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Editorial

Measurement of polyp size at colonoscopy: Addressing human and technology bias

David G. Hewett[1,2]

[1]*Faculty of Medicine, The University of Queensland and* [2]*Colonoscopy Clinic, Brisbane, Australia*

Colonoscopy is a powerful tool for the detection and prevention of colorectal cancer (CRC). The impact of colonoscopy on cancer prevention derives from the removal of CRC precursors, and removal of adenomas is known to reduce CRC mortality.[1] Detection of adenomas also predicts risk of metachronous neoplasia, and patients with adenomas and serrated lesions are advised to return for surveillance colonoscopy.[2]

Predictors of risk of metachronous neoplasia on surveillance include the presence of an advanced adenoma, defined as an adenoma with high grade dysplasia, villous change, or size ≥10 mm. Compared to those with no polyps, individuals with an advanced adenoma or large serrated polyp have a 3–4-fold increased risk for CRC.[3] Assessment of polyp size is therefore routine and relevant, because assignment of conventional adenomas and serrated-class polyps into size categories of ≤9 and ≥10 mm determines recommended surveillance interval in guidelines worldwide.[2]

However, methods for measuring polyp size at colonoscopy are rudimentary at best. Colonoscopists have traditionally used visual estimation, in real-time, prior to resection. Assessment of polyp size using the pathologic specimen is not recommended due to disintegration, distortion, and potential shrinkage of the specimen during resection, retrieval, and histologic processing. Yet colonoscopic visual estimation of polyp size is subject to measurement bias and, without a calibrated visual reference, is wildly inaccurate.[4–6]

Measurement inaccuracy derives from technology and human bias. Technology bias occurs due to image distortion from the colonoscope's fish-eye lens, where objects in the center of the display appear magnified and objects at the periphery appear small and warped.[7] Makeshift measurement tools, such as forceps or snare catheters,[6] potentially worsen measurement error from technology bias coupled with illusions of relative size, particularly if viewing distance is not considered.

Endoscopist (human) bias is also an important factor in measurement error. Endoscopists are known to exhibit terminal digit preference[5] and cluster polyp measurements at 5 mm intervals, with an underrepresentation of measurements ending in 1 and 9.[4] Endoscopists are also subject to bias due to fee-for-service financial incentives or fear of missing lesions (and the consequences), both of which incentivize endoscopists to upsize polyps to 10 mm to shorten surveillance intervals and reduce the impact of detection failure.[5] Upsizing of small polyps to ≥10 mm increases the health system burden of surveillance colonoscopy, although may compensate for operator-driven failures in advanced lesion detection.

The systemic and pervasive bias in polyp measurement casts doubt on the historical accuracy of size data from large prospective clinical studies and polyp registries, and on the validity of the critical 10 mm size threshold that determines metachronous neoplasia risk and surveillance strategies. It also undermines international postpolypectomy surveillance guidelines[2] and the "resect and discard" management paradigm for diminutive polyps.[4]

With recognition of systemic polyp measurement error, various through-the-scope tools or colonoscope attachments have been developed to improve accuracy. Compared with the use of existing noncalibrated devices, such as forceps and snare catheters, calibrated tools further improve measurement accuracy. These include graduated forceps and injection needles, ruler snares, calibrated hoods, and structured laser light probes,[8] which fundamentally provide a calibrated reference for more accurate visual estimation of polyp size. If combined with systematic photography of the lesion,[5] these devices could reduce both technology and endoscopist bias. However, the time taken to deploy and align these tools with the lesion, and their cost, limit their practical application.

Instead, push-button solutions that integrate with the colonoscope have been eagerly anticipated.[7] Such improvements in instrument technology could address both endoscopist and technology bias.

A recent application of artificial intelligence (AI) is a computer-aided measurement tool that is reported[9] and editorialized[6] in a recent issue of *Digestive Endoscopy*. This technology uses the distance between blood vessel

bifurcations in background mucosa as a reference distance ("bifurcation to bifurcation technique") and is the first published AI-based measurement technology. It promises instant and accurate measurement using integrated computer-aided analysis, without the need for adjuvant devices or tools. However, as reported, the technology is very early in development with published data from still image analysis only and, as yet, no prospective reports from simulated or clinical colonoscopy. How this technology will work in real-time is unknown, and its functionality in the clinical environment remains untested, where the visualization impact of clinical variables such as bowel preparation, residual stool, insufflation, or spasm has not been assessed.

In this issue of *Digestive Endoscopy* is the first study of an integrated measurement device within a commercially available instrument platform. Shimoda *et al*.[8] evaluate a promising advance in which a measurement scale or ruler for real-time polyp measurement is incorporated within a current generation colonoscope. On identification of a target lesion, the endoscopist can instantly switch on (and off) a virtual scale using a button on the colonoscope, and apply the scale to the mucosa without the need for any additional tools. The prototype colonoscope, which is part of the ELUXEO 7000 series (Fujifilm, Tokyo, Japan) with an outer diameter of 12.8 mm, incorporates a red laser to calculate the viewing distance, enabling a calibrated virtual ruler to be overlaid on the visual field of the endoscopist so lesions can be measured in real time. The virtual scale includes markings at 5, 10, and 20 mm, and its length is adaptively adjusted using triangulation data from the red laser about the distance between the instrument tip and the mucosa. The scale can be used over a viewing distance of 4–30 mm. When the viewing distance is <20 mm, the scale length shown is 10 mm; when the viewing distance is <10 mm, the scale is 5 mm. The scale operates in both white light and linked color imaging but not in blue-light imaging.

Shimoda *et al*. report findings from a simulation-based study at two centers in Japan. The virtual scale colonoscope (EC-760S-A/M with EW10-VM01 software; Fujifilm) was used by 10 endoscopists (five experienced and five trainee) to evaluate 20 simulated polyps in four colon models (LM-107 simulator type II; Koken Co., Ltd., Tokyo, Japan). Measurement accuracy using the virtual scale was significantly higher than visual estimation for both experts (85% vs. 64%) and trainees (83% vs. 61%); although virtual scale estimation took longer (20 polyps in 6.4 min vs. 2.9 min), experts were quicker overall (3.8 min vs. 2.8 min, $P = 0.005$). A tendency to underestimate lesion size was seen in 90% of endoscopists with both virtual scale and visual estimation, although this was significantly less with virtual scale estimation ($P < 0.001$).

This technology is an exciting development that promises to bring measurement accuracy to everyday colonoscopy. The measurement scale appears designed for easy and seamless application to routine clinical practice and may finally allow accurate and easy measurement of colorectal lesions.

Yet, some technical barriers may remain. For measurement, the endoscopist must position the virtual measurement scale across the target lesion, with the scale appearing centrally and horizontally in the endoscopic view. The endoscopist must align the left side of the scale with the left edge of the polyp, and measure size at the right margin of the polyp. This presumably requires the endoscopist to maintain a stable position with sufficient tip control to target the scale over the lesion and align the scale with the lesion's maximum dimension. Like most other aspects of colonoscopy, there is likely to be performance variation depending on the skill of the operator. The accuracy, ease, and speed of application of the virtual scale will vary with the endoscopist's skill in tip control and maintaining a stable instrument position. In Shimoda *et al*.'s study,[8] one trainee did not achieve higher accuracy with virtual scale estimation, likely due to failure to adequately align the scale with the target lesion.

Measurement error can also occur if the endoscopic target is not flat or parallel to the instrument tip. The calculated length of the virtual scale assumes the measurement target is on a plane parallel to the tip of the endoscope. An earlier study[10] showed that nonlinear measurement errors occurred with increasing tilt angle of the target "mucosa", particularly when the left side of the image was closer to the instrument tip compared with the right, generating underestimates of lesion size due to distortion from the fish-eye lens. This was influenced by the viewing distance, which when increased, improved tolerance of mucosal tilt. When the target lesion was placed on a plane parallel to the endoscope tip, the measurement error of the virtual scale was only 0.7 mm.[10]

We do not yet know how this measurement scale will perform in vivo in a human colon or with varying polyp morphology. Shimoda *et al*. only evaluated simulated polyps that were hemispherical, so it remains to be seen how the scale will perform with flat or pedunculated lesion morphology, or variable lesion shape, or with in vivo colonic dynamics such as peristaltic movement, spasm, variable insufflation, residual stool, and bubbles, all of which may confound measurement accuracy. There is also a risk that this measurement scale may compound terminal digit preference or upsizing, as the ruler only includes markings for 5, 10, and 20 mm sizes, which may discourage measurement to a specific millimeter unless lesion photography with the superimposed scale became standard.

In summary, these findings are of significance and relevance to colonoscopy practice. The technology appears simple and convenient to use and could be readily incorporated into routine colonoscopy. Measurement error using visual estimation is a systemic phenomenon at colonoscopy, and one of many facets of colonoscopy performance that vary between endoscopists. Integrated colonoscope measurement devices using virtual scales[8] or AI[9] will reduce bias and can only improve the awareness and performance of endoscopists for accurate sizing of colorectal lesions.

CONFLICT OF INTEREST

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REFERENCES

1 Loberg M, Kalager M, Holme O *et al*. Long-term colorectal-cancer mortality after adenoma removal. *N Engl J Med* 2014; **371**: 799–807.
2 Gupta S, Lieberman D, Anderson JC *et al*. Recommendations for follow-up after colonoscopy and polypectomy: A consensus update by the US Multi-Society Task Force on Colorectal Cancer. *Gastroenterology* 2020; **158**: 1131–53.
3 He X, Hang D, Wu K *et al*. Long-term risk of colorectal cancer after removal of conventional adenomas and serrated polyps. *Gastroenterology* 2020; **158**: 852–61.
4 Sakata S, Klein K, Stevenson ARL, Hewett DG. Measurement bias of polyp size at colonoscopy. *Dis Colon Rectum* 2017; **60**: 987–91.
5 Hassan C, Repici A, Rex DK. Addressing bias in polyp size measurement. *Endoscopy* 2016; **48**: 881–3.
6 Utsumi T, Horimatsu T, Sano Y, Seno H. Warning from artificial intelligence against inaccurate polyp size estimation. *Dig Endosc* 2022; **34**: 1196–7.
7 Sakata S, McIvor F, Klein K, Stevenson ARL, Hewett DG. Measurement of polyp size at colonoscopy: A proof-of-concept simulation study to address technology bias. *Gut* 2018; **67**: 206–8.
8 Shimoda R, Akutagawa T, Tomonaga M *et al*. Estimating colorectal polyp size with a virtual scale endoscope and visual estimation during colonoscopy: Prospective, preliminary comparison of accuracy. *Dig Endosc* 2022; **34**: 1471–7.
9 Kwak MS, Cha JM, Jeon JW, Yoon JY, Park JW. Artificial intelligence-based measurement outperforms current methods for colorectal polyp size measurement. *Dig Endosc* 2022; **34**: 1188–95.
10 Yoshioka M, Sakaguchi Y, Utsunomiya D *et al*. Virtual scale function of gastrointestinal endoscopy for accurate polyp size estimation in real-time: A preliminary study. *J Biomed Opt* 2021; **26**: 096002.