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Title:

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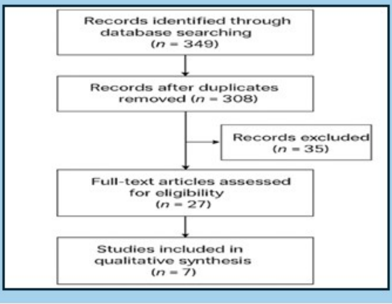
Introduction

DPDS after necrotizing pancreatitis often leads to recurrent peripancreatic fluid collections after endoscopic transmural drainage.
Strategy: leave long-term double-pigtail plastic stents after removing a lumen-apposing metal stent to keep internal drainage.



Methods

Design & search

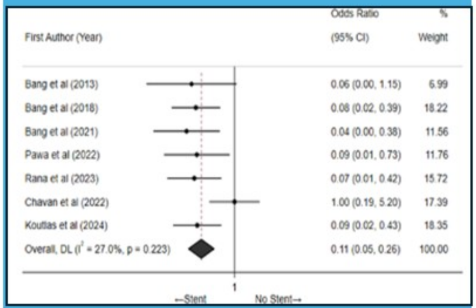
- Systematic review + meta-analysis (PRISMA)
- Databases: MEDLINE, EMBASE, SCOPUS (Apr–Nov 2025)

Population / comparison

- Adults with confirmed DPDS after transmural drainage
- Intervention: long-term indwelling plastic stents
- Comparator: no stent maintenance
- 1 randomized trial + 6 cohort studies

Outcomes

Recurrence of collections



Fernández García et al.

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Sustained transmural drainage with plastic stents after LAMS removal in disconnected pancreatic duct syndrome: evidence from a systematic review and meta-analysis

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Abbreviations

Abbreviation	Full term
DPDS	Disconnected Pancreatic Duct Syndrome
PFC(s)	Peripancreatic Fluid Collection(s)
DPS	Double-Pigtail Plastic Stent(s)
LAMS	Lumen-Apposing Metal Stent
ANP	Acute Necrotizing Pancreatitis
WON	Walled-Off Necrosis
ERCP	Endoscopic Retrograde Cholangiopancreatography
CT	Computed Tomography
MRI	Magnetic Resonance Imaging
PICO	Population, Intervention, Comparison, Outcome
NOS	Newcastle–Ottawa Scale
EUS	Endoscopic Ultrasound

ABSTRACT

Background: Disconnected pancreatic duct syndrome (DPDS) is a common sequela of necrotizing pancreatitis, often leading to recurrent peripancreatic fluid collections (PFCs) after transmural drainage. The long-term placement of double-pigtail plastic stents (DPS) following lumen-apposing metal stent (LAMS) removal has been proposed to maintain drainage and prevent recurrence. This study aimed to evaluate the efficacy and safety of DPS maintenance in patients with DPDS.

Methods: A systematic review and meta-analysis was conducted following PRISMA guidelines and registered in PROSPERO (**CRD420251167723)**. MEDLINE, EMBASE, and SCOPUS were searched for comparative studies including adult patients with DPDS who underwent endoscopic transmural drainage with or without DPS maintenance. We included observational cohorts studies and a randomized clinical trial. The primary outcome was PFC recurrence; secondary outcomes included reintervention and adverse events.

Results: Seven studies (n=597) met inclusion criteria. PFC recurrence was significantly lower with DPS maintenance than without (2.9% vs. 22.6%; OR 0.11; 95% CI 0.05–0.26; I^2=27%). DPS placement also reduced reintervention rates (5.8% vs. 12.6%; OR 0.28; 95% CI 0.09–0.85; I^2=8.2%). Adverse events occurred in 8.25% of cases, mostly asymptomatic stent migration.

Conclusions: Long-term DPS placement after LAMS removal appears to be associated with lower recurrence and need for reintervention in patients with DPDS, without major safety concerns.

Keywords: Pancreatic ducts/pathology. Pancreatitis. Necrotizing/complications. Stents/therapeutic use.

Introduction

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Acute pancreatitis is one of the most prevalent conditions in gastroenterology, with most cases being mild to moderate. However, up to 15% of patients develop a severe form of the disease, with a mortality rate approaching 20% [1,2]. Approximately 70% of these severe cases present with acute necrotizing pancreatitis (ANP), often complicated by the development of walled-off necrosis (WON) [3]. A common complication of ANP is disconnected pancreatic duct syndrome (DPDS), which occurs in 15–46% of affected patients and is characterized by necrosis of the main pancreatic duct combined with the persistence of viable pancreatic parenchyma in the upstream remnant [4]. Circumferential necrosis of the duct prevents the physiological drainage of pancreatic secretions into the gastrointestinal tract, and persistent exocrine output from the viable pancreatic tissue can lead to recurrent peripancreatic fluid collections (PFCs) or external pancreatic fistulas [5].

Diagnosis relies on clinical context and cross-sectional imaging assessment of main pancreatic duct integrity. Contrast-enhanced CT and MRI/MRCP (preferably secretin-enhanced MRCP when available) are commonly used to suspect DPDS and to evaluate ductal discontinuity and associated collections, with diagnostic performance influenced by the timing from the index episode. Although ERCP can delineate ductal disruption, in contemporary practice it is typically performed with therapeutic intent once DPDS is suspected rather than solely to confirm the diagnosis [6].

Management aims to achieve durable internal drainage of DPDS-related collections and to prevent clinically significant recurrence. Contemporary guidelines like ESGE and ASGE [7,8] endorse a minimally invasive step-up strategy and recognize EUS-guided transmural drainage as a central component for symptomatic mature collections, including walled-off necrosis [9–11].

In contrast, transpapillary pancreatic duct interventions are not routinely required when transmural drainage is feasible and are generally reserved for selected scenarios (e.g., partial disruptions or favorable ductal anatomy) rather than being mandatory, particularly in confirmed DPDS.

With respect to stent choice for transmural drainage, both multiple plastic stents and LAMS are widely used. Randomized trials have not consistently demonstrated clinical superiority of LAMS over plastic stents for walled-off necrosis, although LAMS may

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

facilitate endoscopic necrosectomy in selected cases [11]

To reduce collection recurrence risk, long-term placement of double-pigtail plastic stents (DPS) following LAMS removal has been proposed as a strategy to maintain transmural drainage. The available evidence, however, remains controversial. To date, only one randomized controlled trial [12], has evaluated the role of long-term transmural plastic stent placement after LAMS removal in patients with DPDS and did not demonstrate a statistically significant reduction in recurrence, although a numerical trend favoring DPS was observed. In contrast, several observational studies—mostly retrospective and one prospective—have reported lower recurrence rates with sustained DPS placement.

These observational findings must be interpreted cautiously, as they are subject to selection bias and confounding by indication. However, given the limited availability of randomized data in this specific clinical scenario, a systematic synthesis of the available evidence may help contextualize the RCT findings and generate hypotheses for future trials.

Two meta-analyses have attempted to clarify the efficacy of this approach [13,14]. While both reported reduced short-term recurrence of PFCs, their conclusions diverged regarding the need for reintervention and the rate of adverse events. Importantly, the study by Liu et al. included only three studies, limiting the strength of its conclusions, whereas the meta-analysis by Hawa et al., despite including 16 studies, did not distinguish between patients with and without DPDS. Thus, the current evidence remains limited.

The aim of this study was to evaluate whether long-term indwelling transmural plastic stents, used to maintain drainage after resolution of DPDS-associated collections (commonly after LAMS), reduce recurrence and the need for reintervention compared with no stent maintenance.

Methods

This systematic review and meta-analysis were conducted in accordance with the PRISMA guidelines and was registered in PROSPERO (**CRD420251167723**) to ensure reproducibility. No deviations from the registered protocol were made.

Search Strategy

A comprehensive search was carried out in MEDLINE, EMBASE, and SCOPUS from 3 April 2025 to 19 November 2025. In MEDLINE (PubMed), the following terms were used: *"Disrupted/Disconnected pancreatic duct syndrome" OR "walled-off pancreatic necrosis" AND "plastic stents" OR "endoscopic drainage maintenance."* Detailed search strategies are provided in Supplementary Appendix 1. Additionally, references from relevant primary studies were manually screened to identify further eligible articles.

Inclusion Criteria

Studies were considered eligible if they addressed the following PICO framework:

- **Population:** Adult patients (>18 years) with a diagnosis of walled-off pancreatic necrosis and disconnected pancreatic duct syndrome.
- **Intervention:** Long term indwelling of plastic stents to maintain transmural drainage at initial drainage of after removal of initial LAMS.
- **Comparison:** No additional treatment after transmural drainage either with or without endoscopic necrosectomies.
- **Outcome:** Recurrence of peripancreatic collections and development of complications.
- **Study design:** Analytical, experimental, or observational studies published within the last 10 years.

Studies with mixed populations (DPDS and non-DPDS) were included only when DPDS-specific outcomes could be extracted separately for quantitative synthesis.

Exclusion Criteria

Studies were excluded if they did not meet inclusion criteria, were duplicates or had incomplete data. Studies including cases of disconnected pancreatic duct syndrome secondary to surgery or abdominal trauma were also excluded.

Given the limited number of randomized controlled trials in disconnected pancreatic duct syndrome, both randomized and observational comparative studies (prospective

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The Spanish Journal of Gastroenterology

and retrospective) were eligible for inclusion. Non-comparative studies were excluded to reduce the risk of uncontrolled bias. Retrospective studies were not excluded by design, acknowledging their potential for selection and recall bias, but reflecting real-world practice in a field with scarce randomized data.

Quality assesment

To address this, methodological quality was systematically assessed using the Newcastle–Ottawa Scale (NOS) for observational studies and the PEDro scale for randomized trials. The NOS was not applied to the randomized trial.

The NOS scale was used for observational studies, analyzing selection criteria, comparability between groups, and outcome. The PEDro scale has been developed for clinical trials and consists of 11 items, with a qualitative scoring system like the NOS scale. Data quality was classified as low (0–2 points), moderate (3–6 points), or high (≥7 points). We included a table that summarizes the quality analysis in study characteristics section. The supplementary material includes a extended quality analysis of the studies based on these scales in Figure S1.

Definitions

- DPDS was defined by the evidence of complete discontinuity of the MPD with specific diagnostic criteria outlined in each study. Across studies, DPDS was generally defined as complete disruption/discontinuity of the main pancreatic duct with a viable upstream pancreatic segment. Diagnostic confirmation varied by study and included CT and/or MRI/MRCP (most commonly MRCP), with ERCP or EUS pancreatography used selectively. Definitions and diagnostic modalities are detailed in Supplementary Table S2.
- Transmural drainage was defined as an endoscopic approach that involved formation of fistula between PFC and the gastrointestinal tract, usually the stomach or duodenum.

- Recurrence was defined as a PFC >2cm on imaging studies after initial successful treatment of WON or pseudocyst.

- The need for reintervention was defined as the need for new drainage after the recurrence of the collection.

Outcomes

The primary outcome was recurrence of peripancreatic collections. Secondary outcomes included the need for reintervention and the occurrence of adverse events.

Data Extraction

Two authors (VJGS and RFG) independently reviewed and extracted data from the included studies. Discrepancies were resolved by a third author (ERC). Extracted data included study design, number of patients, intervention type, recurrence rates, adverse events, and follow-up duration.

Assessment of potential confounders

Data on potential confounding factors and relevant co-interventions were extracted when available. These included: characteristics of indwelling transmural plastic stents (type, diameter, length, and number), pancreatitis etiology, pancreatic duct interventions (pancreatic sphincterotomy and/or transpapillary pancreatic duct stenting), and ERCP use (diagnostic/procedural planning vs therapeutic transpapillary drainage). Additional variables were collected when reported, including timing of LAMS removal, prior non-endoscopic drainage approaches, pancreatic duct stenosis, and underlying chronic pancreatitis

Statistical Analysis

Categorical variables were summarized as odds ratios (OR) with 95% confidence intervals (CI), pooled across studies. Recurrence rates and reintervention needs were compared between patients receiving plastic stents and those who did not, using pooled ORs. Heterogeneity was assessed with the I^2 statistic and Cochran's Q test, with significance set at $p < 0.10$. I^2 values were interpreted as follows: low (<25%), moderate (25%–75%), and high (>75%). We used the random effects model, even though heterogeneity was not high, because its estimation is more conservative. The

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

tests were two-tailed, and the significance level was set at $p<0.05$. Publication bias was evaluated visually with funnel plots and statistically with Egger's test. Analyses were performed using JAMOVI® (The jamovi project (2025). jamovi (Version 2.6) [Computer Software]. Retrieved from https://www.jamovi.org) and Stata® (StataCorp. 2025. *Stata Statistical Software: Release 19*. College Station, TX: StataCorp LLC).

A leave-one-out sensitivity analysis was performed sequentially excluding each individual study to assess the robustness of the pooled effect and to explore the potential impact of overlapping cohorts.

Results

Search Results

The initial search yielded 349 articles. After removing duplicates, irrelevant records, and studies not meeting inclusion criteria, 63 articles remained. Following title and abstract screening, 35 were excluded. Of the 27 full-text articles assessed, 7 studies met the eligibility criteria and were included in the analysis. The flowchart of included studies according to PRISMA is shown in Figure 1.

Study Characteristics

Among the 7 included studies, one was a randomized controlled trial (RCT) [12], one was a prospective cohort study [16], and five were retrospective cohort studies [15,17–20]. Five studies were conducted in the United States [15–17,19,20] and two in India [12,18].

A total of 597 patients were included, with 376 patients in the plastic stent maintenance group and 221 patients in the non-stent group. Of these, 90.4% had walled off necrosis (WON) and the remainder had pseudocysts. Notably, the studies by Rana and Chavan [12,18], excluded patients with pseudocysts. All patients included had DPDS, although only four studies exclusively include patients with PDD [12,18,20]. We only analyzed patients with PDD in studies that have patients with and without this syndrome.

All studies exclude patients with DPDS secondary to surgery, neoplasia, or trauma. The most common etiologies of pancreatitis were idiopathic, biliary, and alcohol related.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Study characteristics are summarized in Table 1.

Overall study quality was moderate-to-high: three studies were rated as moderate quality and four as high quality (no low-quality studies, Table 2). Observational cohorts were assessed using the Newcastle–Ottawa Scale, and the randomized controlled trial was assessed using the PEDro scale.

The intervention consisted of plastic stent placement following endoscopic drainage of WON or pseudocyst. In Chavan et al. [12], patients were randomized, while in the remaining studies, stent placement was based on clinical judgment and generally not performed when complete cavity collapse was observed. Indwelling transmural stents were double-pigtail plastic stents (DPS), typically 7–10 Fr in diameter and 3–5 cm in length; the number of stents placed was at the discretion of the endoscopist. Treatment success was generally defined as radiologic resolution of the index collection (typically <2 cm on follow-up imaging, commonly assessed at 6 months). Recurrence was defined as subsequent reappearance of a collection ≥2 cm at the same location after initial resolution, in most studies.

Potential confounders and co-interventions

Across the seven included studies, indwelling plastic stents used for long-term transmural drainage were relatively homogeneous, with diameters ranging from 7 to 10 Fr and lengths between 3 and 5 cm. The number of stents was determined by the endoscopist in all studies. Alcohol-related pancreatitis was the most frequent etiology overall, followed by biliary pancreatitis. Studies including traumatic or postoperative pancreatitis were excluded a priori, thereby limiting etiological heterogeneity.

With respect to pancreatic duct interventions, prior or concurrent pancreatic sphincterotomy or transpapillary pancreatic duct stenting were exclusion criteria in all but one study (Bang et al., 2018) [15]. Consequently, most patients included in the meta-analysis had not undergone pancreatic duct instrumentation before or during transmural drainage. Transpapillary (retrograde) drainage was not used as a drainage strategy in the DPDS population included in this meta-analysis; when ERCP was performed, it was used for diagnostic assessment and/or procedural planning rather than therapeutic transpapillary drainage.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Other potentially relevant variables, such as timing of LAMS removal or prior non-endoscopic drainage approaches, were inconsistently reported and could not be reliably analyzed across studies. Data on pancreatic duct stenosis and underlying chronic pancreatitis were extracted when reported; established chronic pancreatitis was generally excluded, and reporting of pancreatic duct stenosis was inconsistent, with outcomes not stratified by this variable, precluding formal analyses.

Follow-up

Follow-up was performed according to clinical practice, typically at 3 months, except in Chavan et al.[12], who scheduled visits at 3, 6, and 12 months, and Rana et al. [18], who followed patients quarterly. However, the total follow-up duration varied across cohorts, ranging from approximately 3 months to >24 months (and longer in selected series). This variability may influence the detection of late recurrences and therefore the comparability of absolute recurrence rates across studies.

Primary Outcome

The overall recurrence rate of peripancreatic collections after initial drainage was 10.21%, with recurrence in 2.92% of patients with plastic stent placement versus 22.62% without stents. Across the 7 included studies, long-term DPS placement significantly reduced recurrence in patients with PFCs and DPDS (OR 0.114; 95% CI 0.049 to 0.263; Figure 2). We also calculated the Absolute risk reduction (ARR)=0.251 and the Number needed to treat (NNT)=5.125. Heterogeneity was moderate (I^2 = 27%). The data related to recurrence are shown in Table 3. Publication bias analysis did not reach statistical significance by Egger´s test (*p* = 0.454), given the small number of studies (<10), these tests should be interpreted cautiously. Although visual inspection suggested asymmetry (Figure S2 in Suplementary Material), with more studies favoring intervention being published, which was mainly driven by the randomized controlled trial by Chavan et al., the only study reporting no significant difference between groups.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Design-based sensitivity analysis. When restricting the analysis to observational studies (excluding the only RCT), the association remained statistically significant and consistent (OR 0.07, 95% CI 0.03–0.16; I^2=0.0%), suggesting that the overall findings were not dependent on inclusion of the randomized trial. We show this result in Figure 4.

Leave-one-out sensitivity analyses demonstrated that the pooled effect estimate remained stable after exclusion of each individual study. Notably, exclusion of the studies by Bang et al. (2013) and Bang et al. (2018) resulted in pooled odds ratios of 0.12 (95% CI 0.05–0.30) and 0.12 (95% CI 0.04–0.33), respectively, which were comparable to the primary analysis (OR 0.11; 95% CI 0.05–0.26). These findings indicate that the overall results were not driven by any single study and were robust to potential cohort overlap (Supplementary Figure S3).

In a further population-based sensitivity analysis restricted to DPDS-only cohorts (Pawa et al., Rana et al., Chavan et al., and Koutlas et al. [12,18–20]), the association remained significant (OR 0.159; 95% CI 0.044–0.580), confirming that the observed signal persisted when limiting the analysis to studies exclusively enrolling DPDS patients. Supplementary figure S4.

Secondary Outcomes

Four studies evaluated the need for reintervention due to recurrence after initial drainage [16,17,19]. Among 172 patients included in these studies, reintervention was required in 5.81% of patients in the DPS group versus 12.59% in the non-stent group. Pooled analysis demonstrated that DPS reduced the risk of reintervention (OR 0.28; 95% CI 0.09 to 0.85), with low heterogeneity (I^2 = 8.2%). We also calculated the ARR=0.087 and NNT 11.49. Both visual funnel plot assessment and statistical testing by Egger´s test (p = 0.055) indicated no significant publication bias (In Figure S3).

Adverse Events

Reported adverse events were infrequent. As spontaneous asymptomatic DPS migration/extrusion may occur after cavity resolution and does not necessarily

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

represent a clinically meaningful adverse event, we report these separately as stent-related events. The overall event rate was 8.25%, largely driven by asymptomatic migration/extrusion (5.19%). After excluding asymptomatic migration/extrusion, clinically significant adverse events occurred in 3.07% of patients. Severe events were rare, with one bowel perforation reported (Bang et al. [14]). Event types and frequencies are summarized in Supplementary Table S1.

Discussion

This systematic review and meta-analysis suggest that long-term plastic stent placement after transmural drainage of peripancreatic collections in patients with DPDS is associated with lower recurrence and the need for reintervention compared with drainage without stent maintenance. Moreover, this strategy is safe, with a low rate of adverse events, most of which were minor, such as asymptomatic stent migration.

DPDS is an underdiagnosed and poorly understood condition, and its management after initial drainage of associated collections remains uncertain due to limited and low-quality evidence[6]. This study represents one of the few published meta-analyses that include exclusively patients with disconnected pancreatic duct syndrome (DPDS), and it is the largest to date specifically focused on plastic stent maintenance after transmural drainage of pancreatic collections. A prior meta-analysis [13] included only three studies reported findings consistent with ours, with recurrence rates of 6.2% in the DPS group compared with 2.92% in our pooled analysis. Thus, our study reinforces the role of DPS in preventing recurrence of PFCs.

Our findings can be interpreted within the current ESGE/ASGE therapeutic framework, in which EUS-guided transmural drainage is a cornerstone for symptomatic mature collections and either plastic stents or LAMS may be used as first-line transmural devices. LAMS may be particularly useful when necrosectomy is anticipated, whereas plastic stents may be preferred in selected patients (including those with suspected DPDS) to facilitate longer-term drainage strategies.

Our results contrast with the only available RCT, Chavan et al.[12], which failed to reach statistical significance despite a trend toward reduced recurrence in the stent

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

group. The reported recurrence rate of 13.5% at 6 months in both the long-term plastic stent group and the no-stent group, with no statistically significant difference between arms. At 12 months, recurrence increased to 19% in the plastic stent group and 25% in the no-stent group, although this difference also did not reach statistical significance.

In contrast, the present meta-analysis, pooling predominantly observational studies with longer follow-up, found lower recurrence rates in patients managed with sustained plastic stent placement. These findings should be interpreted cautiously, as differences may reflect study design, follow-up duration, and patient selection rather than a definitive treatment effect. The discrepancy between our findings and the randomized controlled trial by Chavan et al. should be interpreted cautiously. While pooled observational data suggests a protective effect of long-term plastic stent placement, randomized evidence remains limited, and differences may reflect study design, patient selection, and outcome definitions rather than sample size alone.

Unlike the meta-analysis by Hawa et al., which pooled heterogeneous populations—pseudocysts and walled-off necrosis (WON) after acute and chronic pancreatitis, as well as postoperative collections—and combined patients with and without disconnected pancreatic duct syndrome (DPDS), analyzing DPDS only as a subgroup with variability in index stent type and number of double plastic stents (DPS), our study restricts the clinical question to patients with confirmed DPDS in the contemporary setting of transmural drainage with lumen-apposing metal stents (LAMS) followed by elective DPS maintenance. This narrower focus reduces confounding by indication and the dilution of treatment effects inherent to mixed cohorts, yielding estimates that are more directly applicable to DPDS in terms of recurrence and need for reintervention, while preserving a low adverse-event profile. Whereas Hawa et al. reports an overall benefit of DPS maintenance over standard removal—suggesting a larger effect in WON and when ≥2 stents are placed—their conclusions depend on combining DPDS and non-DPDS cases, multiple drainage strategies (metallic and plastic), and heterogeneous follow-up. By isolating the DPDS

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

population after LAMS, our meta-analysis provides more precise, practice-oriented evidence on the true effect of sustained DPS and, therefore, offers clearer guidance for long-term management in this high-risk subgroup.

Importantly, our analysis also showed a lower need for reintervention in the DPS group, a novel finding not reported by Liu et al. [13], who observed no difference between groups. Two broader meta-analyses including both DPDS and non-DPDS patients did suggest reduced reintervention rates with DPS [14,21]. We believe this is one of the most clinically relevant findings of our study: while preventing recurrence is important, reducing reinterventions may have even greater clinical impact, as reinterventions are associated with symptomatic, clinically significant collections and increased healthcare costs and procedure-related risks. Only four studies reported detailed reintervention data, limiting statistical power, although heterogeneity was low and no evidence of publication bias was observed.

Regarding safety, our data supports a favorable long-term safety profile for DPS maintenance after index transmural drainage in DPDS. Reported safety events were uncommon and were largely driven by asymptomatic stent migration/extrusion, which may occur after cavity resolution and does not necessarily represent a clinically meaningful adverse event. Severe events were rare, with only one bowel perforation reported in the entire dataset. Importantly, available series with extended follow-up—including cohorts with typical follow-up of 16–24 months and one study reporting outcomes up to 7 years—did not show a signal of late, clinically meaningful complications attributable to indwelling DPS. Taken together, the evidence suggests that sustained transmural drainage with plastic stents is well tolerated over time, provided routine clinical surveillance is maintained. Future randomized trials should define optimal surveillance strategies and whether specific subgroups (e.g., marked upstream atrophy or complete cavity collapse) can safely undergo stent removal without compromising long-term outcomes.

The optimal number of plastic stents remains uncertain. Rana et al. [18] reported similar outcomes with one versus two stents in DPDS patients , whereas another meta-analysis suggested that two or more stents may be superior, though this finding was based on indirect comparisons rather than pooled patient-level data [14]. In our

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

review, only Chavan et al. analyzed recurrence according to number of stents; in the remaining studies, at least two stents were routinely placed, precluding further analysis.

Despite the clinical relevance of the topic, the present meta-analysis has important limitations that must be emphasized. Only a small number of studies met inclusion criteria, and most were retrospective observational cohorts, with only one randomized controlled trial available. As a result, the pooled estimates are primarily driven by non-randomized data, which are inherently more susceptible to selection bias, confounding, and unmeasured variables.

Furthermore, many potentially relevant studies in the field could not be included due to heterogeneous populations, lack of confirmed DPDS, or insufficient reporting of outcomes. Although diagnostic modalities varied slightly across included studies (MRCP/CT with selective pancreatography), DPDS definitions were largely consistent (complete duct disruption with viable upstream pancreas), making substantial misclassification unlikely. Importantly, in most included cohorts the decision to leave long-term transmural DPS was not randomized and was based on clinical judgment (for example, often omitted when complete cavity collapse was observed), which introduces potential confounding by indication.

Follow-up schedules were relatively consistent across studies (typically every 3 months), which likely reduces variability in early recurrence detection. Nevertheless, total follow-up duration differed between cohorts, which may affect the capture of late relapses and limits comparability of absolute event rates. Time-to-event data were not consistently reported, precluding formal adjustment for follow-up duration; however, our pooled estimates are based on within-study comparative effect measures (odds ratios), which partially mitigate differences in follow-up across studies

Although study designs and follow-up schedules varied, statistical heterogeneity was low-to-moderate for recurrence (I^2=27%) and low for reintervention (I^2=8.2%), suggesting a directionally consistent effect across cohorts. Importantly, in most observational series DPS placement was omitted when complete cavity collapse was observed, a practice that would be expected to bias outcomes in favor of the non-stent group. Despite this, the pooled association continued to favor DPS, supporting the robustness of the observed signal while acknowledging that residual confounding cannot be excluded.

Because the determinants of this decision (e.g., perceived recurrence risk, ductal anatomy, and collection characteristics) were inconsistently reported and effect estimates were largely unadjusted, a pooled adjusted analysis was not feasible. In addition, key clinical variables were not consistently reported across studies, precluding adjusted analyses or subgroup evaluations. Therefore, although our findings suggest a potential benefit of sustained transmural plastic stent placement, the overall quality of evidence remains limited, and the results should be interpreted as hypothesis-generating rather than definitive.

In conclusion, sustained transmural drainage with plastic stents after LAMS removal in patients with DPDS is associated with lower recurrence and reintervention rates in predominantly observational studies. However, given the limited number of studies and the scarcity of randomized evidence, these findings should be interpreted with caution. Well-designed, adequately powered prospective randomized controlled trials are required to confirm the validity of these results and to better define the optimal long-term management strategy for DPDS.

Keypoints

- **Disconnected pancreatic duct syndrome (DPDS)** is a frequent and underdiagnosed consequence of necrotizing pancreatitis, leading to recurrence of peripancreatic fluid collections (PFCs) after initial drainage.
- This meta-analysis of seven comparative studies (n=597) found that long-term transmural DPS maintenance was associated with lower PFC recurrence (2.92% vs 22.62%; OR 0.11; 95% CI 0.05–0.26).

- DPS maintenance was also associated with a lower need for reintervention (5.81% vs 12.59%; OR 0.28; 95% CI 0.09–0.85)
- Sustained transmural drainage with DPS represents a safe and effective long-term strategy for patients with DPDS after LAMS removal.

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Conflict of interest

The authors declare that they have no conflicts of interest related to this study. No financial, personal, or professional relationships influenced the conduct or reporting of this research.

Ethical approval

This study is a systematic review and meta-analysis of previously published data and did not involve direct patient participation. Therefore, ethical approval and informed consent were not required. All procedures were conducted in accordance with the ethical standards of the institutional and national research committees and with the 1964 Helsinki Declaration and its later amendments.

References:

[1] Valverde-López F, Martínez-Cara JG, Redondo-Cerezo E. Pancreatitis aguda. Med Clin (Barc) 2022;158:556–63. https://doi.org/10.1016/j.medcli.2021.12.012.

[2] Mederos MA, Reber HA, Girgis MD. Acute Pancreatitis: A Review. JAMA 2021;325:382. https://doi.org/10.1001/jama.2020.20317.

[3] Párniczky A, Kui B, Szentesi A, et al. Prospective, Multicentre, Nationwide Clinical Data from 600 Cases of Acute Pancreatitis. PLoS One 2016;11:e0165309. https://doi.org/10.1371/journal.pone.0165309.

[4] Verma S, Rana SS. Disconnected pancreatic duct syndrome: Updated review on clinical implications and management. Pancreatology 2020;20:1035–44. https://doi.org/10.1016/j.pan.2020.07.402.

[5] Fischer TD, Gutman DS, Hughes SJ, et al. Disconnected Pancreatic Duct Syndrome: Disease Classification and Management Strategies. J Am Coll Surg 2014;219:704–12. https://doi.org/10.1016/j.jamcollsurg.2014.03.055.

[6] Wilcox CM, Bang JY, Asombang A, et al. Management of the Disconnected Pancreatic Duct in Pancreatic Necrosis. Clinical Gastroenterology and Hepatology 2025;0. https://doi.org/10.1016/j.cgh.2025.05.024.

[7] Arvanitakis M, Dumonceau JM, Albert J, et al. Endoscopic management of acute necrotizing pancreatitis: European Society of Gastrointestinal Endoscopy (ESGE) evidence-based multidisciplinary guidelines. Endoscopy 2018;50:524–46. https://doi.org/10.1055/A-0588-5365.

[8] Muthusamy VR, Chandrasekhara V, Acosta RD, et al. The role of endoscopy in the diagnosis and treatment of inflammatory pancreatic fluid collections. Gastrointest Endosc 2016;83:481–8. https://doi.org/10.1016/J.GIE.2015.11.027.

[9] Chong E, Ratnayake CB, Saikia S, et al. Endoscopic transmural drainage is associated with improved outcomes in disconnected pancreatic duct syndrome: a systematic review and meta-analysis. BMC Gastroenterol 2021;21. https://doi.org/10.1186/s12876-021-01663-2.

[10] Varadarajulu S, Rana SS, Bhasin DK. Endoscopic Therapy for Pancreatic Duct Leaks and Disruptions. Gastrointest Endosc Clin N Am 2013;23:863–92. https://doi.org/10.1016/j.giec.2013.06.008.

[11] Arvanitakis M, Dumonceau JM, Albert J, et al. Endoscopic management of acute necrotizing pancreatitis: European Society of Gastrointestinal Endoscopy (ESGE) evidence-based multidisciplinary guidelines. Endoscopy 2018;50:524–46. https://doi.org/10.1055/A-0588-5365.

[12] Chavan R, Nabi Z, Lakhtakia S, et al. Impact of transmural plastic stent on recurrence of pancreatic fluid collection after metal stent removal in disconnected pancreatic duct: a randomized controlled trial. Endoscopy 2022;54:861–8. https://doi.org/10.1055/a-1747-3283.

[13] Liu J, Wei Z, Huang Q, et al. Effect of Plastic Stents Following Lumen-Apposing Metal Stent Placement on Recurrence of Pancreatic Fluid Collections in Disconnected Pancreatic Duct Syndrome: A Systematic Review and Meta-Analysis. Surg Laparosc Endosc Percutan Tech 2024;34:376–82. https://doi.org/10.1097/SLE.0000000000001292.

[14] Hawa F, Chalhoub JM, Vilela A, et al. Efficacy and safety of long-term indwelling plastic stents after resolution of pancreatic fluid collections with endoscopic transmural drainage: a systematic review and meta-analysis. Surg Endosc 2024;38:2350–8. https://doi.org/10.1007/s00464-024-10784-0.

[15] Bang JY, Wilcox CM, Navaneethan U, et al. Impact of Disconnected Pancreatic Duct Syndrome on the Endoscopic Management of Pancreatic Fluid Collections. Ann Surg 2018;267:561–8. https://doi.org/10.1097/SLA.0000000000002082.

[16] Bang JY, Mel Wilcox C, Arnoletti JP, et al. Importance of Disconnected Pancreatic Duct Syndrome in Recurrence of Pancreatic Fluid Collections Initially Drained Using Lumen-Apposing Metal Stents. Clinical Gastroenterology and Hepatology 2021;19:1275–1281.e2. https://doi.org/10.1016/j.cgh.2020.07.022.

[17] Bang JY, Wilcox CM, Trevino J, et al. Factors impacting treatment outcomes in the endoscopic management of walled-off pancreatic necrosis. J of Gastro and Hepatol 2013;28:1725–32. https://doi.org/10.1111/jgh.12328.

[18] Rana SS, Sharma R, Sharma G, et al. Safety and Efficacy of Long-Term Transmural Plastic Stent Placement After Removal of Lumen Apposing Metal Stent in Resolved Pancreatic Fluid Collections with Duct Disconnection at Head/Neck of Pancreas. Dig Dis Sci 2023;68:3436–41. https://doi.org/10.1007/s10620-023-07973-7.

[19] Pawa R, Dorrell R, Russell G, et al. Long-term transmural drainage of pancreatic fluid collections with double pigtail stents following lumen-apposing metal stent placement improves recurrence-free survival in disconnected pancreatic duct syndrome. Digestive Endoscopy 2022;34:1234–41. https://doi.org/10.1111/den.14266.

[20] Koutlas N, Bentley B, Dorrell R, et al. Clinical outcomes of long-term transmural drainage with double pigtail stents in disconnected pancreatic duct syndrome. Transl Gastroenterol Hepatol 2024;9:4. https://doi.org/10.21037/tgh-23-94.

[21] Iwashita T, Sato T, Hamada T, et al. Risk of recurrence with or without plastic stent after EUS-guided treatment of peripancreatic fluid collections: A systematic review and meta-analysis. Endosc Int Open 2024;12:E188–98. https://doi.org/10.1055/a-2226-1237.

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Table 1. Studies characteristics.

First Author	Year	Design	N	Won	Pseudocyst	Follow-up	Definition of recurrence
Bang et al.	2013	Retrospective cohort	76	76	0	24 months	symptomatic peripancreatic fluid collection diagnosed on CT imaging following initial treatment success
Bang et al.	2018	Retrospective cohort	291	114	44	7 years	NR
Bang et al.	2021	prospective cohort	94	80	14	5 years	Presence of new collection in same location 3-4 weeks after resolution
Pawa et al.	2022	Retospective cohort	48	42	6	20 months	Reaccumulation of PFC (>2 cm) in the same location on follow-up imaging
Rana et al.	2023	Retrospective cohort	53	53	0	16 months	NR

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Chavan et al.	2022	Clinical trial	104	104	0	18 months	Ocurrence of a new PFC at the same location after prior documented resolution of WON
Koutlas et al.	2024	Retrospective cohort	139	40	4	18 months	PFCs that increased to greater than 2 cm following LAMS removal were categorized as recurrent collections

Table 2. Quality analysis of included studies.

Study identification	Total score	Quality
JY Bang et al. (2013)	5	Moderate
JY Bang et al. (2018)	6	Moderate
JY Bang et al (2021)	7	High
Pawa et al (2022)	6	Moderate
Chavan et al.(2022)*	8	High

Rana et al. (2023)	9	High
Koutlas et al. (2024)	7	High

Table 3. Show the recurrences in each group.

First Author	**Year**	**Design**	**Groups**	**N**	**N recurrence**	**Follow-up**
Bang et al.	2013	Retrospective cohort	G1 DPS	29	0	24 months
			G2 No	24	5	
Bang et al.	2018	Retrospective cohort	G1 DPS	121	2	7 years
			G2 No	46	8	
Bang et al.	2021	prospective cohort	G1 DPS	70	1	5 years
			G2 No	24	6	
Pawa et al.	2022	Retospective cohort	G1 DPS	21	1	20 months
			G2 No	27	10	
Rana et al.	2023	Retrospective cohort	G1 DPS	39	2	16 months
			G2 No	14	6	
Chavan et al.	2022	Clinical Trial	G1 DPS	52	3	18 months
			G2 No	52	3	
Koutlas et al.	2024	Retrospective cohort	G1 DPS	44	2	18 months
			G2 No	34	12	

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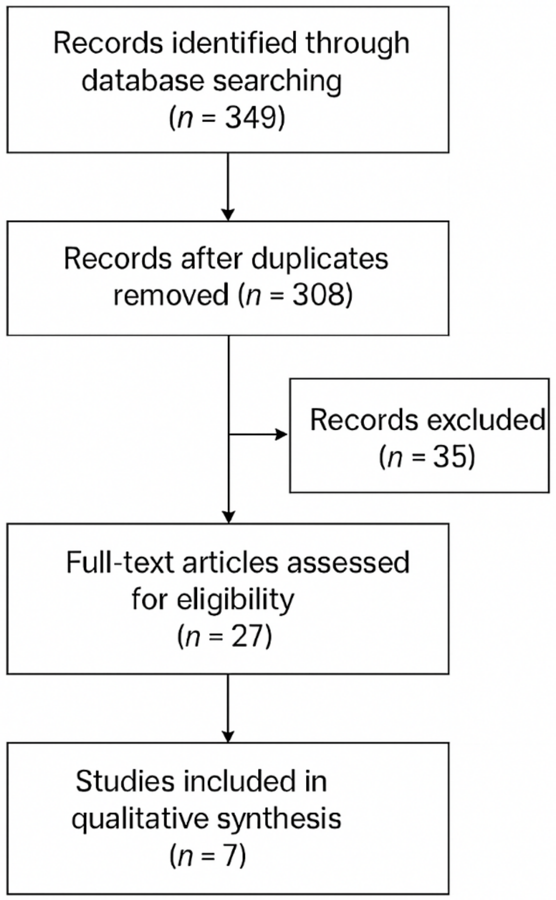

Figure 1: Flowchart of included studies.

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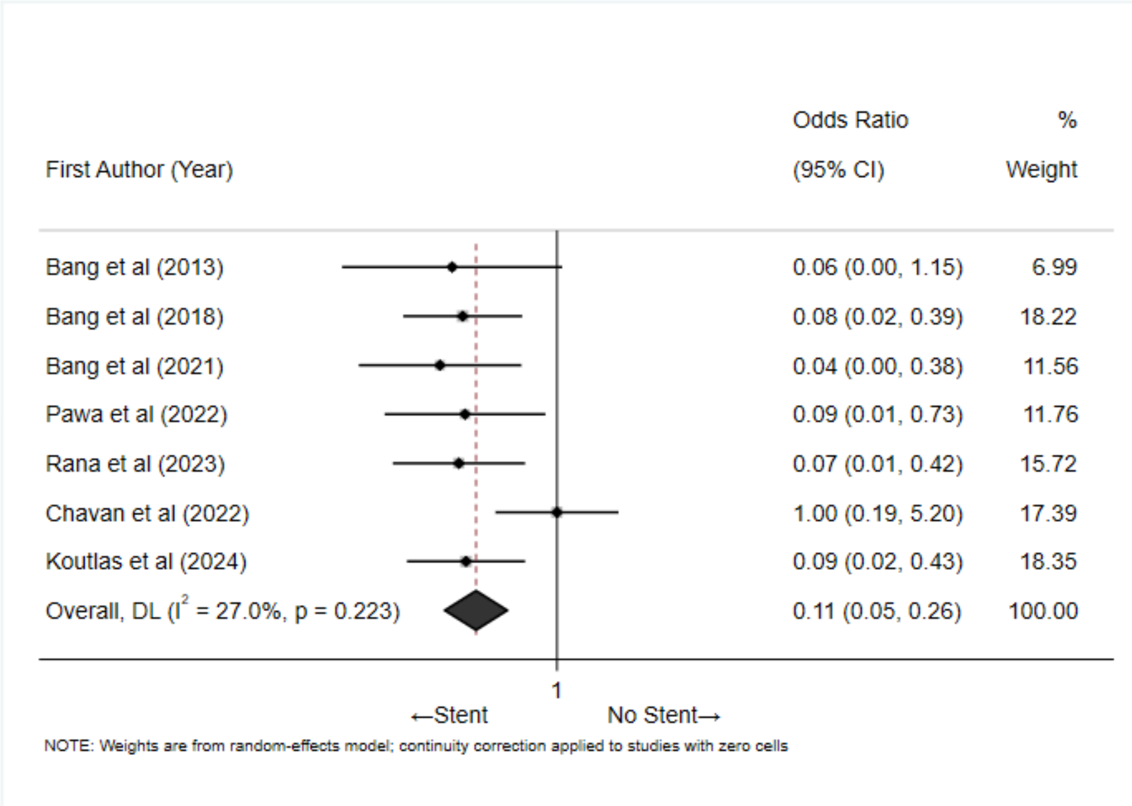

Figure 2. Forest plot for primary outcome

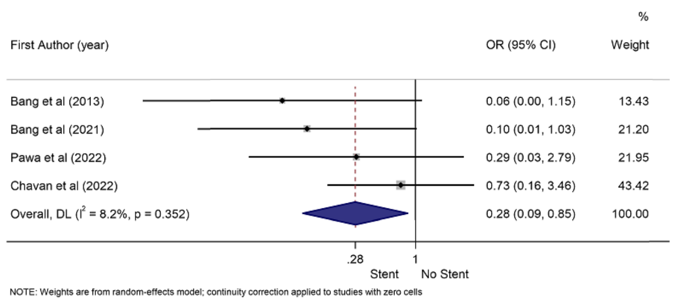

Figure 3. Forest plot for need for reintervention

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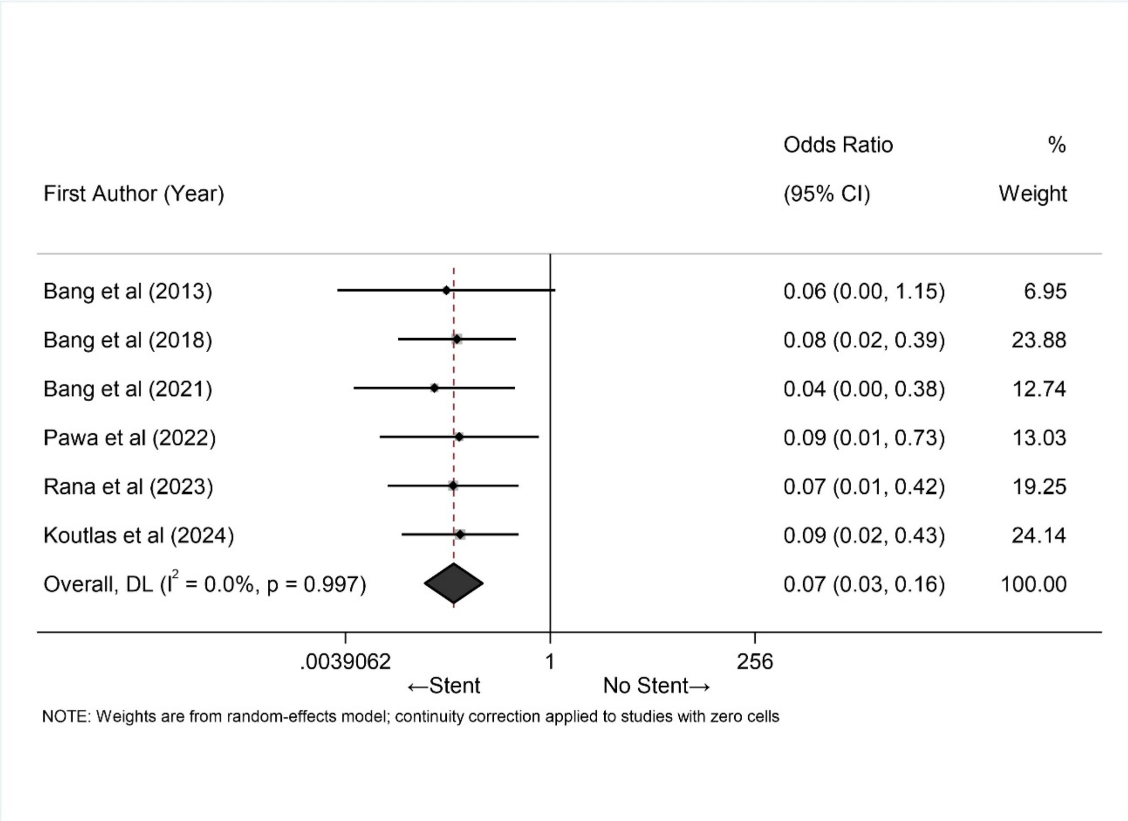

Figure 4: Forrest plot for recurrence in observational studies.