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Minimally invasive surgery for resection of duodenal carcinoid tumors: endoscopic full-thickness resection under laparoscopic observation

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Abstract

Background Carcinoid tumors of the duodenum are rare, and the most effective treatment for duodenal carcinoid tumors remains debatable. Because carcinoid tumors of the gastrointestinal tract tend to spread to the submucosal layer even during the early stages of the disease, the possibility of tumor seeding in the vertical margin of the tumor cannot be eliminated by conventional endoscopic mucosal resection (EMR). In addition, because the duodenal wall is thinner than the gastric wall, EMR performed for duodenal lesions may be associated with a high risk of accidental perforation. In this article, we introduce a minimally invasive endoscopic full-thickness resection technique after laparoscopic repair for the local resection of duodenal carcinoid tumors.

Methods Under general anesthesia, after the duodenum was mobilized laparoscopically, the duodenal serosa at the site of the lesion was suctioned under laparoscopic observation, and full-thickness resection of the duodenum was performed using a cap-fitted endoscope, i.e., EMR-c, without injecting hypertonic saline-epinephrine. The sample was retrieved endoscopically after resection. After confirming that the full-thickness resection of the duodenal

wall with enough surgical margins was achieved and that there was no active bleeding, the wound was sutured by the laparoscopic hand-suturing technique.

Results We have performed this surgical procedure in two cases of duodenal carcinoid tumor. The mean operation time was 116 ± 14 minutes, and the estimated blood loss was 2.5 ± 0.5 ml. The postoperative courses were uneventful in both cases.

Conclusions The technique of endoscopic full-thickness resection of gastrointestinal tract under laparoscopic observation is a safe, simple, and can be radical surgical procedure for a small duodenal carcinoid tumor. This surgical procedure may be applicable in the case of other gastrointestinal tumors.

Keywords Duodenal carcinoid tumor · Laparoscopic surgery · Endoscopic mucosal resection

Carcinoid tumors of the duodenum are rare and account for only 2.6% of the carcinoid tumors reported in the United States [1]. With the widespread use of gastrointestinal endoscopy, these tumors are being increasingly recognized. Although several papers have reported the successful treatment of these tumors by endoscopic mucosal resection (EMR) after submucosal hypertonic saline-epinephrine (HSE) injection [2–4], the most effective treatment for duodenal carcinoid tumors remains debatable. Because carcinoid tumors of the gastrointestinal tract tend to spread to the submucosal layer even during early stages of the disease, the possibility of tumor seeding in the vertical margin of the tumor cannot be eliminated by conventional EMR. In addition, because the duodenal wall is thinner than the gastric wall, EMR performed for duodenal lesions may be associated with a high risk of accidental

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perforation. Therefore, it is necessary to develop an effective minimally invasive surgical procedure for the treatment of gastrointestinal submucosal tumors, including duodenal carcinoid tumors [5–7].

We introduce a minimally invasive endoscopic full-thickness resection technique after laparoscopic repair for the local resection of duodenal carcinoid tumors.

Setup for laparoscopic surgery

After the induction of general anesthesia, the patient was placed in a supine position with his right side elevated. The surgeon stood on the left side of the patient and the first assistant, on the right side; the laparoscopist stood between the abducted legs of the patient, and either the endoscopic operator or the assistant was positioned at the patient's head. A camera port was inserted into an inferior umbilical incision. Next, a pneumoperitoneum of 10 mmHg was created, and four additional ports (2 ports with a diameter of 12 mm and 2 with a diameter of 5 mm) were inserted into the left upper, right lower, left lower, and right upper quadrants, under laparoscopic imaging.

Mobilization of the duodenum and blood vessel preparation

A clamp forceps was applied at the jejunum at a distance of 10 cm from the Treitz ligament toward the anal side; the tumor location was confirmed by endoscopy. Blood vessels in the area around the tumor margin were occluded by using an ultrasonically activated sealing device (Harmonic Scalpel Ace; Ethicon, Tokyo, Japan). The adhesions between the gallbladder and the transverse colon were sharply dissected, and the bulb and the second portion of the duodenum were exposed (Fig. 1). The Kocher maneuver was then performed, and complete lateral mobilization of the duodenum was achieved. To determine the precise location of the tumor laparoscopically, the wall of the duodenum was endoscopically maneuvered using a biopsy forceps on the mucosal side (Fig. 2).

Full-thickness resection using the EMR technique

The duodenal serosa at the site of the lesion was suctioned under laparoscopic observation, and full-thickness resection of the duodenum was performed using a cap-fitted endoscope, i.e., EMR-c, without injecting HSE (Fig. 3). The sample was retrieved endoscopically after resection. After confirming that the full-thickness resection of the duodenal wall with enough surgical margins was achieved

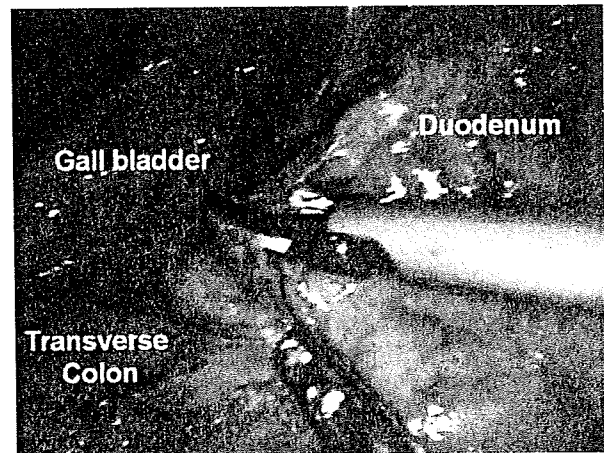


Fig. 1 Blood vessels in the area around the tumor margin were occluded using an ultrasonically activated sealed device (Harmonic Scalpel Ace). Adhesions between the gallbladder and transverse colon were sharply dissected, and the bulb and the second portion of the duodenum were exposed

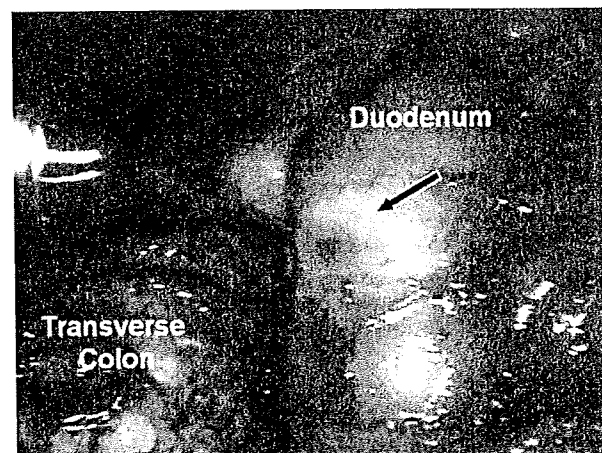


Fig. 2 Kocher maneuver was performed and the duodenal wall was endoscopically maneuvered by using biopsy forceps on the mucosal side to confirm the precise location of the tumor by laparoscopic imaging

and that there was no active bleeding, the wound was sutured by the laparoscopic hand-suturing technique (Figs. 4 and 5). The completion of closure was tested by laparoscopic examination after insufflating air into the duodenum and submerging the suture line under water. A closed suction drain was placed adjacent to the duodenal suture line.

We have performed this surgical procedure in two cases of duodenal carcinoid tumor (Table 1). The mean operation time was 116 ± 14 minutes, and the estimated blood loss was 2.5 ± 0.5 ml. The postoperative course was uneventful in both cases.

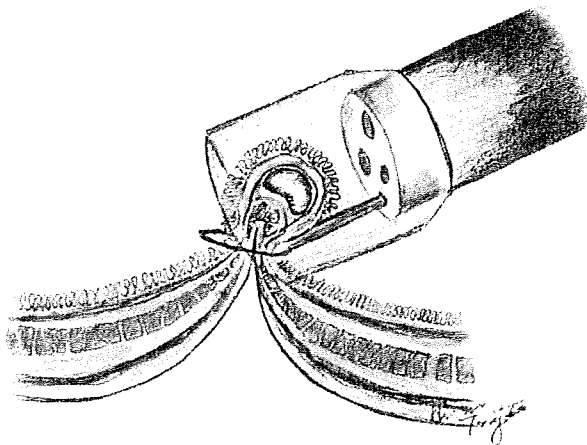


Fig. 3 Duodenal serosa at the site of the lesion was suctioned under laparoscopic observation, and full-thickness resection of the duodenum was performed using a cap-fitted endoscope, i.e., EMR-c, without injecting hypertonic saline-epinephrine



Fig. 4 After confirming that the full-thickness resection of the duodenal wall was achieved and that there was no active bleeding, the wound was sutured by the laparoscopic hand-suturing technique

Case report

A 76-year-old man was diagnosed with a duodenal submucosal tumor, which was <1 cm in size and located in the second portion of the duodenum (Fig. 6A, B). Histological examination of the endoscopic biopsy specimens revealed a carcinoid tumor. Endoscopic ultrasonography (EUS) demonstrated that the tumor had spread to the mucosa and the submucosa, and there was no metastasis to the periduodenal lymph nodes (Fig. 6C). Macroscopic examination of the resected specimen showed a yellowish, submucosal tumor <1 cm in size, with a sufficient surgical margin (Fig. 6D). Pathological examination revealed a well-circumscribed carcinoid tumor located in the submucosal layer adjacent to



Fig. 5 Laparoscopic view after the completion of laparoscopic hand sutures

Table 1 Clinicopathological features in the two cases of carcinoid tumor of the duodenum

	Case 1	Case 2
Age (yr)	76	62
Gender	Male	Male
Location of tumor	2nd portion	Duodenal bulb
Size of resected specimen	22 mm × 19 mm	21 mm × 13 mm
Operation time (min)	130	102
Intraoperative blood loss (ml)	3	2
Comorbidity	Hypertension	None
Postoperative complication	No	No
Time until start of oral intake (days)	3	3
Postoperative hospital stay (days)	9	7
Pathological findings		
Size of tumor	8 mm × 8 mm	6 mm × 6 mm
Depth of tumor	Submucosa	Submucosa
Chromogranin A	Positive	Positive
Synaptophysin	Positive	Positive
S100 protein	Positive	Positive
Cytokeratin	Positive	Positive
Ki-67 labeling index	<1%	<1%
Mitosis	0/20 HPF	0/20 HPF

the muscularis propria (Fig. 6E); the tumor cells had round or oval nuclei and proliferated in a trabecular and microglandular pattern without mitotic figure (Fig. 6F). During the postoperative period, the patient had 24 hours of nasogastric decompression, underwent water-soluble contrast study on postoperative day 3 to confirm patency of the duodenal lumen, was started on a liquid diet, and was discharged on postoperative day 9.

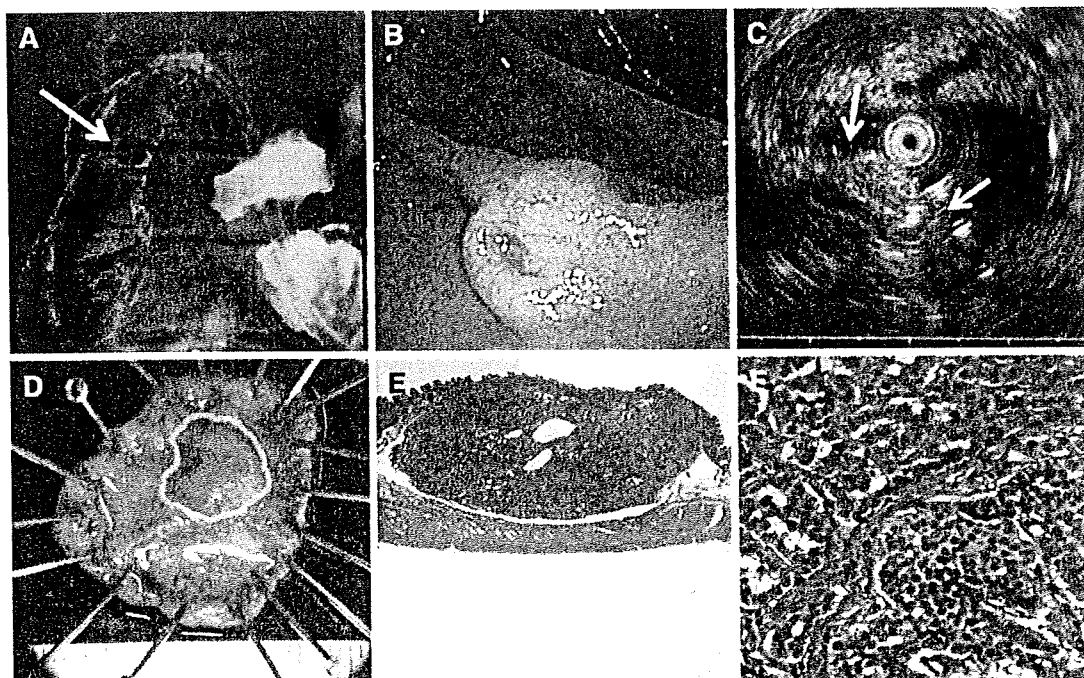


Fig. 6 Images of the duodenal carcinoid tumor in our patient. A 76-year-old man was diagnosed with a duodenal submucosal tumor, which was <1 cm in size and located in the second portion of the duodenum (A, B). Endoscopic ultrasonography (EUS) demonstrated that the tumor had spread to the mucosa and the submucosa, and there was no metastasis to the periduodenal lymph nodes (C). Macroscopic

examination of the resected specimen showed a yellowish, submucosal tumor, <1 cm in size, with a sufficient surgical margin (D). Pathological examination revealed a well-circumscribed carcinoid tumor located in the submucosal layer adjacent to the muscularis propria (E). The tumor cells had round or oval nuclei and proliferated in a trabecular and microglandular pattern without mitotic figure (F)

Discussion

Duodenal carcinoid tumors are relatively uncommon neuroendocrine tumors; no guidelines regarding the treatment for duodenal carcinoid tumors are available, because data on their natural history are scarce [8]. In the largest series of duodenal carcinoid tumors to date, Burke et al. reviewed 99 cases of duodenal carcinoid tumors and reported that when these tumors are localized in the submucosal layer, were <1 cm in size, and had no mitotic figures; they were indolent and did not demonstrate metastasis [9]. These data suggested that small duodenal carcinoid tumors localized within the submucosa and without lymph node metastasis as a clinical findings can be treated by local resection, and not by radical resection with lymphadenectomy.

Toyonaga et al. treated duodenal carcinoid tumors located on the anterior duodenal bulb using laparoscopic linear staplers [10]. Bowers et al. reported the laparoscopic local resection of carcinoid tumors in the posterior duodenal bulb by laparoscopy and closure of the wound margins by the laparoscopic hand-suturing technique [11]. Both authors performed laparoscopic local resection of the duodenum assisted by simultaneous duodenoscopy. However, local resection using laparoscopy, especially if

laparoscopic linear staplers are used, should prevent post-operative duodenal stenosis and be performed by keeping a sufficient surgical margin as well as a minimal negative margin.

Suzuki et al. developed the technique for full-thickness resection and complete defect closure using endoscopy for gastrointestinal malignancies, including duodenal carcinoid tumors, in the early stage [12]. However, endoscopic full-thickness resection of duodenum without laparoscopic observation may lead to suction of the adjacent tissue or an organs, such as the transverse colon, pancreas, or gallbladder, which may lead to serious complications. In this regard, we believe that the surgical procedure presented in this report has several advantages over the conventional endoscopic and/or laparoscopic techniques for local resection of duodenal carcinoid tumors.

Conclusions

The technique of endoscopic full-thickness resection under laparoscopic observation is a safe, simple, and radical surgical procedure for a small duodenal carcinoid tumor. Although we have experienced two cases of this surgery

for duodenal carcinoid tumor due to the rareness of this tumor, this surgical procedure may be applicable for an early gastric cancer, gastric submucosal tumor, including gastrointestinal stromal tumors (GIST).

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