No. 2, demonstrating obstructive tumor in the bowel lumen.

Fig. 5 Three-dimensional helical CT image from the anal side (left) and cross-sectional view (right) in Case No. 2, showing obstruction of the ascending colon by adenocarcinoma.

consideration at the time of operation, anterior resection was safely performed. The resected specimen reconfirmed the accuracy of the 3-D image of tumor extent (Fig. 3).

Case No. 2 was admitted to hospital with signs of large bowel obstruction caused by ascending colon cancer. After a few weeks of palliative treatment with IVH, colonoscopy was performed. On examination, passage of the scope was prevented by the large tumor mass and visualization of the carcinoma was impossible either by

barium enema or by conventional CT (Fig. 4). With helical CT scanning, the entire tumor and the colon proximal to the tumor were clearly visualized (Fig. 5). Right hemicolectomy was successfully performed and the resected specimen again confirmed the accuracy of the 3-D image obtained by helical CT (Fig. 6).

In the other 4 patients with poor visualization of the tumor either because of stenosis or location, accurate images could not be obtained by conventional barium

Fig. 6 Appearance of the resected specimen, demonstrating obstruction of the bowel lumen by the tumor mass in the ascending colon.

enema or by colonoscopy, but were achieved with helical CT and helped to determine the most suitable operation.

In all 6 colorectal cancer patients with bowel stenosis, helical CT proved to be effective in obtaining the necessary information with regard to tumor size, contour, and longitudinal invasion of the large intestine. The 3-D images were helpful to determine the optimum extent of resection to remove the tumor without causing any additional risk.

Discussion

Although CT is useful for examining colorectal cancer patients suspected of having extensive disease, its low accuracy in identifying primary tumors prevents the routine use of conventional CT for large intestinal imaging. In most cases, colonoscopy and barium enema are able to provide sufficient information with regard to tumor size or location and the presence of additional intraluminal lesions adjacent to or distant from the primary tumor.

In patients with bowel stenosis or obstruction, however, those modalities are not necessarily very useful. Stenosis caused by a tumor often prevents a colonoscope from passing the lesion, and even in patients without severe stenosis, visualization of the tumor is sometimes impossible because of difficulty in orienting the scope. Barium enema is also sometimes unable to visualize the bowel beyond the stenotic site. In addition, introduction of the contrast medium to the stenotic bowel segment requires an elaborate technique and is associated with the risk of fatal perforation or ileus due to barium.

In this study, we used helical CT as an adjuvant diagnostic modality in patients with colorectal stenosis

and employed air instead of a liquid contrast medium. In the English literature, there have been no report on use of helical CT for the diagnosis of primary colorectal cancer, except for one preliminary study of Thoeni et al⁹.

We found that 3-D images obtained by helical CT were effective in visualizing the entire tumor and provided data which could not have been obtained by conventional modalities. Even when passage of colonoscope was possible (as in our case #6), accurate visualization of the cancer and its relations with the surrounding villous adenoma could not have been achieved. Using helical CT in this case, the three-dimensional relations of the tumor and the bowel wall were clearly visualized. In addition, intraluminal lesions located proximal to the stenosis could have been visualized. Such information is of particular importance for colorectal cancer surgery, because of the relatively frequent presence of double cancer and benign polyps.

Of course, there are certain limitations to this method. In the case of complete obstruction, introduction of air past the tumor site is impossible. As with other modalities, helical CT cannot provide images without evacuation of the bowel. Also, information with regard to the color and hardness of the tumor is not provided by this method. Discrimination of intraluminal mucosa or tumor from stool or mucus is also difficult to achieve only by 3-D imaging.

Despite these weaknesses, we believe that 3-D helical CT should be useful as an adjuvant diagnostic method for stenotic colorectal cancer. Compared to ordinary barium enema, infusion of air is much easier and less harmful than the injection of liquid contrast medium, and therefore may reduce patient discomfort. It should also be noted that by controlling the amount of infused air, the entire large intestine can be visualized with less time and less burden on the patient. To obtain detailed information, discrimination of the lesion from stool or mucus is also necessary. With regard to this problem, we believe that the additional combination of axial CT, which can better define the characteristics of these materials, will be of great help for more accurate diagnosis.

Despite the fact that 3-D CT requires less time and is less distressing to the patient, we think that this method is not yet suitable for routine screening of colorectal cancer. More detailed images with a higher resolution are necessary in order to decrease the false-negative rate to a level comparable to that of other modalities. At present, 3-D CT is a useful adjuvant diagnostic tool for stenotic colorectal cancer, allowing visualization of the entire tumor and detection of coexisting lesions proximal to the tumor.

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