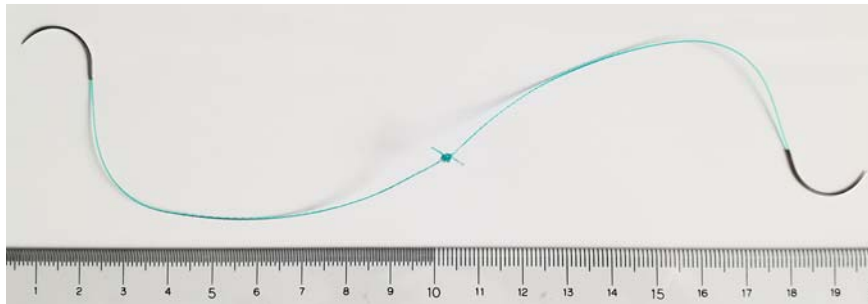


Continuous suturing with a stay suture after endoscopic full-thickness resection in an experimental study

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► **Fig. 1** Photograph of the suture needle developed, which was a double-ended needle made by cutting a V-loc180 (VLOCL0604; Covidien, Mansfield, Mass, USA) at 10 cm and joining the cut ends.



► **Fig. 2** The intestinal model (WetLab, Shiga, Japan) with a 4-cm diameter defect that was used in all endoscopic procedures.



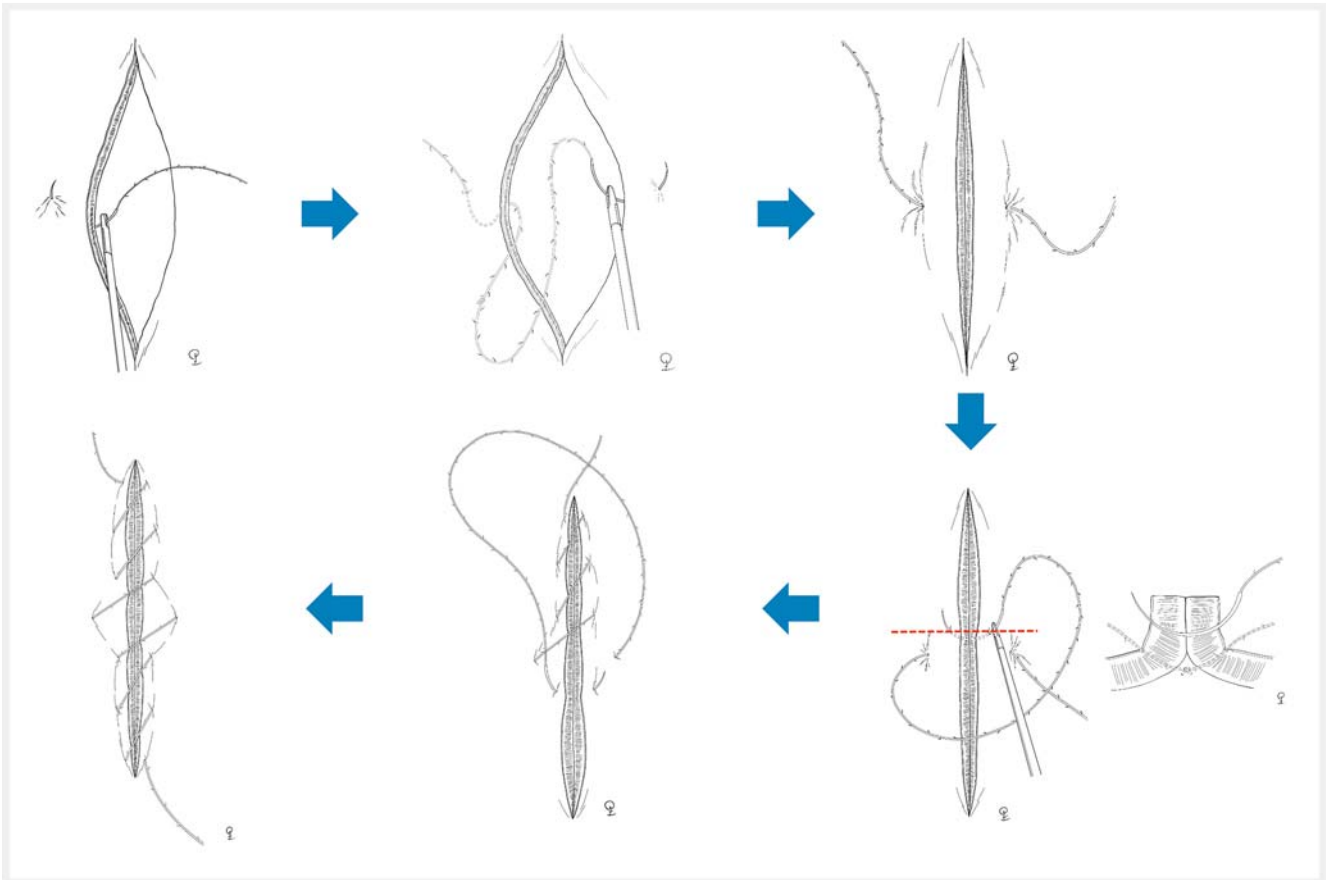
► **Video 1** Closure of a full-thickness perforation of around 4 cm in diameter using the continuous suturing with stay-suture technique.

Endoscopic full-thickness resection, as an extension of endoscopic submucosal dissection, has been attracting much attention for the treatment of submucosal tumors [1]. An essential part of this technology is a reliable full-layer closure method. Although no commonly accepted technique exists to realize full closure [2], suturing methods, which have been considered difficult, have shown promising results recently [3]. We describe a new technique for reliably closing large perforations. Endoscopic manipulation has many limitations compared with sur-

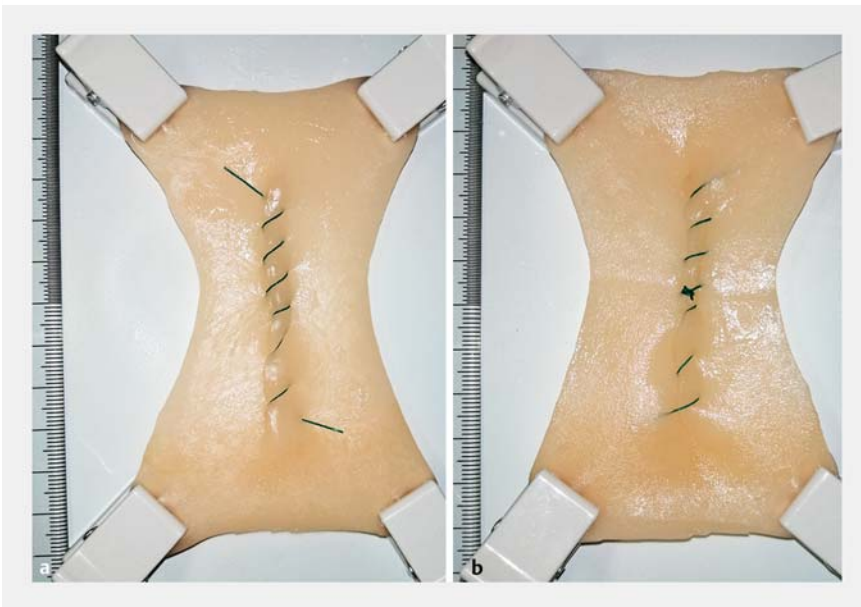
gical procedures where both hands are available; however, the development of a new suture needle for use with endoscopes can help to establish a suturing method similar to surgery. The suture needle is a double-ended needle with V-loc180 (VLOCL0604; Covidien, Mansfield, Massachusetts, USA) cut at 10 cm and joined at the cut ends (► **Fig. 1**). All of the procedures were performed endoscopically using an intestinal model (WetLab; Shiga, Japan) with a 4-cm diameter defect (► **Fig. 2**). The needle holder for flexible endoscopes mimicked a pre-

viously reported type [4]. To begin, one needle was inserted from the outside to the inside of the intestine at the wound center, and the other needle was inserted in the same manner on the contralateral side. By pulling the threads toward each other, the wound edge was turned inward, which became a stay suture. The wound, now raised in the center, was immediately penetrated horizontally and sutured continuously. Half of the wound was sutured with one end of the thread (► **Fig. 3**; ► **Video 1**). The needle tip did not exit the lumen during the entire process. We have named this procedure “endoscopic full-thickness continuous suturing with stay suture” (EFT-CSS). All five closures in this study were completed. The median procedure time was 29 minutes 18 seconds. All stitches reliably sutured the full layer (► **Fig. 4**), and no gaps existed because of manual tension.

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► **Fig. 3** Schema showing the suture procedure: one needle is inserted from the outside to the inside of the intestine at the wound center, and the other needle is inserted in the same manner on the contralateral side; the threads are pulled toward each other, turning the wound edge inward; the wound, now raised in the center, is immediately penetrated horizontally and continuously sutured (the cross-sectional view shows the position of the red-dotted line); half of the wound is sutured by one end of the thread, the remainder by the other end. Source: Risa Ishimura, Photo Center, Chiba University Hospital.



► **Fig. 4** Photograph showing the full layer reliably sutured by all stitches from: **a** front view; **b** back view.

Acknowledgments

► **Fig. 3** was drawn by Risa Ishimura, who is a member of the photo center of our facility.

Competing interests

The authors declare that they have no conflict of interest.

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