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ENDOSCOPIC SUTURING USING A COMPUTER-CONTROLLED MASTER AND SLAVE ROBOT: ANIMAL STUDY

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Background: Ideally, endoscopic suturing should mimic surgical closure as the latter is stronger than most endoscopic closure devices. However, endoscopic suturing is challenging due to the confined endoluminal space and lack of dexterity of current endoscopic instruments. We have developed a novel robotic suturing device to overcome these problems.

Aim: This animal study aims to demonstrate the feasibility of this device in closing perforations.

Method: The trial was conducted on an anaesthetized live pig. A double-channel colonoscope was first inserted into the rectum. Following saline lift, a 10 mm submucosal incision was created in the rectum to simulate a perforation. The robotic suturing device and grasper were inserted into the two colonoscope channels, allowing the endoscope to remain in position for tool exchanges or needle reloading. Both the effectors were intuitively tele-operated by the user via a robotic master console.

This robotic suturing device manipulated a curved, double-point needle (with a 10 cm 3-0 Vicryl suture) to penetrate tissues at desired orientations. The needle could be switched between both jaws of the device through a locking mechanism. This facilitated passing the needle through tissues to form stitches or through suture loops to form surgical knots. The articulated joints and five degrees of freedom allowed dexterous steering to reach targets and triangulation with other tools in a confined space. The robotic grasper facilitated handling of tissue and suture.

Result: A total of four running stitches were performed and secured with a surgical knot by passing the needle through suture loops. The suture was cut and the needle was removed by the robotic grasper through the channel. 11 min and 4 min were required to stitch and tie the knot respectively. There was no complication.

Conclusion: Our novel endoscopic robotic device can suture perforations resulting from complex endoscopic procedures. As our suturing method is similar to laparoscopic and robotic suturing, closure using our device is expected to be as strong as a surgical through-and-through closure. When developed further, this device can be used to close full-thickness resection sites and orifices in transluminal endoscopic surgery.