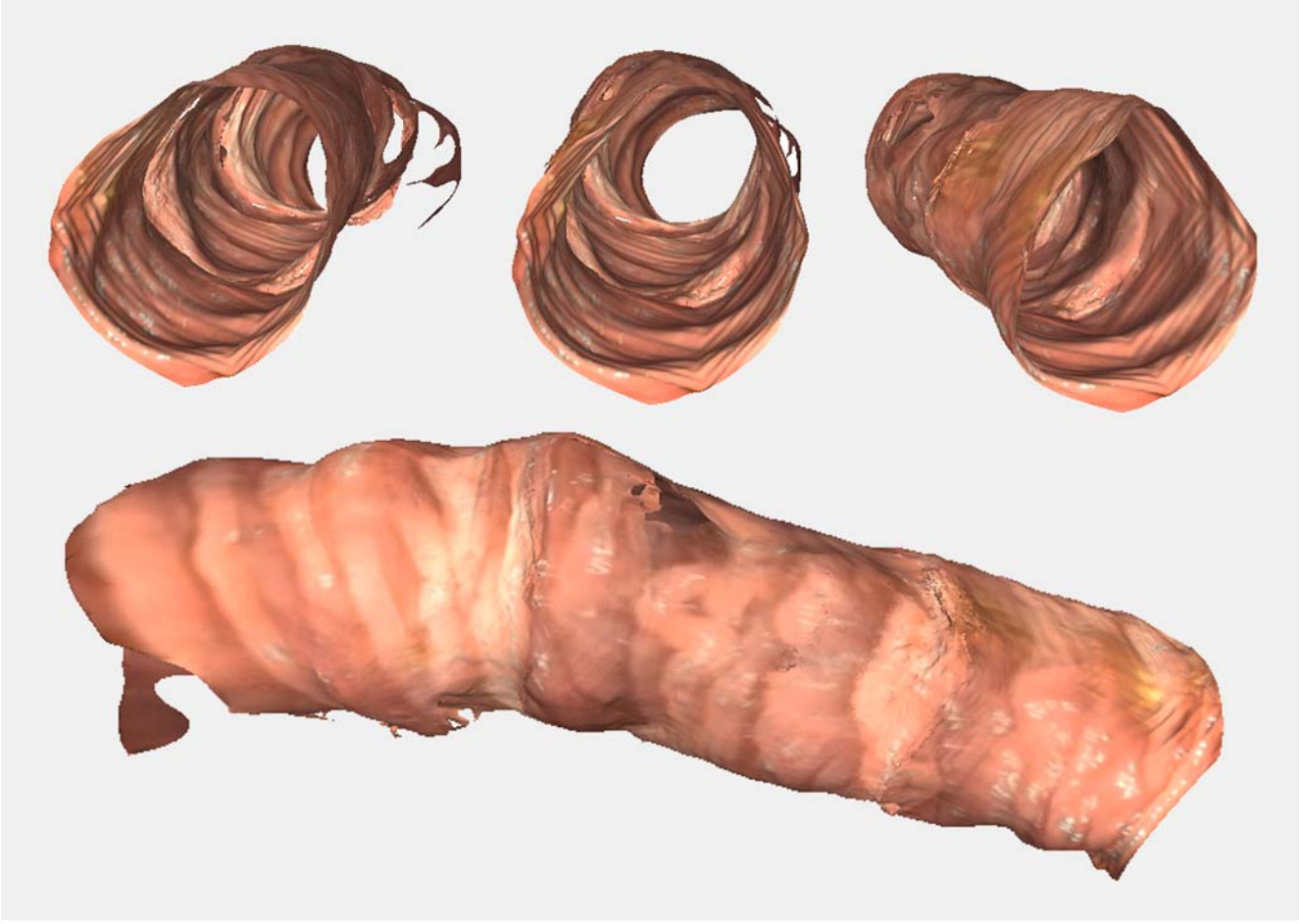
Artificial intelligence identifies and quantifies colonoscopy blind spots

Some mucosal surfaces on folds and within haustra may not be visualized at all during colonoscopy, and thus precancerous lesions are missed. We describe here preliminary results of an artificial intelligence (AI) technology that identifies and quantifies these "blind spots," with the aim, potentially, that endoscopists may be directed to them in real time.

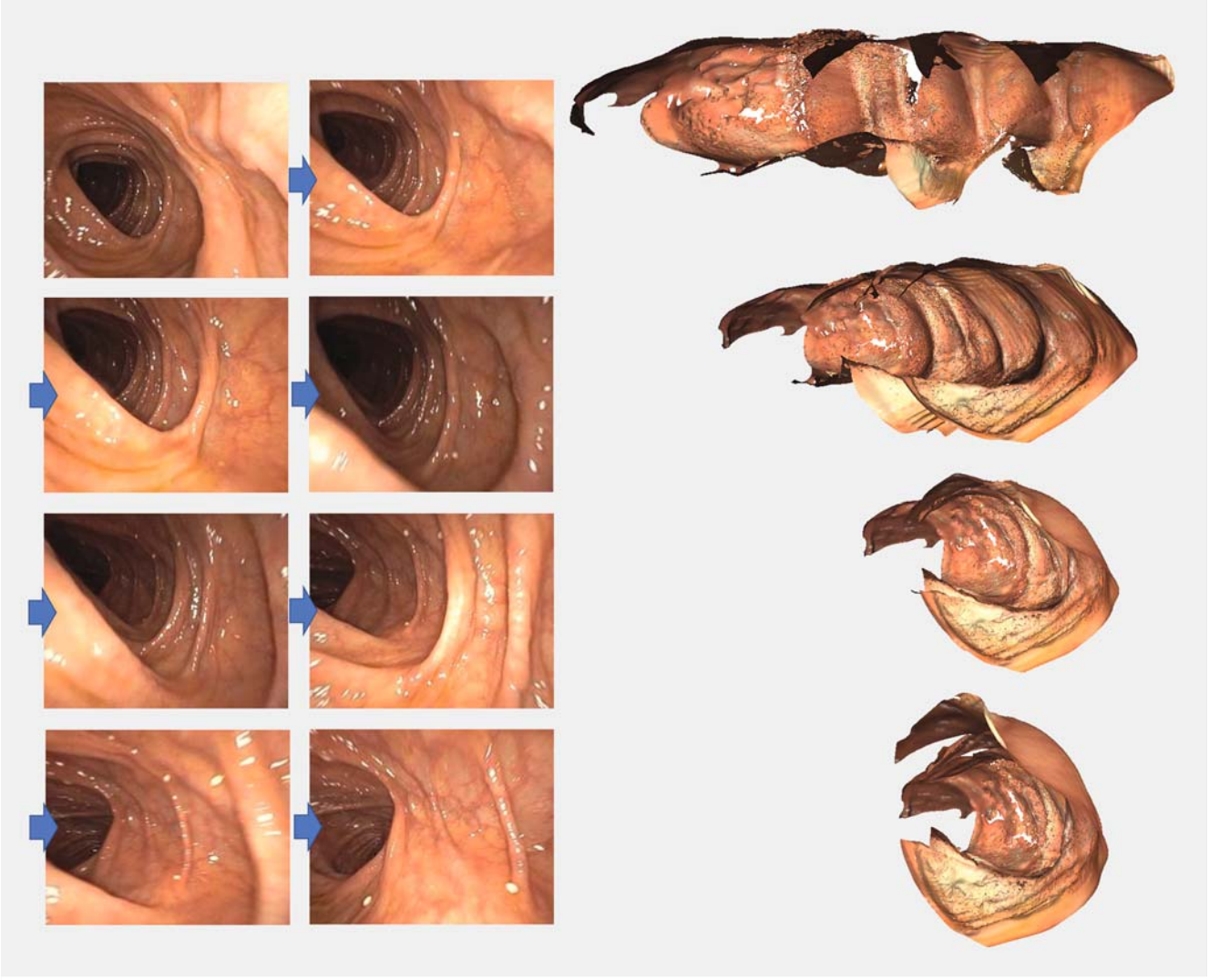
Anonymized colonoscopy videos were acquired from a single endoscopist with a high (47 %) adenoma detection rate (ADR), using Olympus CF and PCF devices (Olympus USA, Valley Forge, Pennsylvania, USA) and high definition recording (Epiphan, Palo Alto, California, USA). The main AI modalities applied were a recurrent neural network (an AI type particularly suitable for sequential data), that had been trained to compute depth [1, 2] combined with visual simultaneous localization and mapping (SLAM) [3].

The AI software was applied to 76 colonoscopy video sequences from 18 patients, showing colon segments of 4–25 cm in length. This created three-dimensional (3 D) reconstructions of the colon segments and then identified blind spots, showing as holes or gaps in the reconstructions, and quantified these non-visualized areas. The study endoscopist reviewed the reconstructions and validated that the blind spots had not been seen in the colonoscopy video. The last 12 3 D reconstructions were done in real time with the video sequence; these were 2–6 seconds in duration, corresponding to colon lengths of 7–25 cm (median 10 cm).

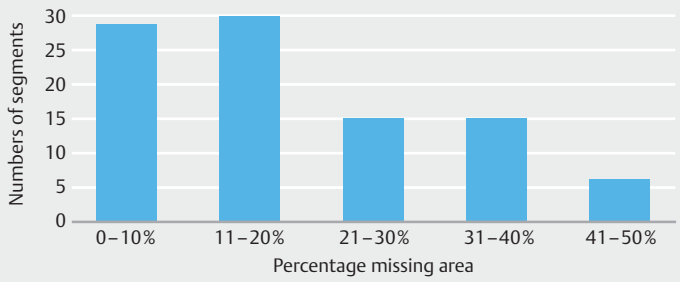
▶ **Video 1** shows a colonoscopy video alongside the real-time reconstruction highlighting a blind spot. ▶ **Fig. 1** is an example of a reconstructed segment of colon with no blind spot, while ▶ **Fig. 2** shows a sequence of video images where



▶ **Fig. 1** AI-reconstructed segment of the colon with no blind spot.



▶ **Fig. 2** The blind spot of left colon wall missed at colonoscopy is seen as a gap in this reconstruction.



▶ **Fig. 3** Histogram of frequency of percentage missing area among 76 segments of colonoscopy video.

the left wall of the colon was not visualized because of the camera angle, and the reconstructions with corresponding gaps.

Our system calculated that among the 76 reconstructed segments, the blind spots ranged from 1 % to 50 % of the total surface area (interquartile range 8.7 %–27 %), with a median 19 % of surface area being missed despite the high ADR of the operator. ▶ **Fig. 3** shows the distribution of the differing missed area percentages among the 76 reconstructed colonic segments.

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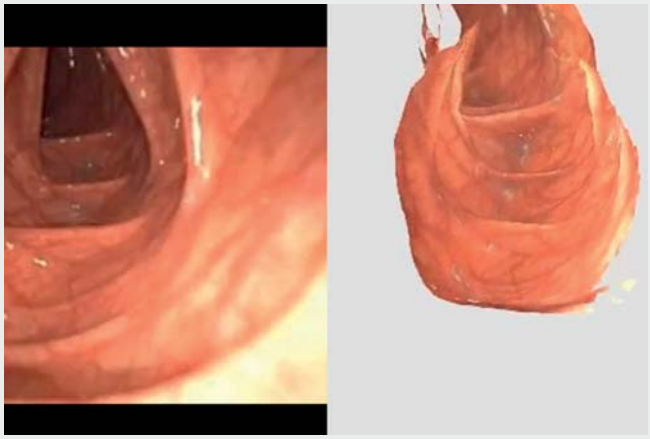

Video 1 Artificial-intelligence identification and quantification of colonoscopy blind spots. The video shows the colonoscopy video (left) and real-time reconstruction (center and right) which highlights the blind spot in the colon wall.

Competing interests

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