Clinical results by CT colonoscopy

Abstract With increasing emphasis among the medical community on the early diagnosis and staging of colorectal cancer, interest has grown in CT colonography as a developing technique to challenge existing methods such as the barium enema and conventional colonoscopy. First introduced in 1994, CT colonography has experienced dramatic improvements in both hardware and software capabilities, resulting in shorter scanning times, greater user-friendliness and promising performance statistics. The recent development in multi-slice CT scanners has meant the ability to scan patients in a single breath hold, while innovations in image reconstruction and manipulation have optimised and yet greatly simplified study interpretation. Recent imaging protocols that use IV contrast to stage known or suspected colorectal cancer have been described. Current interest has focused on improving patient acceptance of the technique through the development of faecal tagging agents to avoid full bowel catharsis. This review summarises the development of CT colonography to date, evaluates its applications and performance in the detection and screening of colorectal polyps and looks at future directions of this exciting technique.

Keywords CT · Colonography · Virtual colonoscopy

Introduction

Colorectal carcinoma is the second leading cause of cancer death both in Europe and in the United States. The lifetime incidence of colorectal cancer is 5%, with 90% of cases occurring after 50 years of age. One-third of patients who develop colorectal cancer die of the disease. Clinical trials have demonstrated that the incidence and mortality of colorectal cancer can be decreased by early diagnosis, particularly through detection and removal of colonic polyps [1, 2]. More recently, the issue of screening for colorectal cancer in the general population has been discussed and recommendations made [2]. The impetus behind screening is the acknowledgement of the malignant potential of colorectal polyps, the recognition of populations at varying risk of developing colorectal carcinoma, and the improved survival of patients who have cancers detected and removed at an earlier stage. As 45% of cancers arise proximal to the splenic flexure the importance of evaluating the entire colon has been emphasised over the past decade.

Virtual colonoscopy is the term used to describe thin-section CT of the prepared colon with the volumetric data set reviewed both as two-dimensional and three-dimensional endoluminal images of the colonic mucosa. It is an exciting new innovation, first introduced by Vining and Gelfand in 1994, when they displayed three-dimensional endoluminal images of the colon in a cine loop, stimulating intense interest in investigators in the field of gastrointestinal imaging [3]. Since that time it has rapidly evolved with substantial improvements both in scanner hardware and computer reconstruction software. The advantages of virtual colonoscopy over con-
ventional endoscopy include safety, its ability to demonstrate the entire colon from rectum to caecum in almost all patients even following incomplete colonoscopy, to examine the bowel in both antegrade and retrograde directions in order to visualize both sides of hastral folds, to accurately localize lesions with reference to extra-colonic landmarks seen on axial images, to examine the proximal bowel with minimal risk in patients with obstructing lesions and in frail, debilitated patients, and to provide staging information in the pre-operative evaluation of patients with carcinoma.

Technique

Investigators have described a variety of techniques for performing virtual colonoscopy, but the basic principle of thin-section helical data acquisition following colonic cleansing remains the same. Bowel preparation consists either of a magnesium citrate laxative commonly employed for barium enema examinations such as Picolax (Ferring Pharmaceuticals, Berkshire, UK), or an osmotic laxative such as Klean-Prep (Helsinn Birex, Dublin, Ireland), as used prior to conventional colonoscopy. The advantage of the barium enema preparation is that it avoids the excessive residual intraluminal fluid seen with the colonoscopic preparations, which hinders visualisation of the colon on virtual colonoscopy. Adequate bowel preparation is one of the most crucial requisites of virtual colonoscopy. It is, however, the most uncomfortable for the patient, leading to intense interest in the development of fecal tagging agents that might reduce the need for full bowel catharsis. In a recent study of 40 consecutive patients who were randomised to undergo either standard colonic cleansing or reduced cleansing with tagging of fecal residues, the investigators found a significant improvement in their confidence to differentiate stool from polyps with the use of fecal tagging agents with the added benefit of reducing patient discomfort [4].

Also important for maximum soft tissue–air contrast is optimal colonic distension: the patient is placed in a decubitus position on the CT table and room air is insufflated into the colon by means of a soft rectal enema tip. Carbon dioxide has been advocated by some as an alternative agent for colonic distension, on the grounds that it is better tolerated by the patient and produces better bowel distention as a result [5, 6], but for convenience, room air is still widely used. Adequacy of colonic distension is assessed on the scout film and further insufflation is performed, if necessary.

Motion artifact must be minimised. Peristalsis can be reduced by spasmylytic agents: glucagon hydrochloride (Glucagon, Eli Lilly, Indianapolis, Ind.) at a dose of 1 mg IV is popular in the United States, whereas hyoscine n-butyl bromide (Buscopan, Boehringer Ingelheim, Berkshire, UK) is more widely used in Europe. Buscopan has the advantage of eliminating small bowel peristalsis more effectively and of being cheaper than glucagon, but its anticholinergic properties may produce troublesome side effects and its use is contraindicated in patients with closed angle glaucoma or cardiovascular disease. In one study of 152 patients undergoing CT colonography with or without glucagon, the use of IV glucagon did not improve colonic distension or enhance diagnostic accuracy for detecting colorectal polyps and cancers [7]. Scanning the entire abdomen and pelvis with conventional helical CT requires approximately 50 s. Respiratory artifact can be reduced by increasing the pitch to 1.5 [8], by asking the patient to exhale slowly following a longest breath hold [9], or by scanning in stages with several breath holds [10]. Faster multi-slice CT acquisitions will overcome problems with motion artifact in the future.

The abdomen and pelvis are scanned in both the supine and prone positions. The following parameters have been described for single-slice helical CT: collimation of 5 mm; table speed of 6.25 mm/s (pitch of 1.25); 2-mm reformating index; 4-mm filming index; smallest field of view to fit: 120 mA; 110 kVp; and a 512 × 512 matrix [8]. The patient radiation dose per acquisition is approximately 0.44 rem, which is lower than that of conventional axial CT of the abdomen and pelvis and is equivalent to that of a barium enema study [11]. The high inherent soft tissue–air contrast allows reduction of the milliampere to as low as 70 mA without sacrificing image quality [8, 12]. Further dose reductions can be brought about by higher pitch values: Springer et al. have shown how dose is mainly dependent on collimation, and that thinner collimation with higher pitch values can dramatically reduce patient dose without significantly affecting image quality [13]. The authors advise beam collimation of 3 mm and a higher pitch of 1.5–2 as a reasonable compromise between radiation dose and acceptable image quality. A reformatted slice overlap of 50% minimizes partial-volume averaging effects and stairstep artifacts. A smooth or standard algorithm is chosen, and axial 2D images are reviewed at lung window settings (window level, ~750 HU, window width, 1500 HU). Scanning in both the supine and prone positions enables discrimination between mobile fecal material and polyps. It also allows a second evaluation of sections of the colon that may have contained excessive intraluminal fluid or may not have been adequately distended with air on the supine scan, particularly the rectosigmoid as well as ascending and descending colons.

Studies using multi-detector array CT scanners utilise slightly different parameters. The fast rotation time (500 ms) and simultaneous acquisition of four slices mean that an abdomen and pelvis can be imaged in under 20 s, allowing rapid single breath-hold studies. Laghi