CT Colonography: Effect of Colonic Distension on Polyp Measurement Accuracy and Agreement—In Vitro Study[1]

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Rational and Objectives. To investigate the effect of colonic distension on polyp measurement accuracy and reader agreement.

Materials and Methods. Institutional review board permission was obtained. A sealed colectomy specimen from a patient with familial adenomatous polyposis was scanned using a four-detector-row computed tomography (CT) after half and full air distension. A histopathologist measured the maximum dimension of all polyps in the opened specimen. Digital photographs and line drawings were used to individually match polyps visible in the CT datasets. Two observers (radiologist, technician) independently estimated the maximum polyp diameter using both two-dimensional (2D) and three-dimensional (3D) surface rendering. Full-distension measurements were repeated 1 week later. Accuracy was analyzed using paired *t*-test. Observer agreement was assessed using Bland Altman limits of agreement.

Results. Twenty-three polyps (4–15 mm) were identified. 2D measurements were significantly smaller than histologic size at both half distension (radiologist first): mean difference [md] –1.1 mm, md –1.7 mm, and full distension md –1.1 mm, md 1.4 mm (all $P < .001$). 3D measurements were not significantly different from true size other than after half distension for the technician (md –0.7 mm, $P = .01$). 95% Bland Altman limits for interobserver agreement were narrower after full distension, and better using 2D (half-distension span of agreement approximately 4.7 mm and 6 mm for 2D and 3D, respectively). 2D intraobserver span of agreement between half and full distension was approximately 3.8 mm and 3.2 mm for the radiologist and technician, respectively, compared with 6.2 mm and 5.5 mm using 3D.

Conclusion. 3D polyp measurement is more accurate than 2D. However, in the presence of suboptimal distension, inter- and intraobserver agreement is superior using 2D.

Key Words. Colonography; computed tomographic; colonic polyps/radiography; imaging, three-dimensional.

CT colonography (CTC) is increasingly advocated for colorectal cancer screening based on encouraging recent performance data (1). However polyp management strategies remain controversial. The risk of malignancy in any given polyp is related to both histology and size, with polyps less than 1 cm rarely containing frank malignancy (2). The overwhelming majority of polyps 5 mm or less are likely of little immediate significance (3,4), and most agree that CTC-detected lesions 1 cm or larger in size should be referred for endoscopic polypectomy. However, the management of medium size polyps (6–9 mm) is less clear-cut. Although the majority of such polyps are likely benign, a significant minority may harbor high-grade dysplasia or frank malignancy (5), and some advocate complete polyp clearance for this reason (6). However, endoscopic

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polypectomy is not without risks related to perforation, bleeding, and the effects of sedation, and CTC follow-up rather than removal has been recently suggested (7,8).

For CTC to fulfill a role in polyp follow-up, it is clear that estimates of polyp size must be both accurate and reproducible. Recent data have suggested relatively wide intra- and interobserver variation (as much as 3–4 mm for polyps less than 10 mm in size) (9), with no clear consensus as to whether two-dimensional (2D) or three-dimensional (3D) measurement is optimal (9,10). However, these initial data are based on endoscopic estimates of polyp size, which are known to be inaccurate (11). Furthermore, when patients return for follow-up CTC examinations, there is no guarantee that scan quality will be identical; for example, it is unclear how changes in colonic distension will influence polyp size measurement. The purpose of this study was to investigate the influence of measurement technique and colonic distension on polyp size measurement accuracy and reproducibility using polyps of exactly known size in a human colectomy specimen.

MATERIALS AND METHODS

Full ethical committee approval was obtained for the study. A 16-year-old male with familial adenomatous polyposis coli scheduled to undergo elective colectomy was identified from the polyposis registry database at our institution and approached by the study coordinator before colectomy. Full written consent for use of the colectomy specimen was obtained from the patient and his parents. Throughout the study, care was taken to ensure that the experiment did not interfere with subsequent diagnostic histologic assessment.

Specimen Preparation

A standard subtotal colectomy was performed at surgery; the specimen was washed with 0.9% saline solution and then emptied of residual fluid. The terminal ileal remnant was tied off with 2/0 Prolene sutures by the attending surgeon to ensure an airtight seal. An 18 Fr Foley urinary catheter attached to a standard insufflation bulb was then inserted through the distal end of the specimen and the retention balloon fully inflated with 10 mL water before suturing. In an attempt to simulate suboptimal colonic distension, insufflation was continued until segmental collapse was abolished, but terminated before full distension was achieved. At this stage (after 20 air puffs),

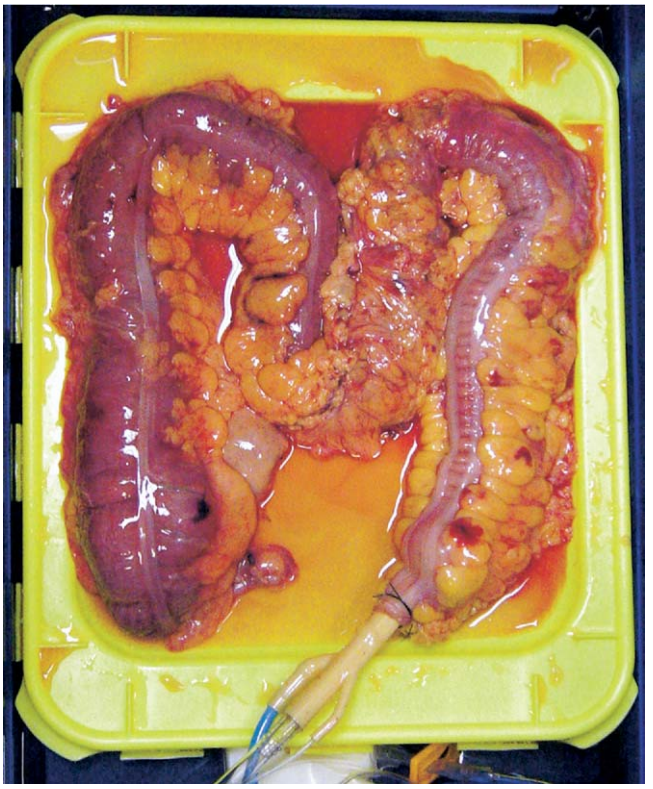

Figure 1. Photographic image demonstrates the specimen arranged and secured to a plastic board before submersion in saline.

the colon still maintained a prominent external haustral pattern, and the maximum diameter of the sigmoid, descending, transverse, ascending colon, and cecum was 3.5 cm, 2.7 cm, 3.9 cm, 4.6 cm, and 4.8 cm, respectively. For ease of presentation, the suboptimal distended specimen will be referred to as "half inflated."

The half-inflated specimen was arranged on a plastic board to mimic the natural in vivo geometric relationships between each colonic segment and secured with loosely applied elastic bands (Fig 1). The secured specimen was submerged in a plastic container containing 20 L 0.9% saline solution. In an attempt to simulate average abdominal attenuation, 60 mL diatrizoate meglumine (Gastrografin [370 mg L/mL]; Schering Health Care Ltd, Burgess Hill, West Sussex, UK) was added to the bathing saline, giving an average attenuation of 35 Hounsfield units (standard deviation 3 Hounsfield units) (12).

Computed Tomography Scanning

The container was then placed in the computed tomography (CT) scanner gantry (four-detector-row CT scanner