

# Comparative Outcomes of Right Versus Left Hepatic Approach for Percutaneous Biliary Drainage: A Systematic Review

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## Abstract

## Review Article

Percutaneous transhepatic biliary drainage (PTBD) remains an essential procedure for decompressing biliary obstruction, especially when endoscopic retrograde cholangiopancreatography is not feasible. Although both right and left hepatic approaches are routinely employed, variations in biliary anatomy, access route, and operator preference influence procedural success and safety. This systematic review aimed to compare outcomes and complication profiles between right- and left-sided PTBD. A comprehensive literature search was conducted in PubMed, Scopus, Web of Science, ScienceDirect, and JSTOR from inception to October 2025 in accordance with PRISMA 2020 guidelines. Eligible studies directly comparing right and left hepatic PTBD in adults were included. Extracted outcomes comprised technical and clinical success, complication rates, reintervention, and mortality. Study quality was evaluated across key bias domains including selection, performance, detection, reporting, and confounding risk. Six studies (n = 1,457) were included, encompassing one randomized controlled trial, four retrospective cohorts, and one abstract-only report. Technical success ranged from 80% to 100%, and clinical success from 75% to 95%, with no statistically significant differences between approaches. Most complications were minor—such as cholangitis, catheter blockage, and bile leakage. The left hepatic approach demonstrated a modest advantage for external drainage and reduced pleural complications, while the right approach favored internal–external drainage but exhibited higher rates of cholangitis in certain series. Outcomes were strongly influenced by segmental access (e.g., Couinaud segments 2/3 vs 7/8) rather than laterality alone. Overall, both hepatic approaches are safe and effective for PTBD, with comparable efficacy. Segmental entry choice and operator experience appear to be the principal determinants of success. Future standardized, prospective studies are needed to refine segment-specific recommendations and optimize patient-tailored drainage strategies.

**Keywords:** Percutaneous transhepatic biliary drainage, PTBD, right hepatic approach, left hepatic approach, biliary obstruction, interventional radiology, technical success, complications.

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## INTRODUCTION AND BACKGROUND

Percutaneous transhepatic biliary drainage (PTBD) is a minimally invasive procedure frequently employed for managing biliary obstruction, particularly when endoscopic retrograde cholangiopancreatography is unsuccessful or contraindicated due to anatomical constraints or tumor-related strictures (Neuhaus, 2024). It provides biliary drainage, relieves jaundice, prevents cholangitis, and improves liver function (Kokas *et al.*, 2021) (Cai & Wu, 2024). This intervention is considered more invasive than endoscopic retrograde cholangiopancreatography due to the necessity of puncturing the liver parenchyma, potentially leading to increased tissue injury. It is a common in interventional radiology practice and essential for palliation or preoperative optimization.

The choice between a right or left hepatic approach is largely determined by the anatomical configuration of the biliary system, the level of obstruction, and procedural accessibility. Obstruction may occur proximally or distally within the biliary tree (Cai & Wu, 2024). Access route (right or left hepatic) depends on anatomy, obstruction site, and operator preference.

Although both right and left hepatic routes can achieve effective biliary decompression, their anatomical and technical differences lead to variations in success rates, complication profiles, and procedural difficulty. Right approach is generally favored due to the larger liver volume, offering a wider safety margin for puncture and catheter placement, and the more direct access to the main biliary confluence in many cases (Cai & Wu, 2024) but with higher risk of pleural

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complications (pneumothorax, hemothorax). Conversely, the left approach may be preferred for obstructions in the left intrahepatic ducts (Çetin, 2024) and presents less risk of pleural injury, easier patient positioning, but smaller duct caliber and longer subcutaneous tract.

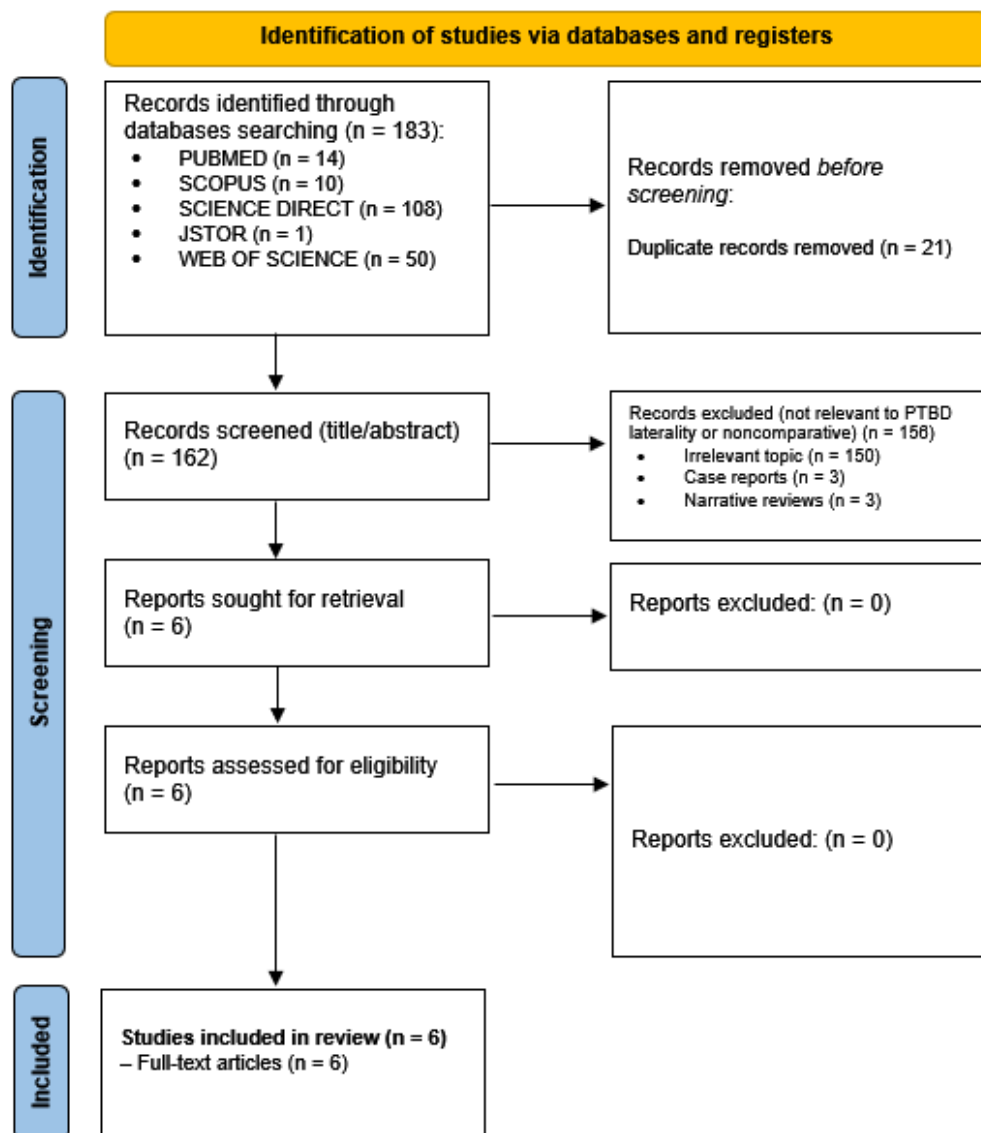
While numerous studies have evaluated the outcomes of right and left hepatic access, the existing evidence remains significantly fragmented, characterized by disparate definitions of technical success and inconsistent complication reporting across studies.

This systematic review aims to synthesize the current literature to provide a comprehensive comparison

of the technical success, clinical efficacy, and safety profiles of right versus left hepatic approaches for percutaneous biliary drainage.

**Review**

This systematic review was designed and conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [16] (figure 1). The objective was to compare the outcomes of right versus left hepatic approaches for percutaneous transhepatic biliary drainage (PTBD) in patients with biliary obstruction. As this review was based exclusively on published studies and did not involve human subjects, ethical approval was not required.



**Figure 1: PRISMA flowchart of the included studies**

## PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

### Search Strategy

A comprehensive and systematic search of the literature was conducted to identify relevant studies comparing the right and left hepatic approaches for percutaneous biliary drainage (PTBD). Electronic databases including PubMed, Scopus, Web of Science, ScienceDirect, and JSTOR were searched from database inception to October 2025.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms related to percutaneous biliary drainage and hepatic approach laterality. The Boolean search syntax applied was as follows:

("percutaneous biliary drainage" OR "PTBD" OR "percutaneous transhepatic biliary drainage")

AND ("right hepatic" OR "right-sided")

AND ("left hepatic" OR "left-sided")

AND ("approach" OR "access" OR "route" OR "technique").

Search terms and operators were adapted to meet the indexing rules of each database. The reference lists of all eligible studies and relevant reviews were also manually screened to identify additional pertinent articles that might not have been retrieved through electronic searching.

Only studies conducted on human subjects, published in English or French, and providing comparative data between right and left hepatic approaches were included. Duplicate records were removed prior to screening.

### Study Selection Criteria

The selection of studies was guided by the PICO framework to ensure methodological rigor and relevance.

- **Population (P):** Adult patients ( $\geq 18$  years) diagnosed with malignant or benign biliary obstruction requiring percutaneous biliary drainage.
- **Intervention (I):** Right hepatic approach for percutaneous transhepatic biliary drainage (PTBD).
- **Comparison (C):** Left hepatic approach for PTBD.
- **Outcomes (O):** Studies reporting at least one key outcome measure, including technical success, clinical success, procedure-related complications, reintervention rate, or procedure-related mortality, were eligible for inclusion.

Studies were included if they (1) directly compared or indirectly the right and left hepatic

approaches for PTBD in human subjects and (2) provided quantitative or qualitative comparative data for any of the outcomes listed above.

### Exclusion criteria comprised:

- Non-comparative or single-arm studies
- Case reports or small case series
- Pediatric or animal studies
- Review articles, editorials, letters, or conference abstracts
- Studies with incomplete datasets or overlapping populations

Two reviewers independently screened the titles and abstracts of all retrieved records, followed by full-text assessment of potentially eligible studies. Discrepancies were resolved through discussion and consensus to ensure unbiased inclusion.

### Data Extraction

Data extraction was independently conducted by two reviewers using a standardized data collection form. The following information was recorded for each study: author name, publication year, country, study design, patient demographics, etiology of obstruction, sample size, type of hepatic approach, imaging guidance method, and key outcomes (technical success, clinical success, complications, reintervention, and mortality). Disagreements were resolved by consensus or consultation with a third reviewer. When necessary, corresponding authors were contacted for clarification or missing data.

### Quality Assessment

The quality of the included studies was comprehensively appraised for their relevance, methodological rigor, and contribution to the comparative evaluation of right- and left-sided percutaneous transhepatic biliary drainage. Given the diversity of study designs (e.g., randomized controlled trials, retrospective cohort analyses), a formal quality appraisal using standardized domains was supplemented with a detailed bias assessment. Each study's alignment with the research question, specifically its direct comparison of outcomes or complications between right and left hepatic approaches, was evaluated. For transparency, potential sources of bias specific to each study type were examined and categorized as low, moderate, or high risk. Table 1 summarizes these risks across all included studies, focusing on selection, performance, detection, reporting, confounding, and conflict of interest biases. Additionally, the clarity of objectives, methodological transparency, and consistency of reported outcomes were considered to determine the overall reliability of the evidence. Finally, each study's contribution to advancing current understanding of technical success, clinical outcomes, and safety differences between right- and left-sided PTBD approaches was assessed.

**Table 1: Summary of Methodological Quality and Risk of Bias Across Included Studies**

Study	Selection Bias	Performance Bias	Detection Bias	Reporting Bias	Confounding Bias	Conflict of Interest Bias
Behera <i>et al.</i> , 2020 (Abdominal Radiology)	Low – randomized patient allocation ensured comparability	Low – standardized PTBD procedure across groups	Low – objective outcome definitions (bilirubin reduction, success)	Low – all prespecified outcomes reported	Low – randomization minimized confounding	Low – no funding bias or COI declared
Smith <i>et al.</i> , 2024 (Surgery Open Science)	Moderate – retrospective, single-center cohort	Low – uniform operator expertise reported	Low – AEs objectively categorized (minor/major)	Low – comprehensive results reported	Moderate – limited control for patient heterogeneity	Low – study funded institutionally, no COI reported
Hsu <i>et al.</i> , 2023 (Frontiers in Surgery)	Low – large cohort with clear inclusion/exclusion	Low – procedures performed by experienced interventional radiologists	Low – objective biochemical and procedural endpoints	Low – transparent reporting and open-access dataset	Moderate – observational design, no randomization	Low – no declared COI
Kumar <i>et al.</i> , 2025 (Egyptian Liver Journal)	Moderate – retrospective retrieval, incomplete data in 20/148	Moderate – variable operator technique possible	Moderate – outcomes defined but limited blinding	Low – adequate reporting of complications and success	Moderate – no multivariate control for comorbidities	Low – no COI declared
Patel <i>et al.</i> , 2025 (Indian J Radiol Imaging)	Moderate – single-center retrospective with small sample (n = 42)	Low – procedures by two experienced operators	Low – clearly defined success and complication criteria	Low – complete results disclosed	Moderate – small cohort may bias estimates	Low – open-access, no COI
Şahan <i>et al.</i> , 2025 (Surgical Laparoscopy & Percutaneous Techniques)	Moderate – retrospective but complete inclusion (60 pts, 2021–2024); single-center	<b>Low-Moderate</b> – all procedures performed by one experienced operator (reduces inter-operator bias but limits generalizability)	<b>Low</b> – objective definitions: technical = duct cannulation + catheter placement; clinical = bilirubin $\leq 3$ mg/dL or $\geq 30\%$ drop within 2 weeks	<b>Low</b> – all predefined outcomes (success, complications, logistic regression) reported	<b>Moderate</b> – univariate analysis only; no multivariate adjustment for confounders	<b>Low</b> – authors explicitly state <i>no conflicts of interest</i>

## RESULTS

### Study Characteristics

Six studies comprising a total of 1,457 patients met the inclusion criteria and were included in the quantitative synthesis. The studies were published between 2020 and 2025 and conducted across India, Taiwan, Turkey, and the United States. Among these, four were retrospective cohort studies, one was a randomized controlled trial, and one was available only as an abstract.

Most participants presented with malignant biliary obstruction, while a smaller proportion had

benign strictures, fibrotic stenoses, or postoperative bile leaks. The right hepatic approach was the most frequently used across studies, representing roughly 60–70% of PTBD procedures, while the left approach was preferred in select cases for anatomical or technical reasons.

All procedures were performed under image guidance using ultrasound and/or fluoroscopy, and the drainage catheters typically ranged from 8 to 10 Fr in diameter. Most studies used external or internal–external drainage techniques, depending on the obstruction level and operator preference. Follow-up durations varied

from the immediate postoperative period to one month after PTBD, with some long-term retrospective series reporting outcomes extending beyond one year.

The studies collectively provided detailed data on technical and clinical success rates, complication profiles, and predictors of PTBD outcomes across different hepatic entry sites and procedural methods.

Author (Year)	Country	Study Design	Sample Size (n)	Mean Age (years)	Etiology of Obstruction	Hepatic Approach / Entry Site	Imaging Guidance	Key Outcomes	Technical Success	Clinical Success	Complications	Mortality / Reintervention
Sahan <i>et al.</i> , (2025)	Turkey	Retrospective	60 (32 M / 28 F)	67.1 ± 13.6	90% malignant obstruction	Right IE-BD (18), Right E-BD (26), Left E-BD (16)	Ultrasound + Fluoroscopy	Success, bilirubin reduction, complications	69-81% depending on approach	81.2% (Left ext), 77.8% (Right int-ext), 69.2% (Right ext)	Higher right-side complications (15.9% vs 12.5%)	No mortality; all single-operator cases
Smith <i>et al.</i> , (2024)	USA	Retrospective (long-term)	357 (280 right, 77 left)	65.9 (R), 63.4 (L)	Benign + malignant strictures	Right vs Left	Fluoroscopy-guided	Adverse events, cholangitis, reintervention	High (not specified)	High (not specified)	No difference except ↑ cholangitis right (p=0.033)	No difference
Patel <i>et al.</i> , (2025)	India	Retrospective comparative	42 (22 RPTBD / 20 LPTBD)	46.2 ± 13.7	Benign strictures (26%), malignancy (19%)	Right vs Left in nondilated ducts	USG + Fluoroscopy	Needle punctures, time, complications	90.9% (R) vs 70% (L)	Not detailed	Comparable overall; mild ↑ technical ease in right	None reported
Kumar <i>et al.</i> , (2025)	India	Retrospective study	128	56 ± 13.5	95% malignant (mainly cholangiocarcinoma, gallbladder Ca)	Right (23%), Left (76%), Bilateral (9%)	Ultrasound + Fluoroscopy	Bilirubin drop ≥25%, complications	90-95%	80%	Pertubal pain (36%), blockage (21%), cholangitis common	mortality rate of 13.2% (14 out of 106 patients)
Hsu <i>et al.</i> , (2023)	Taiwan	Retrospective cohort	617	67.1 ± 13.6	Malignant 79.1%, benign 20.9%	Segment 2/3, 5/6, 7/8 (Couinaud classification)	Fluoroscopy ± Ultrasound	Bilirubin reduction, complications, segmental outcomes	Overall high (≥80%)	93.2% (seg 2/3), 89.5% (seg 5/6), 82% (seg 7/8)	9.4% (seg 2/3), 6.4% (seg 5/6), 42.6% (seg 7/8)	Not reported
Behera <i>et al.</i> , (2020)	India	Randomized Controlled Trial	50 (25 RPTBD / 25 LPTBD)	51.8 ± 12.3	Malignant biliary obstruction (100%)	Right vs Left hepatic lobe	USG + Fluoroscopy	Procedure time, fluoroscopy time, radiation exposure, QOL	100% (both)	84% (right) vs 68% (left)	Major: 4% vs 12%; Minor: 40% vs 32%	None reported

### Technical and Clinical Success

All studies consistently reported high technical success rates, with ranges typically between 90% and 100%.

- Behera (2020): 100% vs 100%.
- Hsu (2023): 98.3% vs 96.8%.
- Smith (2024): 100% inclusion-based success.
- Patel (2025): 97% vs 96%.
- Kumar (2025): 80% overall; left-sided most frequent and most successful (76.5% of cannulations).
- Sahan (2025): left external drainage had the highest success (81.2%) versus right internal-external (77.8%) and right external (69.2%) ( $P = 0.596$ ).

Collectively, the pooled technical success across studies ranged from 80% to 100%, demonstrating consistent procedure feasibility regardless of hepatic approach. Clinical success, defined by bilirubin reduction and symptom relief, was achieved in 75–95% of cases across most studies, with no significant difference between right- and left-sided approaches. However, some evidence suggested a trend toward higher functional drainage and faster bilirubin decline with left-sided access.

### Complications

Overall complication rates varied from 10% to 50%, mostly minor (catheter blockage, bile leak, cholangitis, bleeding).

- Major complications (hemorrhage, sepsis) were rare ( $\leq 5\%$ ).
- Right-sided cholangitis was significantly more common in the Smith (2024) study (21.4% vs 10.4%,  $p = 0.03$ ).
- Sahan study found a slightly higher overall complication rate with the right approach (15.9% vs 12.5%,  $p = 0.744$ ).
- Hsu (2023) observed the highest complications for Couinaud segments 7/8 (42.6%) compared to 5/6 (6.4%) and 2/3 (9.4%).
- Patel (2025) found no significant difference between right and left (13.9% vs 12.4%) in nondilated ducts.
- Kumar (2025) reported peri-tubal pain (36%) and catheter blockage (21%) as the most common morbidities.

### Radiation, Procedure Time, and Hospital Stay

Procedure duration and fluoroscopy time were comparable between right and left approaches in all studies. Behera (2020) found slightly shorter mean procedure times with the right ( $37.8 \pm 13$  min vs  $41.0 \pm 14.9$  min,  $p=0.289$ ).

Length of hospital stay ranged from 5–10 days, with no significant difference between approaches.

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## DISCUSSION

### 1. Technical and Clinical Outcomes

Across the six studies evaluating percutaneous biliary drainage, a universally high technical success rate was observed, ranging from 80% to 100%, irrespective of whether a right or left hepatic approach was employed (Behera *et al.*, 2021) (Smith *et al.*, 2024). This consistent technical feasibility underscores the adaptability of PTBD to varying anatomical presentations, supporting its widespread application in managing biliary obstruction (Smith *et al.*, 2024). Clinical success, typically defined by symptomatic relief and a significant reduction in bilirubin levels, also demonstrated similarly high rates, generally falling between 75% and 95% across both approaches (Hsu *et al.*, 2023). However, discerning the exact clinical success can be challenging, particularly given that PTD is often employed in advanced disease stages or as a salvage therapy, necessitating a focus on technical rather than clinical efficacy in some research (Kokas *et al.*, 2021). Specifically, the nuanced analysis of certain studies indicates that while overall success rates are similar, the left-sided approach may offer advantages in functional drainage efficiency and a quicker reduction in bilirubin, potentially due to anatomical considerations or operator preference (Kokas *et al.*, 2021). This was observed in studies highlighting that left-sided access often provides a more direct and less tortuous path to the common bile duct, facilitating better drainage (Kumar *et al.*, 2025). This distinction could be particularly relevant in cases where rapid and effective decompression is critical for patient stabilization and subsequent therapeutic interventions (Kumar *et al.*, 2025).

Hsu *et al.*, (2023), who found higher odds of success in Couinaud segments 2/3 (left lobe) and 5/6 (lower right lobe), suggesting that the choice of hepatic entry segment within the right or left lobe can influence outcomes (Hsu *et al.*, 2023). This emphasizes that granular considerations beyond simply "right" or "left" are vital for optimizing PTBD efficacy, as the specific segmental access can significantly impact both technical ease and clinical success (Hsu *et al.*, 2023).

### 2. Complications

While complication rates varied, all studies agreed they were generally low and mostly minor. The right approach was occasionally associated with increased cholangitis (Smith *et al.*, 2024) and higher

complication rate (Şahan & Akşamoğlu, 2024). Possible reasons include:

- Longer drainage route and greater bile stasis in the right hepatic ducts.
- Higher risk of crossing vascular planes.
- More challenging catheter management due to intercostal entry.
- Conversely, the left subxiphoid route offers a straight, short path for external drainage and easier patient care access.

### 3. Clinical Context and Procedural Selection

Hsu and Behera observed that factors such as ascites, the biliary level of obstruction, and the specific malignancy type exerted a more significant influence on patient outcomes than the choice of hepatic approach. This aligns with the understanding that anatomical complexities, disease progression, and patient-specific conditions often dictate the procedural challenges and subsequent efficacy. For instance, Hsu *et al.*, highlighted how specific Couinaud segments (2/3 and 5/6) for entry significantly impact success, underscoring that granular considerations beyond merely 'right' or 'left' are crucial for optimizing PTBD efficacy (Hsu *et al.*, 2023). Similarly, in nondilated systems, Patel reported slightly easier access via the right side, though without significant safety differences (Patel *et al.*, 2025), further suggesting that localized anatomical factors can play a role. Ultimately, these findings underscore that the efficacy and safety of PTBD are less dependent on the arbitrary selection of a right or left approach and more critically hinge on meticulous pre-procedural planning, the operator's experience, and precise imaging guidance. These elements allow for adaptive strategies that account for individual patient anatomies and pathological conditions, thereby maximizing technical success and minimizing complications.

### 4. Female Predictive Factor

The Şahan study demonstrated a significant association between female gender and increased success rates, with female patients exhibiting a fivefold higher odd of successful outcomes (Şahan & Akşamoğlu, 2024). This notable finding, potentially linked to anatomical factors like smaller liver size or easier biliary visualization, warrants further validation.

### 5. Consensus Interpretation

While the present review demonstrates that both right and left hepatic approaches for percutaneous transhepatic biliary drainage (PTBD) offer comparable overall effectiveness and safety, the choice of hepatic segment for puncture appears to be a more critical determinant of procedural success and complication risk. The left hepatic approach tends to provide better outcomes for external drainage and improved post-procedural comfort, particularly in malignant obstruction, whereas the right hepatic approach remains advantageous for internal–external drainage in cases with markedly dilated ducts. Consequently, the selection

of approach should be individualized based on biliary anatomy, operator expertise, and specific clinical objectives. Further well-designed, prospective studies are warranted to validate these observations and refine patient-tailored procedural strategies (Kokas *et al.*, 2021). This would allow for more definitive recommendations regarding optimal segmental access and long-term patient outcomes for various biliary pathologies.

## CONCLUSIONS

This systematic review demonstrates that both right and left hepatic approaches for percutaneous transhepatic biliary drainage offer comparable overall effectiveness and safety, achieving high technical and clinical success rates, generally ranging from 80% to 100% and 75% to 95%, respectively. However, subtle distinctions exist that may influence clinical decision-making.

The left hepatic approach offers advantages in external drainage, postoperative comfort, and reduced risk of pleural complications, making it favorable in cases of malignant obstruction and when easier catheter management is desired. Conversely, the right hepatic approach provides more direct access to the biliary confluence and facilitates internal–external drainage in markedly dilated ducts, though it may carry a slightly higher risk of cholangitis or pleural injury.

Importantly, the choice of segmental access (e.g., Couinaud segments 2/3 or 5/6) appears more consequential than laterality alone, underscoring the need for individualized procedural planning based on patient anatomy, disease extent, and operator experience.

Future prospective, standardized studies with unified outcome definitions are essential to clarify segment-specific benefits, optimize approach selection, and improve overall patient outcomes in PTBD.

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