


BENIGN INTERVENTION

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 Transverse CT image showing 14 mm polyp in rectum (left); volume-rendered 3D image (right) confirms polyp beneath rectal fold. Courtesy of Matthew Barish, MD, Brigham and Women's Hospital, Boston.

Colonoscopies, fecal occult blood tests, sigmoidoscopies, and barium enemas are known for their use as screening tools for the early detection of colorectal cancer,¹ yet many people still find these procedures objectionable in spite of their benefits. Those in the highest risk group for colon cancer tend to avoid screening tests completely because they are risky and unpleasant, and by some accounts, fewer than half of all adults over age 50 get screened for colon polyps. A 1995 survey even found that people who had never had a colonoscopy would rather give up 3 months of life than undergo the test.²

In the face of such obvious patient aversion, virtual colonoscopy a more comfortable yet still effective screening examination performed using a multidetector CT (MDCT) scan is emerging as an alternative that may open the door to a much higher patient participation rate.

Judy Yee, MD, is associate professor of radiology at the University of California San Francisco (UCSF), director of the 3D Imaging Laboratory, and chief of CT and GI radiology at Veterans Affairs Medical Center in San Francisco, and she has definitely noted an increased reliance on virtual colonoscopy over the past 5 years.

"We know that if we can offer a more appealing study, more patients will come in," Yee says. "A virtual colonoscopy is minimally invasive and associated with fewer complications than the standard colonoscopy. It is also less expensive and faster, and doesn't require IV sedation, so patients do not lose a whole day or require someone to drive them to the facility."

Virtual colonoscopy has been offered at the VA since 1997, and UCSF started offering it last year, according to Yee, who has taught more than 80 radiologists how to perform and interpret virtual colonoscopies.

"The prevalence is increasing nationally every week," she says. "It began at academic centers, but research validated the procedure so more community sites have added it."

Matthew Barish, MD, is director of 3D and the image processing center and director of the virtual colonoscopy center at Brigham and Women's Hospital in Boston, which has been offering virtual colonoscopies since January 2002. Barish says that the largest pool of patients are those unable or unwilling to undergo conventional colonoscopy, and the second group includes those for whom colonoscopy has failed. "We do allow patients to inquire about virtual colonoscopies or to refer themselves, but we request that they contact a physician to issue a formal referral for the test before they come in," says Barish, who also serves as assistant professor of radiology at Harvard Medical School.

At Epic Imaging in Beaverton, Ore, which has done close to 250 virtual colonoscopy scans since the end of 2001, about a third of the current virtual colonoscopy patients come from gastroenterologists (for cases of incomplete colonoscopies), while the rest are referred from internists and family practitioners. "The biggest reason we are so busy is that there is a 4- to 6-month wait for the typical colonoscopy," says Joel Rubenstein, MD, PhD, who has been

with Epic for 3 years. “Certainly frail, older patients do better with this technique, as well as those who don’t want or can’t have sedation.

“We have average-risk patients, however, so there is not a high incidence of disease,” Rubenstein continues. “That emphasizes the value of virtual colonoscopy for screenings, because most people don’t really need the invasive test.”

Patient Preparation

Even if virtual colonoscopy spares patients the discomfort inherent in other colon screening examinations, it does not spare them the preparation process. Virtual colonoscopy patients undergo a standard preparation 24 hours in advance that includes a liquid diet and a laxative cleansing. Sodium phosphate laxatives have emerged as the best choice for this colonic cleansing, according to Yee, who cites studies comparing it to polyethylene glycol. In those patients who used sodium phosphate, there was significantly less residual fluid.³

Brigham’s is now doing studies of variations in patient preparation routines. In addition to looking at a modified preparation that allows the patient to eat a low-residue rather than a liquid diet, researchers are reducing the laxative and adding a barium tagging agent to the preparation routine. Patients ingest a positive contrast agent 1 or 2 days before the scan, and the contrast tags the residual fluid and stool within the colon. The barium appears as a bright white density on the CT images, and the polyps appear as grey structures.

“The benefits of the barium tagging agent are that when it coats well, it allows us to differentiate retained stool from true polyps,” Barish says, noting that the biggest false positive comes from retained stool.

“More research needs to be done, but the hope is to combine the test with specific software that is able to subtract out the tagged material,” Yee says. “We also hope that with fecal tagging, we may be able to eliminate the laxative.”

Barish notes that a disadvantage of the tagging is that if the stool does not mix completely, there may be a higher false-positive rate. “The belief would be that everything that did not mix is likely to be a real polyp,” Barish explains. “The tagging agent may also slow reading time, and sometimes the coating’s bright intensity distracts from the reading. However, [resolving] that is going to be a training issue and once we see more cases using the barium, [the problem] will begin to disappear.”

To Insufflate or Not

Colon distension is also a factor in getting a readable scan, and can be accomplished with either carbon dioxide or room air. “CO₂ is much more rapidly resorbed across the colonic wall because there is a steep diffusion gradient,” Yee says. “Likewise, an electronic insufflator is better because it provides constant infusion and automatically determines whether more air is needed based on a preset pressure.”

At Brigham, the majority of examinations are done with a carbon dioxide insufflator, although a fair number are done with room air as well. Barish says that decision is usually based on the preference of the radiologist, though the patient’s preference also is taken into account.

“An advantage of air is that it allows the patients to do the insufflation themselves, controlling the speed, volume, and pressure,” he says. “Some patients report it is more comfortable to use room air during the procedure because they can control it. On the other hand, an advantage of CO₂ is that following the procedure, the gas is absorbed through the colon wall and there is less cramping.”

While glucagon was used in early CT colonography studies with the presumption that it would decrease colonic spasm and lead to more diagnostic examinations, that has turned out not to be the case, according to Yee. “There is one published study evaluating the usefulness of 1 mg of intravenous glucagon prior to the study, and it found there was no significant difference in colonic distension compared to those who did not receive the glucagon,” Yee says.⁴

Virtual Colonoscopy in Action

Once the patient preparation is complete, the actual examination is very rapid. Most facilities use either a 4-slice or 16-slice multidetector CT, and the scan takes mere seconds. A supine and prone view are necessary for a complete

view of the colon. After the scan is done, most radiologists use the 2D images, going to 3D only for problem-solving. "That is more time-efficient, as they have to be able to understand the appearance of a polyp and different entities in 3D," Yee says.

"Much of the current software allows simultaneous viewing of the supine and prone axial images, which can help to decrease interpretation times," Yee says. "Other software allows viewing of antegrade and retrograde 3D endoluminal views at the same time, and there are several postprocessing methods used to generate those views. The two most widely used are surface rendering and volume rendering, and it is not clear at this time whether there is any significant difference in detection rates for each method."

Even with variations in the postprocessing method, studies have shown virtual colonoscopy to be very effective at finding polyps of certain sizes. Evaluating the most current-to-date performance data using a per-patient analysis, CT colonography has a sensitivity range of 83% to 100% and a specificity range of 93% to 100% for the detection of 10 mm or larger polyps, according to Yee, who conducted the largest published series to date.⁵

One of the few studies of asymptomatic patients⁶ found a sensitivity of 100% for polyps measuring 7 mm or larger with CT colonography, using per-polyp and per-patient matching. "Virtual colonoscopy is not good for picking up small and flat lesions, though thinner collimation may allow for increased sensitivity for small and medium-sized polyps as well as flat lesions," Yee says. "Luckily, we are not so much concerned about smaller lesions, because they have little chance of harboring malignancy. The focus is on the larger polyps, and we are conventionally concerned with those that are 10 mm and larger. The virtual colonoscopy is very good at detecting them, and several studies have found it to be as accurate as colonoscopy for detecting larger polyps and cancers."

For those patients with a family history of colon cancer, however, a standard colonoscopy is still the best technique. "There is a higher chance of finding something that needs a biopsy in those patients," Rubenstein says. "By having a standard colonoscopy, that lessens the chance of those patients needing two preparations and two charges for the procedure."

Future Expectations

As virtual colonoscopy comes to the forefront of radiological discussion, more attention is being paid to how it should be implemented. This year, the technique will again be the focus of a fourth annual international symposium, to be held in Boston in October.

"The first two symposiums focused on up-and-coming research and techniques, while the third symposium focused on integrating the virtual procedure into standard screenings for colorectal cancer," Barish says. "That was the first time the issue of the procedure having a place in screening was really discussed, and the majority of individuals believed it had a place at that time.

"We are still in the early phase, so it is suitable for certain patients and individuals at this point," Barish says. "We are expecting that at the next symposium we will really focus on making sure the procedure has a place in screening of colorectal cancer."

In addition, software and postprocessing techniques are still evolving in the realm of virtual colonoscopy, and Yee notes that several research centers are currently evaluating alternative displays that allow the radiologist to view larger areas of the colonic surface at one time. "A virtual pathology' view bisects the colon along its latitudinal axis, opening the colon so that it may be inspected like a surgical pathological specimen," Yee says. "A second approach involves using a map projection of a segment of the colon. CAD of colorectal lesions is also under investigation as a way to shorten interpretation times, and computer software that allows automated polyp detection is under development."

Yee thinks the biggest emphasis at this stage, however, should be on training radiologists in performing and interpreting colo-

rectal MDCT studies correctly. "There is a learning curve for the radiologist, because this is still a new technique. Radiologists must be trained in performing the scans and in reading them," Yee says. "It is a mistake for radiologists to start performing and interpreting these studies without additional training because if you miss lesions and you tend to do so without training that does a disservice to the patients as well as the whole examination."

Elizabeth Finch is a contributing writer for Decisions in Axis Imaging News.

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