

Focus on technique helps CT colonography

BY PHILIPPE LEFERE, M.D., AND STEFAAN GRYSPEERDT, M.D.

Good results require thorough patient preparation, dual positioning during imaging, and experienced readers

The introduction of CT colonography generated considerable excitement almost immediately in both the radiological and gastrointestinal communities. All signs indicated that this noninvasive technique would become an efficient way of screening for colorectal cancer that would rival conventional diagnostic tools.

CTC subsequently performed well in single-center studies conducted by experienced teams.¹ The results from some major multicenter trials, however, were less promising.^{2,3} The idea that CTC could be used for colorectal cancer screening did not seem viable.

Advocates for virtual colonoscopy subsequently elaborated a state-of-the-art protocol for CTC. This focused on the important aspects of patient preparation, colonic distention, data acquisition, and image interpretation. Results from the latest multicenter trials show that this work has been worthwhile.

It is now accepted that CTC may be performed after optical colonoscopy is incomplete because of an obstructing lesion or colonic redundancy. It may also be used if optical colonoscopy is contraindicated (for example, if a patient is taking anticoagulants or has severe cardiopulmonary disease) or refused by the patient. CTC is also an indication in frail and elderly patients. It may eventually be used as a screening tool for colorectal cancer in the future.

Meticulous technique and interpretation are critical to good CTC performance. The European Society of Gastrointestinal and Abdominal Radiology

(ESGAR) has produced detailed guidelines for practitioners to follow.⁴ The society's guidance distinguishes between imaging of asymptomatic patients (i.e., in a screening setting) and symptomatic patients.

- *Bowel preparation.* Adequate bowel preparation the day before CTC is essential. This should consist of a low-residue diet, cathartic cleansing, and fecal tagging. ESGAR recommends full bowel purgation for symptomatic patients and optional fecal tagging.⁴ A dry preparation, using sodium phosphate or magnesium citrate laxatives, that leaves a dry colon is preferred over wet preparation with polyethylene glycol.

Full cathartic preparation is similarly advised for asymptomatic patients, though cleansing may be reduced to improve patient compliance for screening. Fecal tagging, however, is mandatory for this patient group. The

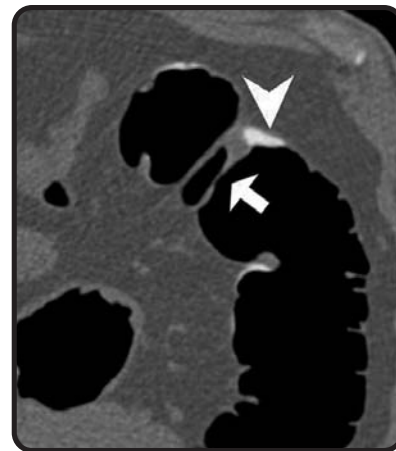


FIGURE 1. CTC performed in patient prepared with fecal tagging. Pedunculated polyp (arrow) with thin pedicle and head is surrounded by tagged residue (arrowhead).

DR. LEFERE and DR. GRYSPEERDT are staff radiologists at Roeselare District Hospital in Belgium.



FIGURE 2. CTC reveals sessile 8-mm polyp (arrow) in a well-distended transverse colon. Patient was examined with ultralow dose protocol (140 kV, 10 mAs).

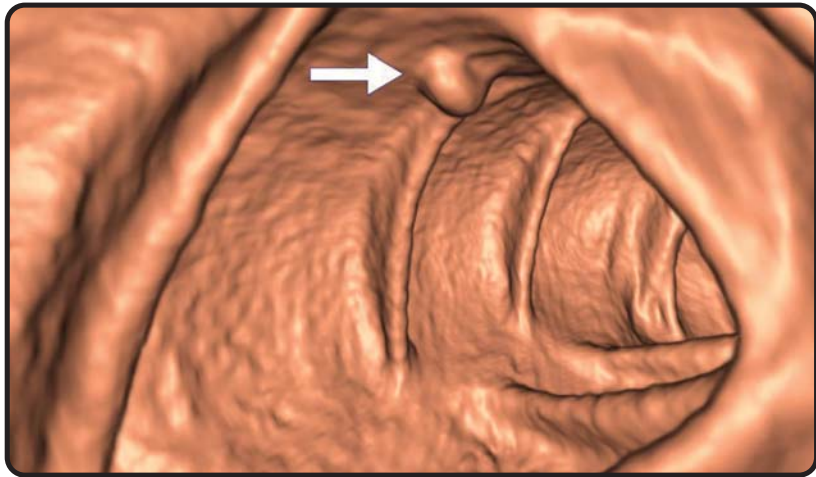


FIGURE 3. Corresponding 3D image shows sessile polyp (arrow) with no noise despite ultralow dose.

labeling of fecal residue (solid stool and colonic fluid) helps readers to differentiate residual stool from colonic polyps (Figure 1). This is accomplished using a combination of iodinated contrast and barium.

- *Colonic distention.* Inadequate colonic distention can lead to errors in interpretation. Good colonic distention is thus another cornerstone of state-of-the-art CTC practice (Figures 2 and 3). The three key elements to achieve this are smooth muscle relaxation, colonic inflation, and dual positioning.

Opinions vary over which agent to use for smooth muscle relaxation. Hyoscine butylbromide was shown to improve colonic distention in two separate studies.^{5,6} Results for glucagon have been more contradictory, though this was used in the American College of Radiology Imaging Network (ACRIN) CT colonography trial.⁷

Injector-administered carbon dioxide is preferred over manual insufflation of room air for colonic inflation. Dual positioning is universally agreed to be essential. Imaging in the supine position promotes optimal distention in the anterior colon, while distention in the posterior colon is best when patients lie prone. Dual positioning also increases polyp conspicuity, improving overall diagnos-

tic performance.

- *Acquisition.* ESGAR guidelines recommend a slice thickness of ≤ 3 mm for CTC. Low-dose CTC should be performed at 120 kV with a tube current of ≤ 100 mAs for supine imaging, and at 120 kV with < 50 mAs tube current when patients lie prone.⁴

Data for the ACRIN CTC trial were collected on multislice CT scanners with at least 16 detector rows. A slice collimation of < 1.25 mm and tube current of < 50 mAs were used for supine and prone acquisitions. The corresponding radiation dose was 5 mSv.⁷

Intravenous contrast may be considered when examining symptomatic patients, but it should not be used for screening purposes. Polyps can be stained by IV contrast agents. Caution should be taken if fecal tagging is also used in case a hyperdense polyp is mistaken for labeled stool.

- *Image interpretation.* Accurate interpretation ideally requires access to native 2D axial images, multiplanar 2D reconstructions, and 3D images. This can be achieved by adopting a primary 2D approach with 3D problem-solving, or vice versa (Figures 4 and 5). Similar results were obtained from both methods in the ACRIN CTC trial, though the primary 2D reading method was more time efficient.⁷ Dedicated

CTC software, updated at regular intervals, is essential whichever method is chosen.

- *Reporting.* A structured report is invaluable for communication with clinicians. The ESGAR CTC working group has devised a C- and E-RADS reporting scheme to deal with colonic and extracolonic findings.⁸ The aim is to provide advice on the severity of lesions observed. This is important because not all colonic lesions need immediate workup or treatment.

The colon should be divided into six segments for reporting purposes. The physical appearance of any lesion should be described (for example, sessile, pedunculated, flat, or mass) together with its attenuation (fat or soft tissue, air inclusion). The distance of the lesion from the anorectal margin may be useful as well.

- *Computer-aided detection.* The ESGAR CTC committee found that CAD is likely to improve diagnostic performance. CAD should detect at least 80% of lesions with diameters of 6 to 9 mm and at least 90% of lesions that are bigger than 1 cm.⁴

The optimal protocol for CAD reading has yet to be established. One study compared concurrent reading (the reader views CAD marks while interpreting the images) against the use

of CAD as an independent second reader (the reader is blinded to the CAD marks while reading the colonic images). The researchers concluded that the concurrent reading method was more time-efficient. Both methods had a similar diagnostic performance for lesions >6 mm, but sensitivity for smaller lesions improved when CAD was used as a second reader.⁹

- **Training.** Radiologists who want to perform CTC should read a minimum of 50 to 75 endoscopically verified cases prior to commencing clinical practice, according to ESGAR guidance. Readers should be tested after this training period and, ideally, retested at regular intervals.⁴ Radiologists from the 15 participating centers in the ACRIN CTC trial had read >500 cases and were obliged to detect at least 90% of adenomas larger than 1 cm. Failure to meet this condition led to retraining.⁷

- **Implementation.** The ESGAR CTC consensus document, published in early 2007, concluded that CTC should be considered as the examination of choice for symptomatic patients. CTC was not deemed ready for mass colorectal screening programs. The committee decided that validated local expertise would be required first.⁴

EUROPEAN PERSPECTIVE

Several multicenter trials examining CTC have been started in Europe. Some have published results already.

A study by the Italian Multicenter Polyp Accuracy CTC study group (IMPACT trial) has assessed the sensitivity and specificity of CTC for the detection of advanced adenomas in patients at increased risk of colorectal cancer. It also examined the sensitivity of CTC in a screening setting, the frequency of lesions missed by optical colonoscopy, adverse events, acceptability, the relative costs of optical colonoscopy and CTC, and the frequency of extracolonic findings.

Fourteen centers participated, with 917 asymptomatic patients undergoing both CTC and optical colonoscopy. Per-polyp sensitivity was 84% for lesions >1 cm. The sensitivity of CTC to all adenomas and cancers was 84.2% for lesions >6 mm and 90.7% for >10 mm lesions.¹⁰

Researchers from the Munich Colorectal Cancer Prevention Trial assessed adenoma detection in asymptomatic screening patients using 64-slice CTC, optical colonoscopy, sigmoidoscopy, fecal occult blood testing (FOBT), and immunochemical FOBT (imHb). A total of 307 patients with 511 polyps (211 adenomas) were examined. Per-patient sensitivities for adenomas bigger than 9 mm were 92.6%, 100%, 66.7%, 21.7%, and 30.4% respectively. These figures changed to 93.7%, 95.8%, 64.6%, 16.7%, and 37.5% for lesions at least 6 mm in diameter.¹¹

The U.K. National Health Service Special Interest Group in Gastrointestinal Radiology has begun its own trial (SIGGAR-1). This will compare the diagnostic efficacy of CTC, optical colonoscopy, and barium enema for the detection of colorectal lesions that are at least 1 cm in diameter. Two separate randomized trials will be conducted: CTC versus double-contrast barium enema and CTC versus colonoscopy. The costs of each test, patient compliance, and the influence of extracolonic findings will be determined in addition to diagnostic performance. Over 5000 patients have been recruited already.¹²

The French STIC multicenter trial will compare the performance of multislice CTC (>16 detector rows) with same-day optical colonoscopy in asymptomatic patients. A total of 1500 patients are to be examined at the 25 participating centers.

FUTURE PRACTICE?

Several factors indicate that CTC can now fulfill its potential as a screening tool. Both the IMPACT trial and the

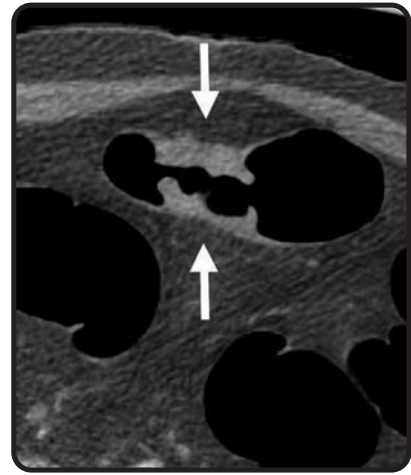


FIGURE 4. CTC shows malignant tumor with shoulder formation and overhanging edges (arrows).



FIGURE 5. Corresponding 3D image confirms 2D findings.

Munich study have produced good results.^{10,11} The ACRIN trial of 2531 patients generated per-patient sensitivities of 78%, 84%, 87%, 90%, and 90% for adenomas >6 mm, >7 mm, >8 mm, >9 mm, and >10 mm, respectively.⁷ Another study of over 3000 patients, comparing CTC and optical colonoscopy for screening, found CTC to be comparable to optical colonoscopy for lesion detection.¹³

Many issues remain to be resolved, however, before CTC can be considered for mass colorectal cancer screen-



ing. These include cost-effectiveness, comparability of results, minimum size for polyp detection, and patient compliance.¹⁴ Cost-effectiveness will depend on many different factors. Test accuracy, extracolonic findings, and patient adherence will all contribute, along with direct costs. Mathematical models indicate that CTC is not cost-effective in the U.S.¹⁵ A separate study from Italy found CTC to be more cost-effective than optical colonoscopy.¹⁶

Direct costs can be reduced by using less expensive scanners; for example, 16-slice MSCT systems as opposed to 64-slice machines. Cheaper consumables, laxative-free bowel preparation, and the deployment of CAD or supervised technologists as readers could also help suppress costs.

The accuracy of the technique will also influence cost-effectiveness. It has been suggested that CTC needs a sensitivity of at least 83% for adenomas >1 cm.¹⁵ Trials have confirmed that this can be achieved with state-of-the-art CTC. Obtaining this level of accuracy in a large group of radiologists, however, will require structured, accredited education and training programs.

Extracolonic findings seen on CTC but not optical colonoscopy can be regarded as an advantage of CTC, but their likely influence on cost-effectiveness in a mass screening program is still unclear. The only data available at present are from retrospective studies with limited follow-up.¹⁴

Patient compliance must be high if screening tests are to be cost-effective. Cathartic cleansing is regarded as the main barrier to CTC-based screening. Fecal tagging and electronic cleansing could reduce the need for laxatives. This option is the subject of intensive research at many institutions.¹⁷

Determining what to do with polyps detected on CTC is another important issue. Do we need to remove each and every polyp or just those that have reached a certain size? The rationale for setting a size threshold is based on two observations. First, the sensitivity of CTC to lesions <5 mm is low. Second, lesions smaller than 1 cm in diameter are also unlikely to develop into invasive cancer (<1% probability).

Screening should ideally target advanced adenomas requiring immediate workup, such as polypoidal lesions at least 1 cm in diameter, either with or without dysplastic and/or villous components. The ESGAR CTC working group recommends the following approach for smaller lesions:

- more than three 6 to 9-mm lesions: remove all lesions;
- one or two 6 to 9-mm lesions: screen patients every three years; and
- any lesion 5 mm or smaller: screen patients every five to 10 years.⁸

In conclusion, CTC requires a state-of-the-art technique. Such an approach is yielding good results in multicenter clinical trials, readying CTC for colorectal cancer screening. ■

References are available online at www.DiagnosticImaging.com