Contrast-Enhanced Computed Tomography Colonography in Preoperative Distinction between T1-T2 and T3-T4 Staging of Colon Cancer

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Rationale and Objectives: To predict the T stage of nonrectal colon cancer using contrast-enhanced computed tomography colonography.

Materials and Methods: Sixty-one patients with 67 nonrectal colon cancers consecutively underwent contrast-enhanced computed tomography colonography after an incomplete colonoscopy. Two readers evaluated wall deformity and perilesional fat abnormality on three-dimensional double contrast enema-like views and multiplanar reconstructions. Pathology was used as the standard of reference. McNemar, Fisher, and Cohen κ statistics were used.

Results: At pathologic examination, we found the following stages: T1 (n = 5), T2 (n = 10), T3 (n = 41), T4a (n = 6), and T4b (n = 5). Intraobserver and interobserver reproducibilities were almost perfect for wall deformity (κ = 1.00 and κ = 0.88, respectively), substantial for perilesional fat abnormality (κ = 0.79 and κ = 0.74, respectively). Using the results of the more experienced reader, accuracy of wall deformity ≥50% (apple-core) alone for T ≥ 3 was 62 of 67 (0.93, 95% confidence interval [CI] 0.83–0.97) and that of perilesional fat abnormality alone was 37 of 67 (0.55, 95% CI 0.43–0.67) (P < .001). Predictive value for ≥ T3 of the association wall deformity ≥50% with perilesional fat abnormality was 22 of 22 (1.00, 95% CI 0.85–1.00), higher, but not significantly, than that of wall deformity ≥50% with normal perilesional fat 29 of 33 (0.88, 95% CI 0.72–0.97) (P = .148, Fisher exact test).

Conclusions: The presence of apple-core wall deformity, regardless of perilesional fat abnormality, is highly predictive of stage T3 or higher.

Key Words: Colon cancer; contrast-enhanced CT; CT colonography; T staging.

Computed tomography (CT) colonography (CTC) represents a good alternative to optical colonoscopy in diagnosing polyps and colorectal cancers because it has been shown to have similar accuracy, a higher patient compliance, and a lower rate of complications (1–8). Moreover, patients with a colorectal cancer detected on optical colonoscopy still benefit from CTC if optical colonoscopy is incomplete (9–13); since contrast-enhanced CT is usually performed for staging, added benefit can be obtained by converting the routine staging CT into a contrast-enhanced CTC instead. Contrast-enhanced CT for preoperative T staging of colorectal cancer was first reported in 1986 (14,15) but an acceptable accuracy was reached only with the advent of spiral CT using pneumocolon in 1998 (16). With the development of CTC, also known as virtual colonoscopy, different reports (10–14,17–21) have described the usefulness of CTC in patients with known colorectal cancer and incomplete optical colonoscopy. Only a few studies have evaluated the accuracy of CTC in preoperative T staging of colorectal cancer, reporting values between 0.78 and 0.84 (11,13,17–21).

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Preoperative T staging of rectal cancers has been well established, and magnetic resonance imaging (MRI) is the standard examination, while the same issue, not currently valid for colon cancers, may soon become more relevant. In particular, preoperative contrast-enhanced CTC staging could help with decisions concerning an appropriate type of surgery or chemoradiation.

The aim of this work is to evaluate the diagnostic performance of combined abdominal contrast-enhanced CT and CTC in the preoperative T staging of colon cancer.

MATERIALS AND METHODS

Population

This study was approved by our institutional review board, and written informed consent was obtained from all the patients. Seventy-nine patients with a known colorectal cancer diagnosed by an incomplete optical colonoscopy and pathologically confirmed consecutively underwent CE-CTC between 2008 and 2010. From the consecutive series of 79 patients, 10 patients who had been surgically treated at institutions other than our hospital were excluded because of lack of complete information about pathological T staging. Moreover, eight patients were excluded because the lesion was located in the rectum. Thus, 61 patients entered the current analysis.

Bowel Preparation

Bowel cleansing was provided through the ingestion of 2 or 4 L of a polyethylene glycol electrolyte solution in a standard manner before the procedure in 31 patients and by ingestion the day before the examination of a half-bottle of a laxative (Phospho-Lax, Sofar, Milan, Italy) in the evening after dinner, followed by 1 L of water in the other 21 patients.

The nine remaining patients used one sachet of a mild laxative per os (Movicol, Norgine Italia srl, Milan, Italy) after breakfast, lunch, and dinner during the 3 days before CE-CTC.

On the day of the examination, at least 2.5 hours before the examination, approximately 50–60 mL of iodinated contrast medium (Gastrografin, Bayer-Schering, Berlin, Germany) diluted in 500 mL of water were administered orally for fecal tagging.

CTC Protocol

All examinations were performed using a 64-row multidetector CT (VCT, General Electric Healthcare, Milwaukee, WI). The CT protocol involved image acquisition with patients initially in prone position and subsequently in supine position, after obtaining an adequate colonic distention. Immediately before CT data acquisition, carbon dioxide was insufflated via an automated insufflator (PROTOCO$_2$L colon insufflator and administration set, Bracco, Milan, Italy) through a small rectal catheter with a retention balloon.

Twenty milliliters of hyoscine butylbromide (Buscopan, Boehringer Ingelheim, Florence, Italy) was intravenously injected before colonic distention in all except patients who had contraindications (recent myocardial infarction).

Each patient was first placed in left lateral decubitus until about 1–1.5 L of carbon dioxide was insufflated and then in the right lateral decubitus position to reach a total of approximately 2–3 L of carbon dioxide. Thereafter, the patient was rolled prone and a CT scout image was taken. If colon distention was deemed adequate, the volumetric CT data acquisition was initiated during end-expiration. The patient was rolled supine and a second scout film was acquired. A second volumetric CT data acquisition was initiated 60–70 seconds after intravenous injection of 100 mL of nonionic iodinated contrast material (Iomeron 400, Bracco SpA, Milan, Italy) followed by 50 mL of saline flush, both at a flow rate of 3 mL/sec, thus providing images during the portal venous phase. In five patients, with a sigmoid segment collapsed on either supine or prone view, we performed an additional volumetric CT data acquisition with the patient in the right lateral decubitus. After the last CT data acquisition, carbon dioxide delivery was stopped, the cuff was deflated, and the rectal catheter was removed.

The CE-CTC technical protocol was as follows: unenhanced CT data acquisition, prone position, 120 kVp (140 kVp in obese patients), 100 mA (300 mA in obese patients); contrast-enhanced CT data acquisition, 120 kVp (140 kVp in obese patients), mA ranging from 80 to 440. For both series: gantry rotation, 0.5 second; slice thickness, 1.25 mm; table speed, 27.5 mm; pitch: 1.375; reconstruction interval, 1 mm. Both series were acquired during end-expiration from the diaphragm to the pubic symphysis in craniocaudal direction.

All the images were processed using dedicated software (CadColon, Im3d, Turin, Italy).

Image Analysis

Two readers in consensus evaluated the quality of bowel preparation on axial two-dimensional and multiplanar reformatted images, on the basis of the presence of fecal residuals and tagged fluids in the six segments of the colon, and rated it on a semiquantitative scale as poor, good, or excellent. The overall distention of the entire colon was also visually evaluated by the two radiologists in consensus and rated as poor, good, or excellent using double contrast enema-like views generated by prone and supine CTC datasets, freely rotating the three-dimensional (3D) views.

The two independent readers, a board-certified radiologist and a resident, with, respectively, 6 and 2 years of experience in CTC, consisting of more than 1000 and 500 CTC cases, respectively, and blinded to pathological staging, analyzed the image datasets. They evaluated the degree of wall deformity (WD) on 3D double contrast enema-like views generated by prone and supine CTC dataset, freely rotating the 3D views. In particular, for each patient they made the analysis