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# CT Colonography

## Overview and Role in Colon Cancer Screening

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# Organization

- Patient presentation
- Colon cancer natural history
- CT colonography fundamentals
- Review of patient findings
- CT colonography and colorectal cancer screening
- Future directions



# Mr. EP

- 69 year-old male with PMHx of prostate CA
- s/p colon polypectomy x 2 (Jan 2002)
  - Two 5mm sessile polyps @ hepatic flexure
  - Pathology: non-cancerous adenomas
  - Advised repeat colonoscopy in two years



## Mr. EP (cont'd)

- Presents in March 2004 for follow-up optical colonoscopy
- Found to be poorly prepped (retained stool)
- No polyps detected but patient advised to have another colonoscopy after repeat bowel prep or “virtual colonoscopy” immediately
- Patient elected to have CT colonography



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# Colon Cancer - Natural History -

- Most begin as benign adenomatous polyps
  - <1cm: <1% malignant, most polyps hyperplastic (no malignant potential)
  - 1cm: clinical threshold for removal
  - >2cm: high malignancy risk
- Polyps take 10-20 years to become malignant
- Flat adenomas
  - 10x more likely to have high-grade dysplasia
  - more prevalent in hereditary nonpolyposis syndromes



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# CT Colonography - Essentials -

- CT Colonography (aka virtual colonoscopy): data from computed tomography used to generate 2D and 3D displays of the colon
- Sensitivity same as optical colonoscopy for polyps >1cm
  - New data from 12/03 suggests sensitivity may be the same down to 6mm
- Current indications:
  - Failed colonoscopy
  - Imaging of colon proximal to occlusive lesion
  - Not for colon cancer screening yet....





# CT Colonography - Procedure -

1. Standard bowel prep
  - +/- PO contrast for stool opacification and subtraction





## Procedure (cont'd)

2. Insufflation of ~2L of air/CO<sub>2</sub> into colon
  - Air: longer retention, greater discomfort
  - CO<sub>2</sub>: shorter retention due to absorption
  
3. Abdomen-pelvis CT x 2
  - Supine and prone
    - Fluid displacement
    - Facilitate luminal dilatation
  - +/- IV contrast, which may help in detection of polyps





# Procedure (cont'd)

4. Post-acquisition image processing
  - a. Multiplanar reformats (i.e. coronal, sagittal)
  - b. 3D surface rendering (rendering of inside of colon)
  - c. 3D endoluminal reconstructions (volume rendering)
  - d. 3D Mercator reconstruction



2D Axial Cut

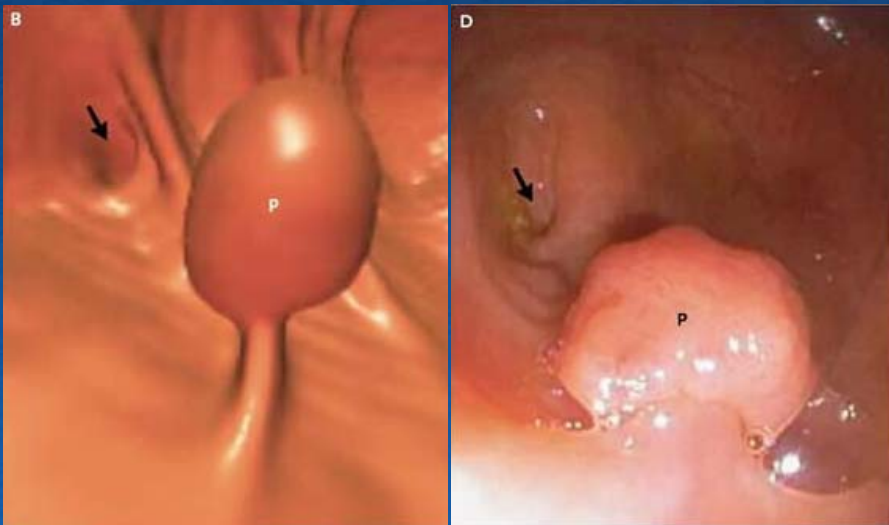


3D Surface Rendering



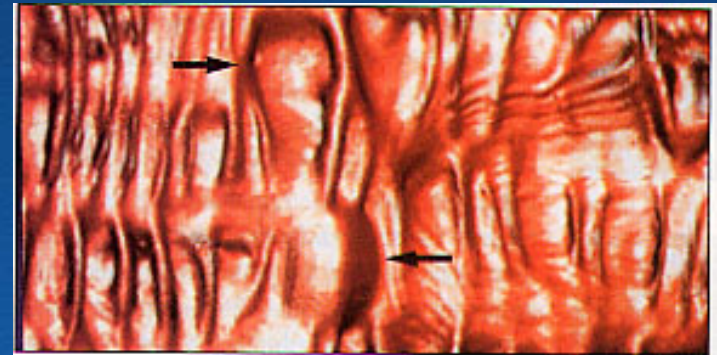
# Procedure (cont'd)

## 4. Post-acquisition image processing (cont'd)



3D Endoluminal  
Reconstruction

Optical Colonoscopy



3D Mercator Reconstruction

Pickhardt PJ, *CT Virtual Colonoscopy to Screen for Colorectal Neoplasia in Asymptomatic Adults*, NEJM 349(23):2191-2200

Taylor SA, *CT Colonography: Methods, Pathology, and Pitfalls*, Clinical Radiology 58:179-190

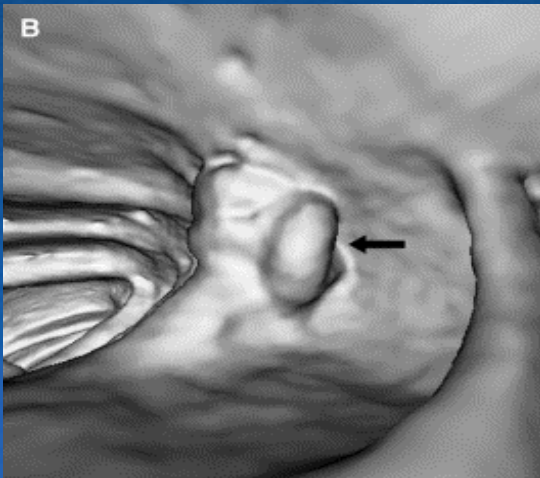




# Procedure (cont'd)

## 5. Study interpretation

- 3D endoluminal fly-through (ante- and retrograde) followed by axial images for suspected lesions, or
- Axial followed by 3D endoluminal views (saves time)



Dachman, *Virtual Colonoscopy: Past, Present and Future*, Radiologic Clinics of North America 41(2) March 2003



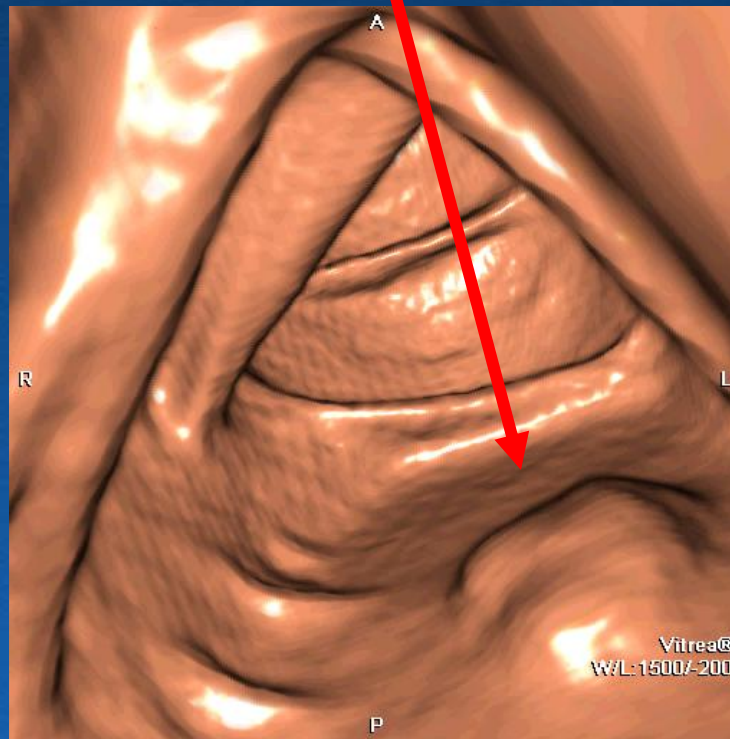


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# Mr. EP Lesion #1

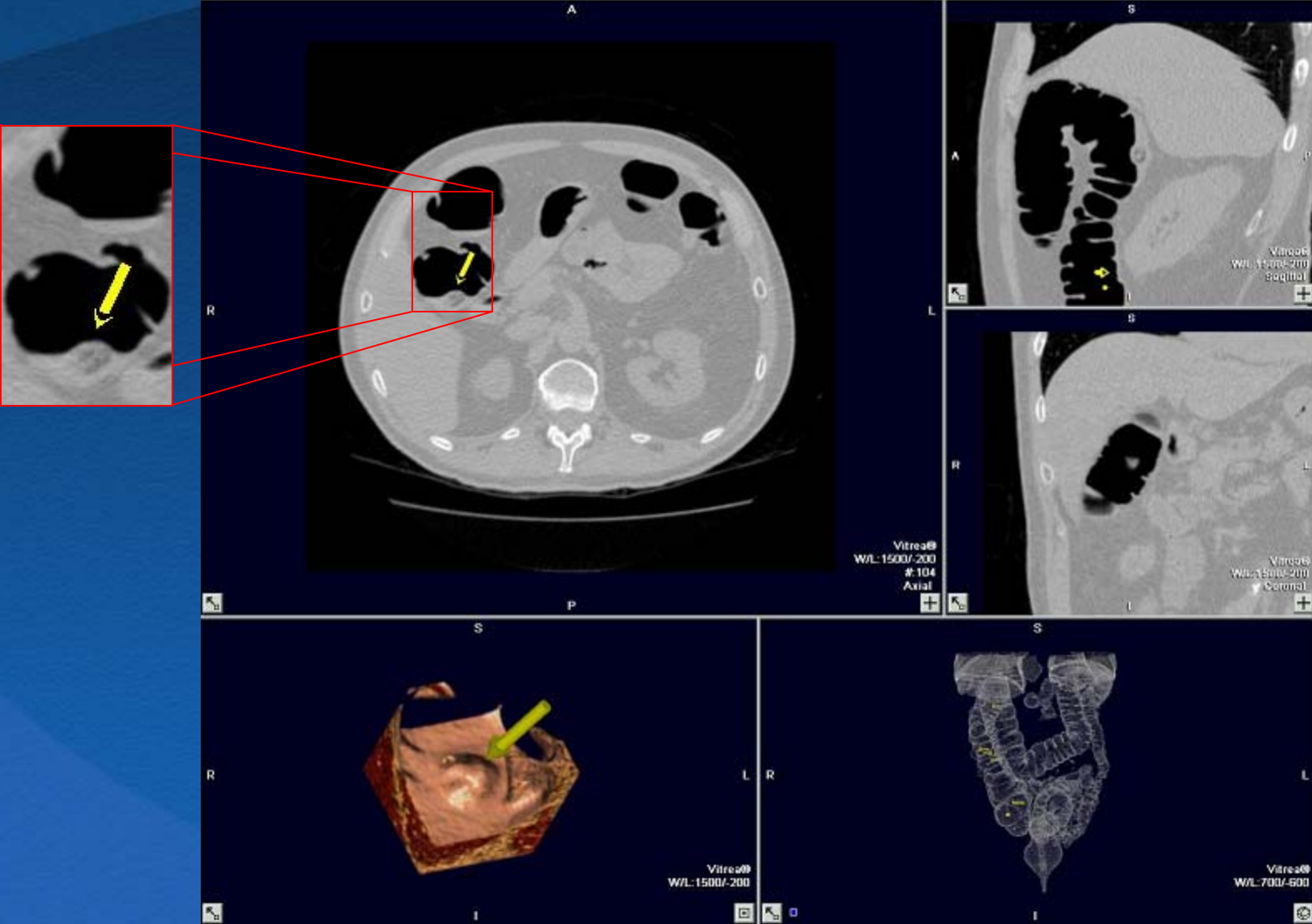


3D endoluminal with lesion in the floor of the transverse colon suspicious for a sessile polyp

Courtesy  
Dr. Gil Narvaez



# Mr. EP - Lesion #1



Courtesy  
Dr. Gil Narvaez



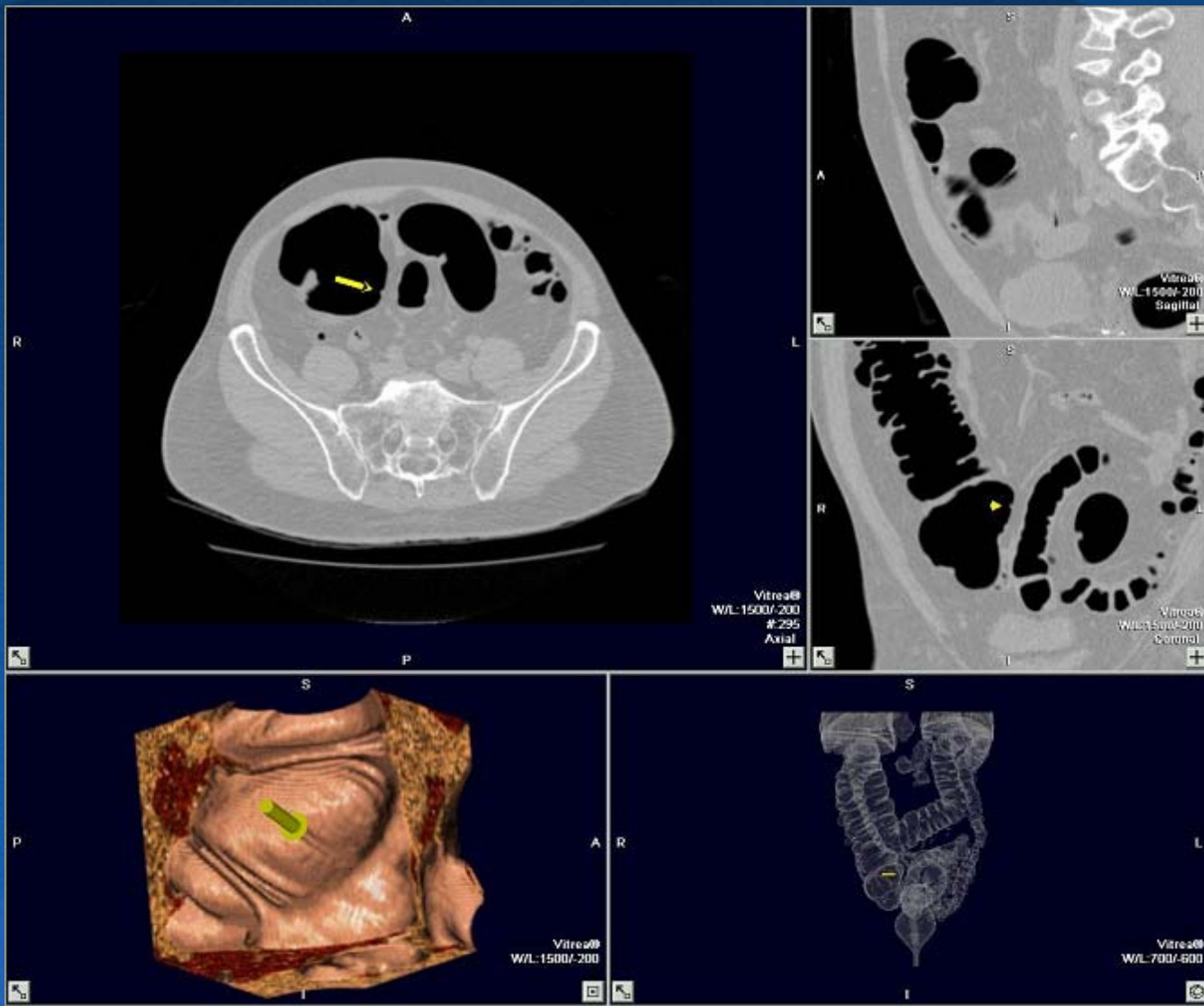
# Interpretation Lessons

- Need to use information from 2D and 3D views
- Stool is a frequent false-positive finding
- Appearance of fat or air in a suspicious lesion favors stool over polyp





# Mr. EP - Lesion #2



Courtesy  
Dr. Gil Narvaez





# Interpretation Lessons

- Need to use information from 2D and 3D views!!



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# CT Colonography Ready for Population Screening?





# Strengths

- For the patient:
  - Less invasive, no sedation
  - Time savings
  - Higher preference
  - Lower risk of complication
- For the provider:
  - Sensitivity same as colonoscopy for polyps >1cm (>6mm?)
  - Antegrade and retrograde views possible
  - Detection of extracolonic findings





## To be addressed...

- Poorer detection of small polyps and flat adenoma
- Dilemma: what to do about small polyps?
- For screening purposes, we must ask
  1. What is the clinical significance of small polyps since removal would require an invasive procedure?
  2. What is the clinical decision making about small polyps? Watchful waiting? Polypectomy for all polyps greater than certain threshold?





# To be addressed...

- Question #1: What is the clinical significance of small polyps?
  - Small polyps less likely to be cancerous or become cancerous
  - CT colonography has good sensitivity for polyps greater than 6mm either by patient or by polyp (see next slide)

Natural History of Colon Polyps<sup>1</sup>

Polyp Size	Likelihood of Being Cancer	10yr Cancer Risk
<5 mm	<0.01%	1%
5-9 mm	<1%	2-5%
10-15 mm	1-5%	5-10%

Sensitivity of CT Colonography<sup>2</sup>

Polyp Size	Sensitivity per polyp	Sensitivity per patient
≤5 mm	50%	71%
6-9 mm	63%	87%
≥10 mm	81%	88%

<sup>1</sup> Ferrucci J, *Colon Cancer Screening with Virtual Colonoscopy: Promise, Polyps, Politics*, AJR 177:975-986

<sup>2</sup> Sosna J, *CT Colonography of Colorectal Polyps: A Metaanalysis*, AJR 181:1593-1598



# To be addressed...(cont'd)

- Sensitivity by polyp shows no statistically significant difference between CT and colonoscopy for polyps >6mm

**Table 3.** Performance Characteristics of Virtual Colonoscopy and Optical Colonoscopy for the Detection of Adenomas.\*

Variable	Size Category				
	≥6 mm	≥7 mm	≥8 mm	≥9 mm	≥10 mm
	<i>no./total no. (% [95% CI])</i>				
<b>Analysis according to patient</b>					
Virtual colonoscopy					
Sensitivity	149/168 (88.7 [82.9–93.1])	100/110 (90.9 [83.9–95.6])	77/82 (93.9 [86.3–98.0])	53/57 (93.0 [83.0–98.1])	45/48 (93.8 [82.8–98.7])
Specificity	848/1065 (79.6 [77.0–82.0])	981/1123 (87.4 [85.3–89.2])	1061/1151 (92.2 [90.5–93.7])	1116/1176 (94.9 [93.5–96.1])	1138/1185 (96.0 [94.8–97.1])
Accuracy	997/1233 (80.9 [78.6–83.0])	1081/1233 (87.7 [85.7–89.5])	1138/1233 (92.3 [90.7–93.7])	1169/1233 (94.8 [93.4–96.0])	1183/1233 (95.9 [94.7–97.0])
Test-positive rate†	366/1233 (29.7 [27.1–32.3])	242/1233 (19.6 [17.4–22.0])	167/1233 (13.5 [11.7–15.6])	113/1233 (9.2 [7.6–10.9])	92/1233 (7.5 [6.1–9.1])
Sensitivity of optical colonoscopy					
	155/168 (92.3 [87.1–95.8])	100/110 (90.9 [83.9–95.6])	75/82 (91.5 [83.2–96.5])	51/57 (89.5 [78.5–96.0])	42/48 (87.5 [74.8–95.3])
<b>Analysis according to polyp</b>					
Sensitivity of virtual colonoscopy	180/210 (85.7 [80.2–90.1])	119/133 (89.5 [83.0–94.1])	88/95 (92.6 [85.4–97.0])	56/61 (91.8 [81.2–97.3])	47/51 (92.2 [81.1–97.8])
Sensitivity of optical colonoscopy	189/210 (90.0 [85.1–93.7])	120/133 (90.2 [83.9–94.7])	85/95 (89.5 [81.5–94.8])	55/61 (90.2 [79.8–96.3])	45/51 (88.2 [76.1–95.6])



## To be addressed... (cont'd)

- CT is non-therapeutic. Who gets a polypectomy?
  - 1cm cutoff: 1 in 13 screening CT colonographies would need optical colonoscopy
  - 6mm cutoff: 1 in 3.3
- Radiation
  - Estimated 60 cancers caused for every 1 million CT scans\*
  - Radiologists are studying a low mA protocol, but are the tradeoffs worth it?
    - 50% of normal radiation → no difference in colonic findings but reduced ability to detect extracolonic findings

\* Berrington De Gonzalez, *Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries*, Lancet 363:345-351



## To be addressed...(cont'd)

- Bowel prep still needed
  - Established principal barrier to colonoscopy
- IV contrast
  - Is it needed at the population level? Risk of reaction?
- Steep learning curve for interpretation
  - Likely to become less of an issue as radiologists gain experience
- Extracolonic findings
  - All must be worked up, but 90% lead to no intervention.
  - Will radiologists be responsible for reading just the colon or entire abdomen and pelvis?





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# Future Directions

- Computer-aided detection
- “Prepless” CT
  - Altering xray attenuation of stool with PO contrast to distinguish from neoplasia
  - Automatic subtraction of stool
- MR colonography
  - Less radiation
  - Very sensitive to movement → IV spasmolytics
  - Gadolinium enema must be used
  - Expensive
- Same day optical colonoscopy for suspected findings



# Summary

1. CT colonography uses standard 2D axial images to reconstruct 2D and 3D views of the colon.
2. Studies have shown that CT colonography is comparably sensitive to optical colonoscopy for polyps  $>1\text{cm}$  and perhaps for polyps  $>6\text{mm}$ .
3. For colorectal screening, radiation exposure and clinical significance of small polyps that may be undetected by CT remain to be addressed.



# References

- Berrington De Gonzalez, *Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries*, Lancet 363:345-351
- Dachman, *Virtual Colonoscopy: Past, Present and Future*, Radiologic Clinics of North America 41(2) March 2003
- Ferrucci J, *Colon Cancer Screening with Virtual Colonoscopy: Promise, Polyps, Politics*, AJR 177:975-986
- Ji H, *Multislice CT Colonography: Current Status and Limitations*, European Journal of Radiology 47:123-134
- McMahon P, *Colorectal Cancer Screening Issues: a Role for CT Colonography?* Abdominal Imaging 27:235-243
- Morrin M, *Screening Virtual Colonoscopy – Ready for Prime Time?* NEJM 349(23):2261-2264
- Pickhardt PJ, *CT Virtual Colonoscopy to Screen for Colorectal Neoplasia in Asymptomatic Adults*, NEJM 349(23):2191-2200
- Sosna J, *CT Colonography of Colorectal Polyps: A Metaanalysis*, AJR 181:1593-1598
- Taylor SA, *CT Colonography: Methods, Pathology, and Pitfalls*, Clinical Radiology 58:179-190



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