

Radiographers are valuable contributors in interpreting computed tomography colonography

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ABSTRACT

INTRODUCTION: Computed tomography colonography (CTC) is the primary radiological examination for detection of colorectal cancer and premalignant polyps. It is a complex technique that requires special training and experience of both the radiographers performing the colonography and the radiologists who interpret the results. The considerable number of CTC performed means that interpretation of the examinations is a time-consuming task for radiologists. Therefore, this study aimed to evaluate the diagnostic performance of radiographers who received a training programme in colon diagnosing.

METHODS: During the period from December 2014 to May 2015, 126 patients underwent CTC screening or diagnostics. The colon was interpreted by both a radiographer and an experienced radiologist. Subsequently, results were compared and consensus established.

RESULTS: A total of 100 patients were included, six polyps (6–9 mm), one polyp (≥ 10 mm), four cancer suspect areas and four second opinions. The result was nine true positives, three false positives, no false negatives and 84 true negatives corresponding to a negative predictive value of 1.000 and an accuracy of 0.969.

CONCLUSIONS: This study shows that radiographers can be a valuable contribution in the interpretation of CTC.

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TRIAL REGISTRATION: not relevant.

Computed tomography colonography (CTC) is the primary radiological examination for detection of colorectal cancer and premalignant polyps. It is a safe and accurate diagnostic method with high demands on both examination quality and interpretation. The diagnostic accuracy is 96–97% in CTC, and for this reason it has replaced the barium enema [1].

In March 2014, a national screening programme for colorectal cancer was initiated in Denmark. The programme includes the performance of CTC in cases where colonoscopy is incomplete [2]. The increased number of CTC is a time-consuming task for radiologists due to the number of examinations and because the interpretation includes time-consuming 3D and 2D visualization and measuring of the pathology.

CTC is a complex technique that requires special

training and experience. Murphy et al found a 15% increase in the detection of intra-colonic lesions when double-reporting of CTC examinations by radiologists was used [3]. Double interpretation is employed in our department, but it is a very time-consuming task for the radiologists.

R. Meertens et al found that radiographers have the potential to serve as first readers of CTC followed by a radiologist as a second reader and reporter on any extra-colonic lesions. This could minimise the need for radiological involvement. However, they also described that any issues with radiographers' CTC interpretation skills may be due to limited experience and insufficient training [4].

The aim of the present study was to evaluate the diagnostic performance of two radiographers after they had completed a training program on diagnosing of the colon in 100 patients; any extra-colonic findings were diagnosed by a radiologist.

METHODS

This was a prospective study of 126 consecutive CTC examinations from December 2014 to May 2015 at the Radiology Department, Vendsyssel Hospital, Frederikshavn, Denmark. It included 80 symptomatic and 20 screening patients. No approval was needed from the Research Ethics Committee of North Jutland. All safety regulations and ethics were respected.

The examinations were interpreted by the same experienced radiologist and also by one of two radiographers (respectively 44 and 56 examinations). The examinations were blinded so that neither the radiologist nor the two radiographers had any knowledge of the patient's medical history and colonoscopy results; and none of them were involved in the performance of the CTC.

Excluded were low-quality examinations involving extensive residues and poor distension of the colon where at least one or more segments were not distended on either prone or supine position [2]. This was determined before discussion of the results in each case. Other exclusion criteria were examinations which required the investigators to consult with the radiologist, and ethical reasons, e.g. if the report could not be performed within five days.

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Prior to this study, the two radiographers with experience in CTC underwent a diagnostic training programme. The programme included 30 lessons in anatomy and pathology of the colon performed by the radiologist, and participation in the Basic ESGAR course in CT colonography. This was followed by 50 interpretations of CTC under the radiologist's supervision. As a supplement, E-learning cases from Virtual Colonoscopy Teaching Centre by Gryspeerdt & Lefere [5] were used.

The radiologist possessed over two years of experience in interpretation of CTC in clinical practice, and more than 20 years of experience in interpretation of CT.

Study design

To evaluate the two radiographers' performance in interpretation of CTC, we compared the results from the radiographers' colon findings with the consensus between the radiographer and the radiologist. The criteria were established in accordance with recommendations by Mang & Schima [6]. In that respect, it is a radiological study without any relation to clinical and colonoscopy findings.

Technical performance

Prior to the examinations, all patients underwent bowel preparation with Picoprep (Ferring, DK) and for foecal tagging Gastrografin 370 mg/ml (Bracco Diagnostics, USA), except for one patient who had Tagitol V (ezem, USA) due to allergy.

The screening group was scanned with a low-dose CT protocol, in both supine and prone position, according to the recommendations of the Danish Society of Radiology [2]. The symptomatic group had a full diagnostic examination in supine position and a low dose in prone position; iodine intravenous contrast media was used.



A clinical lesson in computed tomography colonography.

Relaxation of the bowel was achieved by administration of 20 mg hyoscine butylbromide (Boehringer Ingelheim, DE) intravenously or 1 mg glucagon (Novo Nordisk, DK) intramuscularly in case of contraindications to hyoscine butylbromide. The colon was distended in both the prone and the supine position by CO₂ insufflation using a ProtoCOL insufflator. The objective was to insufflate at least 4 l of CO₂ before the first scan. A scout view was made to secure sufficient distension of the bowel.

All patients were scanned with a Siemens Somatom Definition Flash 128 slice CT scanner. The scan parameters for the screening protocol were: Reference mAs 45, kV 120, pitch 1, rotation time 1, collimation 128 × 0.6 mm, slice thickness 1. For the diagnostic protocol: Reference mAs 110 in supine position and 45 in prone position, kV 120, rotation time 1, pitch 1, collimation 128 × 0.6 mm, slice thickness 1.

To analyse the examinations, a Syngo via Multi-Modality Workplace from Siemens was used. Analysis included 2D and 3D interpretation.

Interpretation

The report from one of the radiographers and the radiologist was divided into four categories according to the C-Rads classification [7]: cancer-suspect lesions, polyps 6–9 mm, polyps ≥ 10 mm, no malignancy-suspect lesions or polyps. In addition, the need for a second opinion was a separate category. Other pathological findings were not the aim of this study.

The sizes of the polyps were defined by the transverse diameter using window W/L: 1,500/–150 [8]. The size, segmental location and distance of the lesions from the anal margin were annotated.

Workflow

The radiographer analysing the colon was chosen randomly. The reports from both the radiographer and the radiologist were compared once finished. Each report was established without knowledge of the response from the other report. In case of disagreement, the radiographer and the radiologist established the diagnosis together following radiological criteria.

Data were processed by a statistician.

Trial registration: not relevant.

RESULTS

A total of 126 patients were examined, and 26 patients met the exclusion criteria previously described.

In four cases, a second opinion was requested. These cases will be discussed below, but initially, we focus on the remaining 96 patients.

The results of the examinations were summarised

in a table of confusion, see **Table 1**. From this, a number of summary quantities were calculated, these are presented in **Table 2**.

DISCUSSION

No essential pathology, e.g. cancer or polyps larger than 6 mm, was missed by the radiographers. For cancer-suspected areas and polyps larger than 6 mm, the study found a sensitivity of 1.000 (0.664-1.000) and a specificity of 0.966 (0.903-0.993) which means that the objectives of this study were achieved.

Achieving a second opinion caused no problems since the radiographers had the opportunity to discuss any uncertainty with radiologists, as is our daily practice. In four cases, the radiographers wanted a second opinion. In two cases, they found a cancer-suspect area (consensus found one cancer, but no cancer in the other case), in one case the patient had a suspected Morbus Crohn, and in one case the radiographer was uncertain of the size of two polyps.

There were disagreements in four cases. In one case, the radiographer found all four polyps, but measured one of these to 15 mm. Consensus on this polyp was 7 mm, and therefore the polyp was categorised as a 6-9 mm polyp, which was the reason for disagreement in this case. In two other cases, the radiographer found a polyp measuring 6 mm, but consensus concluded that the polyps measured less than 6 mm, and they were therefore categorised as Nopolyps. In the last case, the radiographer found a cancer-suspect area; however, the consensus concluded that the area was a non-malignant diverticulitis. We do not find these disagreements more important than disagreements between the radiologists of our department.

As reference standard, we chose consensus between the radiographer and the radiologist to secure agreement on the radiological criteria which were defined as the correct diagnosis.

Despite a relatively short training programme, no pathology of clinical importance was missed. In fact, insufficient length of training programmes has been identified as a major cause of less accurate results in the literature [9]. In regards to interpretation in CTC, the Danish Society of Radiology recommends that the radiologists should be able to document that he or she has received feedback from a qualified CTC radiologist while evaluating his or her first 50 CTC [2]. For a non-radiologist, interpretation of 50 CTC also seems to be a reasonable demand [4]. However, several studies show that interpretation of CTC has a long learning curve, as many as 300 cases [10]. In our study, the 50 supervised cases besides training by radiologist proved to be sufficient to achieve a satisfactory result. Dedicated radiographers and positive management are important factors in this

TABLE 1

Table of confusion of radiographer computed tomography colonography reporting.

Predicted radiographer diagnosis	Actual consensus diagnosis	
	cancer or polyps \geq 6 mm	no cancer and no polyps \geq 6 mm
Cancer or polyps \geq 6 mm	9 true positives	3 false positives
No cancer and no polyps \geq 6 mm	0 false negatives	84 true negatives

TABLE 2

Summary quantities of the numbers in Table 1.

Quantity	Formula	Result (95% exact binomial CI)
Sensitivity (TPR)	$TPR = TP / (TP + FN) = 9 / (9 + 0)$	1.000 (0.664-1.000)
Specificity (TNR)	$TNR = TN / (TN + FP) = 84 / (84 + 3)$	0.966 (0.903-0.993)
Positive predictive value	$PPV = TP / (TP + FP) = 9 / (9 + 3)$	0.75 (0.428-0.945)
Negative predictive value	$NPV = TN / (FN + TN) = 84 / (0 + 84)$	1.000 (0.957-1.000)
Accuracy	$ACC = (TP + TN) / (TP + FN + FP + TN) = 93 / 96$	0.969 (0.911-0.994)

ACC = accuracy; CI = confidence interval; FN = false negative; FP = false positive; NPV = negative predictive value; PPV = positive predictive value; TN = true negative; TNR = true negative rate; TP = true positive; TPR = true positive rate.

achievement. The number of CTC is increasing rapidly, in part because of screening programmes and because CTC is a relatively new examination technique. Therefore, cost considerations and the time spent on interpretation seem interesting. However, since the learning curve for the radiographers had not peaked when the study was performed, we found that these factors should await a later study.

Compared with other studies, the incidence of pathological findings seems low [11, 12]. One explanation could be that the colonography in this study was secondary to incomplete colonoscopy where polypectomy could have been performed.

In our experience, a better understanding of the diagnostic demands allows the radiographer to increase the technical quality of the CTC. In addition, the radiographers now form part of the team that teaches new radiologists.

CTC is a limited and finite task. CTC performance is highly reproducible, but it is also a very time-consuming task [13]. Under certain circumstances and after participation in an expedient training programme, we conclude that radiographers are valuable contributors in the interpretation of CTC. We also recommend the use of radiographers as co-readers of colonographic examinations.

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