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Original Article

Short-term and long-term outcomes of pancreas preserving total duodenectomy: A case series from a single center with 13 years' experience and complimentary meta-analysis

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Backgrounds/Aims: To determine short-term and long-term outcomes after pancreas preserving total duodenectomy (PPTD).
Methods: A case series and a complementary meta-analysis were conducted. All patients with (pre)neoplastic lesions of duodenum who underwent PPTD in a tertiary center for pancreatic surgery between May 2009 and October 2022 were included for the case series. All studies in the literature with a sample size of 10 or more patients reporting outcomes of PPTD were included for the meta-analysis.
Results: A total of 439 patients (18 from case series and 421 from literature) were analyzed. Clavien-Dindo (CD) I complications in 2.9% (95% confidence interval [CI] 0.6%–5.2%), CD II complications in 21.1% (14.6%–27.6%), CD III complications in 18.1% (9.3%–26.9%), CD IV complications in 2.7% (0.5%–4.9%), and CD V complications in 2.2% (0.2%–4.2%) of patients were found. Probabilities of overall survival and recurrence-free survival at 15 years were 87% and 86%, respectively. There was no significant difference in the risk of mortality (odds ratio [OR]: 0.82, p = 0.830), total complications (OR: 0.77, p = 0.440), postoperative pancreatic fistula (OR: 0.43, p = 0.140), delayed gastric emptying (OR: 0.70, p = 0.450), or postoperative bleeding (OR: 0.97, p = 0.960) between PPTD and pancreaticoduodenectomy.
Conclusions: PPTD is safe and feasible for (pre)neoplastic lesions of duodenum not involving the pancreatic head. The risk of severe complications (CD > III) is low and long-term outcomes are favorable. Whether PPTD provides advantages over more radical techniques in terms of long-term outcomes remains controversial and requires further research.

Key Words: Duodenectomy; Complications; Survival

INTRODUCTION

Management of pancreas in patients with neoplastic or pre-neoplastic lesions affecting the duodenal mucosa without potential to invade regional lymph nodes has always been the subject of debate [1]. Pancreaticoduodenectomy used to be the treatment of choice for lesions that could not be resected endoscopically. However, morbidity associated with pancreaticoduodenectomy has encouraged surgeons to move from a radical approach to conservative organ-preserving techniques [2]. Pancreas preserving total duodenectomy (PPTD) was first described in 1995 by Chung et al. [2] Since then, it has gained popularity.

PPTD involves resection of the entire duodenum with preservation of the pancreatic head. It demands a surgeon with meticulous operative skills and detailed knowledge of peripancreatic anatomy [3]. It involves full Kocherization of the duodenum and the head of the pancreas, release of the duodenojejunal flexure and ligament of Treitz, mobilization of the 4th part of the duodenum, division of jejunum distal to duodenojejunal flexure, division of duodenal branches of the inferior pancre-

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aticoduodenal vascular arcade, division of the first part of the duodenum from the pylorus, division of anterior and posterior branches of superior pancreaticoduodenal vessels, division of pancreatic and biliary ducts ensuring that the ampulla of Vater is included in the resected specimen, and re-implantation of pancreatic ducts into the side of the jejunum with end-to-end pylorojejunostomy.

Pancreaticoduodenectomy is considered the standard operation for malignant neoplasm of duodenum, preneoplastic lesions of duodenum involving the pancreatic head, and preneoplastic lesions of duodenum that cannot be removed by less invasive approaches such as endoscopy resection, enucleation, or pancreas-preserving subtotal or total duodenectomy. PPTD might be an attractive alternative to pancreaticoduodenectomy for treating (pre)neoplastic lesions of duodenum that are confined to the mucosa without involving the pancreatic head. These lesions may include familial duodenal adenomatous polyposis (FAP), duodenal gastrointestinal stromal tumors (GIST), duodenal neuroendocrine tumors (NET), large sporadic benign villous duodenal polyps, mucosa-associated lymphoid tissue lymphoma, Crohn's disease, intestinal amyloidosis, and extensive isolated duodenal injuries [4-6]. When performed by an adequately skilled surgeon for appropriate indication, PPTD might have advantages over more radical alternatives [1-6]. Potential advantages of PPTD include sparing the entire pancreatic parenchyma while achieving complete resection of the duodenum, reducing the number of anastomoses, avoiding pancreatic enteric anastomosis, and restoring the gastrointestinal continuity in a way that allows future surveillance of the neodeuodenum [1-6]. Nevertheless, the short-term and long-term outcomes of PPTD are poorly understood. Thus, this study aimed to report a series of patients who underwent PPTD in our center over 13 years and to conduct a complementary meta-analysis to evaluate short-term and long-term outcomes of PPTD. Moreover, a meta-analysis was conducted to compare outcomes of PPTD with those of pancreaticoduodenectomy.

MATERIALS AND METHODS

A case series and a complementary meta-analysis were conducted following the Preferred Reporting of Case Series in Surgery (PROCESS) guidelines [7] and the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement standards [8], respectively. The case series study had a retrospective design involving non-identifiable data from hospital databases and the meta-analysis used non-identifiable data from electronic databases. Hence, approval by Research Ethics Committees and patient consent were not needed. This study was compliant with the Helsinki medical research ethical principles and policies recommended by the local Clinical Governance Unit.

Study design and patient selection

Case series

Prospectively maintained electronic hospital records were used to identify eligible patients. Consecutive adult patients aged 18 years or more with neoplastic or pre-neoplastic lesions of duodenum who underwent PPTD in a tertiary center for pancreatic surgery located in South Wales between May 2009 and October 2022 were considered eligible for inclusion. Indications of interest for PPTD included duodenal FAP, duodenal GIST, duodenal NET, and duodenal sporadic polyps. Preoperative workup included upper gastrointestinal endoscopy using both front viewing and side viewing scope to assess the relation of the lesion to the ampulla and to determine the Spiegelman stage in case of duodenal polyps. Patients also had endoscopic ultrasound to assess depth of invasion and status of local lymph nodes. Patients who had T1 polyps were deemed appropriate for the procedure. Magnetic resonance cholangiopancreatography was done for all patients to assess pancreatic ductal anatomy and identify pancreatic divisum or substantial accessory pancreatic duct. Metastatic and invasive diseases were excluded preoperatively. All patients were discussed in a multidisciplinary team meeting preoperatively.

Meta-analysis

Electronic databases were searched to identify all retrospective or prospective studies including at least 10 patients undergoing PPTD due to one of the aforementioned indications. A comprehensive search strategy consisting of proper search keywords. Limits, thesaurus headings, and operators were created, adopted, and applied on the following electronic sources: Scopus, MEDLINE, the Cochrane Central Register of Controlled Trials, the Cumulative Index to Nursing and Allied Health Literature, the International Standard Randomized Controlled Trial Number Registry, the International Clinical Trials Registry Platform, ClinicalTrials.gov, and the Grey Literature Network Service (Appendix 1). Two authors with expertise in evidence synthesis designed and applied the search strategy on October 1, 2024 with no language restrictions. Moreover, reference lists of relevant reviews and articles were screened for more potentially eligible studies. Two authors independently screened identified articles through titles and abstracts against the aforementioned eligibility criteria and retrieved full texts of potentially eligible articles. Articles that met the eligibility criteria were selected for inclusion. Methodological quality was evaluated for all included studies using the JBI (Joanna Briggs Institute) Critical Appraisal tool for case-series. The above steps were performed by two independent authors. Disagreements between the first two authors were resolved by involving a separate author (the third author).

Surgical technique

Either rooftop incision or midline incision was used. Full Kocherization of the duodenum and the head of the pancreas

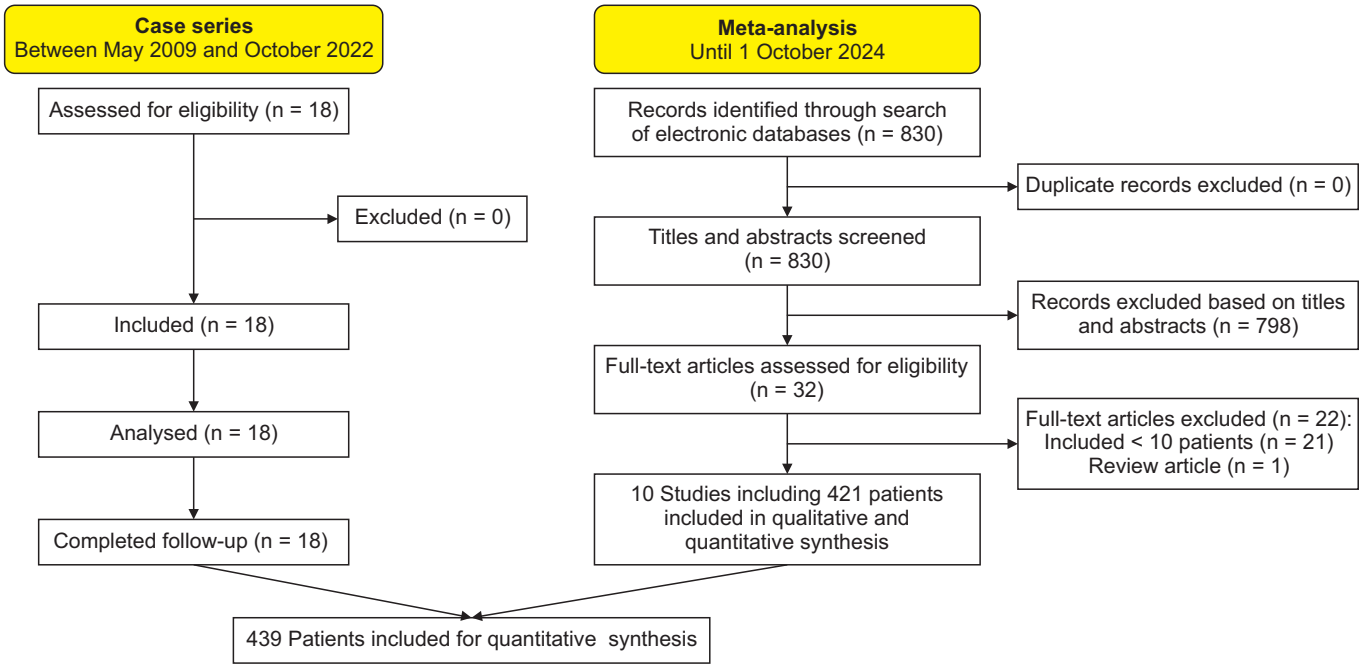

Fig. 1. Flow diagram of this study.

Table 1. Baseline characteristics of included patients

	Value
Age (yr)	49.5 (41–59)
Sex	
Male	5 out of 18 (27.8)
Female	13 out of 18 (72.2)
ASA status	
I	0 out of 18 (0)
II	12 out of 18 (66.7)
III	6 out of 18 (33.3)
IV	0 out of 18 (0)
V	0 out of 18 (0)
Indication for operation	
FAP	10 out of 18 (55.6)
Sporadic polyp	5 out of 18 (27.8)
GIST	2 out of 18 (11.1)
NET	1 out of 18 (5.6)
Need for blood transfusion	0 out of 18 (0)
Operative time (min)	305 (290–345)
R0 resection	18 out of 18 (100)
Length of hospital stay (day)	10 (9–11)

Values are presented as median (interquartile range) or number (%).
ASA, American Society of Anesthesiologists; FAP, familial adenomatous polyposis; GIST, gastrointestinal stromal tumor; NET, neuroendocrine tumor.

was performed followed by release of the duodenojejunal flexure and ligament of Treitz to allow full mobilization of the 4th part of the duodenum. The upper jejunum was divided using a linear stapler at a suitable level to allow subsequent reconstruction. A harmonic scalpel was used to detach the third and fourth parts of the duodenum off the pancreas by dividing duodenal branches of the inferior pancreaticoduodenal vascular arcade. Dissection continued up to the level of the ampulla of Vater. Dissection was then started proximally by dividing the first part of the duodenum from the pylorus using a linear stapler, ensuring that all duodenal mucosa were enclosed with the resected duodenum. Dissection was carried out by dividing anterior and posterior branches of the superior pancreaticoduodenal vessels. At this point, only pancreatic and biliary ducts were attachments left. Both ducts were divided, ensuring that the ampulla of Vater was included in the resected specimen. The transacted jejunum was brought up and reconstruction was carried out. Initially, biliary pancreatic ducts were re-implanted into the side of the jejunum using combined 3/0 and 4/0 polydioxanone (PDS) in interrupted two-layer's anastomosis. End-to-end gastrojejunostomy was then fashioned using interrupted 3/0 PDS in a single layer.

Outcome measures

Primary outcomes were postoperative complications within 30 days of operation. These complications were classified based on Clavien-Dindo classification system. Secondary outcomes included mortality, intraabdominal collection, anastomotic leak, gastric outlet obstruction, need for reoperation, anastomotic stenosis, anastomotic ulcer, need for endoscopic intervention, pancreatitis, recurrence, overall survival, and

recurrence-free survival. For comparison meta-analysis, outcomes included mortality, overall complications, postoperative pancreatic fistula, delayed gastric emptying, and postoperative bleeding.

Data collection

All steps of data collection were performed by two independent authors. An independent third author was consulted in the event of disagreement. We collected information on age, sex, American Society of Anesthesiologists (ASA) status, indication for PPTD, need for intraoperative blood transfusion, operative time, length of hospital stays, R0 resection, and outcomes.

Table 2. Histological detail of resected lesions

	Value
FAP (n = 10)	
Tubulovillous adenoma with low grade dysplasia	7 out of 10
Villous adenoma with high grade dysplasia	1 out of 10
Tubular adenoma with low grade dysplasia	1 out of 10
Adenocarcinoma	1 out of 10
Sporadic polyp (n = 5)	
Tubulovillous adenoma with low grade dysplasia	3 out of 5
Tubulovillous adenoma with high grade dysplasia	2 out of 5
GIST (n = 2)	
High grade	1 out of 2
Low grade	1 out of 2
NET (n = 1)	
Low grade	1 out of 1

FAP, familial adenomatous polyposis; GIST, Gastrointestinal stromal tumor; NET, neuroendocrine tumor.

Data synthesis and statistical analyses

Case series

MedCalc® Statistical Software version 22.002 (MedCalc Software Ltd.) was used for all statistical analyses. Demographics, clinical characteristics, and outcome data were summarized using median and interquartile range (IQR) for continuous variables and frequencies/percentages for categorical variables. Survival outcomes were analyzed using Kaplan–Meier survival analysis model. Follow-up was censored on January 1, 2024. The survival time for each patient was defined as the time between the PPTD and death or the last follow-up. All statistical tests were two-tailed and statistical significance was set at $p < 0.05$.

Meta-analysis

OpenMeta[Analyst] software (ICRHPS, Tufts Medical Center, Boston, MA, USA) was used for proportion meta-analysis model. Quantitative risks of complications were integrated from individual studies to calculate a numerical estimate of the overall effect. Freeman-Tukey double arcsine transformation and DerSimonoan-Laird random-effects method were used to calculate weighted summary proportions under random effects modeling. RevMan 5.4 software was used for comparison meta-analysis in which odds ratio (OR) was calculated as a summary measure. The unit of analysis was an individual patient. Statistical heterogeneity was measured as I^2 using Cochran's Q test (χ^2). Heterogeneity was classified as low when I^2 was 0%–25%, moderate when I^2 was 25%–75%, and high when I^2 was 75%–100%. Results are reported in forest plots with 95% confidence intervals (CIs).

Table 3. Baseline characteristics of included studies in the meta-analysis

Author	Year	Country	Journal	Design	Sample size	Indication of PPTD				JBI risk of bias
						FAP	Sporadic polyp	GIST	NET	
Mackey et al. [9]	2005	USA	J Gastrointest Surg	Retrospective case series	21	21	0	0	0	Low
Al-Sarireh et al. [10]	2008	UK	Br J Surg	Retrospective case series	12	6	3	3	0	Low
de Castro et al. [11]	2008	Netherland	Br J Surg	Retrospective case series	26	26	0	0	0	Low
Müller et al. [12]	2008	Germany	Am J Surg	Retrospective case series	23	13	9	0	1	Low
Penninga and Svendsen [13]	2011	Denmark	J Hepatobiliary Pancreat Sci	Retrospective case series	13	10	2	1	0	Moderate
Rangelova et al. [14]	2015	Sweden	J Gastrointest Surg	Retrospective case series	20	13	5	1	1	Low
Nakayama et al. [18]	2017	Japan	Surg Today	Retrospective case series	21	0	16	4	1	Low
Watanabe et al. [15]	2017	Japan	Fam Cancer	Retrospective case series	10	10	0	0	0	Moderate
Ganschow et al. [16]	2018	Germany	Langenbecks Arch Surg	Retrospective case series	27	27	0	0	0	Low
Aelvoet et al. [17]	2022	Netherland	HPB	Retrospective case series	30	30	0	0	0	Low
Current study	2024	UK	Not applicable	Retrospective case series	18	10	5	2	1	Low

FAP, familial adenomatous polyposis; GIST, Gastrointestinal stromal tumour; NET, neuroendocrine tumour; PPTD, pancreas preserving total duodenectomy; JBI, Joanna Briggs Institute.

Ethical approval and patient consent

The study was compliant with the institutions' policies recommended by local Clinical Governance Unit based on which the need for Research Ethics Committees approval and patient consent were waived due to retrospective nature of the study, use of non-identifiable hospital data, and indirect involvement of patients in the study.

RESULTS

A total of 439 patients were included in this study. A total of 221 patients were included in the proportion meta-analysis (18 patients from the case series and 203 patients from 10 studies [9-18] identified from literature search). For the comparison meta-analysis, we included 301 patients (83 patients who underwent PPTD and 218 patients who underwent pancreaticoduodenectomy). Fig. 1 demonstrates the study flow chart.

Table 4. Complications after pancreas preserving total duodenectomy

	Value
Clavien-Dindo classification	
I	0 out of 18 (0)
II	2 out of 18 (11.1)
III	5 out of 18 (27.8)
IV	1 out of 18 (5.6)
V	0 out of 18 (0)
Mortality	0 out of 18 (0)
Intraabdominal collection	6 out of 18 (33.3)
Anastomotic leak	1 out of 18 (5.6)
Gastric outlet obstruction	1 out of 18 (5.6)
Need for reoperation	1 out of 18 (5.6)
Complications after 30 days	
Anastomotic stenosis	1 out of 18 (5.6)
Anastomotic ulcer	1 out of 18 (5.6)
Need for endoscopic intervention	1 out of 18 (5.6)
Pancreatitis	2 out of 18 (11.1)
Recurrence	2 out of 18 (11.1)

Complications within 30 days.
Values are presented as number (%).

Baseline characteristics of included patients

Table 1 summarizes baseline characteristics of patients included in the case series. The median age was 49.5 years (IQR: 41–59 years). Males accounted for 27.8% (5/18) and females accounted for 72.2% (13/18). In terms of ASA status, 0% (0/18), 66.7% (12/18), 33.3% (6/18), 0% (0/18), and 0% (0/18) were classified as ASA I, ASA II, ASA III, ASA IV, and ASA V, respectively. The indication for PPTD was FAP in 55.6 % (10/18), sporadic polyp in 27.8% (5/18), GIST in 11.1% (2/18), and NET in 5.6% (1/18). No patient (0%, 0/18) required intraoperative blood transfusion. The median operative time was 305 minutes (IQR: 290–345 minutes). The median length of hospital stay was 10 days (IQR: 9–11 days). R0 resection was achieved in all (100%, 18/18) patients. The median length of follow-up was 8 years (IQR: 5–13 years). Histological details of resected lesions are shown in Table 2. Baseline characteristics of studies included in the meta-analysis are shown in Table 3.

Complications

Postoperative complications occurring within and after 30 days of operation are summarized in Table 4. Postoperative complications within 30 days of operation were classed as Clavien-Dindo I in 0% (0/18), Clavien-Dindo II in 11.1% (2/18), Clavien-Dindo III in 27.8% (5/18), Clavien-Dindo IV in 5.6% (1/18), and Clavien-Dindo V in 0% (0/18) of patients. Thirty-day mortality occurred in 0% (0/18) of patients. Intraabdominal collection occurred in 33.3% (6/18) of patients. Among the six patients who developed postoperative collections, five

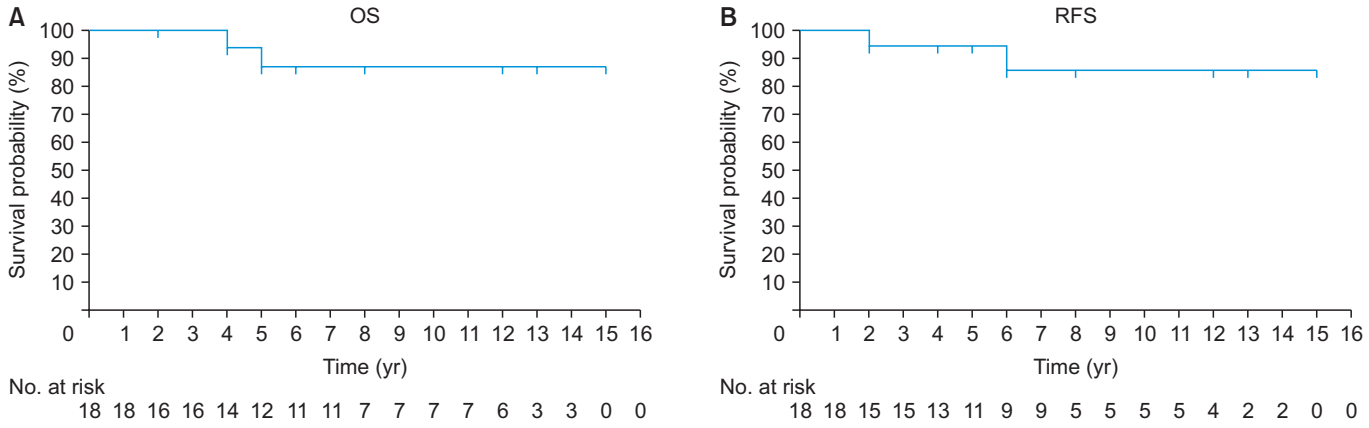

Fig. 2. Kaplan–Meier survival curve for overall survival (OS) (A) and recurrence-free survival (RFS) (B) after pancreas-preserving total duodenectomy. Probability of OS was 87% at 5 years, 87% at 10 years, and 87% at 15 years. Probability of RFS was 94% at 5 years, 86% at 10 years, and 86% at 15 years.

Table 5. Results of Kaplan–Meier survival analyses

	Overall Survival			Recurrence-free Survival		
	5-year	10-year	15-year	5-year	10-year	15-year
All patients	87%	87%	87%	94%	86%	86%
FAP	89%	89%	89%	90%	90%	90%
Sporadic polyps	75%	75%	75%	100%	100%	100%
GIST	100%	100%	100%	100%	50%	50%
NET	100%	100%	100%	100%	100%	100%

FAP, familial adenomatous polyposis; GIST, gastrointestinal stromal tumor; NET, neuroendocrine tumor.

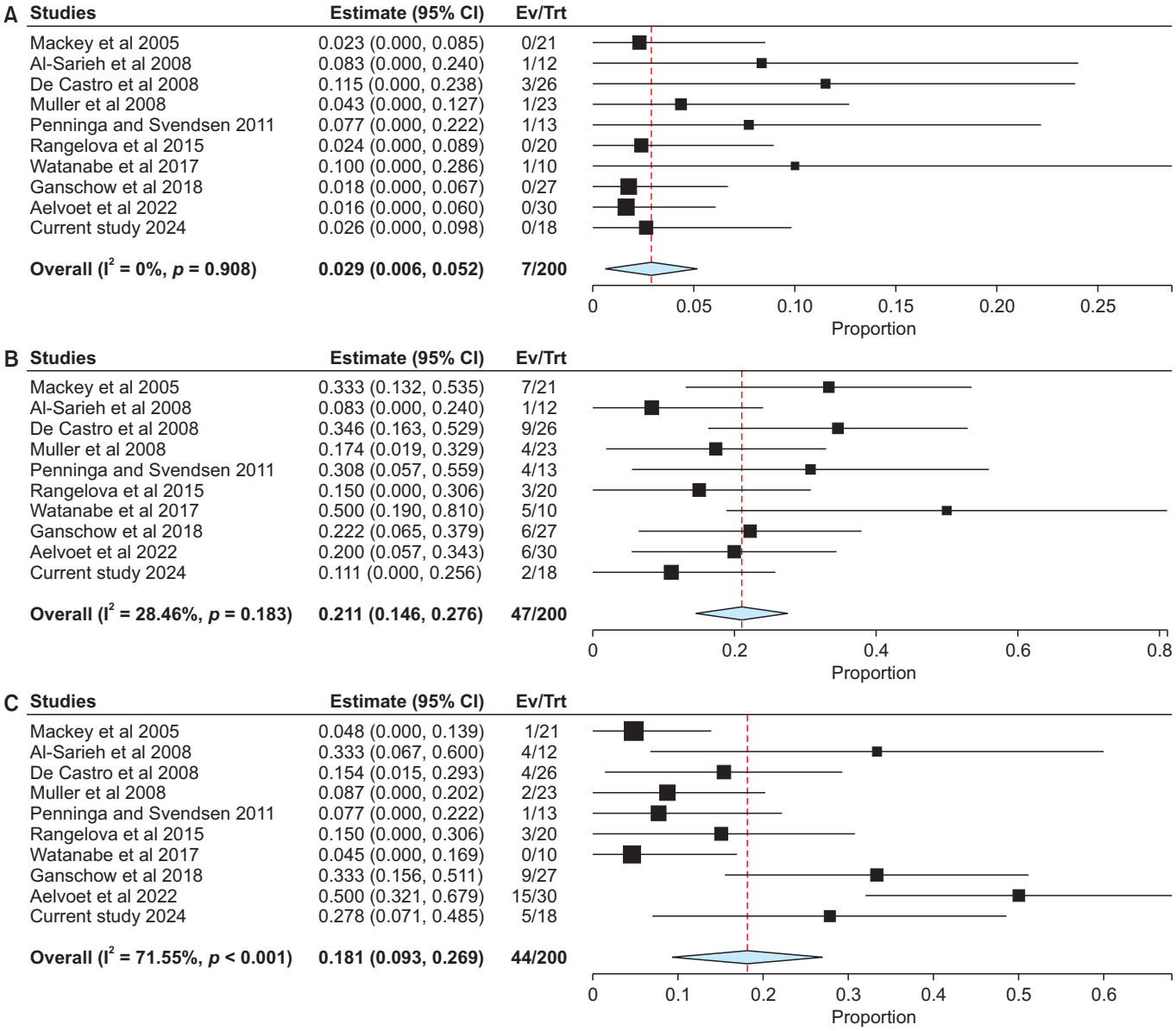

Fig. 3. Forest plots for pooled risks of (A) Clavien-Dindo I complications; (B) Clavien-Dindo II complications; (C) Clavien-Dindo III complications; (D) Clavien-Dindo IV complications; and (E) Clavien-Dindo V complications. Ev/Trt, events/total; CI, confidence interval.

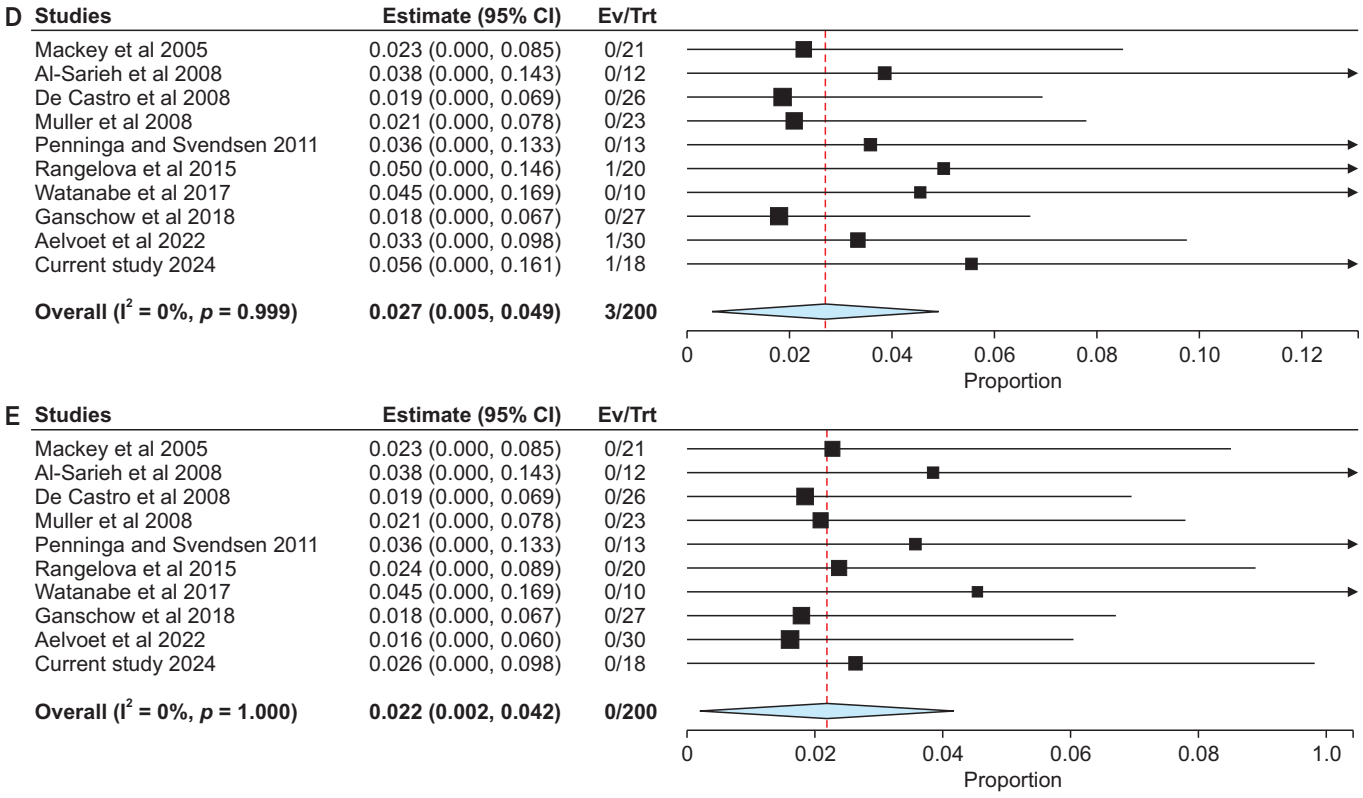

Fig. 3. Continued.

patients were treated with radiologically guided percutaneous drainage and one patient was treated with antibiotics only. Complete resolution of collection was achieved in all six patients. Anastomotic leak occurred in 5.6% (1/18) of patients. It was treated with intravenous antibiotics which resulted in a full recovery. Gastric outlet obstruction occurred in 5.6% (1/18) of patients. This patient needed reoperation and creation of gastrojejunostomy which resulted in a full recovery.

In terms of complications after 30 days, anastomotic stenosis occurred in 5.6% (1/18) of patients. This patient was treated with endoscopic dilatation with no further recurrence during follow-up. Anastomotic ulcer occurred in 5.6% (1/18) of patients. It was treated medically, resulting in complete resolution of symptoms. Pancreatitis occurred in 11.1% (2/18) patients. It was resolved with conservative management without any complications of pancreatitis. Two (11.1%) patients developed disease recurrence. One patient with high-risk GIST as original pathology who developed liver metastasis six years later after the PPTD was treated with right hemi-hepatectomy. One patient with original pathology of duodenal adenocarcinoma who developed recurrence at neodeuodenum two years after PPTD was treated with completion pancreaticoduodenectomy.

Survival outcomes

Kaplan–Meier survival analyses suggested that the probability of overall survival was 87% at 5 years, 87% at 10 years, and 87% at 15 years (Fig. 2). The probability of recurrence-free survival was 94% at 5 years, 86% at 10 years, and 86% at 15 years (Fig. 2). Survival outcomes based on different indications for PPTD are summarized in Table 5.

Complementary proportion meta-analysis

Analysis of 200 patients suggested that risks of Clavien-Dindo I complications, Clavien-Dindo II complications, Clavien-Dindo III complications, Clavien-Dindo IV complications, and Clavien-Dindo V complications were 2.9% (95% CI: 0.6%–5.2%, $I^2 = 0\%$), 21.1% (95% CI: 14.6%–27.6%, $I^2 = 28\%$), 18.1% (95% CI: 9.3%–26.9%, $I^2 = 72\%$), 2.7% (95% CI: 0.5%–4.9%, $I^2 = 0\%$), and 2.2% (95% CI: 0.2%–4.2%, $I^2 = 0\%$), respectively (Fig. 3).

Pancreas preserving total duodenectomy versus pancreaticoduodenectomy

Analysis of 301 patients from four studies showed no significant difference in the risk of mortality (OR: 0.82, 95% CI: 0.12–5.34, $p = 0.830$, $I^2 = 0\%$), total complications (OR: 0.77, 95% CI: 0.40–1.50, $p = 0.440$, $I^2 = 29\%$), postoperative pancreatic fistula (OR: 0.43, 95% CI: 0.14–1.33, $p = 0.140$, $I^2 = 62\%$), delayed gastric emptying (OR: 0.70, 95% CI: 0.28–1.76, $p = 0.450$, $I^2 = 0\%$), or postoperative bleeding (OR: 0.97, 95% CI: 0.32–2.95, $p = 0.960$, $I^2 = 0\%$) between PPTD and pancreaticoduodenectomy

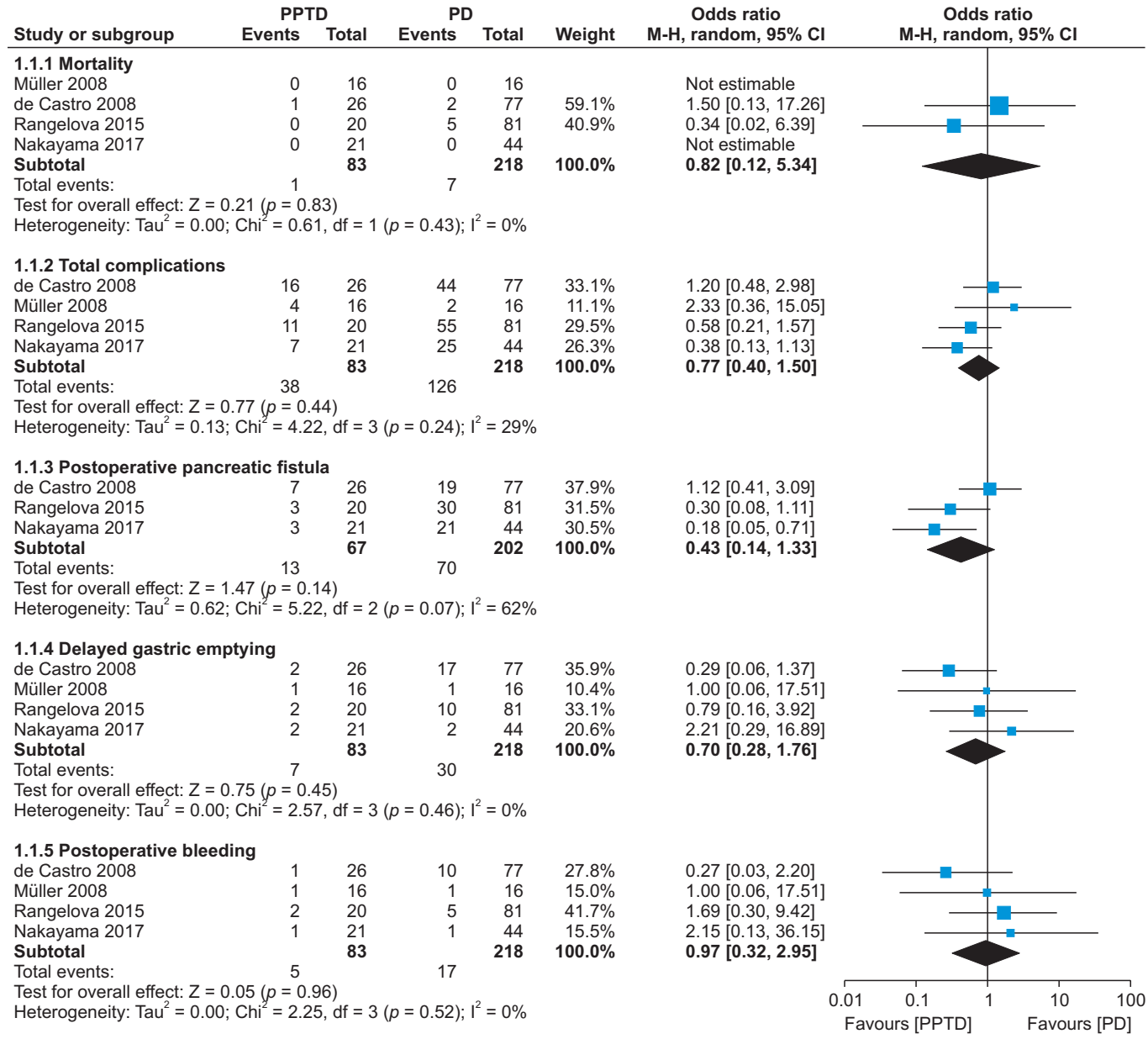

Fig. 4. Forest plot for comparison of outcomes between pancreas preserving total duodenectomy (PPTD) and pancreaticoduodenectomy (PD). M-H, Mantel–Haenszel; CI, confidence interval.

(Fig. 4). Included studies did not provide adequate data about long-term outcomes of either technique.

DISCUSSION

We conducted a case series with complementary meta-analysis to evaluate short-term and long-term outcomes of PPTD. Analysis of 439 patients suggested that PPTD was a safe alternative to more aggressive procedures for (pre)neoplastic lesions of duodenum not involving the pancreatic head. The risk of severe complications was low in the case series (5.6% Clavien-Dindo IV and 0% Clavien-Dindo V) and the meta-analysis (2.7% Clavien-Dindo IV and 2.2% Clavien-Dindo V) with long-term outcomes being favorable (87% 15-year overall survival and 86% 15-year recurrence-free survival). Moreover, comparison meta-analysis showed no significant differences in risks of short-term complications between PPTD and pancreaticoduodenectomy.

Results of the current study are consistent with findings of previous studies. Cantalejo-Díaz et al. [1] have conducted a

high-quality systematic review of case reports and case series without formal statistical analysis and concluded that PPTD is associated with low risks of morbidity and mortality. Cantalejo-Díaz et al. [1] have reported a postoperative morbidity rate of 49.7%, of which 76% are classed as Clavien-Dindo < III with a mortality rate of 1.4%. These findings of the study by Cantalejo-Díaz et al. [1] could serve as external validity of our findings.

As mentioned previously, potential advantages of PPTD include sparing the entire pancreatic parenchyma while achieving complete resection of the duodenum, thus eliminating chances of local recurrence. This is of particular importance in patients with FAP. Moreover, PPTD can reduce the number of anastomoses and avoid pancreatic enteric anastomosis in a non-dilated pancreatic duct with soft pancreas. In addition, PPTD allows restoring gastrointestinal continuity which allows future endoscopic surveillance of patients who are at risk of developing polyps in the neodeuodenum, particularly in patients with FAP. However, results of the comparison meta-analysis showed no significant differences in short-term complications between PPTD and pancreaticoduodenectomy. Whether PPTD provides advantages over more radical techniques in terms of long-term outcomes remains a subject of debate and requires further research.

Despite the above advantages, PPTD can be technically challenging. It requires meticulous operative skills and detailed knowledge of peripancreatic anatomy. Although PPTD is indicated for premalignant lesions, it is not an appropriate treatment for malignant lesions with potential to invade regional lymph nodes. There is a risk that postoperative histology shows incidental carcinoma despite extensive preoperative investigations. Thus, patients should be made aware of this potential risk during the consent process.

The current study has some limitations. Sample sizes of the case series and included studies in the meta-analysis were small which might subject findings to a potential type 2 error. The retrospective nature of this study and included studies in the meta-analysis might subject findings to an inevitable selection bias. All included patients in the series were operated by a single surgeon in a single center. Although this would reduce the confounding effect of operative skills on outcomes, it might affect the generalizability of findings.

In conclusion, PPTD is safe and feasible for (pre)neoplastic lesions of duodenum not involving the pancreatic head. The risk of severe complications (CD > III) is low and long-term outcomes are favorable. Whether PPTD provides advantages over more radical techniques in terms of long-term outcomes remains controversial and requires further research.

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CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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AUTHOR CONTRIBUTIONS

Conceptualization: BAS. Data curation: MH, SH. Analysis and interpretation: MH, SH, BAS. Writing - original draft: MH, SH, BAS. Writing - review & editing: MH, SH, BAS. Final approval of the article: MH, SH, BAS.

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Appendix 1

Appendix 1. Literature search strategy

Search number	Search description	Action
Number 1	Duodenectomy	Titles, abstracts, keywords
Number 2	Total near 2 duodenectomy	Titles, abstracts, keywords
Number 3	Pancreas preserving near 2 duodenectomy	Titles, abstracts, keywords
Number 4	Number 1 OR Number 2 OR Number 3	Combined with OR