European Journal of Radiology 82 (2013) 1144–1158

Contents lists available at SciVerse ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Review

Colon distension and scan protocol for CT-colonography: An overview

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ARTICLE INFO

Article history:
Received 18 April 2011
Accepted 31 October 2011

Keywords:
CT colonography
Distention
Scan parameters
Colorectal cancer
Polyps
Radiation

ABSTRACT

This article reviews two important aspects of CT-colonography, namely colonic distension and scan parameters. Adequate distension should be obtained to visualize the complete colonic lumen and optimal scan parameters should be used to prevent unnecessary radiation burden. For optimal distension, automatic carbon dioxide insufflation should be performed, preferably via a thin, flexible catheter. Hyoscine butylbromide is – when available – the preferred spasmolytic agent because of the positive effect on insufflation and pain/burden and its low costs. Scans in two positions are required for adequate distension and high polyp sensitivity and decubitus position may be used as an alternative for patients unable to lie in prone position.

The great intrinsic contrast between air or tagging and polyps allows the use of low radiation dose. Low-dose protocol without intravenous contrast should be used when extracolonic findings are deemed unimportant. In patients suspected for colorectal cancer, normal abdominal CT scan protocols and intravenous contrast should be used in supine position for the evaluation of extracolonic findings.

Dose reduction can be obtained by lowering the tube current and/or voltage. Tube current modulation reduces the radiation dose (except in obese patients), and should be used when available. Iterative reconstructions is a promising dose reducing tool and dual-energy CT is currently evaluated for its applications in CT-colonography.

This review also provides our institution's insufflation procedure and scan parameters.

1. Introduction

Adequate distension is a prerequisite for computed tomography (CT)-colonography and efforts should be made to obtain good distension [1]. In CT-colonography distension is obtained by the insufflation of gas. Drawback of insufflation is that it may lead to cramping pain, windiness, burping, nausea, vasovagal reactions and very rarely to perforation [2–5]. Practitioners should therefore acquire enough knowledge and experience to find the right balance between patient comfort and adequate distension. To reach optimal distension several choices have to be made concerning the distension methods used, such as: which type of catheter, type of insufflation (automatic vs. manual), room air or carbon dioxide, use of a spasmolytic agent and the positions to use during insufflation.

When optimal distension has been obtained, it is important to use an adequate CT scan protocol. Here a compromise has to be made between the benefits and risks involved with ionizing radiation. The first protocols for CT-colonography were based on clinical abdominal CT protocols. Some of these protocols had a relative high radiation dose [6]. During the last decade the dose has been reduced and the CT-colonography protocol has been differentiated based on the clinical suspicion for colorectal cancer [7]. In patients with a low chance on colorectal cancer (e.g. screening), CT-colonography without intravenous contrast medium can be performed, while in other patients (e.g. obstructive cancer at colonoscopy) intravenous contrast medium will be administered as CT-colonography is also used for staging. In the latter situation higher dose protocols are needed as contrast for extracolonic organs is much smaller than for intracolonic lesions. When the CT primarily concerns colonography, less radiation can be used due to the large contrast between air and polyps.

Initial studies on CT-colonography were performed using single- or 4-detector-row CT scanners. Here there was a trade-off between thin slices for detecting all relevant polyps and the length of a single breath hold. Nowadays, many centres are equipped with scanners having at least 16 detector-rows or more, making the difficult considerations of the past unnecessary as good image quality can be obtained with acceptable breath hold times.

In this review, we will point out which insufflation methods are available and we will discuss the development of high-dose scan protocols into low-dose protocols in the last 15 years.

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doi:10.1016/j.ejrad.2011.10.030

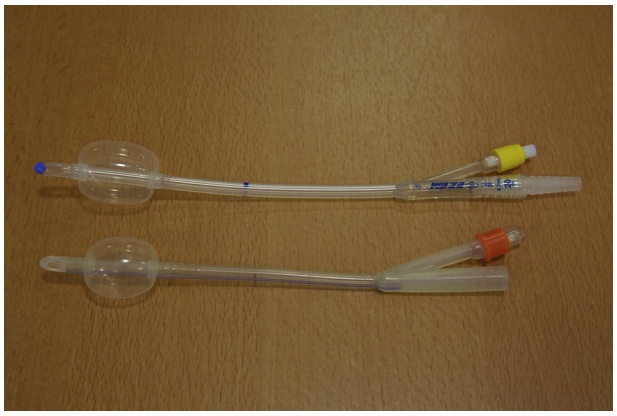

Fig. 1. Two examples of thin flexible balloon-tipped rectal catheters. The uppermost catheter is 20 French gauge with a 30 cm^3 balloon (for Protoco2l, Bracco). The undermost catheter is 18 French gauge with a 20 cm^3 balloon (for MedicCO2LON, Medicsight).

2. Insufflation methods

2.1. Type of catheters

The first catheters used for CT-colonography were rigid large diameter barium enema tubes with a 100 mL balloon. This type of balloon-tipped catheters was primarily used to prevent spill of barium contrast (and air) during the examination. However, in CT-colonography there is no rectal administration of barium contrast and therefore no risk of rectal spill of this material. At the most incontinence for air (or carbon dioxide) may occur. Importantly, the introduction of a rigid large diameter catheter is uncomfortable, as is the inflation of the large rectal balloon. Further, some of the rare perforations in CT-colonography are associated with the use of large balloon catheters [8]. This also included cecal perforations, which are most likely caused by the combination of uncontrolled insufflation in a colon with a competent ileocecal valve and occlusion of the rectum by a large balloon.

Because of the aforementioned reasons, the authors as well as guidelines [9,10] advise against the use of rigid catheters and the use or large balloons. Currently, the standard catheter used for CT-colonography is a thin flexible rectal catheter of approximately 20 French with a small (20–30 mL) balloon which is much smaller than the ones used for barium enema. The discomfort is substantially lower while the risk of perforation with this type of balloon is expected to be much smaller. In addition, no significant difference in number of adequately distended segments during CT-colonography could be detected [11]. Although currently used balloons are small, it still might obscure a rectal lesion, therefore it is important to make sure that the balloon is deflated in at least one of the positions in which CT-colonography is made. For that reasons, some centres use a catheter without balloon (or the balloon is not inflated) to have the view not obscured in neither position (Fig. 1).

2.2. Insertion of the catheter

A careful history including recent colonoscopy, previous colonic surgery and active colitis is mandatory before inserting a catheter (especially when using a larger diameter rigid catheter – which we discourage). If the patient recently underwent a colonoscopy, an occult perforation may be present. Therefore it may be useful to obtain a low-dose CT scan before starting the CT-colonography procedure, to detect extraluminal air. One should consider performing digital rectal examination prior to insertion. Firstly, to diagnose possible reasons for not inserting the catheter (e.g. low rectal obstruction) and secondly to diagnose very low rectal lesions close to the catheter that otherwise may not be detected at CT-colonography. In many patients digital rectal examinations (or colonoscopy) has been performed by the referring physician, and in these patients digital rectal examination is not mandatory.

The easiest way to insert the catheter is when the patient is lying on its left or right side, with his back towards the insufflation machine. Before insertion the anus should be inspected for haemorrhoids or other lesions that might need cautious insertion. Some lubricant is administrated to the tip of the catheter. Avoid force during the flexible catheter insertion, but gently introduce the catheter. The balloon is preferably filled with air instead of fluid to secure its position during position changes of the patient, as with air an indentation of the catheter by a polyp can be appreciated while it will be obscured when using water for balloon insufflation. When no balloon is used, the catheter is taped near the anus to secure its position.

2.3. Manual vs. automatic insufflation

Initially CT-colonography was performed using manual insufflation of room air. Here a number of puffs of air were given until either a preset volume was administrated or the patient indicated discomfort. Subsequently the distension was checked at a scout view. Since then, both type of insufflation and gas used have changed, as nowadays it is routine to use an automatic insufflator with carbon dioxide. Although both room air and carbon dioxide lead to adequate distension, the advantage of carbon dioxide is that it is rapidly absorbed through the bowel wall, followed by elimination via the lungs. Therefore desufflation of the colon is much faster using carbon dioxide with therefore reduced discomfort of colonic distension after the examination [12].

In previous studies, carbon dioxide has proven to reduce discomfort in colonoscopy and double contrast barium enema studies [13–15]. One study showed a reduction of discomfort using automatic carbon dioxide insufflation compared with manual room air insufflation for CT-colonography. In this study little post-procedural pain was observed, the least in the carbon dioxide group [16]. However, the use of carbon dioxide might be contraindicated in patients with severe chronic pulmonary obstructive disease.

Colon insufflation can be performed manually or automatically. The advantage of manual insufflation is that it is a simple, cheap method requiring minimal use of material. Disadvantage is the uncontrolled administration of the gas with therefore the chance of either over distension or suboptimal distension. The use of an automatic insufflator has been introduced in 2002 [17]. Studies showed an improved distension using automatic insufflation compared to manual insufflation, while patient acceptance was not superior [16,18]. The beneficial distension is greatest in the left colon, particularly when the patient is in supine position. Very few perforations have been recorded since the introduction of automatic insufflation and the use of flexible catheters with small volume balloons [2], which seems to confirm the advantage of using this technique.

Automatic insufflation has several other important advantages over manual insufflation. Automatic insufflation produces a controlled intracolonic pressure. Pressure sensors measure the pressure continuously and gas is insufflated when the pressure drops below the target pressure. This means that gas loss is also replaced during scan acquisition. When the pressure exceeds the preset threshold an alarm sound is produced and an air valve releases excessive pressure. This last safety feature may reduce the risk of perforation. Automatic insufflation creates a more