Signature: © Pol J Radiol, 2010; 75(3): 38-41

Polish Journal of Radiology
www.PolRadiol.com
REVIEW ARTICLE

Received: 2009.11.02
Accepted: 2009.11.23

Computed tomography colonography – reasons for different and false results

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Summary

Computed tomography colonography (CT colonography) is one of the latest radiological methods of colorectal diagnostic imaging. Many studies confirmed a high efficacy of CT colonography in diagnosing colorectal polyps and tumors. However, this imaging method is not devoid of false diagnoses. Our paper presented the main causes of false results, causes of heterogeneity of the results among centres, as well as ways of avoiding them.

Key words: computed tomography colonography • CT colonography • computed tomography • colonography • colorectal cancer • colorectal polyps • imaging diagnostics

PDF file: http://www.polradiol.com/fulltxt.php?ICID=881146

Computed tomography colonography (CT colonography) is one of the latest radiological methods used in the diagnostics of the large intestine. Since its introduction by Vining in 1994, it has been constantly modified, especially thanks to the technological advancement, as well as new experiences and conducted studies [1,2]. Many studies confirmed the efficacy of the CT colonography in diagnosing polyps and tumours of the great intestine. However, this method is not completely devoid of false diagnoses. What are the causes of false diagnoses and diverse results and how to avoid them? Many authors have been asking these questions, trying to find answers to them.

Both the supporters and the sceptics of CT colonography are intrigued by the diversity of results provided by different study centres [3–5]. There were reports presenting very good results, encouraging to a more common use of CT colonography in everyday practice [6–8], and those advocating for a critical approach to that method [9–11]. Their authors were trying to find the causes of such divergences [4,6,9,12].

Halligan, on the basis of an analysis of reports from 24 centres, came to a conclusion that the main cause of such a phenomenon is the assumed methodology. First of all, there are different ways of patients' preparation for the examination and the tests themselves are carried out with the use of different CT scanners having different technical parameters and different software [4].

Pickhardt was ascribing his better results to the use of an 8-row CT scanner while other centres were still using 1-, 2-, and 4-row scanners [6]. The introduction of a multirow CT tomography (currently available are the 256-detector scanners, or even the first 320-detector scanner, in the United States) and development of the computer software have substantially influenced the quality of the examination [6–8,11,13].

The analysed studies included different groups of patients, with different symptoms, risks of colorectal cancer, indications, and sample size. Different results should be expected in groups revealing no symptoms and a medium risk of colorectal cancer than in groups of patients with colorectal tumours [6,7,9,10].

There are also different methods of interpretation of the CT colonography results. Pickhardt showed that starting the evaluation with 3D virutal reconstructions and using the 2D reconstructions for clarification of any ambiguities, contributed to the achievement of better results in the diagnostics of polyps [6]. However, this was connected with a longer time of evaluation. Nevertheless, with the development of the software, introduction of the automated navigation, and with a more efficient management of the virtual endoscope, the evaluation time was reduced. There are also other authors who prefer a similar sequence of evaluation procedures. They point to a better detection of the colorectal lesions and to fewer false-negative results [6,7,11,12].

From the analysis of the scientific reports it follows that every CT colonography was interpreted by many different radiologists. However, it remains unclear how a common ground was achieved in case of different opinions: after a joint consultation or after consulting someone from the outside? [6].

Application of different methods of examination is also connected with an incredibly important, although not always considered, factor, i.e. the experience of the radiologists interpreting CT colonography [6,7,11,14]. Doshi and Gluecker found that the majority of the inaccurate interpretations and false-negative results are connected with a perceptional mistake of the evaluating radiologists and not with technical factors [11,13]. Introduction of modern techniques should improve and facilitate the detection of the lesions. These techinques include the computer-aided detection (CAD) in which the polyps are detected by a computer program and shown in different colours, and Vascular Views technique, in which the carcinomatous infiltrations are shown in the images of virtual endoscopy in different colours [15–17].

The application of the reference methods is also very controversial [6,10]. In most of the centres, a standard colonoscopy is used; sometimes this is a pathomorphological or intraoperative examination and rarely – lower gastrointestinal series with the use of two contrast media [7,17–19]. In some of the centres, a double colonoscopy is used [6,7,10]. Colonoscopy performed for the second time as a reference examination after the endoscope operator becomes familiar with the results of the CT colonography and of the previous endoscopy, allows for evaluation of precision of the CT colonography and colonoscopy. It turned out that the first colonoscopy is not a perfect reference method due to the lesions that remain undetected. According to the study by Pickhardt, the first colonoscopy overlooked 5% of polyps measuring ≥6 mm, and the results of CT colonography turned out to be better than the endoscopic ones [6]. The superiority of CT colonography over colonoscopy in detecting polyps was also proved by Chung. According to his study, the sensitivity of CT colonography was 90% and of the colonoscopy 78%. This difference was mainly connected with incomplete endoscopes [7]. According to other publications, the rate of polyps undetected by colonoscopy amounted to 4–6% in case of lesions measuring more than 10mm, 6–13% of those measuring 6–9 mm, and 15–27% of those measuring less than 5 mm. In general, the undetected polyps constituted 48% of the lesions [6,7,10,20].

In the research papers, the standard colonoscopy is not always properly characterised, which may influence its value as a reference method. Experience of the endoscope operators, possibility to record the examination, replay it and to evaluate it precisely etc. is not always taken into consideration. In the study by Halligan, much emphasis was placed on more precise measurements of lesions found in endoscopy and CT colonography, and especially in colonoscopy [4]. In the centres included in the evaluation, the measurements were referred to the size of the biopsy forceps or were carried out *in vitro*, after polypectomy. Sometimes, it was not defined what the measurement was referred to. Only few examinations used a special measuring equipment [6,10]. Incorrect measurements may lead to inappropriate conclusions [11,21]. Studies tend to group polyps on the basis of their sizes. An imprecise measurement may lead to a situation in which the same polyp is qualified to different groups on the basis of two different methods [11]. For example, a polyp assessed in CT colonography for 9 mm would be qualified to the group of medium-sized lesions, while the same polyp assessed by colonoscopy for 10 mm would be classified as a large one. This should lead to a false-positive diagnosis of a medium-sized polyp in CT colonography and to a false-negative diagnosis of a large polyp. Precise measurements are especially important in the screening process as they influence further management and qualification for colonoscopy and polypectomy [22]. In case of CT colonography, there are computer programs which measure the size (including the volume) of the lesions automatically.

The problem concerns false-positive results – whether the lesion shown by CT colonography and not confirmed by colonoscopy really constitutes a false-positive result? Of course, this may be the case, but there is also a possibility that the lesion was not detected during colonoscopy, or was assessed as a lesion of a different size or location. The lesion may also be overlooked in the reference colonoscopy [7,10]. A typical example would be a polyp hidden behind a fold. In the study by Pickhardt, most of the polyps regarded as false-positive ones were hidden behind the folds, at locations inaccessible to colonoscopy [6].

A proper preparation of the large intestine plays a very important role in a correct interpretation of CT colonography results. This fact is jointly emphasised by all radiologists evaluating the examinations [6,7,10,23]. A properly prepared intestine should be well distended, clean and 'dry'. An improperly cleaned large intestine is a the most common cause of false diagnoses [7,8,10,11,24,25]. On the one hand, faecal remnants may be deceptively similar to polyps, and on the other hand, the fluid and larger faecal masses may 'hide' real polyps. Both these situations lead to a wrong diagnosis. There are some features which allow for differentiation of the faecal remnants. They include: air bubbles inside it, multiangular outlines, hyperdense edging and hypodense central part, or inhomogeneous density of the lesion [22,25]. It is also helpful to change the location of the faecal remnants by repositioning the patient. However, it should be remembered that a pedunculated polyp may change its position too. The differentiation is not always possible and any remaining uncertainties may be solved by colonoscopy. In case of any residual fluid, the change

of body position results in fluid displacement, leading to an increased chance of visualisation of those lesions that were not detectable ('immersed' in the fluid). However, with large volumes of the fluid and a small distention of the intestine, the repositioning may not be enough. In such cases, the pedunculated polyps may move along with the fluid and thus remain invisible. In order to eliminate (at least partially) such difficulties with interpretation and to facilitate the differentiation of the lesions, the patients are commonly examined in two positions – ventral and supine one [7,22,25,26]. Labelling of the faecal remnants and intravenous application of the contrast medium facilitate the differentiation of the lesions as well [22,27].

A standard preparation to CT colonography is the same as in case of the classic colonoscopy [1,2]. Normally, on the day preceding the examination, the patient receives oral laxatives – polyethylene glycol-electrolyte solution or phosphate preparation, and remains on a liquid diet. Some authors were also using Bisacodyl and enemas [7,10]. However, the p.r. Bisacodyl suppositories administered on the day of the procedure may lead to a worse rectal clearance [6]. Macari compared the results of intestinal preparation depending on the applied laxative. One group of patients received polyethylene glycol-electrolyte solutions, and the second one – sodium phosphate with Bisacodyl tablets and suppositories. The preparation in the second group turned out to be better than in the first one and it was connected with lower volumes of the remaining fluid as well as a 'drier' intestine. Macari underscored also that the endoscopists performing colonoscopy rated the preparation with PEG-ES solutions as a better one as they preferred a 'wet' intestine, with the remaining fluid that may be aspirated and does inhibit the intestinal assessment [23]. According to another publication, the use of Bisacodyl reduced the volume of the remaining fluid [7]. In colonoscopy, the remaining fluid or the faecal remnants do not cause such problems with interpretation as in case of CT colonography. Thus, patient's preparation for CT colonography should be better than for colonoscopy.

To achieve a better clearance of the large intestine or to make the interpretation of the detected lesions easier, we may use 'labelling' of the faecal remnants. Lefere suggested a method of reparation that is different from the traditional one. One day before the procedure, he 'labelled' the faecal remnants with oral barite and introduced a low-cellulose diet and less aggressive laxatives. Such a preparation method led to a better detection of the polyps. There were no false-positive results as the identification of a labelled faecal mass was easy. Moreover, this method was also less bothersome for the patients [28]. A similar rule was applied by Pickhardt, but apart from the barite for faecal remnants labelling, he also used an additional liquid contrast medium to enhance the fluid. With the use of a special program, the labelled, i.e. contrasted-enhanced, remnants were 'subtracted' from the obtained image, showing the intestinal polyps and enabling the interpretation of the examination [6]. Other publications mentioned the use of oral contrast media only, without any restrictive diet or laxatives. The obtained results were similar or minimally worse than the ones of colonoscopy used for the detection of lesions of more than 10 mm in size [29,30].

Another important factor influencing the interpretation of CT colonography is the right distension of the large intestine. An insufficiently distended intestine may imitate pathological narrowings or, another way round – the narrowing may remain undiagnosed [7,25,31]. For an easier introduction of the air and a better distension of the intestine, as well as to avoid any movement artefacts, it is common to administer spasmolytics right before the examination. They cause hypotonia of the intestine (these are mostly scopolamine or glucagon preparations) [1,2,8,10,31]. Rogalla stated that butylscopolamine (Buscolysine) and, to a slightly lesser degree, also glucagon, significantly increase the distension rate of the intestine [31].

The interpretation of CT colonography may be also influenced by such factors as the tiredness of the specialists interpreting the study. The fatigue is connected with a long evaluation time depending mostly on how well the intestine was cleaned and distended and how many lesions were found, as well as on experience of the radiologists [14,27].

Many studies confirmed the high effectiveness of CT colonography in detecting malignancies of the large intestine [6,32,33]. However, CT colonography is not devoid of false diagnoses. Their number decreases with technical improvements and new experiences. The causes of inaccurate diagnoses (apart from the most common one: an improperly prepared and distended intestine) may include the thickening of the folds and the diverticular disease [34]. Infiltrating tumours in their early stage may have a form of a thickened fold and thus every isolated fold thickening should be considered as suspicious and subjected to further diagnostic work-up [34]. Diagnostic difficulties concern also patients with the diverticular disease of the large intestine, leading to the stenosis of the intestinal lumen and the thickening of its walls, as well as to inflammatory infiltrations of the adjacent fat tissues [34]. This may imitate a carcinomatous infiltration. The ileocaecal valve is also difficult to interpret due to its high morphological heterogeneity [34,35]. Special attention should be paid to the rectum, and its lower part. This is a region which is hard to evaluate by colonoscopy and CT colonography. The anal canal does not get distended due to the anal sphincter tone and multiple lesions, such as enlarged haemorrhoids or hypertrophied anal papillae, may lead to incorrect diagnoses. An introduced cannula used for insufflation may mask some potential lesions, and thus it is indicated to remove it in at least one projection. Fortunately, this is a region which can be approached per rectum and this examination should always supplement the whole diagnostic process [14,36].

In CT colonography, the false-negative results may follow from the presence of flat lesions [10,37]. MacCarthy, in his analysis of the reasons of false-negative results in CT colonography, was trying to eliminate all factors that are commonly accepted as causes of non-detected lesions. These are: improper patients' preparation, technical parameters, inexperienced radiologists or methods of examination evaluation. It turned out that most of the false-negative results were connected with nondetection of the lesions and not with perceptional or technical mistakes. This concerned the flat lesions mainly [37].

Nowadays, there is no one model of examination. The need for introduction of some common standards is underscored by many authors [6,22]. An expert group (The Working Group on Virtual Colonoscopy) suggested introduction of a uniform system of examination and reporting, called C-RADS (CT Colonography Reporting and Data System), based on the BI-RADS system used in mammography (Breast Imaging Reporting and Data System) [22]. It seems that if we reach a consensus on the methodology of the examination and establish one applying examination protocol, and the radiologists undergo a continuous learning process and gain experience, it will be soon possible to achieve uniform results and to minimise the incidence of false diagnoses. This should also contribute to a wider use of CT colonography in everyday clinical practice.

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