



Segmental resection with partial mesopancreatic and mesojejunal excision (pMME) for duodenal carcinoma of the third or fourth portion

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Received: 2 January 2022 / Accepted: 22 May 2022 / Published online: 30 May 2022
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Abstract

Introduction Pancreatoduodenectomy is the standard procedure for duodenal carcinoma of the third or fourth portion. As an alternative option, we developed a novel segmental resection (SR) with partial mesopancreatic and mesojejunal excision (pMME) that enhances radicality. In this report, the surgical technique with video and outcomes are described.

Method We performed SR with pMME on seven consecutive patients with third or fourth duodenal carcinoma between 2009 and 2021. We divided the procedure into four sections, including (1) wide Kocher's maneuver, (2) supracolic anterior artery-first approach, (3) dissection of the mesopancreas and mesojejunum, and (4) devascularization of the uncinate process and dissection of duodenum.

Result Median operative time was 348 min (range, 222–391 min), and median blood loss was 100 mL (range, 30–580 mL). Major complications of Clavien-Dindo classification grade 3a or more occurred in one patient. All patients achieved R0 resections with 10 mm or more proximal margin. Six cases (85%) were alive without recurrence.

Conclusion We developed a radical and safe procedure of SR with pMME as an alternative and less invasive approach for duodenal carcinoma of the third or fourth portion.

Keywords Duodenal carcinoma · Limited resection · Mesopancreatic dissection · Partial resection · Segmental resection

Abbreviations

PD	Pancreatoduodenectomy
SR	Segmental resection
pMME	Partial mesopancreatic and mesojejunal excision
SMV	Superior mesenteric vein
SMA	Superior mesenteric artery
IPDA	Inferior pancreatoduodenal artery
JA	Jejunal artery

Introduction

Duodenal carcinoma is a rare malignancy that accounts for 0.8% of gastrointestinal carcinoma cases [1]. Pancreatoduodenectomy (PD) is the standard procedure for duodenal carcinoma [2]; however, the high morbidity and mortality following PD make surgeons think twice before performing this invasive procedure.

Segmental resection (SR) is an alternative option in patients with duodenal carcinoma that results in reduced postoperative morbidity [3, 4]. Another advantage of SR compared with PD is the potential to preserve the pancreas. However, given that 57% of duodenal carcinoma with T1b or greater involved lymph node metastasis [2], and lymph node metastasis is predictive of worse outcomes [2, 5–7], SR without lymph node dissection is not sufficient as a radical procedure. Furthermore, in patients with duodenal carcinoma of the third or fourth portion, systematic lymph node dissection is technically demanding due to the complex structure of the mesopancreas [8].

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We developed a novel SR with partial mesopancreatic and mesojejunum excision (pMME) that balances radicality and safety for duodenal carcinoma of the third or fourth portion. In this report, the surgical technique and outcomes are described for seven patients who underwent SR with pMME.

Methods

Patients

We performed SR with pMME on seven consecutive patients with distal third or fourth duodenal carcinoma (five patients from the Cancer Institute Hospital and two patients from the Juntendo University Hospital) between 2009 and 2021. Our institutional review board approved this retrospective study with waived informed consent. Demographic data, clinical history, operation record, morbidity, mortality, and pathological data were reviewed.

Indications for SR with pMME

Duodenal carcinoma of the third or fourth portion away from the pancreas was an indication for SR with pMME. Tumor extension was confirmed using computed tomography and endoscopic ultrasonography preoperatively. Patients with the tumor deeper than T1b (submucosal invasion) were candidates for this procedure. Tumors with suspicious lymph node metastases around the pancreas head (hepatic, pyloric, or pancreaticoduodenal station) were excluded. Intraoperatively, lymph node metastases around the pancreas head were routinely explored, and PD was performed when lymph node metastases were confirmed by frozen section.

Surgical procedure

We divided the procedure into four sections, including (1) wide Kocher's maneuver, (2) supracolic anterior artery-first approach, (3) dissection of the mesopancreas and mesojejunum, and (4) devascularization of the uncinate process and dissection of duodenum.

Wide Kocher maneuver (Fig. 1 and video Section 1)

After laparotomy with upper abdominal midline incision, abdominal exploration and a wide Kocher maneuver were conducted. A routine frozen section biopsy of para-aortic nodes was performed. And if lymph node metastasis around

Table 1 Patient outcomes

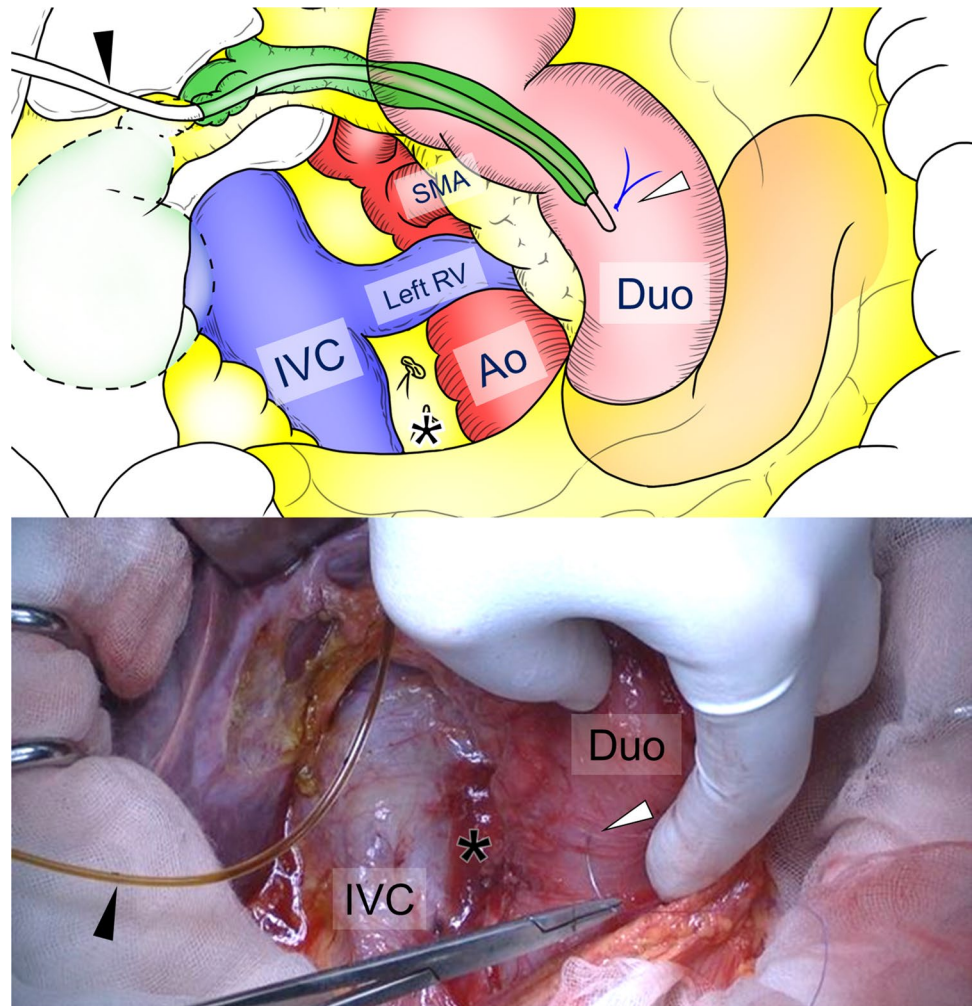
Case	Sex	Age	BMI	PS	Operative time (min)	Blood loss (mL)	Morbidity	The Clavien-Dindo classification	Pathological stage*	Number of metastases/number of LNR	Resection margin
1	Male	52	21.8	1	222	130	SSI and diarrhea	2	T3N0M0 Stage IIA	0/17	R0
2	Female	48	17.2	1	284	80	PF and diarrhea	2	T4N2M0 Stage IIIB	4/46	R0
3	Male	54	22	2	348	150	DGE and diarrhea	2	T3N0M0 Stage IIA	0/23	R0
4	Male	65	19.2	2	391	580	DGE and diarrhea	2	T4N0M0 Stage IIB	0/31	R0
5	Female	63	17.5	2	373	30	Diarrhea	2	T4N0M0 Stage IIB	0/21	R0
6	Male	71	26	3	243	50	Anastomotic bleeding	3a	T4N0M0 Stage IIB	0/10	R0
7	Male	58	22.4	2	390	100	Diarrhea	2	T3N0M0 Stage IIA	0/16	R0
Median (range)		58 (48–71)	21.8 (17.2–26)		348 (222–391)	100 (30–580)					

Cases 1 to 5 were treated at Cancer Institution Hospital. Cases 6 and 7 were treated in Juntendo university hospital

*Pathological stage based on 8th Edition of the Union for International Cancer Control staging system

BMI, body mass index; PS, physical status based on American Society of Anesthesiologists Classification; DGE, delayed gastric emptying; PF, pancreatic fistula; SSI, surgical site infection; LNR, lymph node resected; R0, resection margin was pathologically negative

Fig. 1 Wide Kocher maneuver. After mobilization of the duodenum and colon, the left renal vein and superior mesenteric artery were exposed. We routinely performed frozen section biopsy of para-aortic nodes (black asterisk) to confirm the contraindication of resection. Cholecystectomy and insertion of tube (black arrowhead) via the cystic duct were performed to identify the location of the major papilla. The site opposite the major papilla in the second duodenum was marked with suture thread (white arrowhead). SMA, superior mesenteric artery; RV, renal vein; IVC, inferior vena cava; Ao, aorta; Duo, duodenum



the pancreas head was suspected, a frozen section biopsy was done. The cholecystectomy and insertion of cystic duct tube was done to identify the location of the major papilla.

Supracolic anterior artery-first approach (Fig. 2 and video Section 2)

The superior mesenteric vein (SMV) was exposed and taped. The mesopancreatic dissection preserving the entire pl-SMA (level 2) was conducted by supracolic anterior artery-first approach, which we previously described as a surgical practice for pancreatoduodenectomy [9]. With a pinpoint rotation of the superior mesenteric artery (SMA) via retracting the pl-SMA, the common trunk of the inferior pancreaticoduodenal artery (IPDA) and the first jejunal artery (JA) was exposed and ligated. With full mobilization, the SMA was exposed and taped. After isolation of the SMA, Treitz's ligament was divided to the level of the left renal vein.

Dissection of the mesopancreas and mesojejunum (Fig. 3 and video Section 3)

In infracolic section, the mesojejunum was dissected. The proximal jejunum supplied by the first or up to the second jejunal artery was resected following a central vascular ligation method [10, 11]. In supracolic section, the first jejunal vein was divided. The third and fourth duodenum with dissected mesopancreas was passed to the right side below the superior mesenteric vessels.

Devascularization of uncinate process and dissection of duodenum (Fig. 4 and video Section 4)

Tiny distal branches of the IPDA and IPDV to the pancreas head were carefully divided. The distal second portion of the duodenum was divided with enough surgical margin to preserve the major papilla. Reconstruction was performed by end-to-end or end-to-side duodenojejunal anastomosis with retrocolic or original retroperitoneal route.

Results

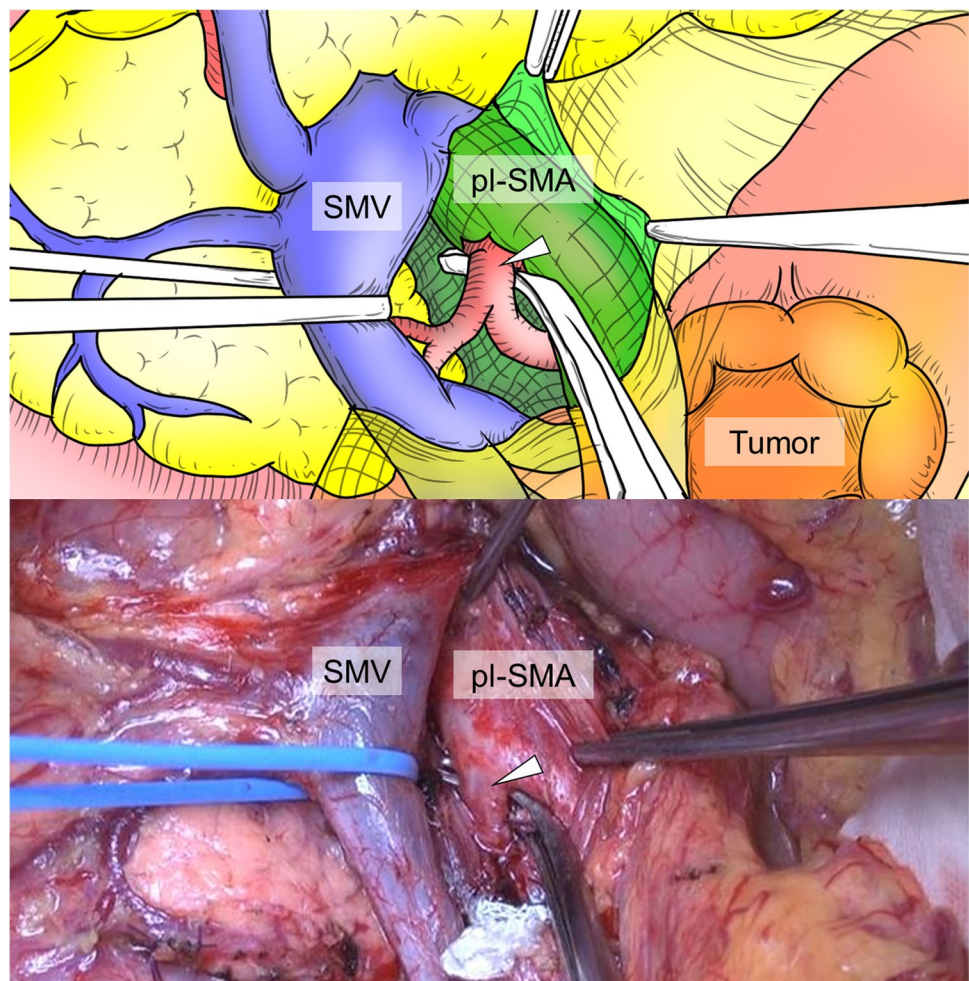
Table 1 summarizes the outcomes of seven patients. Median operative time was 348 min (range, 222–391 min), and median blood loss was 100 mL (range, 30–580 mL). Major complications of Clavien-Dindo classification grade 3a or more occurred in one patient (anastomotic bleeding), who was treated by arterial embolization. Pancreatic fistula of grade B as defined by the International Study Group on Pancreatic Fistula was found in one patient. Six patients with postoperative diarrhea treated by antidiarrheal drugs (4 patients with non-opioid antidiarrheal drugs, 2 patients with opioid antidiarrheal drugs), and all of them were controllable. The median number of lymph nodes resected was 21 (range, 10–46). All patients achieved R0 resections with 10 mm or more proximal margin. The median follow-up duration was 46 months (range, 2–75 months). Six cases (85%) were alive without recurrence. Case number 2, the most advanced stage, had recurrence with peritoneal and ovarian metastasis 11 months after surgery.

Discussion

In this report, we are the first to demonstrate the technique of SR with pMME in patients with duodenal carcinoma of the third or fourth portion. In seven patients, SR with pMME was safely performed, and the number of lymph nodes resected (LNR) ensured the radicality of this procedure.

Mesopancreatic excision is a part of the surgical procedures performed during PD for pancreatic carcinoma [12–14]. The concept of pMME is high ligation of the supplying arteries and en bloc resection of the mesenteries [10, 11]. In pMME, part of the mesopancreas, so-called PLPh1, is preserved, which may correspond to the concept of partial mesorectal excision [15]. Although the term “mesopancreas” remains controversial [16], it is helpful to understand the complex anatomy around the SMA. Embryonic rotation leads the mesopancreas to form spirally (Fig. 3). However, a de-rotated mesopancreas is a simple fan-shaped structure similar to the mesorectum shown in Fig. 4 [8]. The fact that fourth duodenal carcinomas spread to the superior mesenteric lymph nodes [2] suggests the mesopancreas is the mesentery

Fig. 2 The supracolic anterior artery-first approach. The superior mesenteric vein was taped. Rotating the superior mesenteric artery with retraction of the plexus, the common trunk of the inferior pancreaticoduodenal artery and the first jejunal artery as central vessel (white arrowhead) were exposed. SMV, superior mesenteric vein; pl-SMA, plexus of superior mesenteric artery



of the fourth duodenum. Hence, pMME is a regional lymph node dissection of fourth duodenal carcinoma. A large population-based cohort study including 1611 patients with duodenal carcinoma demonstrated that SR had the smaller number of LNR (6.8 vs. 11 [$P < 0.0001$]) than conventional PD [17]. In our seven cases, the median number of LNR was 21. The number of LNR and the long-term outcomes warrant the oncological radicality of SR with pMME.

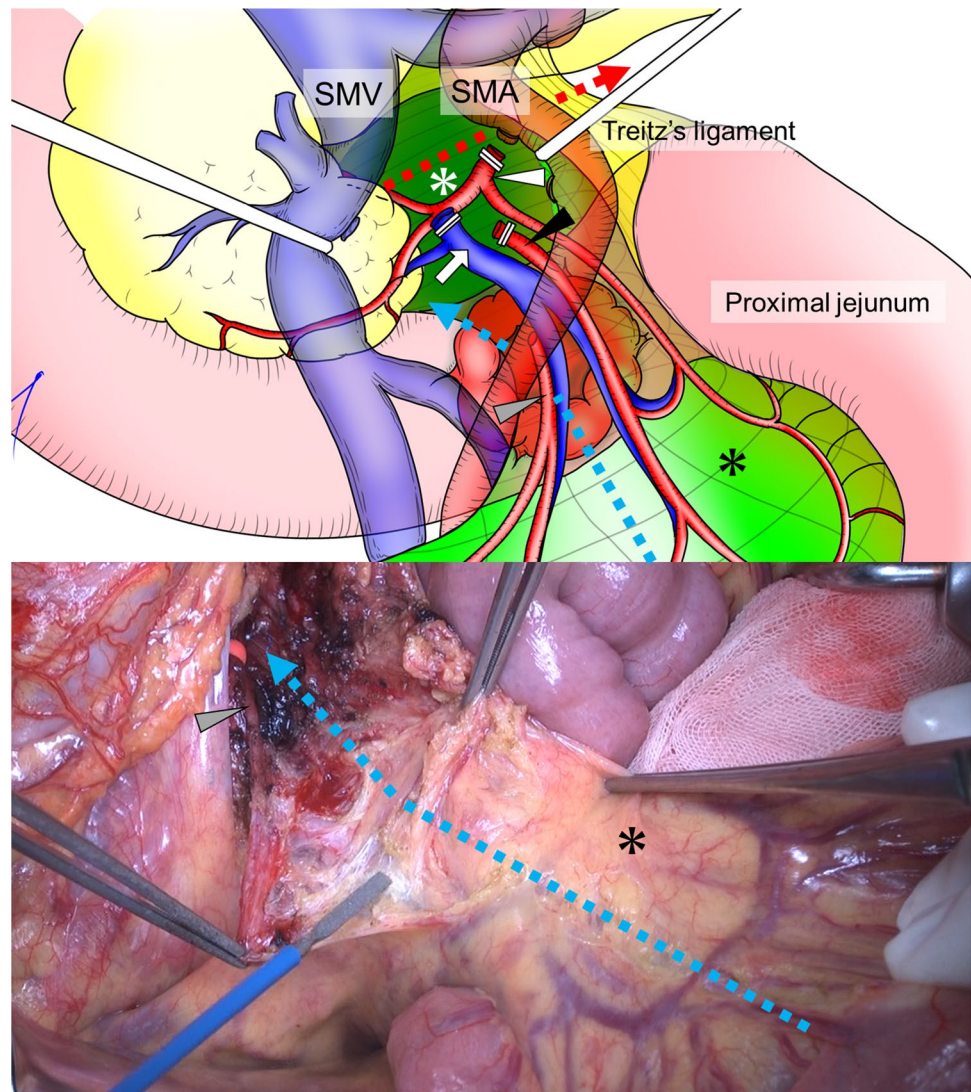
The devascularization of uncinate process (section four of the procedure) is a specific procedure of SR with pMME, which is different from that of PD. In this section, it is important to avoid injury of the major papilla by confirming the location with tube insertion, performed in Sect. 1. Additionally, an important point is to avoid tumor exposure that leads to worse outcomes [5–7, 18–21]. The horizontal and vertical margins are regulated by the location of the major papilla and the presence of pancreatic invasion, respectively. These margins need to be established with intraoperative

frozen section analysis, and conversion to PD should be considered when tumor invasion is confirmed.

A recently published report of 16 patients with fourth duodenal tumor demonstrated the possibility of SR with lymph node dissection with a minimally invasive approach. In this report, four patients with fourth duodenal adenocarcinoma had laparoscopic SR with superior mesenteric lymph node dissection. Oncological outcomes of the four patients were feasible, achieving R0 resection and no recurrence during the follow-up period [22]. Nowadays, a robotic approach is being applied to complicated surgeries including PD. The next step may be to develop and promote robotic SR with pMME by investigating the safety and feasibility of the procedures.

In this report, SR with pMME was performed with no postoperative mortality. The major complication of Clavien-Dindo grade 3a or more was found in only one patient who had a severe comorbidity classed as ASA-PS

Fig. 3 Dissection of the mesopancreas and mesojejunum. Treitz's ligament and the top of the mesopancreas (white asterisk) were dissected (red dotted arrow). The white, black, and grey arrowheads and white arrow show the common trunk of the inferior pancreaticoduodenal artery, the first jejunal artery, the second jejunal artery, the third jejunal artery, and the first jejunal vein trunk, respectively. The blue dotted arrow shows the en-bloc dissecting line of the mesojejunum (black asterisk) and mesopancreas (white asterisk) and preservation of the third jejunal artery (grey arrow). SMV, superior mesenteric vein; SMA, superior mesenteric artery

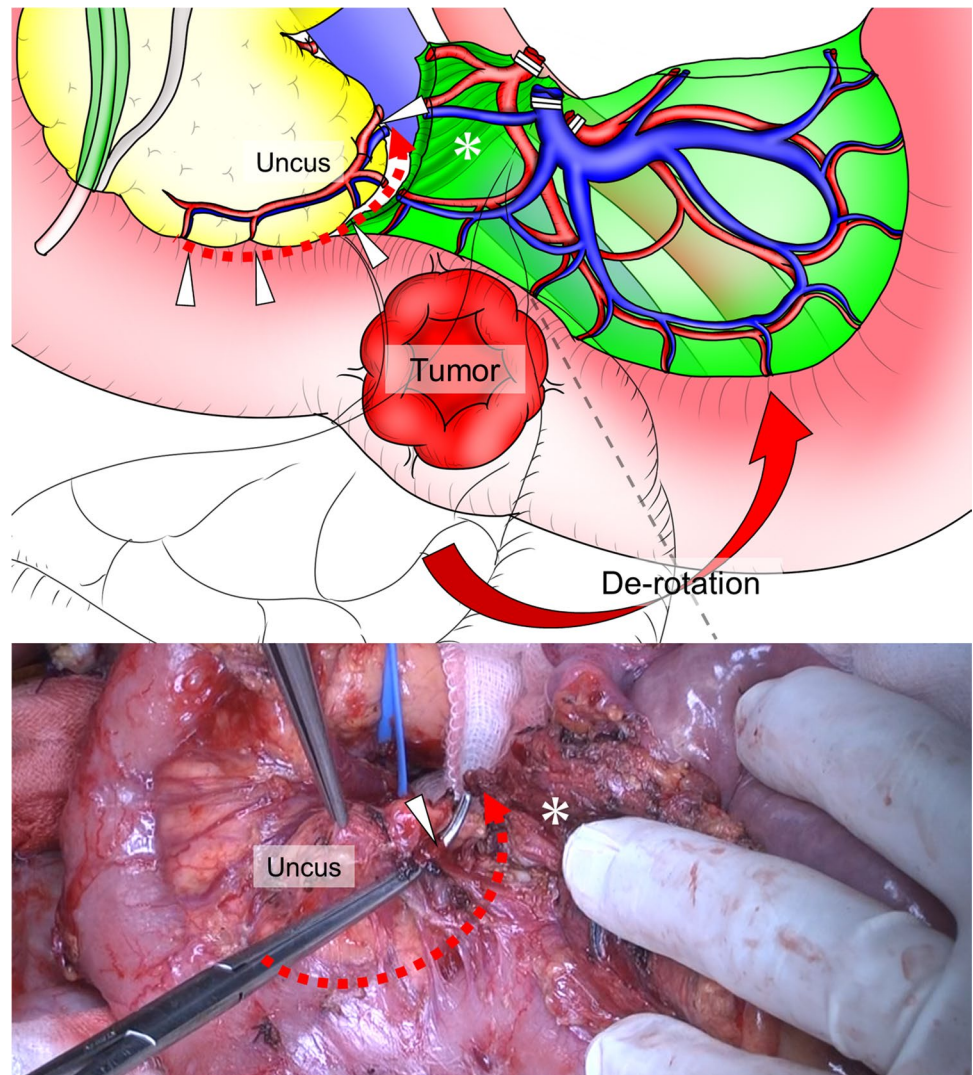


3. Available evidence revealed that surgery for duodenal carcinoma is associated with significant mortality. Cloyd et al. reported that the 90-day mortality rate of 1611 patients undergoing surgery for duodenal carcinoma was 12.5% [17]. Importantly, PD for the soft pancreatic parenchyma in patients with non-pancreatic tumors bears a risk of life-threatening pancreatic fistula [23]. In our series, pancreatic fistula of grade B occurred in one case, which may have been caused by minor injury to the pancreatic parenchyma during devascularization of the uncinate process. Although six patients had postoperative diarrhea, all of them were well controlled by antidiarrheal drugs. The key to SR with pMME for duodenal carcinoma is to preserve the pl-SMA not to compromise the health-related quality of life of patients because the dissection of pl-SMA significantly increases the risk of refractory diarrhea [24]. We recently reported that postoperative diarrhea is manageable with antidiarrheal drugs in patients undergoing radical PD for pancreatic

adenocarcinoma. In that report, more than half of patients with diarrhea stopped using the antidiarrheal drugs, and the nutritional status recovered within 2 years.

Currently, there is no standardized chemotherapy for duodenal carcinoma, and surgical resection is the only effective treatment. Although a latest meta-analysis demonstrated the long-term outcomes following SR were not inferior to those after PD in patients with duodenal carcinoma, this study has certain drawbacks because tumor location and T categories were not taken into consideration for prognostic assessment [25]. We have to stress that the best practice for advanced duodenal carcinoma is still unknown. In this report, we provided with a new surgical choice for cancers of the third or fourth portion of the duodenum. Further investigation is needed to assess that, compared with radical PD, SR with pMMR does not impair the oncological radicality and yet improves the health-related quality of life by preserving the pancreas in patients with distal duodenal carcinoma.

Fig. 4 Devascularization of the uncinate process and dissection of the duodenum. The distal duodenum and proximal jejunum with dissected mesopancreas (white asterisk) and mesojejunum were passed to the right side below the superior mesenteric vessels and de-rotated (red arrow). Distal tiny branches of inferior pancreaticoduodenal vessels (white arrowheads) lead to the uncinate process of the pancreas. After resection of these tiny branches, the partial mesopancreatic and mesojejunum excision were finished. Uncus, uncinate process of the pancreas



Conclusion

We developed a radical and safe procedure of SR with pMME for duodenal carcinoma of the third or fourth portion.

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1007/s00423-022-02569-7>.

Authors' contribution Study conception and design: R.I, M.Y, Y.T, Y.I, A.S. Acquisition of data: R.I. Analysis and interpretation of data: R.I, M.Y, A.S. Drafting of manuscript: R.I, M.Y. Critical revision of manuscript: Y.T, Y.I, A.S.

Declarations

Conflict of interest Our institutional review board approved this retrospective study with waived informed consent. All authors have no conflicts of interest or financial ties to disclose.

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