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# Magnetic resonance colonography with a limited bowel preparation and automated carbon dioxide insufflation in comparison to conventional colonoscopy: Patient burden and preferences

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ABSTRACT

*Objectives:* To evaluate patient burden and preferences for MR colonography with a limited bowel preparation and automated carbon dioxide insufflation in comparison to conventional colonoscopy.
*Methods:* Symptomatic patients were consecutively recruited to undergo MR colonography with automated carbon dioxide insufflation and a limited bowel preparation followed within four weeks by colonoscopy with a standard bowel cleansing preparation. Four questionnaires regarding burden (on a five-point scale) and preferences (on a seven-point scale) were addressed after MR colonography and colonoscopy and five weeks after colonoscopy.
*Results:* Ninety-nine patients (47 men, 52 women; mean age 62.3, SD 8.7) were included. None of the patients experienced severe or extreme burden from the MR colonography bowel preparation compared to 31.5% of the patients for the colonoscopy bowel preparation. Colonoscopy was rated more burdensome (25.6% severe or extreme burden) compared to MR colonography (5.2% severe or extreme burden) ($P < 0.0001$). When discarding the bowel preparations, the examinations were rated equally burdensome ($P = 0.35$). The majority of patients (61.4%) preferred MR colonography compared to colonoscopy (29.5%) immediately after the examinations and five weeks later (57.0% versus 39.5%).
*Conclusion:* MR colonography with a limited bowel preparation and automated carbon dioxide insufflation demonstrated less burden compared to colonoscopy. The majority of patients preferred MR colonography over colonoscopy.



## 1. Introduction

Colorectal cancer is one of the leading causes of cancer related deaths in the Western world [1–3]. Early detection and screening of colorectal cancer is essential, as it reduces incidence and colorectal cancer mortality [3–5]. Colonoscopy is considered the most accurate screening tool; however, alternative tools have been evaluated to minimise invasiveness and burden, while preserving high detection rates [2,4]. For that reason CT-and MR colonography were introduced.

CT colonography has demonstrated similar yields of advanced neoplasia per screened invitee [6]. To date, CT colonography is part of daily clinical practice [7]. Yet, the downside of CT colonography is the use of ionising radiation. Although over the years technical developments (e.g. iterative reconstructions and automatic current selection) have substantially reduced the radiation exposure. There is increasing evidence for high accuracy results using low-dose protocols [8]. MR colonography lacks radiation exposure, however, in contrast to CT colonography, no established bowel preparation and distension method has been recognised for MR colonography [7,9].

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The use of faecal tagging and automated carbon dioxide insufflation for bowel distension has been recommended for CT colonography [7]. Faecal tagging in combination with a limited bowel preparation obviates the need for a cathartic bowel preparation and decreases patients' burden [10,11]. Colon distension by means of automated insufflation replenishes gas when intracolonic pressure decreases, which results in superior distension, while high pressures and potential complications are prevented by automated gas release [12–14]. The use of carbon dioxide insufflation in MR colonography has only been evaluated in a feasibility study and in a pilot study with a small number of patients. Patient burden in these studies was only briefly reported [15,16].

The aim of this study was to prospectively evaluate patient burden and preference for MR colonography with iodine faecal tagging and carbon dioxide insufflation in patients scheduled to undergo colonoscopy.

## 2. Material and methods

### 2.1. Patients

From January 2010 to June 2012 patients with symptoms for colorectal cancer (rectal blood loss, altered bowel habits, iron deficiency) who were scheduled to undergo colonoscopy and who gave written informed consent were prospectively and consecutively included in this study. Three participating hospitals; one university hospital Academic Medical Center Amsterdam, Amsterdam, the Netherlands and two secondary referral hospitals Slotervaartziekenhuis, Amsterdam, the Netherlands and Onze Lieve Vrouwe Gasthuis, Amsterdam, the Netherlands recruited patients at the outpatient clinic of the department of gastroenterology. Patients were asked to undergo MR colonography before colonoscopy. Exclusion criteria were: (1) age of less than 18 years; (2) bowel perforation or bowel obstruction in medical history or at present; (3) contraindication for intravenous administration of gadolinium containing contrast agents; (4) contraindication for oral administration of iodine containing contrast agents; (5) severe chronic obstructive pulmonary disease and (6) contraindication for MRI (e.g. pacemaker, claustrophobia).

The study was approved by the local ethical committees. The study population is similar to the study population used for the evaluation of diagnostic accuracy of MR colonography compared to colonoscopy [17]. In the earlier study we evaluated different outcome parameters; diagnostic accuracy of MR colonography for colorectal lesion detection and colonic distension with automated carbon dioxide insufflation. In this recent study we evaluated the patient burden and future preferences.

### 2.2. Diagnostic accuracy

Per-patient sensitivity and specificity for MR colonography in detection of colorectal lesions of ≥10 mm and ≥6 mm were calculated [17]. Colonoscopy served as the reference standard. For reproducibility purposes three readers evaluated the MR colonography images; one expert reader and two less experienced readers.

Furthermore, detection rates of advanced neoplasia were evaluated. Advanced neoplasia was defined as advanced adenoma or adenocarcinoma. An adenoma was considered advanced when ≥10 mm or showing high-grade dysplasia or a prominent villous component.

### 2.3. Bowel preparation

Bowel preparation consisted of a limited bowel preparation with iodine faecal tagging and a low-fibre diet, based on an earlier feasibility study [16]. The day before imaging patients ingested 50 mL meglumine-ioxithalamate (Telebrix Gastro 300 mg I/mL; Guerbet, Cedex, France) at lunch and dinner. On the day of MR colonography another 50 mL meglumine-ioxithalamate was ingested 1.5 h before imaging (total 150 mL). The day before MR colonography patients consumed a low-fibre diet, and a liquid diet on the day of MR colonography.

### 2.4. MR colonography

The MR colonography was performed at the university hospital by a dedicated radiology research physician (M.P.v.d.P.) and a trained radiographer. Carbon dioxide was rectally administrated by means of automated insufflation (MedicCO2LON, MedicSight PLC, UK) outside the MRI suite via a balloon-tipped flexible rectal catheter (20 French gauge), which was extended with a tube of approximately seven metres. This extended system has been demonstrated to be adequate for high pressure gas release and low pressure gas replenishment [16]. Carbon dioxide was administrated in three consecutive positions (right side, supine, left side). Target pressure was 25 mmHg during insufflation and maintained at 20 mmHg throughout the examination after insufflation [13]. After 3 L of administrated carbon dioxide or based on patients' posture and tolerance, data acquisition started. A smooth muscle relaxant, hyoscinebutylbromide (Buscopan; Boehringer-Ingelheim, Ingelheim, Germany), was administrated before carbon dioxide insufflation (10 mg) and before data acquisition of the 3D T1-weighted sequence (10 mg supine, 10 mg prone) or, if was contraindicated; glucagon hydrochloride 1 mg, (Glucagen; Novo-Nordisk, Bagsvaerd, Denmark) to reduce bowel motion and discomfort [16].

Data was acquired with a 3.0 Tesla (Intera, Philips Healthcare, Best, the Netherlands) MR scanner with a 16-channel SENSE-XL-Torso coil. The MR protocol consisted of a contrast-enhanced (0.2 mL/kg body weight dimegluminegadopentetate 0.5 mmol/mL (Magnevist; Schering, Berlin, Germany) coronal T1-weighted 3D sequence and a coronal T2-weighted 2D sequence. Each sequence consisted of two coronal stacks in the *z*-axis from upper and lower abdomen. Data was acquired during breath-holds of 15–20 s.

The T1-weighted sequence was used for lesion detection and was acquired both in supine and prone position for optimal distension of the colon. T2-weighted images were used for problem solving (supine only).

No sedative or analgesic agents were administrated. The total examination time (defined as start of insufflation until leaving the MRI room), intracolonic pressure, amount of administrated carbon dioxide were reported.

### 2.5. Colonoscopy

The MR colonography was not performed on the same day of the colonoscopy examination as bowel preparations differed. Standard bowel cleansing preparations were used for colonoscopy; a low-fibre diet two days or the day preceding colonoscopy. Polyethylene glycol-electrolyte solution (4L Klean-Prep, Norgine B.V., the Netherlands or 2L Moviprep, Norgine B.V., The Netherlands) starting the day before colonoscopy (or, when the examination was in the afternoon, starting the same day) [18]. Patients were not allowed to eat while ingesting the bowel preparation, but clear liquids were allowed. Colonoscopy was performed by an experienced gastroenterologist or gastroenterology resident with supervision of experienced gastroenterologists using a standard colonoscope (160 or 180 series, Olympus, Tokyo, Japan). Analgesics (fentanyl, Fentanyl-Janssen; Janssen Pharmaceuticals, Beerse, Belgium), sedation (midazolam, Dormicum; Roche, Basel,

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