Evaluation of a new flexible fiber CO_2 laser for gastrointestinal cutting: NOTES and mucosectomy in a porcine model

The CO_2 laser is one of the most widely used surgical tools in otolaryngology, offering precise cutting, hemostasis, predictable penetration depth, and minimal collateral damage, due to efficient absorption of CO_2 laser energy by tissue water. Endoscopic use was previously limited by lack of an efficient, flexible delivery system. In 2002, Fink et al. described a hollow-core photonic band-gap fiber created with multilayered dielectric mirrors [1]. The fiber core acts as a channel for both helium flow (3 l/minute) and beam delivery, and allows improved power output. Although the precision and safety of the device have been described in the larynx and airway [2], its performance in the gastrointestinal tract has not been described. In a nonsurvival porcine model, we evaluated the performance of the flexible-fiber CO_2 laser in two novel endoscopic applications: mucosectomy and natural orifice transluminal surgery (NOTES). Indeed, the hemostatic abilities of the laser and the established safety of CO_2 in the peritoneal cavity make it ideal for these applications.

Four Yorkshire pigs underwent general anesthesia and gastroscopy with a double-channel endoscope. Using a 1.8 m fiber at 20 W pulsed current, 1.5 cm incisions were made along the greater curvature in two pigs. No blood was noted at the incision sites and the peritoneal cavity was accessed. In the first pig, biopsies were taken of the liver and spleen using standard forceps. Bleeding at the splenic biopsy site was successfully cauterized using the CO_2 laser (**Fig. 1**). In the second pig, grasping forceps were used to pull a loop of jejunum into the stomach. The loop was then anchored to the interior gastric wall with clips, and an incision made to create a gastrojejunostomy (**Fig. 2**).

The remaining two pigs underwent endoscopy and free-hand mucosectomy in the esophagus and stomach after injection of submucosal saline. No bleeding was noted. A 2 cm segment of mucosa was removed from each site. Histopathology confirmed removal of the mucosa and part of the submucosa with minimal damage to the muscularis propria (**Fig. 3**).

Fig. 1 Peritoneoscopy with splenic biopsies. Bleeding at the splenic biopsy site is cauterized successfully with the CO_2 laser.

Fig. 2 A loop of jejunum is grabbed and anchored to the gastric body to create a gastrojejunostomy.

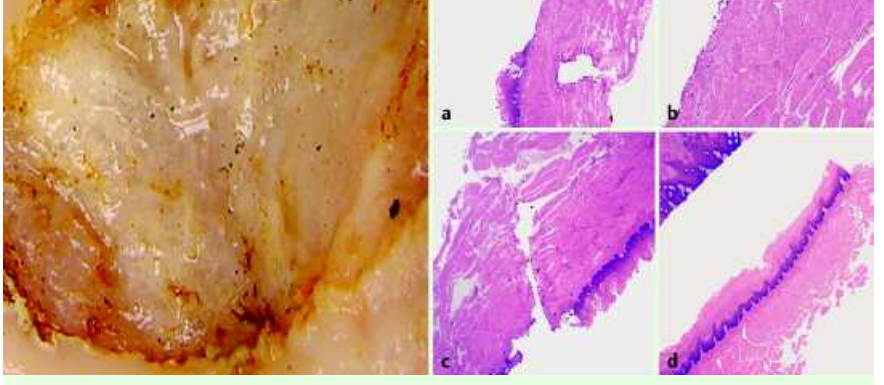

Fig. 3 The esophageal mucosectomy crater and histopathology of the specimen (hematoxylin & eosin). Histopathologic analysis reveals that depth of injury is confined to the submucosa as seen at both × 100 (**a**) and × 200 (**b**) magnification. There is a small focus of linear defect extending into muscularis propria which is more likely artifact than laser effect (**c**). The adjacent squamous mucosa shows only a minute focus of superficial epithelial damage (**d**).

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