Reduction of perception error by double reporting of minimal preparation CT colon

R MURPHY, MB, ChB, FRCR, A SLATER, MB, ChB, R UBEROI, MB Bchir, MRCP, FRCR, H BUNGAY, MB Bchir, MRCP, FRCR and C FERRETT, MB, ChB

Department of Radiology, John Radcliffe Hospital, Headley Way, Headington, Oxford OX3 9DU, UK

ABSTRACT. Minimal preparation CT colon (MPCTC) is a useful test for frail elderly patients, who tolerate full bowel preparation poorly, and has the potential advantage of identifying extra-colonic pathology. Double reporting has been shown to reduce perception errors in a variety of radiological investigations, and we sought to determine its usefulness for MPCTC. A prospective consecutive cohort of 186 patients undergoing MPCTC for lower gastrointestinal symptoms was double reported. Radiologists were blinded to each report. Data for each report were divided into colonic and extra-colonic findings, with the latter being graded as clinically relevant or irrelevant. Discrepancies between the two reports were identified. A positive colonic lesion was defined as one where direct endoscopic visualisation was recommended. A clinically relevant extra-colonic lesion was defined as one that could impact on future patient management. 13% (24/186) of patients had a significant colonic lesion; 7 of these were identified only by 1 observer, although only 1 was confirmed endoscopically to be cancer. The positive predictive value for colon cancer was 69% for single reporting and 54.5% for double reporting. There were 67 clinically relevant extra-colonic lesions, and 25 of these were reported only by only 1 observer. In conclusion, double reporting found one extra-colonic cancer, but at the expense of five unnecessary endoscopic procedures. This seems a reasonable trade-off and we would therefore recommend double reporting. However, implementation would have a significant impact on manpower and service delivery.

Received 14 November 2008
Revised 19 March 2009
Accepted 21 April 2009

DOI: 10.1259/bjr/65634575

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Minimal preparation CT colon (MPCTC) is a useful, non-invasive, sensitive method for investigation of the colon for carcinoma in frail elderly patients [1–3], and has the advantage of being easy to tolerate [4]. Extra-colonic organs are inevitably also imaged, which may provide an advantage over the competing modalities of endoscopy and barium enema [5–7].

It has been shown that double reporting reduces perception error in a number of radiological investigations, including double contrast barium enemas, neuroradiology and mammography [8–11]. We perform a large number of MPCTC investigations in our institution and, because the colonic result can be easily dichotomised, we felt that the advantages of double reporting could easily be investigated.

Methods and materials

Local ethics committee approval was obtained. A prospective cohort of consecutive patients was included in this study in a single unit over 5 months. These patients were referred for MPCTC for investigation of suspected large bowel carcinoma. Local referral guidelines are that patients over 75 years of age, or younger

patients in whom it is thought that full colonic cleansing would be poorly tolerated owing to comorbidity, should have MPCTC.

Four consultant radiologists with experience in this technique (8, 5, 4 and 2 years' experience of reporting at consultant level) reported the images. Before starting the study, potential pathologies were divided into clinically relevant and irrelevant groups. A clinically relevant colonic lesion was one in which direct endoscopic visualisation was recommended. We did not make any attempt to differentiate between errors of perception or interpretation; merely the presence or absence of a colonic lesion requiring investigation was recorded. A clinically relevant extra-colonic finding was defined as a lesion that likely to impact on future patient management.

Each CT image was reported by two of the four consultant radiologists. Each radiologist reported independently, and was blinded to the other report. The data for each report were recorded on a standardised form and divided into clinically relevant and irrelevant findings. The reports were analysed for discrepancies and any clinically relevant discrepancy was documented; the referring clinicians were informed if the finding was not on the formal report. The colonic lesions were followed up by clinical and endoscopic correlation. Follow-up radiology examinations as a result of MPCTC findings were also documented.

Address correspondence to: Raman Uberoi, Department of Radiology, John Radcliffe Hospital, Headley Way, Headington, Oxford OX3 9DU, UK. E-mail: raman.uberui@orh.nhs.uk

MPCTC protocol guidelines

Each patient received oral contrast before the study — six doses of 5 ml of Gastrografin (Schering, Berlin, Germany) diluted in 500 ml of water was taken in the 72 h before the day of the exam (morning and evening). A further 5 ml diluted in 500 ml of water was taken on the morning of the exam and a final 5 ml in 500 ml of water was taken 30 min before the scan. No laxative, spasmolytic or intravenous contrast was administered. CT examinations were performed on a GE Lightspeed four-slice scanner (General Electric, Milwaukee, WI). Axial 5 mm helical images were obtained at 120 kVp from the diaphragm to the pubic symphysis.

Results

Over five months, 186 patients were included in the study: 89 males and 97 females aged between 53 years and 99 years old (mean age, 81 years). There were 91 clinically relevant findings. There was at least 1 discrepancy in 111 of the reports (60%; 111/186), although many of these were deemed not clinically relevant. Within this group, there were 24 clinically relevant colonic lesions and 67 clinically relevant extra-colonic lesions (Figure 1). 32 of the clinically relevant lesions (in 28 patients) were reported in only one of the reports for that patient. 7 of these were colonic lesions and 25 were extra-colonic lesions. Some reports had more than one clinically relevant finding that only appeared in one report (range, 1–3). 78 lesions deemed not clinically relevant were only noted in one report.

Colonic pathology

Both radiologists reported 17 colonic lesions. 11 of these were proven to be cancers on biopsies taken during subsequent colonoscopy. Five of these 17 patients had subsequent normal colonoscopies and so these lesions were deemed to be false-positives. All of these false-positives were in the rectum or sigmoid. One patient from this group did not attend for colonoscopy and was lost to follow-up.

Table 1. Clinically relevant lesions with no discrepancies in the report ($n=42$)

Hyperdense liver ($n=3$)
Pulmonary consolidation ($n=2$)
Pleural effusion
Pericardial effusion
Malignant liver lesion
Adnexal cyst
Ovarian mass ($n=3$)
Peritoneal metastases
Destructive bone lesion
Sclerotic bone lesion
Hyperdense renal lesion
Small bowel dilatation ($n=2$)
Extensive mesenteric lymphadenopathy
Para-aortic lymphadenopathy
Intrahepatic duct dilatation
Focal liver lesion ($n=4$)
Liver nodularity ($n=2$)
Cystic mass in pancreas ($n=4$)
Abdominal aortic aneurysm >4 cm ($n=2$)
Renal artery aneurysm 2 cm in diameter
Splenic artery aneurysm
Indeterminate pulmonary nodules ($n=3$)
Ascites
Enlarged prostate, bladder outflow obstruction ($n=2$)
Heart failure

Of the seven reports in which a clinically relevant colonic lesion was reported by only one of the radiologists, we found one biopsy-proven cancer, which was in the caecum (Figure 2). This was a T1 tumour less than 1 cm in diameter. In the remaining six patients, one of the clinically relevant colonic lesions reported was a rectal prolapse. One patient underwent follow-up MPCTC for thickening of the transverse colon. This had resolved on the follow-up scan three months later and was taken to be inflammatory in nature. Three patients had normal endoscopy and one patient did not attend for endoscopy and was lost to follow-up. Therefore, we had five false-positives in this group (four in the rectum or sigmoid). If we discount those cases with inadequate follow-up, single reporting yielded 11 true-positive colonic lesions and five false-positives, giving a positive predictive value (PPV) of 69%. For

Figure 1. Flow chart showing the breakdown of results. "DNA" indicates that the patient was lost to follow-up, precluding confirmation of the CT results.

Figure 2. Caecal cancer (arrow) reported only by one radiologist.

double reporting, there were 12 true-positives and 10 false-positives, producing a PPV of 54.5%.

Extra-colonic pathology

There were 67 extra-colonic lesions deemed clinically relevant. Both radiologists reported 42 out of 67 lesions (Table 1). Of these lesions, 12 were followed up with further imaging (Table 2). Three previously undiagnosed extra-colonic cancers were identified by both reporters (Figure 3). 25 clinically relevant extra-colonic lesions were reported by only one of the reporters, and these were confirmed at consensus review by all of the

Figure 3. Omental nodularity (arrow) identified in the absence of ovarian masses, which was confirmed to be metastases from ovarian carcinoma following biopsy.

reporters (Table 3). Of these, 12 patients went on to have follow-up imaging (Table 2). Three patients also had extra-colonic biopsies: one omental biopsy diagnosing ovarian carcinoma, one endoscopic retrograde cholangiopancreatography (ERCP) biopsy diagnosing cholangiocarcinoma and one bone biopsy diagnosing a plasmacytoma.

Discussion

Error is inevitable with any sophisticated investigation, but is considered important in radiology as data are stored for a long time and so are available for retrospective analysis. Potential ways of reducing error include double reporting, and this has been investigated for various radiographic techniques. A recent audit of the second reading of head CT images by a specialist neuroradiologist revealed a 13% major discrepancy rate [10].

Leslie and Virjee [9] suggested that double reporting of barium enemas increased sensitivity for colorectal cancer by at least 8%. Double reporting of mammograms has become standard practice and increases breast cancer detection by 1–4% [11, 12]. Johnson et al [13] investigated detection of large (>1 cm) polyps in CT colonography compared with colonoscopy as a reference standard. They found that double reporting increased detection by ~30%, but only for the two reporters who had the poorest results; results in this study were poor overall.

We have shown that double reporting has the potential to increase the diagnosis of clinically relevant colonic and extra-colonic lesions in MPCTC. One extra true-positive colon cancer was detected by double reporting at the expense of five unnecessary colonoscopies, thus reducing the PPV. This seems a reasonable trade-off, but it is interesting to speculate whether consensus reporting would reduce the number of false-positives without missing the extra true-positive. We cannot answer this question from the data presented here, but this is reported to be successful for mammography [14].

The incidence of colonic cancer in our study (6.5%) is similar to that reported in previous studies in the literature [1, 3, 4]. Although we cannot calculate sensitivity and specificity from our data, as we do not have a reference standard to detect colonic cancers that were missed on MPCTC, our PPV compared favourably with other studies. Kealey et al [4] reported a PPV of either 18% or 43% depending upon whether “possible” lesions were included, compared with a PPV of 49% for Ng et al [1]. Our study confirms previous findings [3, 15] that the rectum and sigmoid are difficult to evaluate in this test, as 9 out of the 10 false-positive cases were in this region. Flexible sigmoidoscopy is much easier to tolerate

Table 2. Additional examinations as a result of MPCT

	US	CECT	MRI	CXR	SBE
No discrepancy in report	4	8			
Discrepancy in report	2	4	3	1	2

MPCT, minimal preparation CT colon; US, ultrasound; CECT, contrast-enhanced CT; CXR, chest X-ray; SBE, small bowel enema.

Table 3. Clinically relevant lesions with discrepancies in the report ($n=25$)

Focal liver lesion ($n=3$)
Dense liver
Complex renal cyst
Renal artery aneurysm (1 cm)
Common femoral artery aneurysm
Moderate splenomegaly
Small bowel dilatation ($n=2$)
Duodenal thickening
Extensive mesenteric lymphadenopathy
Consolidation
Heart failure
Ventricular aneurysm
Inguinal hernia containing bowel
Complex adnexal cyst ($n=2$)
Renal mass
Moderate hydronephrosis
Intra-hepatic/CBD stone ($n=3$)
Pericardial effusion ($n=2$)

than full colonoscopy, and so sigmoidoscopy and MPCTC have valuable complementary roles.

A wide range of extra-colonic pathologies was identified, which is not surprising in an elderly population. The most important were three extra-colonic malignancies (2%), detected at a rate similar to other studies [5, 7, 15]. All of these were reported by both investigators. Deciding which extra-colonic abnormalities are clinically relevant is subjective and depends upon symptoms, not all of which are available on the CT request card, and age. Clearly, the finding of subclinical pulmonary fibrosis in a 20-year-old patient is very important, but many radiologists would view such a finding in an 85-year-old patient as irrelevant. Many of our apparently discordant reports were a result of differing opinions among radiologists about what findings were relevant. Some of these incidental findings will result in further investigations that ultimately prove to be unnecessary, with attendant inconvenience, cost, radiation dose and anxiety for patients. Even detecting incidental tumours may not necessarily equate to a survival benefit to the patient, a problem that has marred studies into lung cancer screening [16]. This is an aspect of colonic CT imaging that the CT colonography versus colonoscopy or barium enema for diagnosis of colonic cancer in older patients (SIGGAR) trial [17] hoped to address, and its publication is awaited with interest. As many of the patients with lesions identified as clinically relevant did not undergo further investigation, this raises questions as to whether they were actually relevant in this elderly population.

Xiong et al [7] conducted a meta-analysis of extra-colonic findings on 17 published papers investigating MCTPC and CT colonography. Only five of these papers used intravenous contrast. Of 3280 patients considered eligible, extra-colonic malignancies were found in 2.7%, with renal and ovarian findings being the most common. 0.9% had aortic aneurysms; 13.8% had further investigation of extra-colonic significant abnormalities; and 40% had extra-colonic findings considered important, although the categorisation of this differed between papers. The largest paper included in this meta-analysis was that by Gluecker et al [5], which reported the extra-colonic

findings of 681 asymptomatic patients undergoing CT colonography. The cost of subsequent radiological investigations triggered by extra-colonic findings was estimated at \$34.33 per patient.

12 patients (6%) in our series went on to have contrast-enhanced CT for further characterisation of abnormalities following MPCTC. We think that this small number validates the policy of not giving intravenous contrast routinely for this investigation, thus saving time, money and the risk of contrast reactions. It is not known whether giving intravenous contrast would increase the detection of colonic lesions or reduce the number of false-positives, although there is some evidence from CT colonography that contrast increases the identification of medium-sized polyps [18].

Although we have shown some benefit of double reporting, this has major resource implications and comes at the expense of increased false-positives. For this reason, we have not adopted routine double reporting of MPCTC in our department. Consensus reporting of detected abnormalities may offer a more time-efficient way of increasing accuracy.

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