ELSEVIER

European Journal of Radiology 60 (2006) 453–459

EJR
EUROPEAN JOURNAL OF RADIOLOGY

www.elsevier.com/locate/ejrad

# Accuracy of single phase contrast enhanced multidetector CT colonography in the preoperative staging of colo-rectal cancer

Pier Paolo Mainenti [a,b,*], Luigi Carlo Cirillo [b,c], Luigi Camera [b], Francesco Persico [d], Teresa Cantalupo [b], Leonardo Pace [b], Giovanni Domenico De Palma [d], Giovanni Persico [d], Marco Salvatore [b]

[a] *IBB CNR, Via Pansini 5, 80131 Naples, Italy*
[b] *Department of Biomorphological and Functional Sciences, University of Naples "Federico II", Via Pansini 5, 80131 Naples, Italy*
[c] *Hospital "dei Pellegrini", ASLNA 1, Via Portamedina 41, 80100 Naples, Italy*
[d] *Department of General Surgery, Geriatry and Endoscopy, University of Naples "Federico II", Via Pansini 5, 80131 Naples, Italy*

Received 6 February 2006; received in revised form 2 August 2006; accepted 3 August 2006

**Abstract**

*Aim:* The optimal acquisition time for staging colo-rectal carcinoma with a contrast enhanced multidetector CT colonography (CE CTC) has not yet been established. A dual phase with both arterial and portal venous acquisition has been proposed. The purpose of our study is to assess the value of single portal venous phase CE CTC in the preoperative staging of colo-rectal carcinoma.

*Materials and methods:* Fifty two (30 M, 22 F; aged 35–82 years) consecutive patients with a histologically proven diagnosis of colo-rectal adenocarcinoma or a highly suspected colo-rectal cancer on conventional colonoscopy underwent a four-slice CE CTC. The procedure was performed 70 s (portal phase) after the intravenous bolus (3 ml/s) administration of 120 ml iodinated non-ionic contrast agent (370 mg iodine/ml). Scans were performed using the following parameters: 2.5 mm beam collimation, pitch 1.25, 120 kV, 200 mAs, rotation time 0.75 s. Images were reconstructed with an effective thickness of 3.2 mm at intervals of 1.6 mm.

Two radiologists independently evaluated the depth of tumour invasion into the colo-rectal wall (T), regional lymph node involvement (N), and extracolonic metastases (M). Disagreement was resolved by means of a consensus decision. The pathological results served as the standard of reference. Assessment was made of sensitivity, specificity and accuracy, as well as positive and negative predictive values were assessed.

*Results:* CE CTC correctly staged the pT of 52/56 (93%) and the N of 40/56 (71%) lesions, as well as properly identifying 13/14 (93%) extracolonic findings.

*Conclusion:* The single portal venous phase CE CTC scanning protocol enables satisfactory preoperative assessment of T, N and M staging in patients with colo-rectal cancer.



*Keywords:* Multidetector CT; Colonography; Carcinoma; Staging

## 1. Introduction

Accurate preoperative staging of colo-rectal cancer is essential for the planning of optimal therapy considering the many therapeutic options available. The usefulness of conventional CT for the preoperative staging of colo-rectal carcinoma is controversial: diverse results are reported for staging accuracy ranging between 48% and 77% [1,2]. The introduction of helical CT and, subsequently, of the multidetector devices has improved abdominal CT images, providing thin collimation as well as improvement of spatial resolution and of multiplanar reformatted images (MPR). CT colonography represents an accurate technique for detecting cancers [3–5]. As a result, in more recent reports, the use of single- or multidetector helical CT associated with air or enema colo-rectal distension offered more satisfactory results in colo-rectal cancer staging with an accuracy rate ranging between 80% and 95% [6–9].

The optimal time of acquisition for staging colo-rectal carcinoma with a contrast enhanced multidetector CT colonography

* Corresponding author at: Corso Vittorio Emanuele 670, 80122 Naples, Italy. Tel.: +39 0817613060; fax: +39 0817616013.
*E-mail address:* pierpamainenti@hotmail.com (P.P. Mainenti).

0720-048X/$ – see front matter © 2006 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.ejrad.2006.08.001

has not yet been established. Very few reports are present in English literature [8,9]. Filippone et al. [8] proposed a dual phase protocol characterized by arterial and portal acquisition, since the arterial phase imaging seems to improve the differentiation between the tumour and the adjacent organs and tissue [6], while the portal phase is useful for the evaluation of liver metastases and lymph nodes. This protocol is more expensive and time consuming both for acquisition and interpretation. Moreover, the patient is exposed to a higher radiation dose. On the other hand, Kulinna et al. [9] proposed a portal venous acquisition, although only rectal cancers were included in their study and the evaluation was limited to the local staging.

The purpose of our study was to assess the value of single portal venous phase contrast enhanced multidetector CT colonography (CE CTC) in the preoperative staging of colorectal carcinoma.

## 2. Materials and methods

### 2.1. Patients

Fifty-two consecutive patients (30 M, 22 F; aged 35–82 years) were included in the study. Inclusion criteria were either a histologically proven diagnosis of colo-rectal adenocarcinoma ($n = 20$) or a highly suspected colo-rectal cancer on conventional colonoscopy ($n = 32$). All patients gave their written informed consent and underwent a CE CTC in our department.

Twenty-seven conventional colonoscopies (CC) were incomplete due to the presence of an impassable neoplastic stenosis and 7 due to the intolerance of the patients, while 18 were complete.

The endoscopic biopsy subsequently confirmed the presence of an adenocarcinoma in the 32 patients with a highly suspected diagnosis of colo-rectal cancer on conventional colonoscopy.

All patients underwent surgical resection within 10 days of CT examination. A preoperative therapy (radiotherapy and/or chemotherapy) was not performed in any patient.

### 2.2. Location and pathologic TNM stage

The association of surgical and pathological findings served as the standard of reference for location.

Pathological findings served as the standard of reference for depth of tumour invasion and nodal involvement. T and N staging was based on the TNM classification [10].

The standard of reference for peritoneum and retroperitoneum implants was abdominal cavity exploration and histopathological examination.

The standard of reference for the liver was the intraoperative bimanual liver palpation integrated when necessary by histopathological examination and the results of a liver ultrasound and/or an abdominal-pelvis CT performed within 12 months of surgery (30 patients underwent CT, 18 ultrasound and 4 both examinations). The liver metastases identified during intraoperative bimanual liver palpation, or on post surgical liver ultrasound or CT, were classified as false negative if they were not shown on the preoperative CE CTC. Intraoperative liver ultrasound was not performed on any patient.

### 2.3. CT protocol

Twenty-four hours prior to examination, each patient received a bowel preparation in the form of polyethylene glycol solution (Isocolan; Giuliani, Milan, Italy). Extra bowel preparation was not necessary in any patient since the CT was scheduled 2 h after the CC examination in 32 cases and 1 day before surgery in 20 cases.

Before CT scanning, a 12-French balloon-tipped rectal tube was inserted and the colon was insufflated, to the maximum level tolerated by the patient, from a bag containing room air connected to the rectal tube. To reduce bowel peristalsis and colonic spasms, 20 mg of joscine *N*-bromuro (Buscopan; Boehringer Ingelheim, Florence, Italy) was administered intravenously immediately before air insufflation.

A scout view was acquired to assess the degree of colonic distension and further air was insufflated as necessary. A single breath-hold data acquisition was used to examine the entire colon.

The procedure was performed with the patient in the supine position 70 s (portal phase) after the intravenous bolus (3 ml/s) administration of 120 ml iodinated non-ionic contrast agent, iopromide (Ultravist, 370 mg iodine/ml; Schering, Berlin, Germany), into an antecubital vein by means of an 18-gauge needle. The procedure was performed in prone position if the tumour was located in the rectum.

All CT examinations were performed using a four-slice multidetector CT system (Philips, MX8000). Scans were acquired using the following parameters: 2.5 mm beam collimation, pitch 1.25, 120 kV, 200 mAs, rotation time 0.75 s. Images were reconstructed with a 3.2 mm effective thickness at 1.6 mm intervals. The scan time for 40 cm was 25 s.

All CT images were transferred to a workstation (Vitrea 2.6, Vital Images, Minneapolis, USA). For each patient the axial images and the relative MPR images were evaluated using lung (width: 1500 HU; level: −200 HU) and abdominal (width: 360 HU; level: 60 HU) window settings.

### 2.4. Interpretation

Two abdominal radiologists, who were aware of the results of CC, were asked to identify the tumours and to report their location, size and attenuation value. For the location of each lesion the large intestine was divided into eight anatomic segments: rectum, sigmoid colon, descending colon, splenic flexure, transverse colon, hepatic flexure, ascending colon and cecum. The maximum diameter of the lesions was measured on multiplanar reconstructed images obtained by aligning the segment involved with the longitudinal axis of the colon. Attenuation of each lesion was measured by the largest possible region-of-interest circle that did not cause partial volume averaging between the lesion and surrounding air, colon wall or pericolic fat. The two radiologists measured the CT attenuation values by means of consensus reporting.

The two radiologists were asked to stage the cancers before surgery. Thus, the two radiologists were unaware of the surgical and pathological findings.