

Appendix 1

The AMSTAR2 is a methodological quality appraisal tool with 16 items. Among these, Items 2, 4, 7, 9, 11, 13, and 15 formed critical domains. These seven critical items were as follows:

- ❖ Q2: Did the protocol be established prior to conducting the review?
- ❖ Q4: Did a comprehensive literature search strategy be applied?
- ❖ Q7: Did the excluded studies justify?
- ❖ Q9: Did the risk of bias in individual studies be fully assessed?
- ❖ Q11: Did MAs authors use the appropriate statistical methods?
- ❖ Q13: Did the risk of bias be adequately considered when discussing the results of the review?
- ❖ Q15: Did publication bias and its impact have been fully assessed?

Table S1 Search terms utilized in the umbrella review (search date up to 19 June, 2023)

Terms 1	Terms 2	Database	Restrictions	Results
“postoperative pancreatic fistula” OR “post-operative pancreatic fistula” OR “pancreatic fistula” OR “pancreatic leak”	“meta analysis” OR “meta-analysis” OR “meta”	PubMed	All field	475
“postoperative pancreatic fistula” OR “post-operative pancreatic fistula” OR “pancreatic fistula” OR “pancreatic leak”	“meta analysis” OR “meta-analysis” OR “meta”	Web of Science	Topic	530
“postoperative pancreatic fistula” OR “post-operative pancreatic fistula” OR “pancreatic fistula” OR “pancreatic leak”	“meta analysis” OR “meta-analysis” OR “meta”	Embase	ti, ab, kw	520
“postoperative pancreatic fistula” OR “post-operative pancreatic fistula” OR “pancreatic fistula” OR “pancreatic leak”	“meta analysis” OR “meta-analysis” OR “meta”	Cochrane Databases of Systematic Reviews	Cochrane reviews, trails	338

Table S2 GRADE and AMSTAR2 result of 84 evidence

First author, year	Summary of findings				Certainty assessment (degradation factor)					Certainty assessment (escalation factors)			Importance	GRADE	AMSTAR2
	Diseases and treatment	Study design [Number]	Outcome	Relative effect (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Large effect	Plausible confounding	Dose response gradient			
Chierici, 2022 (13)	PD: PDO vs. pancreatic anastomosis	Non-RCT [12]	All-grade POPF (RR <1 favors PDO)	RR, 2.38 (1.46, 3.87)	Not serious	Serious ^b	Not serious	Not serious	Undetected	Yes	Yes	No	7-Critical	⊕⊕⊕○ (moderate)	Low
Chierici, 2022 (13)	PD: duct suture vs. pancreatic anastomosis	Non-RCT [5]	All-grade POPF (RR <1 favors duct suture)	RR, 2.09 (0.59, 7.38)	Not serious	Serious ^b	Not serious	Not serious	Undetected	No	Yes	No	6-Important	⊕⊕○○ (low)	Low
Chierici, 2022 (13)	PD: sealant vs. pancreatic anastomosis	Non-RCT [7]	All-grade POPF (RR <1 favors sealant)	RR, 2.40 (1.33, 4.30)	Not serious	Serious ^b	Not serious	Not serious	Undetected	Yes	Yes	No	7-Critical	⊕⊕⊕○ (moderate)	Low
Chierici, 2022 (13)	PD: sealant vs. pancreatic anastomosis	Non-RCT [3]	“Grade C” POPF (RR <1 favors sealant)	RR, 0.36 (0.10, 1.29)	Not serious	Not serious	Not serious	Not serious	Undetected	No	Yes	No	7-Critical	⊕⊕⊕○ (moderate)	Low
Andreasi, 2020 (14)	PD: with vs. without omental/falciform ligament wrapping	Non-RCT [6]	All-grade POPF (RR <1 favors warping)	RR, 0.70 (0.44, 1.13)	Serious ^a	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Andreasi, 2020 (14)	PD (pancreatic anastomosis: PJ): with vs. without omental/falciform ligament wrapping	Non-RCT [3]	All-grade POPF (RR <1 favors warping)	RR, 0.42 (0.17, 1.02)	Serious ^a	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Andreasi, 2020 (14)	PD: with vs. without omental/falciform ligament wrapping	Non-RCT [4]	“Grade B, C” POPF (RR <1 favors warping)	RR, 0.42 (0.09, 2.05)	Serious ^a	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	7-Critical	⊕○○○ (very low)	Critically low
Andreasi, 2020 (14)	PD (pancreatic anastomosis: PJ): with vs. without omental/falciform ligament wrapping	Non-RCT [2]	“Grade B, C” POPF (RR <1 favors warping)	RR, 0.14 (0.04, 0.49)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	Yes	No	No	8-Critical	⊕⊕○○ (low)	Critically low
Mobarak, 2021 (15)	PD: Roux-en-Y vs. single loop reconstruction	RCT [3]	All-grade POPF (OR <1 favors Roux-en-Y)	OR, 0.82 (0.55, 1.22)	Not serious	Not serious	Not serious	Not serious	Undetected	No	Yes	No	6-Important	⊕⊕⊕⊕ (high)	Low
Mobarak, 2021 (15)	PD: Roux-en-Y vs. single loop reconstruction	Non-RCT [10]	All-grade POPF (OR <1 favors Roux-en-Y)	OR, 1.05 (0.75, 1.46)	Not serious	Serious ^b	Not serious	Not serious	Undetected	No	Yes	No	6-Important	⊕⊕○○ (low)	Low
Mobarak, 2021 (15)	PD: Roux-en-Y vs. single loop reconstruction	RCT + non-RCT [13]	All-grade POPF (OR <1 favors Roux-en-Y)	OR, 0.94 (0.73, 1.22)	Not serious	Not serious	Not serious	Not serious	Undetected	No	Yes	No	6-Important	⊕⊕⊕○ (moderate)	Low
Jin, 2019 (16)	PD: PJ vs. PG	RCT [11]	All-grade POPF (OR <1 favors PG)	OR, 0.67 (0.53, 0.86)	Not serious	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	7-Critical	⊕⊕⊕○ (moderate)	Low
Jin, 2019 (16)	PD: PJ vs. PG	RCT [7]	“Grade B, C” POPF (OR <1 favors PG)	OR, 0.61 (0.34, 1.09)	Not serious	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	7-Critical	⊕⊕○○ (low)	Low
Hajibandeh, 2017 (29)	PD: SA vs. HA	RCT + non-RCT [5]	All-grade POPF (OR <1 favors SA)	OR, 0.83 (0.56, 1.21)	Not serious	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Low
Hai, 2022 (30)	PD: duct-to-mucosa PJ vs. invagination PJ	RCT [7]	“Grade B, C” POPF (RR <1 favors Duct-to-mucosa PJ)	RR, 1.45 (0.64, 3.26)	Not serious	Serious ^b	Not serious	Not serious	Strongly suspected	No	Yes	No	7-Critical	⊕⊕⊕○ (moderate)	High
Hai, 2022 (30)	PD: duct-to-mucosa PJ vs. invagination PJ	RCT [7]	“Grade B” POPF (RR <1 favors Duct-to-mucosa PJ)	RR, 1.41 (0.63, 3.15)	Not serious	Serious ^b	Not serious	Not serious	Strongly suspected	No	Yes	No	7-Critical	⊕⊕⊕○ (moderate)	High
Hai, 2022 (30)	PD: duct-to-mucosa PJ vs. invagination PJ	RCT [7]	“Grade C” POPF (RR <1 favors Duct-to-mucosa PJ)	RR, 1.45 (0.58, 3.61)	Not serious	Not serious	Not serious	Not serious	Strongly suspected	No	Yes	No	7-Critical	⊕⊕⊕⊕ (high)	High
Hai, 2022 (30)	PD: duct-to-mucosa PJ vs. invagination PJ	RCT [10]	All-grade POPF (RR <1 favors Duct-to-mucosa PJ)	RR, 1.13 (0.60, 2.15)	Not serious	Serious ^b	Not serious	Not serious	Strongly suspected	No	Yes	No	6-Important	⊕⊕⊕○ (moderate)	High
Cao, 2020 (1)	PD: PJ-modified Blumgart anastomosis vs. PJ-interrupted transpancreatic suture	RCT + non-RCT [6]	“Grade B, C” POPF (OR <1 favors modified Blumgart anastomosis)	OR, 0.32 (0.12, 0.84)	Serious ^a	Serious ^b	Not serious	Not serious	Strongly suspected	Yes	No	No	8-Critical	⊕○○○ (very low)	Critically low
Cao, 2020 (1)	PD: PJ-modified Blumgart anastomosis vs. PJ-interrupted transpancreatic suture	RCT + non-RCT [4]	All-grade POPF (OR <1 favors modified Blumgart anastomosis)	OR, 0.70 (0.34, 1.44)	Serious ^a	Serious ^b	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Wang, 2020 (31)	PD: restrictive vs. liberal intraoperative fluid management	Non-RCT [11]	All-grade POPF (OR <1 favors restrictive intraoperative fluid management)	OR, 1.03 (0.82, 1.28)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Adiamah, 2019 (21)	PD/PPPD: EN vs. PN	RCT [4]	All-grade POPF (RR <1 favors EN)	RR, 1.07 (0.42, 2.76)	Not serious	Serious ^b	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕⊕⊕○ (moderate)	Low
Peng, 2019 (32)	PD: PDVR vs. PD	Non-RCT [12]	All-grade POPF (OR <1 favors PDVR)	OR, 0.79 (0.60, 1.04)	Serious ^a	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Kotb, 2021 (17)	PD: extended vs. standard lymphadenectomy	RCT [4]	All-grade POPF (OR <1 favors standard lymphadenectomy)	OR, 0.64 (0.38, 1.09)	Not serious	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕⊕⊕○ (moderate)	Low

Table S2 (continued)

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First author, year	Summary of findings				Certainty assessment (degradation factor)					Certainty assessment (escalation factors)			Importance	GRADE	AMSTAR2
	Diseases and treatment	Study design [Number]	Outcome	Relative effect (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Large effect	Plausible confounding	Dose response gradient			
Ironside, 2018 (18)	PD: artery-first vs. standard PD	Non-RCT [11]	All-grade POPF (RR <1 favors artery-first PD)	RR, 0.82 (0.58, 1.17)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕⊕○○ (low)	Critically low
Ironside, 2018 (18)	PD: artery-first vs. standard PD	Non-RCT [7]	“Grade B, C” POPF (RR <1 favors artery-first PD)	RR, 0.59 (0.37, 0.95)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	No	No	8-Critical	⊕⊕○○ (low)	Critically low
Crippa, 2016 (19)	PD-PBD: metal stents vs. plastic stents	Non-RCT [4]	All-grade POPF (OR <1 favors metal stents)	OR, 0.44 (0.20, 0.96)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	Yes	No	No	7-Critical	⊕○○○ (very low)	Critically low
Guo, 2022 (26)	PD: with vs. without pancreatic duct stent	RCT [7]	All-grade POPF (RR <1 favors with pancreatic duct stent)	RR, 0.85 (0.57, 1.26)	Not serious	Serious ^b	Not serious	Not serious	Undetected	No	Yes	No	6-Important	⊕⊕⊕⊕ (high)	Low
Guo, 2022 (26)	PD: with vs. without internal pancreatic duct stent	RCT [3]	All-grade POPF (RR <1 favors with pancreatic duct stent)	RR, 1.25 (0.87, 1.80)	Not serious	Not serious	Not serious	Not serious	Undetected	No	Yes	No	6-Important	⊕⊕⊕⊕ (high)	Low
Guo, 2022 (26)	PD: with vs. without external pancreatic duct stent	RCT [4]	All-grade POPF (RR <1 favors with pancreatic duct stent)	RR, 0.61 (0.43, 0.86)	Not serious	Not serious	Not serious	Not serious	Undetected	No	Yes	No	7-Critical	⊕⊕⊕⊕ (high)	Low
Li, 2023 (33)	PD: EDR vs. LDR	RCT [4]	All-grade POPF (RR <1 favors EDR)	RR, 0.41 (0.12, 1.34)	Not serious	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕⊕○○ (low)	Moderate
Li, 2023 (33)	PD: EDR vs. LDR	Non-RCT [9]	All-grade POPF (RR <1 favors EDR)	RR, 0.26 (0.15, 0.45)	Not serious	Serious ^b	Not serious	Not serious	Strongly suspected	Yes	No	No	7-Critical	⊕○○○ (very low)	Moderate
Gachabayov, 2019 (34)	PD: PDG vs. CSD	RCT + non-RCT [6]	All-grade POPF (OR <1 favors PDG)	OR, 0.81 (0.42, 1.56)	Not serious	Serious ^b	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕○○○ (very low)	Low
Gachabayov, 2019 (34)	PD: PDG vs. CSD	RCT + non-RCT [5]	“Grade B, C” POPF (OR <1 favors PDG)	OR, 1.24 (0.84, 1.84)	Not serious	Not serious	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕⊕○○ (low)	Low
Gachabayov, 2019 (34)	PD: PDG vs. CSD	RCT + non-RCT [5]	“Grade A” POPF (OR <1 favors PDG)	OR, 0.71 (0.33, 1.53)	Not serious	Serious ^b	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕○○○ (very low)	Low
Gachabayov, 2019 (34)	PD: PDG vs. CSD	RCT + non-RCT [4]	“Grade B” POPF (OR <1 favors PDG)	OR, 1.23 (0.74, 2.05)	Not serious	Not serious	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕⊕○○ (low)	Low
Gachabayov, 2019 (34)	PD: PDG vs. CSD	RCT + non-RCT [4]	“Grade C” POPF (OR <1 favors PDG)	OR, 1.08 (0.56, 2.09)	Not serious	Not serious	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕⊕○○ (low)	Low
Lyu, 2020 (20)	PD: peritoneal drainage vs. no drainage	RCT + non-RCT [4]	All-grade POPF (OR <1 favors no drainage)	OR, 0.42 (0.29, 0.62)	Serious ^a	Not serious	Not serious	Not serious	Undetected	Yes	No	No	7-Critical	⊕⊕○○ (low)	Critically low
Lyu, 2020 (20)	PD: peritoneal drainage vs. no drainage	RCT + non-RCT [6]	“Grade B, C” POPF (OR <1 favors no drainage)	OR, 0.66 (0.33, 1.34)	Serious ^a	Serious ^b	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Ouyang, 2022 (35)	PD: RPD vs. LPD	Non-RCT [8]	All-grade POPF (OR <1 favors RPD)	OR, 0.99 (0.79, 1.24)	Not serious	Not serious	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕⊕○○ (low)	Low
Zhang, 2021 (36)	PD: RPD vs. OPD	Non-RCT [15]	All-grade POPF (RR <1 favors RPD)	RR, 1.00 (0.85, 1.19)	Not serious	Not serious	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕⊕○○ (low)	Low
Zhang, 2021 (36)	PD: RPD vs. OPD	Non-RCT [9]	“Grade B, C” POPF (RR <1 favors RPD)	RR, 0.54 (0.41, 0.70)	Not serious	Not serious	Not serious	Not serious	Undetected	No	No	No	8-Critical	⊕⊕○○ (low)	Low
Yan, 2023 (37)	PD: LPD vs. OPD	RCT [4]	All-grade POPF (OR <1 favors LPD)	OR, 0.82 (0.54, 1.24)	Not serious	Not serious	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕⊕⊕⊕ (high)	Low
Yan, 2023 (37)	PD: LPD vs. OPD	Non-RCT [31]	All-grade POPF (OR <1 favors LPD)	OR, 0.94 (0.82, 1.09)	Not serious	Not serious	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕⊕○○ (low)	Low
Yan, 2023 (37)	PD: LPD vs. OPD	RCT + non-RCT [35]	All-grade POPF (OR <1 favors LPD)	OR, 0.93 (0.81, 1.06)	Not serious	Not serious	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕⊕○○ (low)	Low
Halle-Smith, 2022 (12)	PD: external vs. internal pancreatic stent	RCT [3]	All-grade POPF (OR <1 favors external pancreatic stent)	OR, 1.09 (0.75, 1.59)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕⊕○○ (low)	Critically low

Table S2 (continued)

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First author, year	Summary of findings				Certainty assessment (degradation factor)					Certainty assessment (escalation factors)			Importance	GRADE	AMSTAR2
	Diseases and treatment	Study design [Number]	Outcome	Relative effect (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Large effect	Plausible confounding	Dose response gradient			
Halle-Smith, 2022 (12)	PD: external vs. internal pancreatic stent	RCT [3]	“Grade B, C” POPF (OR <1 favors external pancreatic stent)	OR, 1.36 (0.83, 2.23)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	7-Critical	⊕⊕○○ (low)	Critically low
Halle-Smith, 2022 (12)	PD: Braun vs. conventional anastomosis	RCT [2]	All-grade POPF (OR <1 favors Braun anastomosis)	OR, 0.51 (0.16, 1.65)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕⊕○○ (low)	Critically low
Kielbowski, 2021 (8)	PD: PBD vs. no PBD	Non-RCT [9]	All-grade POPF (OR <1 favors PBD)	OR, 0.97 (0.57, 1.64)	Serious ^a	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Kielbowski, 2021 (8)	PD: operation time	Non-RCT [8]	All-grade POPF (MD <0 favors shorter operation time)	MD, 5.87 (−15.31, 27.05)	Serious ^a	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Kielbowski, 2021 (8)	PD: transfusions vs. no transfusions	Non-RCT [5]	All-grade POPF (OR <1 favors no transfusions)	OR, 0.94 (0.72, 1.21)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Lei, 2016 (54)	PD: ultrasonic dissection vs. conventional dissection	RCT + non-RCT [3]	All-grade POPF (RR <1 favors Ultrasonic Dissection)	RR, 0.79 (0.48, 1.29)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Zhang, 2020 (55)	PD: with vs. without polyglycolic acid mesh	Non-RCT [4]	All-grade POPF (RR <1 favors polyglycolic acid mesh)	RR, 0.76 (0.62, 0.92)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	Yes	No	7-Critical	⊕⊕○○ (low)	Critically low
Zhang, 2020 (55)	PD: with vs. without polyglycolic acid mesh	RCT + non-RCT [5]	“Grade B, C” POPF (RR <1 favors polyglycolic acid mesh)	RR, 0.50 (0.37, 0.68)	Serious ^a	Not serious	Not serious	Not serious	Undetected	Yes	Yes	No	8-Critical	⊕⊕⊕○ (moderate)	Critically low
Oweira, 2022 (2)	DP: reinforced stapler vs. standard stapler	RCT + non-RCT [6]	“Grade B, C” POPF (OR <1 favors reinforced stapler)	OR, 0.33 (0.19, 0.57)	Not serious	Not serious	Not serious	Not serious	Strongly suspected	Yes	No	No	8-Critical	⊕⊕○○ (low)	Moderate
Mungroop, 2021 (22)	DP: with vs. without fibrin sealant patch	RCT [4]	“Grade B, C” POPF (OR <1 favors fibrin sealant patch)	OR, 0.89 (0.60, 1.32)	Not serious	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	7-Critical	⊕⊕⊕○ (moderate)	Low
Zhang, 2020 (55)	DP: with vs. without polyglycolic acid mesh	RCT + non-RCT [7]	All-grade POPF (RR <1 favors polyglycolic acid mesh)	RR, 0.74 (0.57, 0.96)	Serious ^a	Serious ^b	Not serious	Not serious	Undetected	No	Yes	No	7-Critical	⊕○○○ (very low)	Critically low
Zhang, 2020 (55)	DP: with vs. without polyglycolic acid mesh	RCT + non-RCT [6]	“Grade B, C” POPF (RR <1 favors polyglycolic acid mesh)	RR, 0.31 (0.21, 0.46)	Serious ^a	Not serious	Not serious	Not serious	Undetected	Yes	Yes	No	8-Critical	⊕⊕⊕○ (moderate)	Critically low
Wu, 2013 (38)	DP: with vs. without PTPS	RCT + non-RCT [4]	All-grade POPF (OR <1 favors PTPS)	OR, 0.45 (0.22, 0.94)	Serious ^a	Serious ^b	Not serious	Not serious	Strongly suspected	Yes	Yes	No	7-Critical	⊕○○○ (very low)	Critically low
van Bodegraven, 2022 (39)	DP: with vs. without abdominal drainage	RCT + non-RCT [5]	“Grade B, C” POPF (RR <1 favors without abdominal drainage)	RR, 0.55 (0.42, 0.72)	Not serious	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	8-Critical	⊕○○○ (very low)	Moderate
Xinyang, 2023 (40)	DP: passive drainage vs. active suction drainage	RCT + non-RCT [4]	“Grade B, C” POPF (OR <1 favors passive drainage)	OR, 3.35 (1.12, 10.07)	Serious ^a	Serious ^b	Not serious	Serious ^c	Strongly suspected	Yes	No	No	8-Critical	⊕○○○ (very low)	Critically low
Chen, 2023 (41)	DP: EDR vs. LDR	RCT + non-RCT [5]	“Grade B, C” POPF (RR <1 favors EDR)	RR, 0.17 (0.13, 0.24)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	Yes	No	No	8-Critical	⊕⊕○○ (low)	Critically low
Li, 2023 (42)	DP: RDP vs. LDP	Non-RCT [30]	“Grade B, C” POPF (OR <1 favors RDP)	OR, 0.91 (0.77, 1.08)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕○○○ (very low)	Critically low
Lyu, 2022 (43)	DP: LDP vs. ODP	Non-RCT [27]	All-grade POPF (OR <1 favors LDP)	OR, 0.99 (0.85, 1.14)	Serious ^a	Serious ^b	Not serious	Not serious	Undetected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Lyu, 2022 (43)	DP: LDP vs. ODP	Non-RCT [24]	“Grade B, C” POPF (OR <1 favors LDP)	OR, 0.86 (0.71, 1.05)	Serious ^a	Serious ^b	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕○○○ (very low)	Critically low
Zhou, 2020 (44)	DP: RDP vs. ODP	Non-RCT [7]	All-grade POPF (OR <1 favors RDP)	OR, 1.19 (0.90, 1.57)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Zhou, 2020 (44)	DP: RDP vs. ODP	Non-RCT [5]	“Grade B, C” POPF (OR <1 favors RDP)	OR, 0.74 (0.44, 1.23)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	7-Critical	⊕○○○ (very low)	Critically low
Hang, 2022 (46)	DP: SVP-DP vs. WT-DP	Non-RCT [19]	All-grade POPF (OR <1 favors SVP-DP)	OR, 0.85 (0.65, 1.11)	Not serious	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Moderate
Hang, 2022 (46)	PD: SVP-DP vs. WT-DP	Non-RCT [14]	“Grade B, C” POPF (OR <1 favors SVP-DP)	OR, 0.84 (0.61, 1.15)	Not serious	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	7-Critical	⊕○○○ (very low)	Moderate

Table S2 (continued)

Table S2 (continued)

First author, year	Summary of findings				Certainty assessment (degradation factor)					Certainty assessment (escalation factors)			Importance	GRADE	AMSTAR2
	Diseases and treatment	Study design [Number]	Outcome	Relative effect (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Large effect	Plausible confounding	Dose response gradient			
Lei, 2016 (54)	DP: ultrasonic dissection vs. conventional dissection	RCT + non-RCT [3]	All-grade POPF (RR <1 favors ultrasonic dissection)	RR, 0.46 (0.27, 0.76)	Serious ^a	Not serious	Not serious	Not serious	Undetected	Yes	No	No	7-Critical	⊕⊕○○ (low)	Critically low
Nakata, 2018 (48)	DP: MI-SPDP vs. MI-DPS	Non-RCT [11]	“Grade B, C” POPF (OR <1 favors MI-SPDP)	OR, 0.43 (0.25, 0.74)	Not serious	Not serious	Not serious	Not serious	Strongly suspected	Yes	No	No	7-Critical	⊕⊕○○ (low)	Low
Tang, 2022 (45)	RAMPS: I-RAMPS vs. o-RAMPS	Non-RCT [2]	“Grade A” POPF (OR <1 favors I-RAMPS)	OR, 1.39 (0.44, 4.36)	Not serious	Not serious	Not serious	Serious ^c	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Low
Tang, 2022 (45)	RAMPS: I-RAMPS vs. o-RAMPS	Non-RCT [4]	“Grade B, C” POPF (OR <1 favors I-RAMPS)	OR, 1.30 (0.57, 2.96)	Not serious	Not serious	Not serious	Serious ^c	Strongly suspected	No	No	No	7-Critical	⊕○○○ (very low)	Low
Zhou, 2019 (47)	RAMPS vs. DP	Non-RCT [5]	All-grade POPF (RR <1 favors RAMPS)	RR, 0.59 (0.29, 1.21)	Serious ^a	Not serious	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Critically low
Xiao, 2018 (49)	CP vs. PD	Non-RCT [18]	All-grade POPF (OR <1 favors CP)	OR, 1.90 (1.46, 2.48)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕○○○ (very low)	Critically low
Bi, 2023 (50)	CP vs. DP	Non-RCT [26]	All-grade POPF (OR <1 favors CP)	OR, 2.25 (1.81, 2.81)	Not serious	Serious ^b	Not serious	Not serious	Strongly suspected	Yes	Yes	No	7-Critical	⊕⊕○○ (low)	Low
Bi, 2023 (50)	CP vs. DP	Non-RCT [20]	“Grade B, C” POPF (OR <1 favors CP)	OR, 2.73 (2.09, 3.58)	Not serious	Serious ^b	Not serious	Not serious	Strongly suspected	Yes	Yes	No	8-Critical	⊕⊕○○ (low)	Low
Shen, 2021 (51)	Enucleation vs. standard surgical resection	Non-RCT [18]	All-grade POPF (RR <1 favors enucleation)	RR, 1.46 (1.22, 1.75)	Not serious	Serious ^b	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕○○○ (very low)	Low
Roesel, 2023 (52)	Open vs. laparoscopy/robot-assisted enucleation	Non-RCT [7]	“Grade B, C” POPF (RR <1 favors laparoscopy/robot-assisted enucleation)	RR, 0.91 (0.60, 1.39)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕○○○ (very low)	Critically low
Roesel, 2023 (52)	Open vs. laparoscopy enucleation	Non-RCT [4]	“Grade B, C” POPF (RR <1 favors laparoscopy enucleation)	RR, 1.10 (0.61, 1.99)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕○○○ (very low)	Critically low
Roesel, 2023 (52)	Open vs. robot-assisted enucleation	Non-RCT [3]	“Grade B, C” POPF (RR <1 favors robot-assisted enucleation)	RR, 0.71 (0.38, 1.33)	Serious ^a	Not serious	Not serious	Not serious	Undetected	No	No	No	7-Critical	⊕○○○ (very low)	Critically low
Małczak, 2020 (53)	With vs. without concomitant arterial resection	Non-RCT [10]	All-grade POPF (RR <1 favors enucleation)	RR, 1.61 (0.91, 2.84)	Serious ^a	Serious ^b	Not serious	Not serious	Strongly suspected	No	No	No	6-Important	⊕○○○ (very low)	Critically low

^a, failure to adequately control for confounding; ^b, conclusions significant heterogeneity was reported; ^c, the credible interval contains invalid values and the credible interval does not exclude significant benefits or harms. CI, confidence interval; CSD, closed suction drainage; CP, central pancreatectomy; DP, distal pancreatectomy; DPS, distal pancreatectomy with splenectomy; EDR, early drain removal; EN, enteral nutrition; HA, hand-sewn anastomosis; LDR, late drain removal; LDP, laparoscopic distal pancreatectomy; LPD, laparoscopic pancreaticoduodenectomy; I-RAMPS, laparoscopic RAMPS; MI, minimally invasive; ODP, open distal pancreatectomy; OPD, open pancreatoduodenectomy; o-RAMPS, open-RAMPS; PBD, preoperative biliary drainage; PD, pancreatoduodenectomy; PDG, passive drainage to gravity; PDO, pancreatic duct occlusion; PDVR, pancreaticoduodenectomy with vein resection; PG, pancreaticogastrostomy; PJ, pancreaticojejunostomy; PN, parenteral nutrition; POPF, postoperative pancreatic fistula; PPPD, pylorus-preserving PD; PTPS, prophylactic transpapillary pancreatic stenting; RAMPS, radical antegrade modular pancreatosplenectomy; RCT, randomized controlled trial; RDP, robotic distal pancreatectomy; RPD, robotic pancreaticoduodenectomy; SA, stapled anastomosis; SPDP, spleen-preserving distal pancreatectomy; SVP-DP, splenic vessels preserving-DP; WT-DP, Warshaw technique-DP.

Table S3 Characteristics and quality assessment of evidence

Author, year	Surgical type & treatment	Evidence	No. of studies	Type of study	No. of patients	Effects model	MA metric	Estimates	95% CI	P value	Heterogeneity		Small-study effects
											I ² (%)	P value	
Chierici, 2022 (13)	PD: PDO vs. pancreatic anastomosis	All-grade POPF (RR <1 favors PDO)	12	Non-RCT	1,034	Random	RR	2.38	1.46, 3.87	<0.001	60	<0.01	No
Chierici, 2022 (13)	PD: duct suture vs. pancreatic anastomosis	All-grade POPF (RR <1 favors duct suture)	5	Non-RCT	389	Random	RR	2.09	0.59, 7.38	0.253	87	NA	No
Chierici, 2022 (13)	PD: sealant vs. pancreatic anastomosis	All-grade POPF (RR <1 favors sealant)	7	Non-RCT	645	Random	RR	2.40	1.33, 4.30	0.004	66	NA	No
Chierici, 2022 (13)	PD: sealant vs. pancreatic anastomosis	“Grade C” POPF (RR <1 favors sealant)	3	Non-RCT	300	Fixed	RR	0.36	0.10, 1.29	0.119	8	0.34	No
Andreasi, 2020 (14)	PD: with vs. without omental/falciform ligament wrapping	All-grade POPF (RR <1 favors wrapping)	6	Non-RCT	3,127	Random	RR	0.70	0.44, 1.13	0.140	80	<0.001	NA
Andreasi, 2020 (14)	PD (pancreatic anastomosis: PJ): with vs. without omental/falciform ligament wrapping	All-grade POPF (RR <1 favors wrapping)	3	Non-RCT	1,021	Random	RR	0.42	0.17, 1.02	0.060	80	0.002	NA
Andreasi, 2020 (14)	PD: with vs. without omental/falciform ligament wrapping	“Grade B, C” POPF (RR <1 favors wrapping)	4	Non-RCT	2,321	Random	RR	0.42	0.09, 2.05	0.280	79	0.003	NA
Andreasi, 2020 (14)	PD (pancreatic anastomosis: PJ): with vs. without omental/falciform ligament wrapping	“Grade B, C” POPF (RR <1 favors wrapping)	2	Non-RCT	215	Random	RR	0.14	0.04, 0.49	0.002	0	0.600	NA
Mobarak, 2021 (15)	PD: Roux-en-Y vs. single loop reconstruction	All-grade POPF (OR <1 favors Roux-en-Y)	3	RCT	548	Fixed	OR	0.82	0.55, 1.22	0.320	0	0.420	No
Mobarak, 2021 (15)	PD: Roux-en-Y vs. single loop reconstruction	All-grade POPF (OR <1 favors Roux-en-Y)	10	Non-RCT	1,453	Fixed	OR	1.05	0.75, 1.46	0.790	42	0.080	No
Mobarak, 2021 (15)	PD: Roux-en-Y vs. single loop reconstruction	All-grade POPF (OR <1 favors Roux-en-Y)	13	RCT + non-RCT	2,001	Fixed	OR	0.94	0.73, 1.22	0.660	33	0.110	No
Jin, 2019 (16)	PD: PJ vs. PG	All-grade POPF (OR <1 favors PG)	11	RCT	1,765	Fixed	OR	0.67	0.53, 0.86	0.002	20	0.250	NA
Jin, 2019 (16)	PD: PJ vs. PG	“Grade B, C” POPF (OR <1 favors PG)	7	RCT	1,184	Fixed	OR	0.61	0.34, 1.09	0.090	61	0.020	NA
Hajibandeh, 2017 (29)	PD: SA vs. HA	All-grade POPF (OR <1 favors SA)	5	RCT + non-RCT	217	Fixed	OR	0.83	0.56, 1.21	0.330	0	0.470	NA
Hai, 2022 (30)	PD: duct-to-mucosa PJ vs. invagination PJ	“Grade B, C” POPF (RR <1 favors duct-to-mucosa PJ)	7	RCT	1,122	Random	RR	1.45	0.64, 3.26	0.370	68	0.004	Yes
Hai, 2022 (30)	PD: duct-to-mucosa PJ vs. invagination PJ	“Grade B” POPF (RR <1 favors duct-to-mucosa PJ)	7	RCT	1,122	Random	RR	1.41	0.63, 3.15	0.400	62	0.020	Yes
Hai, 2022 (30)	PD: duct-to-mucosa PJ vs. invagination PJ	“Grade C” POPF (RR <1 favors duct-to-mucosa PJ)	7	RCT	1,122	Random	RR	1.45	0.58, 3.61	0.420	0	0.640	Yes
Hai, 2022 (30)	PD: duct-to-mucosa PJ vs. invagination PJ	All-grade POPF (RR <1 favors duct-to-mucosa PJ)	10	RCT	1,472	Random	RR	1.13	0.60, 2.15	0.700	64	0.003	Yes
Cao, 2020 (1)	PD: PJ-modified Blumgart anastomosis vs. PJ-interrupted transpancreatic suture	“Grade B, C” POPF (OR <1 favors modified Blumgart anastomosis)	6	RCT + non-RCT	1,467	Random	OR	0.32	0.12, 0.84	0.020	88	<0.001	Yes
Cao, 2020 (1)	PD: PJ-modified Blumgart anastomosis vs. PJ-interrupted transpancreatic suture	All-grade POPF (OR <1 favors modified Blumgart anastomosis)	4	RCT + non-RCT	852	Random	OR	0.70	0.34, 1.44	0.340	85	<0.001	No
Wang, 2020 (31)	PD: restrictive vs. liberal intraoperative fluid management	All-grade POPF (OR <1 favors restrictive intraoperative fluid management)	11	Non-RCT	2,057	Fixed	OR	1.03	0.82, 1.28	0.814	21.6	0.238	No
Adiamah, 2019 (21)	PD/PPPD: EN vs. PN	All-grade POPF (RR <1 favors EN)	4	RCT	512	Random	RR	1.07	0.42, 2.76	0.880	66	0.030	No
Peng, 2019 (32)	PD: PDVR vs. PD	All-grade POPF (OR <1 favors PDVR)	12	Non-RCT	4,086	Fixed	OR	0.79	0.60, 1.04	0.100	50	0.020	Yes
Kotb, 2021 (17)	PD: extended vs. standard lymphadenectomy	All-grade POPF (OR <1 favors standard lymphadenectomy)	4	RCT	623	Fixed	OR	0.64	0.38, 1.09	0.100	0	0.450	NA
Ironside, 2018 (18)	PD: artery-first vs. standard PD	All-grade POPF (RR <1 favors artery-first PD)	11	Non-RCT	840	Fixed	RR	0.82	0.58, 1.17	0.266	18	>0.100	No
Ironside, 2018 (18)	PD: artery-first vs. standard PD	“Grade B, C” POPF (RR <1 favors artery-first PD)	7	Non-RCT	680	Fixed	RR	0.59	0.37, 0.95	0.031	12	>0.100	No
Crippa, 2016 (19)	PD-PBD: metal stents vs. plastic stents	All-grade POPF (OR <1 favors metal stents)	4	Non-RCT	591	Fixed	OR	0.44	0.20, 0.96	0.040	0	0.820	NA
Guo, 2022 (26)	PD: with vs. without pancreatic duct stent	All-grade POPF (RR <1 favors with pancreatic duct stent)	7	RCT	847	Random	RR	0.85	0.57, 1.26	0.410	51	0.060	No
Guo, 2022 (26)	PD: with vs. without internal pancreatic duct stent	All-grade POPF (RR <1 favors with pancreatic duct stent)	3	RCT	374	Random	RR	1.25	0.87, 1.80	0.220	0	>0.100	No
Guo, 2022 (26)	PD: with vs. without external pancreatic duct stent	All-grade POPF (RR <1 favors with pancreatic duct stent)	4	RCT	473	Random	RR	0.61	0.43, 0.86	0.005	29	>0.100	No
Li, 2023 (33)	PD: EDR vs. LDR	All-grade POPF (RR <1 favors EDR)	4	RCT	721	Random	RR	0.41	0.12, 1.34	0.140	55	0.080	NA

Table S3 (continued)

Table S3 <i>(continued)</i>													
Author, year	Surgical type & treatment	Evidence	No. of studies	Type of study	No. of patients	Effects model	MA metric	Estimates	95% CI	P value	Heterogeneity		Small-study effects
											I ² (%)	P value	
Li, 2023 (33)	PD: EDR vs. LDR	All-grade POPF (RR <1 favors EDR)	9	Non-RCT	7,207	Random	RR	0.26	0.15, 0.45	<0.001	74	<0.001	NA
Gachabayov, 2019 (34)	PD: PDG vs. CSD	All-grade POPF (OR <1 favors PDG)	6	RCT + non-RCT	1,338	Random	OR	0.81	0.42, 1.56	0.530	79	<0.001	No
Gachabayov, 2019 (34)	PD: PDG vs. CSD	“Grade B, C” POPF (OR <1 favors PDG)	5	RCT + non-RCT	824	Random	OR	1.24	0.84, 1.84	0.280	0	0.640	No
Gachabayov, 2019 (34)	PD: PDG vs. CSD	“Grade A” POPF (OR <1 favors PDG)	5	RCT + non-RCT	824	Random	OR	0.71	0.33, 1.53	0.390	65	0.020	No
Gachabayov, 2019 (34)	PD: PDG vs. CSD	“Grade B” POPF (OR <1 favors PDG)	4	RCT + non-RCT	714	Random	OR	1.23	0.74, 2.05	0.420	0	0.760	No
Gachabayov, 2019 (34)	PD: PDG vs. CSD	“Grade C” POPF (OR <1 favors PDG)	4	RCT + non-RCT	714	Random	OR	1.08	0.56, 2.09	0.820	5	0.370	No
Lyu, 2020 (20)	PD: peritoneal drainage vs. no drainage	All-grade POPF (OR <1 favors no drainage)	4	RCT + non-RCT	1,037	Random	OR	0.42	0.29, 0.62	<0.001	10	0.340	No
Lyu, 2020 (20)	PD: peritoneal drainage vs. no drainage	“Grade B, C” POPF (OR <1 favors no drainage)	6	RCT + non-RCT	1,538	Random	OR	0.66	0.33, 1.34	0.250	70	0.005	No
Ouyang, 2022 (35)	PD: RPD vs. LPD	All-grade POPF (OR <1 favors RPD)	8	Non-RCT	2,109	Fixed	OR	0.99	0.79, 1.24	0.940	0	0.860	No
Zhang, 2021 (36)	PD: RPD vs. OPD	All-grade POPF (RR <1 favors RPD)	15	Non-RCT	2,042	Fixed	RR	1.00	0.85, 1.19	0.970	0	0.750	No
Zhang, 2021 (36)	PD: RPD vs. OPD	“Grade B, C” POPF (RR <1 favors RPD)	9	Non-RCT	2,047	Fixed	RR	0.54	0.41, 0.70	<0.001	0	0.680	No
Yan, 2023 (37)	PD: LPD vs. OPD	All-grade POPF (OR <1 favors LPD)	4	RCT	818	Fixed	OR	0.82	0.54, 1.24	0.350	0	0.480	No
Yan, 2023 (37)	PD: LPD vs. OPD	All-grade POPF (OR <1 favors LPD)	31	Non-RCT	15,122	Fixed	OR	0.94	0.82, 1.09	0.420	17	0.200	No
Yan, 2023 (37)	PD: LPD vs. OPD	All-grade POPF (OR <1 favors LPD)	35	RCT + non-RCT	15,940	Fixed	OR	0.93	0.81, 1.06	0.290	13	0.250	No
Halle-Smith, 2022 (12)	PD: external vs. internal pancreatic stent	All-grade POPF (OR <1 favors external pancreatic stent)	3	RCT	471	Random	OR	1.09	0.75, 1.59	0.650	0	0.620	NA
Halle-Smith, 2022 (12)	PD: external vs. internal pancreatic stent	“Grade B, C” POPF (OR <1 favors external pancreatic stent)	3	RCT	471	Random	OR	1.36	0.83, 2.23	0.220	0	0.890	NA
Halle-Smith, 2022 (12)	PD: Braun vs. conventional anastomosis	All-grade POPF (OR <1 favors Braun anastomosis)	2	RCT	90	Random	OR	0.51	0.16, 1.65	0.260	0	0.750	NA
Kielbowski, 2021 (8)	PD: PBD vs. no PBD	All-grade POPF (OR <1 favors PBD)	9	Non-RCT	3,712	Random	OR	0.97	0.57, 1.64	0.900	82	<0.001	NA
Kielbowski, 2021 (8)	PD: operation time	All-grade POPF (MD <0 favors shorter operation time)	8	Non-RCT	1,049	Random	MD	5.87	−15.31, 27.05	0.590	55	0.030	NA
Kielbowski, 2021 (8)	PD: transfusions vs. no transfusions	All-grade POPF (OR <1 favors no transfusions)	5	Non-RCT	3,231	Fixed	OR	0.94	0.72, 1.21	0.620	0	0.440	NA
Lei, 2016 (54)	PD: ultrasonic dissection vs. conventional dissection	All-grade POPF (RR <1 favors ultrasonic dissection)	3	RCT + non-RCT	227	Fixed	RR	0.79	0.48, 1.29	0.340	0	0.620	No
Zhang, 2020 (55)	PD: with vs. without polyglycolic acid mesh	All-grade POPF (RR <1 favors polyglycolic acid mesh)	4	Non-RCT	710	Random	RR	0.76	0.62, 0.92	0.006	0	0.700	No
Zhang, 2020 (55)	PD: with vs. without polyglycolic acid mesh	“Grade B, C” POPF (RR <1 favors polyglycolic acid mesh)	5	RCT + non-RCT	837	Fixed	RR	0.50	0.37, 0.68	<0.001	0	0.510	No
Oweira, 2022 (2)	DP: reinforced stapler vs. standard stapler	“Grade B, C” POPF (OR <1 favors reinforced stapler)	6	RCT + non-RCT	525	Random	OR	0.33	0.19, 0.57	<0.001	0	0.550	NA
Mungroop, 2021 (22)	DP: with vs. without fibrin sealant patch	“Grade B, C” POPF (OR <1 favors fibrin sealant patch)	4	RCT	893	Random	OR	0.89	0.60, 1.32	0.560	27	0.250	NA
Zhang, 2020 (55)	DP: with vs. without polyglycolic acid mesh	All-grade POPF (RR <1 favors polyglycolic acid mesh)	7	RCT + non-RCT	761	Random	RR	0.74	0.57, 0.96	0.020	54	0.040	No
Zhang, 2020 (55)	DP: with vs. without polyglycolic acid mesh	“Grade B, C” POPF (RR <1 favors polyglycolic acid mesh)	6	RCT + non-RCT	615	Fixed	RR	0.31	0.21, 0.46	<0.001	28	0.230	No
Wu, 2013 (38)	DP: with vs. without PTPS	All-grade POPF (OR <1 favors PTPS)	4	RCT + non-RCT	200	Fixed	OR	0.45	0.22, 0.94	0.030	68	0.020	NA
van Bodegraven, 2022 (39)	DP: with vs. without abdominal drainage	“Grade B, C” POPF (RR <1 favors without abdominal drainage)	5	RCT + non-RCT	2,153	Fixed	RR	0.55	0.42, 0.72	<0.001	41	0.150	NA
Xinyang, 2023 (40)	DP: passive drainage vs. active suction drainage	“Grade B, C” POPF (OR <1 favors passive drainage)	4	RCT + non-RCT	618	Random	OR	3.35	1.12, 10.07	0.030	79	0.003	NA
Chen, 2023 (41)	DP: EDR vs. LDR	“Grade B, C” POPF (RR <1 favors EDR)	5	RCT + non-RCT	5,303	Fixed	RR	0.17	0.13, 0.24	<0.001	12	0.340	Yes
Li, 2023 (42)	DP: RDP vs. LDP	“Grade B, C” POPF (OR <1 favors RDP)	30	Non-RCT	4,108	Fixed	OR	0.91	0.77, 1.08	0.260	0	0.990	No
Lyu, 2022 (43)	DP: LDP vs. ODP	All-grade POPF (OR <1 favors LDP)	27	Non-RCT	3,993	Fixed	OR	0.99	0.85, 1.14	0.860	82	<0.001	No

Table S3 *(continued)*

Table S3 <i>(continued)</i>													
Author, year	Surgical type & treatment	Evidence	No. of studies	Type of study	No. of patients	Effects model	MA metric	Estimates	95% CI	P value	Heterogeneity		Small-study effects
											I ² (%)	P value	
Lyu, 2022 (43)	DP: LDP vs. ODP	“Grade B, C” POPF (OR <1 favors LDP)	24	Non-RCT	4,071	Fixed	OR	0.86	0.71, 1.05	0.150	49	0.004	No
Zhou, 2020 (44)	DP: RDP vs. ODP	All-grade POPF (OR <1 favors RDP)	7	Non-RCT	2,264	Fixed	OR	1.19	0.90, 1.57	0.220	2	0.410	NA
Zhou, 2020 (44)	DP: RDP vs. OPD	“Grade B, C” POPF (OR <1 favors RDP)	5	Non-RCT	1,104	Fixed	OR	0.74	0.44, 1.23	0.240	0	0.480	NA
Hang, 2022 (46)	DP: SVP-DP vs. WT-DP	All-grade POPF (OR <1 favors SVP-DP)	19	Non-RCT	2,157	Fixed	OR	0.85	0.65, 1.11	0.230	NA	NA	NA
Hang, 2022 (46)	DP: SVP-DP vs. WT-DP	“Grade B, C” POPF (OR <1 favors SVP-DP)	14	Non-RCT	1,811	Fixed	OR	0.84	0.61, 1.15	0.280	2	0.420	NA
Lei, 2016 (54)	DP: ultrasonic dissection vs. conventional dissection	All-grade POPF (RR <1 favors ultrasonic dissection)	3	RCT + non-RCT	198	Fixed	RR	0.46	0.27, 0.76	0.003	39	0.19	No
Nakata, 2018 (48)	DP: MI-SPDP vs. MI-DPS	“Grade B, C” POPF (OR <1 favors MI-SPDP)	11	Non-RCT	687	Random	OR	0.43	0.25, 0.74	0.002	20	0.270	NA
Tang, 2022 (45)	RAMPS: I-RAMPS vs. o-RAMPS	“Grade A” POPF (OR <1 favors I-RAMPS)	2	Non-RCT	81	Fixed	OR	1.39	0.44, 4.36	0.570	8	0.300	NA
Tang, 2022 (45)	RAMPS: I-RAMPS vs. o-RAMPS	“Grade B, C” POPF (OR <1 favors I-RAMPS)	4	Non-RCT	179	Fixed	OR	1.30	0.57, 2.96	0.540	0	0.530	NA
Zhou, 2019 (47)	RAMPS vs. DP	All-grade POPF (RR <1 favors RAMPS)	5	Non-RCT	285	Fixed	RR	0.59	0.29, 1.21	0.150	0	0.680	NA
Xiao, 2018 (49)	CP vs. PD	All-grade POPF (OR <1 favors CP)	18	Non-RCT	1,408	Fixed	OR	1.90	1.46, 2.48	<0.001	5.9	0.385	No
Bi, 2023 (50)	CP vs. DP	All-grade POPF (OR <1 favors CP)	26	Non-RCT	2,487	Fixed	OR	2.25	1.81, 2.81	<0.001	29	0.090	Yes
Bi, 2023 (50)	CP vs. DP	“Grade B, C” POPF (OR <1 favors CP)	20	Non-RCT	2,027	Fixed	OR	2.73	2.09, 3.58	<0.001	42	0.030	Yes
Shen, 2021 (51)	Enucleation vs. standard surgical resection	All-grade POPF (RR <1 favors enucleation)	18	Non-RCT	NA	Fixed	RR	1.46	1.22, 1.75	<0.05	43.5	0.026	No
Roesel, 2023 (52)	Open vs. laparoscopy/robot-assisted enucleation	“Grade B, C” POPF (RR <1 favors laparoscopy/robot-assisted enucleation)	7	Non-RCT	561	Random	RR	0.91	0.60, 1.39	0.670	21	0.270	No
Roesel, 2023 (52)	Open vs. laparoscopy enucleation	“Grade B, C” POPF (RR <1 favors laparoscopy enucleation)	4	Non-RCT	342	Random	RR	1.10	0.61, 1.99	>0.05	34	0.210	No
Roesel, 2023 (52)	Open vs. robot-assisted enucleation	“Grade B, C” POPF (RR <1 favors robot-assisted enucleation)	3	Non-RCT	219	Random	RR	0.71	0.38, 1.33	>0.05	7	0.340	No
Malczak, 2020 (53)	With vs. without concomitant arterial resection	All-grade POPF (RR <1 favors enucleation)	10	Non-RCT	NA	Random	RR	1.61	0.91, 2.84	0.110	55	NA	NA

CI, confidence interval; CSD, closed suction drainage; CP, central pancreatectomy; DP, distal pancreatectomy; DPS, distal pancreatectomy with splenectomy; EDR, early drain removal; EN, enteral nutrition; HA, hand-sewn anastomosis; LDR, late drain removal; LDP, laparoscopic distal pancreatectomy; LPD, laparoscopic pancreaticoduodenectomy; I-RAMPS, laparoscopic RAMPS; MA, meta-analysis; MD, mean difference; MI, minimally invasive; NA, not available; ODP, open distal pancreatectomy; OPD, open pancreatoduodenectomy; o-RAMPS, open-RAMPS; OR, odds ratio; PD, pancreatoduodenectomy; PDG, passive drainage to gravity; PDO, pancreatic duct occlusion; PG, pancreaticogastrostomy; PJ, pancreaticojejunostomy; PN, parenteral nutrition; POPF, postoperative pancreatic fistula; PTPS, prophylactic transpapillary pancreatic stenting; RAMPS, radical antegrade modular pancreateosplenectomy; RCT, randomized controlled trial; RDP, robotic distal pancreatectomy; RPD, robotic pancreaticoduodenectomy; RR, risk ratio; SA, stapled anastomosis; SPDP, spleen-preserving distal pancreatectomy; SVP-DP, splenic vessels preserving-DP; TP, total pancreatectomy; VR, vein resection; WT-DP, Warshaw technique-DP.

Table S4 List of excluded studies after full-text screening

No.	Title	Reason
1	Post-operative morbidity following pancreatic duct occlusion without anastomosis after pancreaticoduodenectomy: a systematic review and meta-analysis	Meta-analyses with overlapping associations and low quality
2	Pancreatic outflow tract reconstruction after pancreaticoduodenectomy: a meta-analysis of randomized controlled trials.	Meta-analyses with overlapping associations
3	The outcome of bioabsorbable staple line reinforcement versus standard stapler for distal pancreatectomy: A systematic review and meta-analysis.	Meta-analyses with overlapping associations
4	Minimally Invasive Versus Open Radical Antegrade Modular Pancreatosplenectomy: A Meta-Analysis	Meta-analyses with overlapping associations
5	Splenic Preservation Versus Splenectomy During Distal Pancreatectomy: A Systematic Review and Meta-analysis	Outdated meta-analyses with overlapping associations
6	Overall Postoperative Morbidity and Pancreatic Fistula Are Relatively Higher after Central Pancreatectomy than Distal Pancreatic Resection: A Systematic Review and Meta-Analysis	Meta-analyses with overlapping associations
7	Central pancreatectomy: a comprehensive, up-to-date meta-analysis	Meta-analyses with overlapping associations
8	Robotic-assisted versus open pancreaticoduodenectomy for patients with benign and malignant periampullary disease: a systematic review and meta-analysis of short-term outcomes	Meta-analyses with overlapping associations
9	Trial sequential meta-analysis of laparoscopic versus open pancreaticoduodenectomy: is it the time to stop the randomization?	Meta-analyses with overlapping associations
10	Laparoscopic versus Open Pancreatoduodenectomy in Patients with Periapillary Tumors: A Systematic Review and Meta-analysis.	Meta-analyses with overlapping associations
11	Laparoscopic versus open pancreatoduodenectomy: an individual participant data meta-analysis of randomized controlled trials	Meta-analyses with overlapping associations
12	Meta-analysis of surgical outcome after enucleation versus standard resection for pancreatic neoplasms	Outdated meta-analyses with overlapping associations
13	Minimally invasive versus open central pancreatectomy: Systematic review and meta-analysis	OR/HR/RR and their corresponding 95% CI were not calculated
14	Short-term clinical outcomes of enteral nutrition versus parenteral nutrition after surgery for pancreatic cancer: a meta-analysis	Meta-analyses with overlapping associations

OR, odds ratio; HR, hazard ratio; RR, risk ratio; CI, confidence interval.

Table S5 AMSTAR2 was used to evaluate the methodological quality of the included literature

Study	Q1	Q2*	Q3	Q4*	Q5	Q6	Q7*	Q8	Q9*	Q10	Q11*	Q12	Q13*	Q14	Q15*	Q16	Overall quality
Chierici, 2022 (13)	Y	Y	Y	Y	Y	N	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Low
Andreasi, 2020 (14)	Y	N	Y	PY	Y	Y	Y	PY	PY	N	Y	N	Y	N	N	Y	Critically low
Mobarak, 2021 (15)	Y	Y	N	Y	Y	Y	N	PY	Y	N	Y	Y	Y	Y	Y	Y	Low
Jin, 2019 (16)	Y	N	N	Y	Y	Y	Y	PY	PY	N	Y	N	Y	N	Y	Y	Low
Hajibandeh, 2017 (29)	Y	Y	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Low
Hai, 2022 (30)	Y	Y	Y	Y	Y	Y	Y	Y	PY	Y	Y	Y	Y	Y	Y	Y	High
Cao, 2020 (1)	Y	N	N	Y	N	Y	N	PY	PY	N	Y	Y	Y	N	Y	Y	Critically low
Wang, 2020 (31)	Y	N	N	PY	Y	Y	N	PY	PY	N	Y	Y	Y	N	Y	Y	Critically low
Adiamah, 2019 (21)	Y	N	N	Y	N	Y	Y	PY	PY	N	Y	Y	Y	Y	Y	Y	Low
Peng, 2019 (32)	Y	N	N	PY	N	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Critically low
Kotb, 2021 (17)	Y	Y	N	Y	Y	Y	N	Y	PY	N	Y	Y	Y	Y	Y	Y	Low
Ironside, 2018 (18)	Y	N	N	PY	Y	N	N	PY	PY	N	Y	Y	Y	N	Y	Y	Critically low
Crippa, 2016 (19)	Y	N	N	PY	Y	Y	N	Y	N	N	Y	N	N	N	N	Y	Critically low
Guo, 2022 (26)	Y	Y	N	Y	Y	Y	N	Y	PY	N	Y	Y	Y	Y	Y	Y	Low
Li, 2023 (33)	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Moderate
Gachabayov, 2019 (34)	Y	Y	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Low
Lyu, 2020 (20)	Y	N	N	Y	Y	N	N	PY	PY	N	Y	N	N	Y	Y	Y	Critically low
Ouyang, 2022 (35)	Y	Y	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Low
Zhang, 2021 (36)	Y	N	N	PY	N	N	Y	PY	PY	N	Y	Y	Y	Y	Y	Y	Low
Yan, 2023 (37)	Y	Y	N	Y	Y	Y	N	Y	PY	N	Y	N	Y	Y	Y	Y	Low
Halle-Smith, 2022 (12)	Y	N	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Critically low
Kielbowski, 2021 (8)	Y	N	N	PY	Y	N	N	PY	N	N	Y	N	N	N	Y	Y	Critically low
Oweira, 2022 (2)	Y	Y	N	Y	Y	Y	Y	PY	Y	N	Y	Y	Y	N	Y	Y	Moderate
Mungroop, 2021 (22)	Y	Y	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Low
Wu, 2013 (38)	Y	N	N	Y	N	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Critically low
van Bodegraven, 2022 (39)	Y	Y	N	Y	Y	Y	Y	Y	PY	N	Y	Y	Y	N	Y	Y	Moderate
Xinyang, 2023 (40)	Y	N	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Critically low
Chen, 2023 (41)	Y	N	N	PY	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Critically low
Li, 2023 (42)	Y	N	N	PY	Y	N	N	Y	PY	N	Y	Y	Y	Y	Y	Y	Critically low
Lyu, 2022 (43)	Y	N	N	Y	N	Y	N	Y	PY	N	Y	Y	Y	Y	Y	Y	Critically low
Zhou, 2020 (44)	Y	N	N	PY	N	Y	N	PY	PY	N	Y	N	N	N	N	Y	Critically low
Tang, 2022 (45)	Y	Y	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Low
Hang, 2022 (46)	Y	Y	N	Y	Y	Y	Y	Y	PY	N	Y	Y	Y	Y	Y	Y	Moderate
Zhou, 2019 (47)	Y	N	N	PY	Y	Y	N	PY	PY	N	Y	N	N	N	N	Y	Critically low

Table S5 (continued)

Table S5 (continued)

Study	Q1	Q2*	Q3	Q4*	Q5	Q6	Q7*	Q8	Q9*	Q10	Q11*	Q12	Q13*	Q14	Q15*	Q16	Overall quality
Nakata, 2018 (48)	Y	Y	N	Y	Y	Y	N	PY	N	N	Y	N	Y	N	Y	Y	Low
Xiao, 2018 (49)	Y	N	N	PY	N	Y	N	PY	PY	N	Y	N	N	N	Y	Y	Critically low
Bi, 2023 (50)	Y	Y	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Low
Shen, 2021 (51)	Y	N	N	Y	Y	Y	Y	PY	PY	N	Y	Y	Y	N	Y	Y	Low
Roesel, 2023 (52)	Y	N	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Critically low
Małczak, 2020 (53)	Y	N	N	Y	Y	Y	N	Y	PY	N	Y	N	N	N	N	Y	Critically low
Lei, 2016 (54)	Y	N	N	Y	Y	Y	N	PY	PY	N	Y	Y	Y	Y	Y	Y	Critically low
Zhang, 2020 (55)	Y	N	N	PY	N	N	N	PY	PY	N	Y	Y	Y	N	Y	Y	Critically low

AMSTAR-2 items: Q1: Did the research questions and inclusion criteria for the review include the components of PICO? Q2: Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review, and did the report justify any significant deviations from the protocol? Q3: Did the review authors explain their selection of the study designs for inclusion in the review? Q4: Did the review authors use a comprehensive Literature search strategy? Q5: Did the review authors perform study selection in duplicate? Q6: Did the review authors perform data extraction in duplicate? Q7: Did the review authors provide a list of excluded studies and justify the exclusions? Q8: Did the review authors describe the included studies in adequate detail? Q9: Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review? Q10: Did the review authors report on the sources of funding for the studies included in the review? Q11: If meta-analysis was performed, did the review authors use appropriate methods for statistical combination of results? Q12: If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis? Q13: Did the review authors account for RoB in primary studies when interpreting/discussing the results of the review? Q14: Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review? Q15: If they performed quantitative synthesis, did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review? Q16: Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review? The items with an asterisk superscript formed critical domains for assessing the methodological quality of literature. Y, yes; N, no; PY, partially yes.