Supplementary Appendix

Endoscopic Ultrasound-Guided Biliary Drainage Versus Endoscopic Retrograde Cholangiopancreatography for Malignant Distal Obstruction: Randomized-Trial Meta-Analysis

Supplementary Table 1 Complete search strategies

Source	Date	Records	Exact query
PubMed/MEDLINE	6 Aug 2026	340	(EUS-guided biliary drainage[tiab] OR endoscopic ultrasound-guided biliary drainage[tiab] OR EUS-BD[tiab] OR choledochoduodenostomy[tiab] OR hepaticogastrostomy[tiab]) AND (ERCP[tiab] OR endoscopic retrograde cholangiopancreatography[tiab] OR Cholangiopancreatography, Endoscopic Retrograde[MeSH Terms]) AND (malignant biliary obstruction[tiab] OR malignant distal biliary obstruction[tiab] OR (biliary[tiab] AND obstruction[tiab] AND malignant[tiab]))
CENTRAL, All Text	6 Aug 2026	75	("EUS-guided" OR "endoscopic ultrasound-guided") AND ERCP AND ("malignant biliary obstruction" OR "malignant distal biliary obstruction")

Source	Date	Records	Exact query
ClinicalTrials.gov	6 Aug 2026	29	("malignant biliary obstruction" OR "malignant distal biliary obstruction") AND (EUS OR "endoscopic ultrasound") AND ERCP
WHO ICTRP via CENTRAL source	6 Aug 2026	22	CENTRAL query above, filtered to Source=ICTRP

Limits: none for date or language. Direct subscription searching of Embase, Scopus, and Web of Science was unavailable. CENTRAL returned 31 Embase-sourced records, 22 ICTRP records, 16 PubMed records, 13 ClinicalTrials.gov records, and one CINAHL record; source categories overlap.

Supplementary Table 2 Ongoing or unpublished randomized studies

Registry	Study	Status at 6 Aug 2026	Relevance
NCT06375928	CARPEDIEM-1	Status shown as unknown; no results	Resectable disease
NCT06375954	CARPEDIEM-2	Not yet recruiting	Borderline disease
NCT06550973	PROMETHEUS	Not yet recruiting	Difficult biliary cannulation
NCT06653192	CARPEDIEM	Suspended	First-line distal obstruction
NCT04898777	Altonbary/Mansoura trial	Completed; conference abstract only	Full data requested for a future update
TCTR20241203002 / TCTR20240601003	RUMBO trials	ICTRP records; no full results	EUS-HGS vs ERCP stenting

Supplementary Table 3 Trial-level outcome definitions and counts

Trial	Technical	Clinical	Adverse events	Pancreatitis	Durability	N EUS/ERCP
Bang 2018	Stent deployed	≥50% bilirubin decline at 2 weeks	Trial-defined early AEs	Treatment-related pancreatitis	Repeat biliary intervention	33/34
Park 2018	Stent deployed	≥50% bilirubin decline within 1 month without recurrent cholangitis/sepsis	Cholecystitis, pancreatitis, bile peritonitis, perforation, or bleeding	Trial report	Stent dysfunction; median follow-up 95/147 days	14/14 analyzed
Paik 2018	Stent deployed	Bilirubin <50% of baseline within 1 week and/or <25% within 4 weeks	ASGE-graded events	Postprocedure pancreatitis	Repeat biliary intervention	64/61
Chen 2023	Stent deployed at index procedure	50% bilirubin reduction by 2 weeks or <25% baseline by 4 weeks	30-day procedure-related AEs	Trial report	Confirmed stent dysfunction to 1 year	73/71

Trial	Technical	Clinical	Adverse events	Pancreatitis	Durability	N EUS/ERCP
Teoh 2023	Stent deployed	50% bilirubin reduction by 2 weeks or <25% baseline by 4 weeks	30-day AEs	Trial report	Stent dysfunction/reintervention to 1 year	79/76
Anderloni 2026	Stent deployed	50% bilirubin reduction by 2 weeks or <25% baseline by 4 weeks	Other procedure-related AEs	Cotton criteria; primary outcome	Stent dysfunction/reintervention to 6 months	111/109

Supplementary Table 4 Arm-level event counts

Outcome	Trial	EUS-BD	ERCP
Technical	Bang 2018	30/33	32/34
Technical	Park 2018	13/14	14/14
Technical	Paik 2018	60/64	55/61
Technical	Chen 2023	66/73	59/71
Technical	Teoh 2023	76/79	58/76
Technical	Anderloni 2026	105/111	86/109
Clinical	Bang 2018	32/33	31/34
Clinical	Park 2018	13/13	13/14
Clinical	Paik 2018	54/60	52/55
Clinical	Chen 2023	62/73	61/71
Clinical	Teoh 2023	74/79	69/76
Clinical	Anderloni 2026	96/111	96/109

Outcome	Trial	EUS-BD	ERCP
Adverse events	Bang 2018	7/33	5/34
Adverse events	Park 2018	0/14	0/14
Adverse events	Paik 2018	4/64	12/61
Adverse events	Chen 2023	6/73	10/71
Adverse events	Teoh 2023	13/79	13/76
Adverse events	Anderloni 2026	22/111	23/109
Pancreatitis	Bang 2018	0/33	1/34
Pancreatitis	Park 2018	0/14	0/14
Pancreatitis	Paik 2018	0/64	9/61
Pancreatitis	Chen 2023	0/73	4/71
Pancreatitis	Teoh 2023	0/79	2/76
Pancreatitis	Anderloni 2026	2/111	8/109
Dysfunction/reintervention	Bang 2018	1/33	1/34
Dysfunction/reintervention	Park 2018	2/14	4/14
Dysfunction/reintervention	Paik 2018	10/64	26/61
Dysfunction/reintervention	Chen 2023	7/73	7/71
Dysfunction/reintervention	Teoh 2023	7/79	9/76
Dysfunction/reintervention	Anderloni 2026	8/111	9/109

Supplementary Table 5 RoB 2 judgments

Trial	Randomization	Deviations	Missing data	Measurement	Selection	Overall
Bang 2018	Low	Some concerns	Low	Some concerns	Low	Some concerns
Park 2018	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Paik 2018	Low	Some concerns	Low	Some concerns	Low	Some concerns
Chen 2023	Low	Low	Low	Low	Low	Low

Trial	Randomization	Deviations	Missing data	Measurement	Selection	Overall
Teoh 2023	Low	Low	Low	Low	Low	Low
Anderloni 2026	Low	Low	Low	Low	Low	Low

Supplementary Table 6 Grading of Recommendations Assessment, Development and Evaluation summary

Outcome	Evidence	Certainty	Main reason(s)
Technical success	6 RCTs; 739	Low	Inconsistency and imprecision; device/setting heterogeneity
Clinical success	6 RCTs; 728	Moderate	Minor indirectness and varying definitions
Procedure-related AEs	6 RCTs; 739	Low	Imprecision and nonuniform ascertainment
Pancreatitis	6 RCTs; 739	Moderate	Few events, but consistent direction and robust sensitivity analyses
Dysfunction/reintervention	6 RCTs; 739	Low	Imprecision and different definitions/follow-up

Supplementary Table 7 Reports assessed in full and excluded

Report/registry	Design	Reason excluded
Zhao et al., 2022	Randomized EUS antegrade vs ERCP	Nontransmural EUS route; different intervention
Inoue et al., 2026	EUS-CDS vs ERCP	Retrospective propensity-matched comparison
Ghoneem et al., 2024	Primary EUS-CDS vs ERCP	Nonrandomized comparative study
Nemakayala et al., 2021	Stent patency comparison	Nonrandomized/abstract report
Artifon et al.	EUS-CDS vs surgical drainage	Different comparator
EUS-BD vs PTBD registry	Rescue drainage after failed ERCP	Different comparator and rescue setting
Altonbary et al., 2025; NCT04898777	Completed randomized trial	Conference abstract/registry only; no complete extractable report
CARPEDIEM-1; NCT06375928	Resectable disease RCT	No results available
CARPEDIEM-2; NCT06375954	Borderline disease RCT	No results available
PROMETHEUS; NCT06550973	Difficult cannulation strategy RCT	No results available and different treatment sequence
Paik conference report	Early report of included trial	Duplicate dataset; complete journal report used

Supplementary Table 8 Sensitivity analyses for pancreatitis

Method	Estimate (95% CI)	Purpose
Random-effects RR with study-level 0.5 correction	0.20 (0.05–0.77)	Primary relative analysis
Peto OR	0.17 (0.08–0.36)	Sparse-event sensitivity
Conditional exact pooled OR	0.08 (0.01–0.31)	Exact sensitivity; ignores study stratification
Absolute risk difference	−6.0% (−9.1% to −3.5%)	Newcombe interval; NNT ≈17

Search and revision audit

The PubMed count increased from 333 on 22 June 2026 in the prior draft to 340 on 6 August 2026. The revision added the complete Park trial and the 2026 Anderloni trial, narrowed eligibility to transmural EUS-BD, removed the nontransmural Zhao route from the eligible intervention, corrected procedure-related adverse-event counts to the trial-reported windows, and replaced the previous single zero-event analysis with three rare-event sensitivity methods. No claim of prospective protocol registration is made.