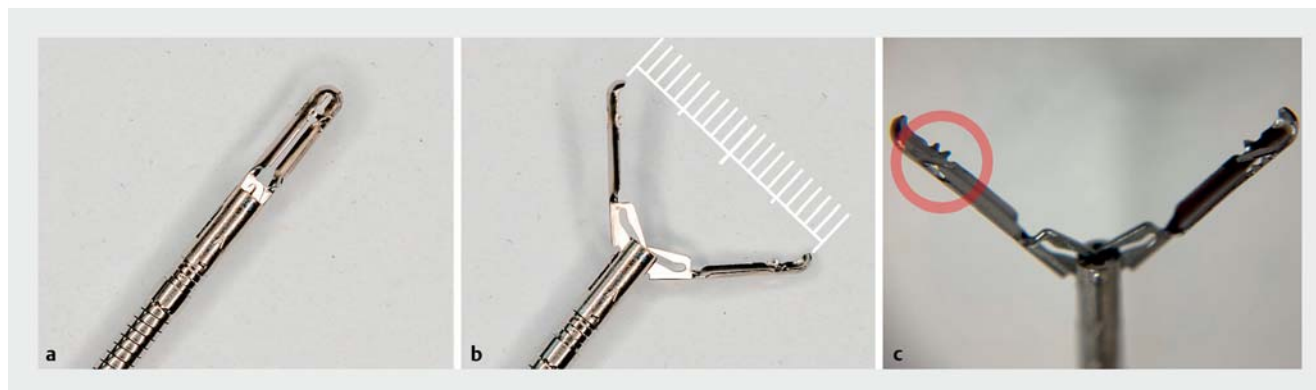


## Closure of full-thickness perforations in porcine stomach using 20-mm reopenable clips

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► **Fig. 1** Photographs showing the 20-mm reopenable clip **a** in the closed position; **b** in the open position with the teeth opened to 20 mm; **c** with its small protrusions on the inside of the teeth (red circles) that help to prevent tissue slippage.

It is difficult to close perforations that are large and full thickness in the gastrointestinal tract using conventional clips. Closure methods using special devices, including the over-the-scope (OTS) clip (Ovesco, Tübingen, Germany), have therefore been devised [1–3]. However, the OTS clip cannot be regripped and cannot be used unless the endoscope is pulled out for the clip to be attached [4]. Therefore, a device that can reliably close a perforation under endoscopic visibility is desired. We introduce a reopenable clip, which has a large width of 20 mm, and demonstrate its ability to close large gastric perforations in a porcine model. The reopenable clip (LOCKADO hemostasis clip; 20 mm; Micro-Tech (Nanjing) Co., Ltd., Nanjing, China) has large teeth with an opening width of 20 mm (► **Fig. 1**). It is possible to regrip and reposition the reopenable clip after it is opened. The clip has small teeth on both sides that are distinct from the tips of the teeth to prevent the gripped tissue from slipping.

A full-thickness perforation of approximately 15 mm was made in a porcine stomach (► **Fig. 2**; ► **Video 1**). The perforation was then gradually closed using 20-mm reopenable clips placed from one end of the perforation to the other. Three 20-mm reopenable clips were used to



► **Fig. 2** Images of full-layer perforation closure using 20-mm reopenable clips in a porcine model: **a–c** for a 15-mm full-thickness perforation; **d–g** for a 25-mm full-thickness perforation; **h, i** showing the closed perforation site including from the serosal side.

achieve complete closure. Because of the greater width of the clips, the muscles and mucosa were inverted toward the

stomach lumen, and no air leakage was observed outside the stomach. Next, a full-thickness perforation of 25 mm was



**Video 1** Closure of two large full-thickness perforations of the stomach (15 mm and 25 mm) in a porcine model using 20-mm reopenable clips.

created. Similarly, the perforation was closed from one end to the other. The clips are repositionable, so they can be grasped and changed to the appropriate position as required. For this larger perforation, an additional 11-mm reopenable clip was added; as a result, the full-layer perforation was completely closed without any air leak.

The 20-mm reopenable clip has the potential to close large full-thickness perforations.

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### Competing interests

The authors declare that they have no conflict of interest.

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