



TECHNOLOGY STATUS EVALUATION
VIRTUAL COLONOSCOPY

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In order to promote the appropriate use of new or emerging endoscopic technologies, the ASGE Technology Committee has developed a series of status evaluation papers. By this process relevant information about these technologies may be presented to practicing physicians for the education and care of their patients. In many cases, data from randomized control trials is lacking and only preliminary clinical trials are available. Practitioners should continue to monitor the medical literature for subsequent data about efficacy, safety and socioeconomic aspects of the technologies.

BACKGROUND

The term virtual colonoscopy (CT colography) refers to using spiral (helical) CT scanning and computers to produce high resolution 2 and 3 dimensional views of the colon and simulate colonoscopy. First described by Vining in 1994⁽¹⁾ the attractiveness of this technology as a potential tool for screening colorectal neoplasia has prompted commercial companies and academic situations to pursue its further development.

TECHNICAL CONSIDERATIONS

Virtual colonoscopy can be divided into four steps: (1) bowel cleansing, (2) pneumocolon, (3) spiral CT scan and (4) computer processing of spiral CT images^(2,3).

1. Bowel Cleansing

Bowel preparation is essential to avoid stool or fluid artifacts. Agents used for barium enema and endoscopic colonoscopy are acceptable.

2. Pneumocolon

The colon is insufflated with room air or carbon dioxide via a rectal tube to maximal patient tol-

erance. Glucagon can be given to control motility. Non-distended segments of bowel may obscure or simulate abnormalities.

3. Spiral CT Scan

Spiral CT scan technology has unique advantages over conventional CT scanning for virtual image rendering. Conventional CT exams take sequential static cross-sectional images during separate breath holds. Respiratory variation can result in imaging gaps limiting detection of pathology. Spiral CT moves the patient continuously through a rotating x-ray beam during a single breath hold eliminating gaps in imaging. Protocol for virtual colonoscopy is to scan the abdomen and pelvis with 5-mm x-ray collimation, a table speed of 5-10 mm/sec and 1 mm image reconstruction intervals. Over 500 potential image slices for colon reconstruction can be obtained during a total scan time of 1-2 minutes requiring one 1-2 breath holds^(2,4).

4. Computer Generation of Image

Computer reconstruction of the CT data creates 3D images for virtual colonoscopy. The colon is displayed as an opaque or semitransparent image. Simulated colonoscopy is the illusion of traveling through the colon when images are displayed at a rate of 15-30 per second (fly-through technique). Unique features include: multidirectional viewing of images (e.g. to see both sides of folds) color enhancement of the colonic wall to indicate abnormalities, splitting of the colon in half for inspection and reporting of a lesion's location^(2,3).

Two dimensional images can also be generated

providing additional information about lesion density, colonic thickness and pericolonic tissue^(2,4).

INDICATIONS

Virtual colonoscopy is presently investigational.

EFFICACY

Limited clinical data are available. To date virtual colonoscopy has been compared in 123 patients to colonoscopy as the gold standard. The specificity and sensitivity of detecting polyps greater than 5 mm was 71-100% and 85-90% respectively. Detection of polyps less than 5 mm has a poorer sensitivity of 11-42%⁽⁵⁻⁸⁾. The combination of 2D and 3D imaging may be better than either modality alone, however, 2D imaging may have a higher false positive rate⁽⁴⁾.

EASE OF USE

Virtual colonoscopy involves a total scan time of 1-2 minutes, image generation approximately 10 minutes and radiologist's interpretation time is 15-30 minutes^(2,3).

Colonic lavage and pneumocolon are required. Sedation is not employed.

SAFETY

The calculated effective total body radiation dose is 582 mrad (5.82 mGy) for women and 423 mrad (4.23 mGy) for men⁽⁴⁾. This is approximately half the dose of a single contrast barium enema⁽⁹⁾. As a single screening test radiation exposure does not appear to be a concern, however, this may be an issue in patients who require frequent screening or surveillance.

FINANCIAL CONSIDERATION

A spiral CT scanner costs around \$1 million but many medical centers already have this technology. Computer hardware capable of rendering 3D images of the colon costs \$50,000 - \$250,000. Software is relatively inexpensive and is available for free through the Bowman Gray School of Medicine (Freeflight; website <http://indigo2.rad.bgsm.edu>)⁽²⁾. There is a separate CPT code (76375) for 3D CT reconstruction⁽¹⁰⁾. Indirect costs may arise with detection of extracolonic abnormalities requiring further investigation during spiral CT scanning of the abdomen and the need for colonoscopy.

COMPARISON TO AVAILABLE TECHNIQUES

Preliminary results suggest that virtual colonoscopy may detect more polyps with fewer false positives than barium enema⁽¹¹⁾. Other potential advantages include lower radiation dose,

avoidance of barium, shorter procedure time, less patient discomfort and more information regarding lesion density, colonic wall and pericolonic structures.

Colonoscopy is more sensitive and specific in detecting colon polyps than virtual colonoscopy⁽⁵⁻⁸⁾. Virtual colonoscopy may offer greater safety, less discomfort, shorter procedure time, more accurate lesion location and lower cost as a screening test. Colonoscopy would be required to evaluate abnormalities detected by virtual colonoscopy⁽²⁾.

MRI virtual colonoscopy reported a sensitivity (80-93%) and specificity (96%) in detecting artificial polyps in autopsy colon specimens. The major advantage of MRI imaging would be absence of radiation risk^(9,12).

CONCLUSIONS

Preliminary data suggest that virtual colonoscopy by spiral CT scanning appears to be safe, non-invasive and sensitive modality for colorectal polyp screening. More rapid scanners may eliminate motion artifact and the development of oral or intravenous contrast agents allowing computer subtraction of fecal or liquid residue may eliminate the need for bowel preparation. Further studies are needed to establish its clinical efficacy and cost-effectiveness.

REFERENCES

1. Vining DJ, Gelfand DW, Bechtold RE, Scharling ES, Grishaw EK, Shifrin RY. Technical feasibility of colon imaging with helical CT and virtual reality. *Am J Roentgenol* 1994;162 (Suppl):104.
2. Vining DJ. Virtual colonoscopy. *Gastrointest Endosc Clin N Am* 1997;7:285-91.
3. Ahlquist DA, Hara AK, Johnson CD. Computer Tomographic Colography and Virtual Colonoscopy. *Gastrointest Endosc Clin N Am* 1997;7:439-52.
4. Hara AK, Johnson CD, Reed JE, Ehman RL, Ilstrup DM. Colorectal polyp detection with CT colography: two versus three-dimensional techniques. *Radiology* 1996;200:49-54.
5. Hara AK, Johnson CD, Reed JE, Ahlquist DA, Nelson H, Ehman RL, et al. Detection of colorectal polyps by computer tomographic colography: feasibility of a novel technique. *Gastroenterology* 1996;110:284-90.
6. Hara AK, Johnson CD, Reed JE, Ahlquist DA, Nelson H. Computed tomographic colography (virtual colonoscopy) for polyp detection: feasibility of a new technology. *Gastroenterology* 1996;110:A526.
7. Hara AK, Johnson CD, Reed JE, McCarty RL, Ahlquist DA, Ehman RL. Colorectal polyp detection with CT colography (virtual colonoscopy): a blinded prospective study. *Radiology* 1996;201(Suppl):252.
8. Vining DJ, Teigen EL, Stelts D, Vanderwenken B, Kopecky

- KK, Rex D, Experience with virtual colonoscopy in 20 patients. *Radiology* 1995;197(P):514.
9. Ahlquist DA, Johnson CD. Screening in cyberspace: the next generation. *Gastroenterology* 1997;112:2150-2.
 10. Vining DJ. Virtual endoscopy: is it reality? *Radiology* 1996; 200:30-1.
 11. Hara AK, Johnson CD, Reed JE, Ahlquist DA, Nelson H, Harmsen WS. Computer tomographic colography (virtual colonoscopy) for polyp detection: early comparison against barium enema. *Gastroenterology* 1997;112:A575.
 12. Schoenenberger AW, Bauerfeind P, Krestin GP, Debatin JF. Virtual colonoscopy with magnetic resonance imaging: in vitro evaluation of a new concept. *Gastroenterology* 1997; 112:1863-70.

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