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Review

Evaluation of colonic lesions and pitfalls in CT colonography: A systematic approach based on morphology, attenuation and mobility

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ABSTRACT

Computed tomographic colonography is a reliable technique for the detection and classification of neoplastic and non-neoplastic lesions of the colon. It is based on a thin-section CT dataset of the cleansed and air-distended colon, acquired in prone and supine position. Two-dimensional and 3D projections are used in combination for image interpretation. The evaluation of CT colonography datasets is based on two steps, lesion perception to detect a polyp candidate and image interpretation to correctly characterize colonic filling defects. A thorough knowledge of the morphologic and attenuation characteristics of common colonic lesions and artifacts facilitates characterization of the findings. The purpose of this review article is to give an overview of the key CT colonographic imaging criteria to correctly characterize common colorectal lesions and to identify typical pitfalls and pseudolesions.

1. Introduction

Computed tomographic (CT) colonography, also known as virtual colonoscopy, is a validated method for the evaluation of the entire colon in asymptomatic and symptomatic patients [1,2]. The examination is based on a helical, thin-section CT of the cleansed and distended colon in the supine and prone positions. Data evaluation is performed on a dedicated CT colonography workstation, with simultaneously available multiplanar 2D images and endoluminal 3D views. The advantages of CT colonography over optical colonoscopy lie in the minimally invasive nature of the procedure and the possibility to evaluate colonic segments not visible by colonoscopy. CT colonography does not require sedation or recovery time; in screening studies, there is virtually no risk for significant procedure-related complications [3]. Since the gas for colonic distention is able to distend prestenotic segments or to fill highly elongated colons, CT colonography allows, in the vast majority of cases, a complete evaluation of the colon. Recent meta-analyses have indicated that CT colonography is highly sensitive for the detection of patients with colorectal adenomas ≥ 10 mm in a screening population (87.9%) [1], and for colorectal cancer detection (96.1%) [4]. CT colonography has recently been recommended by the American Cancer Society as a diagnostic option to screen for colorectal cancer and adenomas [5]. In patients with known colorectal cancer, CT colonography was shown to be highly sensitive in detecting synchronous cancers proximal to a stenosing colorectal cancer [6]. Following colorectal cancer surgery, CT colonography is an accurate tool for simultaneous colonic and extracolonic surveillance to detect metachronous or recurrent neoplasia [7]. However, dedicated training and experience in CT colonographic 2D and 3D reading techniques is required for an accurate evaluation of CT colonographic studies, as well as a thorough knowledge of CT colonographic imaging criteria for common colonic findings.

This article summarizes the key CT colonographic imaging criteria to correctly characterize common colorectal lesions and to identify typical pitfalls and pseudolesions.

2. General diagnostic criteria for the analysis of colonic filling defects

The diagnostic criteria for polypoid lesions have been described previously in a multitude of papers. In this review article, we try to propose a very simple approach to the evaluation of findings that appear at CT colonography. Findings in the colon are characterized by their morphology, their inner structure and attenuation characteristics, and their mobility (Table 1) [8,9]. For CT colonographic evaluation, it is helpful to analyze each filling defect of the colon systematically based on these three basic characteristics [10]. The general morphology of a lesion describes the global or macroscopic appearance, such as the form and the surface. Here,

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Table 1
A simple approach to the evaluation of polypoid findings at CT colonography based on three imaging criteria: 1. morphology, 2. structure and, 3. mobility.

1. *Morphology*: global or outer appearance (3D > 2D).
   Form: sessile, pedunculated; round, oval, or lobulated.
   Surface: smooth, nodular, or irregular.
2. *Structure*: internal structure features (2D).
   Inner structure: CT density, homogeneity.
   Attenuation characteristics: fecal tagging and IV contrast media characteristics
3. *Mobility*: attachment of a finding to the colonic wall (2D + 3D).
   Comparison of prone and supine positions for potential movement of a finding.
   Colonic lesions: arise from the colonic wall: will not move.
   Fecal residuals: will move to the dependent wall.

the reader gets a first morphologic impression of a colonic finding. It can be evaluated with 3D endoluminal and 2D planar views. The general morphology of a filling defect can be polypoid, mass-like, or circular stenotic. Findings may have smooth, lobulated, or irregular surface.

Evaluation of the inner structure and attenuation characteristics of a filling defect is generally performed with 2D planar views. This step is necessary to further specify a colonic filling defect. It focuses on CT density, homogeneity, and the fecal tagging and IV contrast media characteristics. Intrinsic colorectal lesions may demonstrate homogeneous soft tissue attenuation with the exception of lipomas, which consist of fat tissue.

The mobility of a lesion is evaluated by comparing the relative position of a filling defect in the colon when changing the patient's position from prone to supine. This criterion helps the reader to further differentiate colonic lesions from fecal residuals. Intrinsic colonic lesions arise from the colonic wall, and are, therefore, not expected to change their position in the colon. By contrast, pseudolesions, such as residual stool, are not attached to the colonic wall and will likely move to the dependent part of the colon. Mobility of a pseudolesion must be differentiated from "pseudomobility" of a true lesion, which is seen in pedunculated polyps or in polyps located in mobile colonic segments (see Section 5).

3. Common findings in the colon

3.1. Colorectal polyps

Polyps are the most common benign lesions of the colon. Approximately 90% of colorectal carcinomas arise from benign adenomatous polyps. The risk of malignant transformation increases with the size of the polyp. Advanced adenomas are defined as adenomas meeting one or more of the following three criteria: a size of at least 1 cm, the presence of a substantial villous component, and the presence of high-grade dysplasia [11,12] (Fig. 1). Although still benign, these lesions are considered to be associated with a higher risk of progression to colorectal cancer [13]. Adenomatous polyps and, in particular, advanced aenomas are, therefore, the optimal targets for colorectal cancer screening, since their removal is believed to effectively prevent the subsequent development of cancer [12,14,15]. With regard to their macroscopic appearance, polyps may be sessile, pedunculated, or flat. To the best of our knowledge, there are no robust CT colonographic criteria for differentiation of polyp histology. Therefore, CT colonography is not able to reliably distinguish between neoplastic and non-neoplastic polyps, on the basis of morphological features only.

On 3D virtual endoscopic images, sessile polyps are present as round, oval, or lobulated intraluminal filling defects, with a base equal to or larger than the lesion's height (Fig. 2). Typically, the margin to the normal mucosa is displayed as an incomplete ring shadow, referred to as the "incomplete rim sign." Pedunculated polyps typically present a round, oval, or lobulated head. The polyp

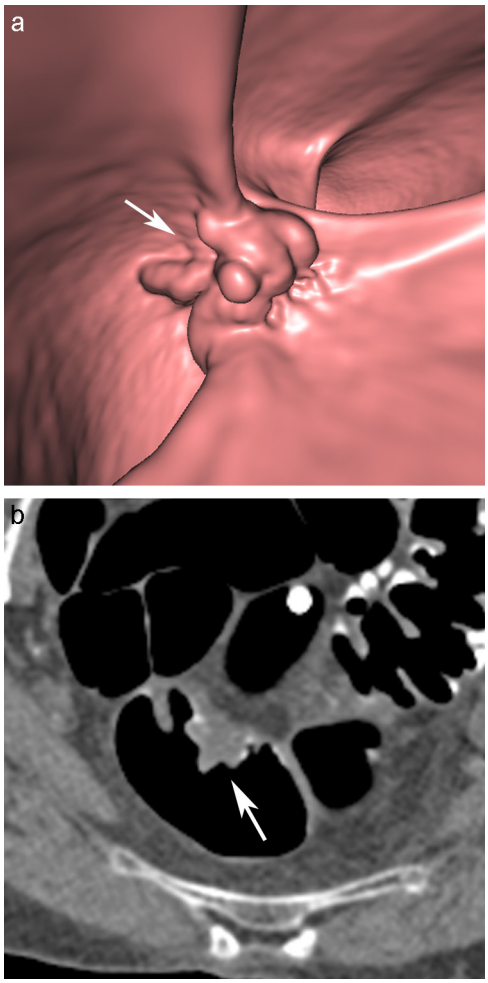

Fig. 1. 23 mm advanced adenoma in the sigmoid colon. (a) 3D endoluminal CT image shows a sessile, broad-based lobulated filling defect (arrow). (b) Prone 2D axial CT image shows a homogeneous soft tissue attenuation of the intraluminal filling defect (arrow).

head is connected to the mucosa by a stalk (Fig. 3). So-called subpedunculated polyps present with a polyp base that is smaller than its height, but without a dedicated stalk. Their appearance may change between the prone and supine positions because of some degree of mobility. The surface of polyps may be smooth or nodular.

On 2D planar images, colorectal polyps typically have homogeneous, soft tissue attenuation when using abdominal window settings [8]. Intrinsic colonic lesions do not, by nature, take up any orally administered contrast media, which are used to label residual stool and fluid in a procedure called "fecal tagging." Thus, colonic polyps may be easily differentiated by their homogeneous soft tissue attenuation from hyperdense tagged stool and fluid. If intravenous contrast material is administered, polyps will enhance [16,17]. Lesions are frequently covered or abutted by tagged residuals.

To evaluate the mobility of a colonic lesion, it is necessary to identify the corresponding colonic segments in the prone and the supine positions. Colonic polyps arise from the colonic wall and are generally not expected to change their position when the patient is turned. However, in pedunculated lesions, the polyp head will change position with gravity while always being fixed to the bowel wall by its stalk. In contrast, fecal residuals, which are, by nature, not attached to the bowel wall, typically move to the dependent part of the colon when the patient's position changes from prone to supine.