Water enema computed tomography: diagnostic tool in suspicion of colorectal tumor

Frank PILLEUL (1, 2), Aurélie BANSAC-LAMBLIN (1), Olivier MONNEUSE (3), Jérôme DUMORTIER (4), Laurent MILOT (1), Pierre-Jean VALETTE (1, 2)

(1) Service de Radiologie Digestive, Hôpital Edouard Herriot, Lyon ; (2) Laboratoire RMN, UMR CNRS 5012, Domaine Scientifique de la Doua, CPE, 69616 Villeurbanne ; (3) Service des Urgences Digestives Chirurgicales, (4) Service d’Hépato-Gastro-Entérologie, Hôpital Edouard Herriot, Lyon.

SUMMARY

Objectives — The aim of this study was to assess the accuracy of water enema multi-row computed tomography (WE-MR-CT) for detecting clinically suspected colorectal tumor.

Patients and methods — A water enema multi-row computed tomography (WE-MR-CT) was performed in 128 consecutive patients (71 women, mean age 67.7 years) referred for suspicion of colorectal cancer. We defined at least one centimeter size of the lesion as the threshold of detection. The results of WE-MR-CT were compared with the diagnosis obtained by colonoscopy, pathology or clinical follow-up.

Results — The overall sensitivity and specificity of water enema multi-row CT in identifying patients with colorectal lesions were 95.5% and 93.5%, respectively. The negative predictive value was 98.8% for a 10-mm threshold lesion size. WE-MR-CT allowed identifying synchronous lesions in three cases.

Conclusions — WE-MR-CT can accurately detect supracentimetric colorectal tumors. The performance of this technique should be further evaluated in prospective studies.

Introduction

In France, colorectal cancer is the most frequent cancer in both men and women with 38000 new cases reported in 2000, 65% localized in the colon. Colorectal cancer is the cause of 16000 deaths per year with an estimated crude 5-year survival rate of 46% [1]. Colorectal cancer is thus a major public health concern.

The screening strategy for colorectal cancer is based on early detection of polyps and cancer at a stage when curative surgical resection can be undertaken, potentially associated with complementary adjuvant treatments [2].

Colonoscopy, the gold standard exploration for the rectum and colon, enables direct visualization of the entire colon; biopsies or resection of identified polyps can be performed as needed. Colonoscopy is recommended for populations with a high or very high risk of colorectal cancer [3]. Mass screening in France uses occult fecal blood tests followed by colonoscopy if the test is positive. This screening approach has demonstrated efficacy and could reduce mortality due to colorectal cancer by 14%, if applied in at least half of the population aged 50-74 years [4, 5]. There is however a limit due to the lack of sensitivity [3].

Virtual colonoscopy is a new imaging technique for the colon, using spiral computed tomography after distension of the colonic lumen by air introduced via the rectum. Images must undergo post-acquisition processing to obtain 3D reconstruction virtual endoscopic images. Virtual colonoscopy enables identification of all colorectal cancers measuring more than 2 cm and has a sensitivity ranging from 75 to 93.8% for the detection of polyps measuring more than 1 cm [6-8]. Conversely, the requirement for a double dorsal and ventral acquisition and the significant post-acquisition processing time limits this technique as a routine examination for screening for colorectal tumors.

The difficulty is to define a detection method for colorectal cancer meeting the prerequisites of a diagnostic test applicable to the general population (reliable, acceptable, safe, results equivalent to gold standard). The target population must include patients presenting a contraindication for colonoscopy or general anesthesia or whose benefit-risk ratio is too high. The ideal examination would also be useful for a population with a high risk of colorectal cancer, i.e. patients aged over 50 years whose diagnosis was established on the basis of chronic or acute symptoms [3].
Water enema multi-row computed tomography (WE-MR-CT) has demonstrated its potential for preoperative localization of colorectal cancer and search for extension [9, 10]. This technique has not been evaluated for the detection of colonic tumors. We thus studied the contribution of WE-MR-CT to the diagnosis of supracentimetric colorectal tumors in a population at risk.

**Material and methods**

This retrospective study included 128 patients (71 women, sex ratio 1.24) who underwent WE-MR-CT during a 15-month period (May 2001-July 2002) in the digestive radiology unit of the Edouard Herriot Hospital in Lyon, France. Mean age of patients was 67.7 years (range 27-94). This study was designed to evaluate the diagnostic value of WE-MR-CT for colorectal cancer in patients with a clinically or biologically suspected tumor.

**Inclusion criteria**

Digestive bleeding (overt bloody stools or occult fecal blood) or iron-deficiency anemia of undetermined origin; recent transit disorders (diarrhea, constipation) or alternating diarrhea-constipation; obstructive syndrome; atypical non-diverticular sigmoiditis; incomplete colonoscopy, search for primary tumor of liver metastases.

**Non-inclusion criteria**

Factors ruling out WE-MR-CT: anal incontinence, renal failure (creatinemia > 140 μM/l), allergy to iodine.

**Water enema multi-row computed tomography**

For scheduled examinations, the patients ingested an oral preparation (PEG) three days before the examination (N = 118). For emergency examinations, the colon was not prepared (N = 10). All examinations were conducted with the same protocol using a multiple-row spiral scan (Siemens Volume Zoom, Erlange, Germany). The patients were installed in the supine position for water distension of the rectum and colon using a balloon probe inserted via the rectum. Correct filling of the colon required administration of 1.5 - 2 L warm water. The water filling was considered sufficient when good distension of the cecum was visualized.

Acquisition: spiral acquisition on the abdomen and pelvis during 15-sec apnea, 60 sec after injection of contrast product (2 cc/kg; 4 cc/s). Colonic filling was maintained throughout the acquisition.

Acquisition settings: 170 Mas, 120 Kv, collimation 4/2.5 with 3 mm slices. This acquisition during the venous phase enabled good enhancement of the digestive wall and optimal enhancement of the liver to search for potential hepatic metastases and/or lymph node enlargement.

**Data analysis**

Protocol: Systematic reconstruction of the injected spiral using cine-display with 1.5 mm slice thickness. Systematic reformating of the injected coronal slices.

Data collection: Data were extracted from the radiology unit’s database of initial reports of water enema CT scans. The WE-MR-CT was considered positive if it described an anomalous colonic wall and/or wall thickening suggestive of a tumor or polyp measuring more than 1 cm in diameter. The examination was considered negative if there were no lesions suggestive of a colonic tumor which could be identified (including lesions not suggestive of a tumor). The examination was also considered negative if an extracolonic anomaly was discovered.

If the initial report did not yield a definitive result, a radiologist investigator re-read the WE-MR-CT images without knowledge of the prior conclusions.

Reference diagnosis: If the WE-MR-CT was positive, the reference diagnosis was established from the pathology examination of the operative specimen after resection or from the result of the endoscopic procedure. If the WE-MR-CT was negative, the reference diagnosis was established on the basis of patient follow-up data evaluating the general status eighteen months after the WE-MR-CT.

**Statistical analysis**

Variables were expressed as mean and standard deviation or percentage. The WE-MR-CT results were compared with the reference diagnosis for colorectal disease to establish the usual values (sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy). Data were processed with Microsoft Excel on a PC.

**Results**

This study included 128 patients who underwent WE-MR-CT. Thirteen patients were lost to follow-up, nine with a negative WE-MR-CT and four with a positive WE-MR-CT.

WE-MR-CT procedures were performed mainly for: recent transit disorders (34%), digestive hemorrhage/occult bleeding (23%), intestinal obstruction syndrome (4%), atypical sigmoiditis (15%), incomplete colonoscopy (14%), search for primary tumor of liver metastases (10%). WE-MR-CT was preferred for 57% of patients with transit disorders or digestive hemorrhage because of patient age, an anesthesia risk, or minimal clinical suspicion (e.g. hematochezia in a patient with hemorrhoids). Then WE-MR-CT was considered negative in 80 patients. Mean age of these 80 patients was 66.1 years (50 women, 38 men, sex-ratio F/M 1.32). The diagnostic correlation was established after digestive surgery (N = 14), complete rectocolonic endoscopic procedure (N = 12), or 18-m medical follow-up after WE-MR-CT (N = 62) including complementary rectosigmoidoscopy in addition to physical examination for thirteen patients. In this group of patients with a negative WE-MR-CT, 35 had transit disorders caused by diarrhea (N = 8), constipation (N = 14) or alternating diarrhea — constipation (N = 13).

There were also nine patients with a history of digestive tumors: colorectal cancer (N = 8), Muller tumor (N = 1), resected colonic polyp (N = 1). Polypoid formations not recognized by the WE-MR-CT were identified in four patients but only one polyp measured more than 1 cm.

The WE-MR-CT was positive in 27 patients. In this group, mean patient age was 73.1 years (13 women, 14 men, sex-ratio F/M 0.93).

The correlation between the WE-MR-CT results and final diagnosis was established from endoscopic and/or pathologic findings. Thus, 21 patients were true positives and six were false positives. Among the true positives, the tumor was localized in the sigmoid colon or the rectosigmoid junction (N = 7) (figure 1), the left colon (N = 3), the transverse colon (N = 1), the right colon (N = 5), the cecum (N = 2) or diffuse (N = 3).

Tumors were colorectal adenocarcinoma (N = 16), villous polyp (N = 3) (figure 2), tubuloud adenoma with low-grade dysplasia (N = 1), zone of high-grade dysplasia in a polyp (N = 1).

For the patients who were false positives for the diagnosis of supracentimetric colorectal cancer (N = 6), the final diagnosis was Melas disease (N = 1), edematous or inflammatory colitis (N = 3), and a technical error by defective expansion of a portion of the colon (N = 2).

Our study thus demonstrated a sensitivity of 95.5% [95CI: 91.5%-99.5%] of WE-MR-CT for screening for supracentimetric colorectal tumors with a specificity of 93.5% [95CI: 88.8%-98.2%]. The positive predictive value was 77.8% with 21 true positives, and six false positives. The negative predictive value was 98.8% with 88 true negatives and one false negative. In three patients, the WE-MR-CT enabled the diagnosis of synchronous lesions.

**Discussion**

Data has been lacking on the diagnostic value of WE-MR-CT for colorectal cancer. Studies published on WE-MR-CT have basically evaluated its performance when searching for locore-
partially resolved with multiplanar visualization [16]. We did not
difficult to study and is a source of potential errors which can be
any pathological aspect at endoscopy. The ileocecal junction is
was the source of doubt requiring endoscopic verification in a

tumor formation. In two cases, defective expansion of the colon
false positives. These cases involved the difficulty in establishing

discovered later at colonoscopy. This polyp was initially
sténosante à la jonction recto-sigmoïdienne (étoile).

WE-MR-CT appears to be a reliable technique for the detection
varies from 75-91% using the 1 cm threshold [6, 7, 14, 15].

 literature for virtual colonoscopy where the sensitivity of detection
sor lesions was 95.5% with a specificity of 93.5% for a detection

We analyzed the sensitivity and specificity of WE-MR-CT for
the diagnosis of colorectal tumors in a selected elderly popula-
Mean age of patients included in this study was 67.7 years,
an age comparable to that in the report by Lipscomb et al. [9].
The overall sensitivity for detecting colorectal cancer and prec-
sor lesions was 95.5% with a specificity of 93.5% for a detection
threshold of 1 cm. These results are similar to data reported in
the literature for virtual colonoscopy where the sensitivity of detection
varies from 75-91% using the 1 cm threshold [6, 7, 14, 15].
WE-MR-CT appears to be a reliable technique for the detection
of colorectal tumors by distension of the colon with water, a neg-
vative contrast agent, avoiding artifacts and offering a better
study of the digestive tract walls and the pericolonic structures,
unlike positive intraluminal contrast agents using iodine [11, 12].

There was one false negative in a patient with a 2-cm polyp
discovered later at colonoscopy. This polyp was initially
described as the presence of fecal matter. There were also six
false positives. These cases involved the difficulty in establishing
the etiological diagnosis for wall thickening which can mimic a
malignant proliferation. In two cases, defective expansion of the colon
was the source of doubt requiring endoscopic verification in a
patient with a pseudohypertrophy of the ileocecal junction without
any pathological aspect at endoscopy. The ileocecal junction is
difficult to study and is a source of potential errors which can be
partially resolved with multiplanar visualization [16]. We did not

compare our results with those obtained with conventional colon-
scopy since this examination was not performed systematically.
Colonoscopy remains the screening examination of choice for
colon cancers [3], enabling direct visualization of lesions and
biopsies for certain diagnosis, an important advantage lacking
with WE-MR-CT [7, 9].

Conventional colonoscopy can however miss 24% of adeno-
mas [15] with a detection sensitivity which can fall to 56% [5, 17].
There are furthermore certain contraindications for colonoscopy:
obstructive syndromes, suspected perforation or fistula, severe
colitis, and the contraindications for general anesthesia.

In our study, all colonic cancers were detected (100% sensitiv-
ity), but the overall sensitivity was 95.5% because one polypoid
formation measuring 2 cm was not detected. Studies devoted to
virtual colonoscopy have reported similar results with 100%
detection of colorectal cancers [7]. Harvey et al. described 97%
sensitivity for the detection of cancer but 86% specificity because
inflammatory or infectious disease could be mistaken for tumors
[6]. We noted one false negative for a 2-cm lesion missed with
virtual colonoscopy [19].

At the present time, barium enema appears to be an obsolete
examination. It nevertheless is mentioned among the international
recommendations concerning colon cancer as a second inten-
tion examination when colonoscopy cannot be performed or is
incomplete. Barium enema only offers a relatively low percentage
detection of colorectal lesions; it is difficult to reach the cecum
[20] and it does not enable an assessment of tumor invasion or
distant extension [21]. Barium enema is insufficient to detect syn-
chronous tumors as well as certain types of colonic obstructions
[22, 23]. Moreover, it exposes the patient to significantly more
radiation than an abdominal computed tomography [15].

WE-MR-CT is a relatively safe exploration which does not
require intravenous iodine injections. There have been no compli-
cations described to date. There have been no reported compli-
cations for virtual colonoscopy, but there is a theoretical risk due
to the colonic distension. It can be recalled that the risk of perfo-
rataion is however present for conventional colonoscopy with vari-
ous rates being reported: 0.016% to 1% for colonoscopy
performed for diagnostic purposes and 0.016% to 3% for colon-
oscopies with biopsy or another therapeutic procedure [24, 25].

In conclusion, our study demonstrated the value of WE-MR-
CT for the diagnosis of suspected colorectal lesions with an ex-
cellent negative predictive value of 98.8%. This technique has also

Fig. 1 – 65 years old woman with recent history diarrhoea and constipation.
Water enema computed Tomography identified a tumoral stenosis at
the junction between the rectum and the sigmoid.
Malade de 65 ans qui présentait des épisodes alternant diarrhée —
constipation. Le coloscanner à l’eau a identifié une masse tumorale
sténosante à la jonction recto-sigmoïdienne (étoile).

Fig. 2 – Polypoid mass (arrow) was identified on water enema computed

tomography in 71 years old man with recent history anemia.
Formation polypoïde (flèche) ; découverte au cours d’un coloscanner
à l’eau réalisé à un malade de 71 ans pour anémie férriprive.
been described as simple, rapid, and easy to interpret, enabling use in the routine clinical setting. WE-MR-CT would be interesting for a selected population, such as frail or elderly subjects for whom conventional colonoscopy is contraindicated or whose risk-benefit ratio is too high. In addition, WE-MR-CT could be useful in an average risk population, including asymptomatic patients.

REFERENCES

16. Gollub MI, Ginsberg MS, Cooper C, Thaler HT. Quality of virtual colonoscopy in patients who have undergone radiation therapy or surgery: how successful are we? AJR Am J Roentgenol 2002;178:1109-16.