The virtuosity of virtuality or how real is virtual colonography

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Virtual colonoscopy can be considered as work in progress and may be the state of the art technique for a non-invasive and perhaps even pleasant colonoscopy in the future

The term "virtual colonoscopy" was initially coined by Vinig *et al* in 1994 who demonstrated the feasibility of creating three dimensional pictures of the colon using spiral computed tomography (CT) technology.¹ Since the term "virtual colonoscopy" is misleading and implies a colonoscopic procedure rather than generation of images, this methodology should be referred to as virtual colonography (VC). VC can be performed using CT or magnetic resonance imaging (MRI). In this issue of *Gut*, Ajaj and colleagues² present an evaluation of a new MR colonography technique employing a water enema for contrasting and extending the colon [see page 1738]. The so called "dark lumen" technique, which was first published in a small feasibility study³ and further described in a recently published review by the same group,⁴ offers the advantage that the lumen of the colon is pictured black whereas the colonic wall as well as polyps are brightly enhanced in T1 weighted sequences following the application of intravenous paramagnetic contrast. So what is the difference between this technique and that used in other published MR colonography studies? The common procedure is still administration of enemas mixed with paramagnetic contrast such as gadolinium, resulting in a "white" lumen in the T1 sequences. The high bright intraluminal signal contrasts with the black signal of the colonic wall; however, air bubbles and residual faeces also appear black with this technique, necessitating collecting data sets from both the prone and supine patient positions to differentiate real "sessile" polyps from "wandering" air bubbles or faeces. Hence the advantages of the "black lumen" are obvious. Because of the bright appearance of the bowel wall in contrast with the dark lumen, most pathological changes within the wall, such as inflammation or polyps, can be better depicted. Furthermore, examination time is shorter as only one dataset (prone position) is necessary.

Does this new technique influence patient acceptance for VC compared with conventional colonoscopy?

Several studies have so far addressed this issue and demonstrated that patients in general prefer VC. Probably the most embarrassing procedure during VC is colonic insufflation with air, carbon dioxide, or enemas containing contrast media to achieve maximal colonic distension,⁵⁻¹⁰ which also has to be performed in the case of the "dark lumen" technique. However, one has to bear in mind that patients judge bowel cleansing as the most negative experience which none the less has to be performed for VC, similar to colonoscopy.⁹ Therefore, the general acceptance for VC would probably markedly increase if it could be performed without bowel cleansing. Research in this area is ongoing and several feasibility studies have been published investigating the so called "faecal tagging" with contrast media, mainly barium, which was administered in the days prior to colonography together with regular meals.¹¹⁻¹⁴

SENSITIVITY OF VC IN COMPARISON WITH COLONOSCOPY

Using the technique of dark lumen colonography, Ajaj *et al* describe a sensitivity of 93% and a specificity of 100% for polyps >5 mm compared with colonoscopy.² These are excellent results but do these values apply for VC in general?

Most of the available data comparing VC with colonoscopy have been generated using CT technology. Only a few studies, conducted mainly in Europe, applied MR colonography, the reason for this probably being the heightened attention of the general population to radiation exposure.¹⁵ In most of these trials the sensitivity of CT or MR colonography for polyps of 1 cm and larger ranged from 75% to 100%, with specificity values of 70-100%. However, these values markedly decreased for

lesions in the 6-9 mm range (sensitivity 30-60%) and polyps of 3-5 mm in size, and flat lesions were not visible. This was also reflected in the study of Ajaj and colleagues,² having not correctly diagnosed a patient with polyposis coli by MR colonography who presented with only very small polyps. The low sensitivity of VC for smaller polyps holds true even for the newer multislice CT technology as recent trials do not report better results than earlier trials using single detector row CT.¹⁶⁻²⁰ Another issue is flat or depressed colorectal lesions, which are poorly depicted by VC^{21,22} but are present in up to 36% of patients undergoing routine endoscopy.²³⁻²⁵ Perhaps newer technique such as colour coding of colonic wall thickness could improve the sensitivity of VC in the future.²⁶

The published results, including those of Ajaj *et al*, demonstrate good sensitivity for large polyps. However, apart from the quality of bowel cleansing before colonography and the available hardware and software, there are other factors which influence the results, even for the detection of polyps larger than 1 cm (table 1).

One factor is the experience of the radiologist in interpreting the two and three dimensional colonographic data sets. Without a doubt, a steep learning curve exists for correctly interpreting findings in VC. This is best illustrated by a study by Spinzi *et al* demonstrating a sensitivity of only 30% compared with colonoscopy in the interpretation of the first 25 virtual colonographies, which improved to over 90% after interpretation of 100 virtual colonographies and vigorous training.²² The learning level also influences interobserver agreement which is highly variable in published studies.²⁷⁻³⁰

Another factor is the prevalence of polyps in the study population. Nearly all of the studies published so far compared colonography with colonoscopy in high risk groups with a high prevalence for colonic polyps. However, one recently published study with the largest screened population so far (703 patients) demonstrated a markedly lower sensitivity (46%; range 32-73% for three independent readers) for the detection of polyps >1 cm. Lack of experience of the readers of the colonographic images is less likely as all three readers were experienced board certified abdominal radiologists who had previously performed at least 150 CT colonography examinations with an endoscopic correlation. As the prevalence of polyps larger than 1 cm in this study was relatively low (6.6%) and comparable with a normal screening population,^{31,32} the more likely explana-

Table 1 Factors influencing the sensitivity and specificity of virtual colonography (VC)

Bowel preparation
Hardware and software
Experience of the reader in VC
Prevalence of polyps

tion is suggested by a commentary on this study by DK Rex that if the VC operator anticipates low disease prevalence the interpretation may be performed with less care or subtle changes in contour may be more likely to be interpreted as normal.³³ Interestingly, despite the experience of all three radiologists, interobserver variability in this study, as given by κ statistic values, ranged from -0.67 to -0.89 , the negative κ indicating agreement which is worse than chance.²⁹

In conclusion, the reported excellent sensitivity of Ajaj *et al* is probably true for centres with an established long experience in VC but needs to be replicated in larger multicentre trials.

CURRENT APPLICATIONS OF VC

Possible applications for VC at present are incomplete colonoscopy due to technical difficulties (for example, adhesions) or obstructing tumours allowing simultaneous tumour staging and inspection of synchronous lesions.^{34–36}

The use of VC in other patient groups, such as those with inflammatory bowel disease (IBD) who were also included in the study of Ajaj *et al*, has to be further evaluated. Particularly in combination with MR enteroclysis,³⁷ this technique could be used in IBD patients for monitoring the extent of intestinal inflammation as well as possible complications such as stenosis or strictures in the whole intestine. Perhaps there may also be an indication for VC in the follow up for patients who were treated for colorectal cancer in a "one stop shopping protocol" as tumour recurrence not only in the colon but also extraintestinal complications such as liver metastasis or even unrelated but other important extracolonic lesions could be detected.^{14–38}

Mainly because of the shortcomings of the sensitivity of the technique, as described above, VC is currently not being recommended for colorectal cancer screening, according to recently published screening guidelines.³⁹ Most probably newer techniques such as virtual pathology or computer aided diagnosis systems for colonic polyps will further improve the sensitivity of VC in the future.⁴⁰ At the moment, the evolution of VC can be considered as work in

progress and VC may be the state of the art technique for a non-invasive and perhaps even pleasant colonoscopy in the future. However, in the age of collapsing health insurance systems due to exploding expenses, one has also to calculate the costs of this technique. Sonnenberg *et al* calculated the costs for the application of VC for colon cancer screening in 1999 and concluded that VC needs to be offered at a very low price (54% less than conventional colonoscopy) or has to result in compliance rates much better than those associated with colonoscopy (at least 15–20% better) to become cost effective.⁴¹

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