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Original Article

A Retrospective Analysis Comparing Technical Difficulty and Safety between Right and Left-sided Percutaneous Transhepatic Biliary Drainage in a Nondilated Biliary System

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Abstract

Objective The aim of this study was to compare the technical difficulty and safety between right-sided percutaneous transhepatic biliary drainage (R-PTBD) and left-sided percutaneous transhepatic biliary drainage (L-PTBD) in patients with nondilated bile ducts.

Materials and Methods Forty-two patients (22 males and 20 females with a mean age of 46.2 ± 13.7 years) who received PTBD in nondilated bile ducts (from September 2021 to January 2024) were dichotomized into the R-PTBD ($n = 22$) and L-PTBD ($n = 20$) groups. The number of needle punctures, successful biliary punctures, technical success, difficulty in catheter placement, total fluoroscopic time, total procedure time, overall complications, and hemorrhagic complications were evaluated and compared between the groups.

Results The R-PTBD group had significantly fewer needle punctures for biliary access (3.9 ± 1.3 vs. 4.3 ± 1.3; $p = 0.004$) and a shorter procedure duration (21 ± 8.5 vs. 29.9 ± 13.2 minutes; $p = 0.021$) than the L-PTBD group. The successful biliary puncture (20 [90.9%] vs. 15 [75%]; $p = 0.229$) and technical success rate (20 [90.9%] vs. 14 [70%]; $p = 0.123$) were also higher for the R-PTBD group than for the L-PTBD group, while R-PTBD required less fluoroscopic time (5.83 [3.5–8.13] vs. 8.16 [4.34–12.9] minutes; $p = 0.113$). However, these differences did not reach statistical significance ($p > 0.05$). Further, difficulty during catheter placement was more frequently encountered in the L-PTBD group (02 [9%] vs. 04 [20%]; $p = 0.367$). The overall complication and hemorrhagic complication rates were comparable between both groups.

Keywords
- percutaneous transhepatic biliary drainage
- nondilated bile ducts
- right-sided versus left-sided PTBD
- adverse events
- benign biliary system
- obstructive biliopathy

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Conclusion When both approaches are equally suitable for patients with nondilated bile ducts, R-PTBD may be favored over L-PTBD, given the evidence demonstrating less technical difficulty in the right-sided approach than in the left-sided approach.

Introduction

Percutaneous transhepatic biliary drainage (PTBD) plays an essential role in managing obstructive biliopathy and postoperative bile leak, mainly when endoscopy is not feasible or fails. PTBD in a dilated system is easy and can be performed even at the bedside under ultrasound guidance alone.[1] On the contrary, PTBD in nondilated bile ducts (BDs) is technically challenging and requires adequate expertise. Central puncture in nondilated PTBD may be technically easier; however, it carries a higher risk of vascular complications. Therefore, peripheral BD puncture is preferred to central puncture.[2] When the peripheral BD is not visualized on ultrasonography (USG), the accompanying portal vein wall is punctured, and the needle is manipulated to get biliary access.[3] This requires precise needle placement under USG guidance. The technical success rate for PTBD in nondilated BDs ranges from 75 to 90%, with a higher complication rate than PTBD performed in dilated BDs.[4–7] Several studies have shown the difference in technical and clinical success between the right- and left-sided PTBD.[8–11] However, data regarding right- versus left-sided PTBD in nondilated biliary systems are lacking.

The present study aims to compare the technical difficulty and safety between the right- and left-sided PTBD in a nondilated system.

Materials and Methods

Study Population

It is a single-center retrospective study performed at a tertiary care hospital. The institutional review board waived approval for this study due to its retrospective nature.

Our departmental database was searched for clinical, laboratory, procedural, and postprocedural details of patients who underwent PTBD from September 2021 to January 2024. Of 562 PTBD patients, 79 patients underwent PTBD in nondilated BDs. Patients fulfilling the following criteria were included in the study: (1) older than 18 years, (2) PTBD performed in the nondilated biliary duct, and (3) patent primary biliary confluence. Patients with incomplete clinical or demographic details were excluded. Finally, 42 patients who underwent PTBD in nondilated BDs with patent primary biliary confluence were included in the analysis. The patients were dichotomized into the right-sided PTBD (R-PTBD) and left-sided PTBD (L-PTBD) groups. The nondilated BD was defined as intrahepatic peripheral BD less than 2 mm or the diameter of the BD less than that of the adjacent portal vein on USG.

Patients' demographic details (age and sex), pathological diagnosis, side of drainage (right/left), and baseline laboratory parameters were collected. The number of needle punctures, successful biliary puncture, technical success rate, total fluoroscopic time, total procedure time, difficulty in catheter placement, and complications were recorded separately for R-PTBD and L-PTBD in nondilated BDs. The successful biliary puncture was defined as the appropriate positioning of the needle, which was confirmed by contrast opacification of the biliary tree followed by the insertion of a guidewire into the biliary tree. Technical success was defined as drainage tube placement within the biliary tree with bile drainage. Complications were categorized according to the Society of Interventional Radiology (SIR) adverse event (AE) classification system[12] and were divided into minor and major complications. All intraprocedural and early postprocedural complications (within 72 hours of the procedure) were collected.

Percutaneous Transhepatic Biliary Drain Procedure

All PTBD procedures were performed in our department's angiographic suite under combined fluoroscopic and ultrasound guidance by one of the two interventional radiologists (right-handed operators) with more than 3 years of experience in hepatobiliary intervention. Written informed consent was obtained in all cases before proceeding with the procedure. Initial screening USG was performed on all patients to choose the suitable peripheral BD for a puncture, and a right or left approach was chosen at the discretion of the interventional radiologist. In case of an international normalized ratio greater than 1.5 and/or platelet counts less than 50,000/mm^3, appropriate measures were taken to correct the coagulopathy.

All PTBD procedures were performed under local anesthesia with mild sedation. The anterior subxiphoid approach was used for the L-PTBD, and the right lateral intercostal approach below the 10th rib was used for the R-PTBD. Under USG guidance, the puncture site was anesthetized from the skin surface to the liver capsule with 10 to 15 mL of 1% lignocaine solution using a 25-gauge needle. Under USG guidance, a suitable peripheral branch of the BD was punctured using a 21-gauge needle of the Micropuncture Introducer set (Cook Medical) or a 22-gauge Chiba needle of the Neff Percutaneous Access Set (Cook Medical). When the BD was not visualized on USG, the anterior or posterior wall of the accompanying peripheral portal vein branch was targeted. Then, a small amount (0.5–1 mL) of diluted iodinated contrast (mixture of iohexol and normal saline in a 1:1 ratio) was slowly injected under fluoroscopic guidance to look for biliary opacification. Minor manipulations were made under combined USG and fluoroscopic guidance until BD opacification was noted. Once the intrabiliary position of the needle tip was confirmed, a 0.018-inch nitinol guidewire was inserted into the biliary tree. Then, the 4-Fr introducer set comprising the inner and outer sheath was introduced into the biliary tree and converted into a 0.035-inch access system. A 0.035-inch angled hydrophilic guidewire (Terumo) was manipulated. Then, a 5-Fr KMP (Kumpe, Cook Medical) catheter was introduced. Over a 0.035-inch stiff guidewire (Amplatz, Cook Medical), the tract was sequentially dilated up to 8 Fr, and an 8-Fr pigtail catheter was placed within the biliary tree for external drainage. The catheter was secured to the skin with sutures, followed by the attachment of a drainage bag. The contralateral approach was attempted in case of technical failure from one side.

Statistical Analysis

Quantitative parameters were expressed in means or median as per the data distribution. An independent *t*-test or Mann–Whitney *U* test was used to compare the quantitative parameters in the R-PTBD versus L-PTBD. The chi-squared or Fisher's exact test was used to compare the data collected on a nominal scale. A *p*-value of ≤ 0.05 was considered statistically significant. All analyses were performed using SPSS version 23.0 (IBM, Chicago, IL, United States).

Results

The demographic and baseline clinical characteristics are the following: A total of 42 PTBD patients who underwent PBTD in a nondilated system were included in the study. Of note, all patients had a patent primary biliary confluence, necessitating only a single PTBD (right/left) for drainage of the entire biliary system. Twenty-two (52.3%) patients were males and 20 (47.7%) were females. The average age of the patients in our study cohort was 46.2 ± 13.7 years (range: 22–76 years).

The two most common etiologies of obstructive biliopathy were benign biliary stricture (11/42 [26.2%]) and pancreatic adenocarcinoma (8/42 [19%]). Three patients (7.1%) underwent PTBD for postoperative bile leak. Thirteen (30.9%) patients had features of cholangitis on presentation. Of 14 (33.3%) patients, 9 (21.4%) had mild ascites, while 5 (11.9%) had also had perihepatic fluid. Three patients required ascitic drainage before PTBD.

The median total bilirubin at baseline was 8.9 mg/dL (4.7–13.6 mg/dL), with a median direct and indirect bilirubin of 5.1 and 3.5 mg/dL, respectively. The other relevant baseline laboratory parameters are summarized in ►**Table 1**.

Table 1 Baseline characteristics of the study cohort ($n = 42$)

Parameters	Value ($n = 42$)
Age (y), mean ± (SD)	46.2 ± 13.7 (22–76)
Sex (M:F)	22:20
Etiology, *n* (%)	
Benign biliary stricture	11 (21.6)
Carcinoma gallbladder	6 (14.2)
Pancreatic adenocarcinoma	8 (19)
Ampullary malignancy	4 (9.5)
Choledocholithiasis	4 (9.5)
Cholangiocarcinoma	3 (7.1)
Postoperative bile leak	3 (7.1)
Others	3 (7.1)
Cholangitis at presentation, *n* (%)	13 (30.9)
Ascites, *n* (%)	14 (33.3)
Perihepatic fluid, *n* (%)	5 (11.9)
Baseline total bilirubin (mg/dL), median (IQR)	8.9 (4.7–13.6)
Direct bilirubin (mg/dL), median (IQR)	5.1 (2.5–8.0)
Indirect bilirubin (mg/dL), median (IQR)	3.5 (2.3–5.5)
ALP, median (IQR)	334.5 (207–657.8)
Hb (g/dL), mean ± SD	10.7 ± 1.9
TLC (/mm^3), median (IQR)	8,550 (6,600–11,660)
TPC (/mm^3), median (IQR)	137 (105–223.3)
INR (mean ± SD)	1.26 ± 0.26
PTBD	
Right:left	22:20
Segment V	11
Segment VI	9
Segment III	20

Abbreviations: ALP, alkaline phosphatase; Hb, hemoglobin; INR, international normalized ratio; IQR, interquartile range; PTBD, percutaneous transhepatic biliary drainage; SD, standard deviation; TLC, total leukocyte count; TPC, total platelet count.

Technical Parameters

Of 42 patients, 22 and 20 underwent R-PTBD and L-PTBD, respectively. While L-PTBD was performed through the segment III BD, R-PTBD was performed either through segment V (11 [50%]) or segment VI (9 [40.9%]).

The mean number of needle punctures required to perform R-PTBD was 3.9 ± 1.3, while that for L-PTBD was 4.3 ± 1.3 ($p = 0.004$). This indicates that a significantly higher number of needle punctures was required to perform L-PTBD than R-PTBD. Biliary puncture was successful in 90.9% (20/22) of cases in the R-PTBD group, but it was successful only in 75% (15/20) of cases in the L-PTBD group. Similarly, the technical success rate for the right-sided approach (90.9% [20/22]) was higher than that for the left-sided approach (70% [14/20]). However, the difference between the two groups regarding successful biliary puncture ($p = 0.229$) and technical success rate ($p = 0.123$) did not reach statistical significance. Of two failed cases in the R-PTBD group, one patient successfully underwent the left-sided approach. L-PTBD initially failed in 6 of 20 (30%) patients, and 4 (20%) of them subsequently underwent R-PTBD.

Difficulty during catheter placement was encountered more frequently in the L-PTBD group (20% [4/20]) than in the R-PTBD group (9% [2/22]). However, this difference was statistically insignificant ($p = 0.367$). We also compared the

Table 2 Comparison between right- and left-sided PTBD in the nondilated biliary system

Parameters	Right PTBD ($n = 22$)	Left PTBD ($n = 20$)	*p*-value
Number of punctures (mean ± SD)	3.9 ± 1.3	4.3 ± 1.3	0.004
Successful biliary puncture, *n* (%)	20 (90.9)	15 (75)	0.229
Technical success, *n* (%)	20 (90.9)	14 (70)	0.123
Total fluoroscopic time (min), median (IQR)	5.83 (3.5–8.13)	8.16 (4.34–12.9)	0.113
Total procedure time (min)	21 ± 8.5	29.9 ± 13.2	0.021
Difficulty in catheter placement, *n* (%)	02 (9)	04 (20)	0.367
Catheter dislodgement, *n* (%)	05 (22.7)	03 (15)	0.547
Hemorrhagic complications, *n* (%)	03 (13.6)	03 (15)	1.0
Total complications, *n* (%)	08 (36.3)	06 (30)	0.662
Technical success through the contralateral approach	01	04	0.643

Abbreviations: IQR, interquartile range; PTBD, percutaneous transhepatic biliary drainage; SD, standard deviation.

fluoroscopic time needed to complete the procedure and found that the total fluoroscopic time required to perform L-PTBD (8.16 minutes [interquartile range (IQR): 4.34–12.9]) was also higher than that for R-PTBD (5.83 minutes [IQR: 3.5–8.13]), although this difference was statistically insignificant ($p = 0.113$). The R-PTBD group had a significantly shorter procedure time than the L-PTBD group (21 ± 8.5 vs. 29.9 ± 13.2 minutes; $p = 0.021$). The comparison between R-PTBD and L-PTBD with respect to technical parameters is enlisted in ►**Table 2**.

Complications

The details of different types of complications encountered in our study are summarized in ►**Table 3**. The total complication rate ($p = 0.662$) and hemorrhagic complication rate ($p = 1$) were comparable between the R-PTBD and L-PTBD groups. Catheter dislodgement following a successful PTBD was encountered in 22.7% (5/22) patients in the R-PTBD group and 15% (3/20) patients in the L-PTBD group ($p = 0.547$). The hemorrhagic complication rate in our study cohort was 14.3% (6/42). The hemorrhagic complications were transient hemobilia ($n = 3$), inadvertent arterial puncture resulting in a thin perihepatic hematoma ($n = 1$), small abdominal wall hematoma ($n = 1$), and biliary-portal fistula ($n = 1$). All but one were clinically insignificant and managed conservatively, while a patient with biliary-portal fistula necessitated transcatheter fistulous tract embolization using coils and glue due to persistent hemobilia and a drop in hematocrit.

Discussion

The difference in the anatomy of the right- and left-sided biliary system may be the reason for the difference in the technical feasibility between R-PTBD and L-PTBD in a nondilated system. The orientation of BDs and portal veins in segment V or VI allows needle entry into the BD with a smaller puncture angle and even parallel entry to the BD in some cases. In addition, the right-sided approach may also allow posterior portal vein wall puncture without traversing the portal vein lumen. On the other hand, peripheral segment III BD is often more parallel to the skin surface, and the puncture angle with the BD is often greater than that of the right-sided approach.[3,4] Therefore, the margin of error for the successful biliary puncture in a left-sided approach is

Table 3 Summary of complications and their management

Complications	SIR category	Right-sided PTBD ($n = 22$)	Left-sided PTBD ($n = 20$)	Management
Catheter dislodgement	Minor	5	3	Catheter reinsertion
Hemorrhagic complications				
Transient hemobilia	Minor	2	1	No additional therapy required
Inadvertent arterial puncture and a thin perihepatic hematoma	Minor	1	0	No additional therapy required
Small abdominal wall hematoma	Minor	0	1	No additional therapy required
Biliary portal fistula	Major	0	1	Coil and glue embolization of fistula tract
Total hemorrhagic complications		03	03	
Overall complications		08	06	

Abbreviations: PTBD, percutaneous transhepatic biliary drainage; SIR, Society of Interventional Radiology.

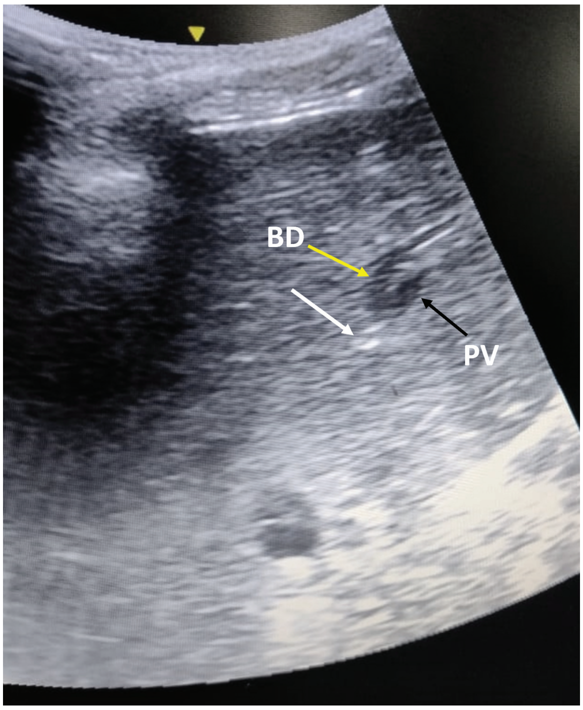

Fig. 1 Grayscale ultrasonography shows a nondilated bile duct with a puncture needle tip within (*white arrow*). PV, portal vein.

less, and a slight movement of the needle may cause displacement out of the BD. Contrary to what was previously thought, the intrahepatic BDs do not have a constant anteroposterior relationship with accompanying portal vein branches.[13,14] So, getting a vessel-free window to puncture the BD may be difficult when the BD is posterior to the portal vein branch (►**Figs. 1**, **2**). These anatomical factors could explain why R-PTBD required significantly fewer needle punctures for a successful biliary entry than L-PTBD ($p < 0.05$). Our study also demonstrated that successful biliary punctures and technical success rates were higher in the R-PTBD group than in the L-PTBD group. Of note, the most rate-limiting step during the insertion of PTBD in a non-dilated system is biliary puncture. Thus, the number of needle punctures, successful biliary puncture rates, and technical success rate are good indicators for assessing technical difficulty. The average R-PTBD procedure time was significantly shorter than that for L-PTBD. Furthermore, the fluoroscopic time required for the right-sided approach was less than that for the left-sided approach. However, a statistically significant difference between the two groups was not observed with respect to successful biliary puncture, technical success, and total fluoroscopic time ($p > 0.05$), which could be due to the smaller sample size of the present study.

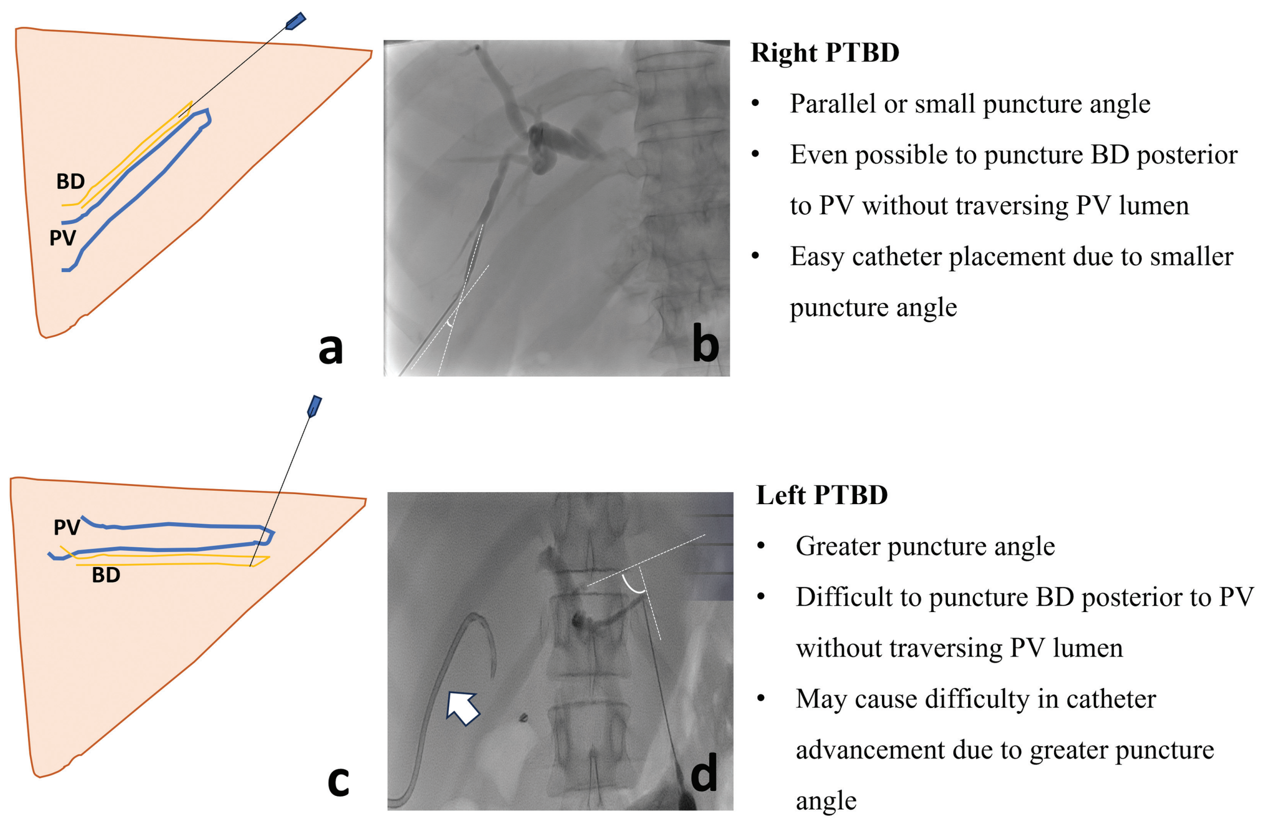

Fig. 2 Technical differences between right- and left-sided-PTBD in a nondilated biliary system. (**a, b**) The puncture angle between the 21-/22-gauge needle and the BD in right-sided PTBD is small (*angle between dashed white lines* in **b**), which has a lower chance of needle dislodgement out of the BD. The smaller puncture angle or even parallel puncture, in some cases, allows puncturing of the posterior wall of the PV without traversing the PV lumen. Further, a small puncture angle provides a smooth catheter advancement over the guidewire. (**c, d**) Segment III BD is often parallel to the skin surface and, hence, the puncture angle is often greater than that of the right-sided approach (*angle between two dashed white lines* in **d**). A greater puncture angle may lead to needle dislodgement out of the BD with slight needle displacement. Further, it may pose difficulty during catheter advancement, causing catheter buckling. A *thick white arrow* in (**d**) shows a catheter placement in the right subhepatic space for biliary collection following a postoperative bile leak. BD, bile duct; PTBD, percutaneous transhepatic biliary drainage; PV, portal vein.

Difficulty in catheter placement was more frequently encountered in the L-PTBD group ($p = 0.367$), which could be explained by a greater puncture angle with the segment III BD that otherwise resulted in a sharp angulation at the BD entry site, leading to buckling of the catheter and difficulty in catheter advancement.

In a recent randomized controlled trial by Behera et al ($n = 50$), no difference with respect to the technical success, safety, radiation exposure, clinical success, and impact on quality of life was found between R-PTBD and L-PTBD. However, in contrast to our study, they included only patients with malignant biliary obstruction where the biliary system was dilated and accessible to puncture using an 18-gauge needle.[8] Pedersoli et al ($n = 187$) compared the difference in technical parameters and complication rate of PTBD between dilated and nondilated biliary systems. They found that PTBD in a nondilated system was technically more difficult than PTBD in a dilated system. However, there was no significant difference in the overall complication rate, while the postprocedural bleeding rate was higher in the nondilated system.[15] In addition, contrary to our results, the left-sided approach was associated with a significantly shorter fluoroscopic time and reduced need for a contrast medium. However, they included PTBD in dilated and nondilated biliary systems together while comparing the right versus left-sided approach.

In our cohort, catheter dislodgement was observed in 22.7% (5/22) of patients in the R-PTBD group and 15% (3/20) in the L-PTBD group. Although not significant, the higher incidence of catheter dislodgement in the R-PTBD group was presumably due to the limited intercostal space and longer excursion of the catheter with the liver during respiration. Hemorrhagic complication rates between the two groups were comparable and occurred in 13.6% (3/22) patients in the R-PTBD group and 15% (3/20) patients in the L-PTBD group. Except for one case of biliary-portal fistula, the remaining hemorrhagic complications were minor. In agreement with our study, previous studies[8–11,15] have also demonstrated no significant difference in complications between right and left-sided approaches for PTBD insertion.

Limitations

The present study had a few limitations. It was a retrospective study with a limited number of patients. Due to its retrospective nature, selection bias could have occurred. Only the intraprocedural and early postprocedural complications (within 72 hours of the procedure) were included. No late complications were included in this study. There could be operator bias as two interventional radiologists performed all the procedures at a single center. R-PTBD minimizes the radiation exposure to the operator's hand. Moreover, the operator's comfort and hand stability are more with the right-sided approach. Thus, there could be operator bias due to the subjective preference of operators who placed PTBD only at our center. Therefore, multicentric randomized controlled trials with more patients are required to further validate our findings.

Conclusion

In conclusion, the right-sided approach required significantly fewer needle punctures for biliary access and a shorter procedure time than the left-sided approach. Successful biliary puncture and technical success rates were higher for patients who underwent R-PTBD. When PTBD was attempted from the left side, operators required longer fluoroscopy duration and more frequently encountered difficulty during catheter placement. However, the complication rates were comparable between the two groups. Hence, in a patient who requires PTBD in a nondilated system and where both approaches are equally suitable, the right-sided approach may be favored over the left-sided approach because the former seems to be technically easier than the latter without any significant difference in complication rates.

Data Availability Statement

Supporting data will be available on contacting the corresponding author.

Authors' Contributions

R.K.P., T.P.T., and N.D.B. conceptualized and designed the study. R.K.P., T.P.T., S.M., T.D., S.G., D.D., S.K.B and S.N. collected the data and S.N. analyzed the data. R.K.P. and T. P.T. prepared the first draft of the manuscript. B.D.P., T.D., S. N., H.K.N., and M.K.P. revised the manuscript with their critical and intellectual inputs. All the authors have seen the manuscript and agree to the results and take full responsibility for the work. Both R.K.P. and T.T. have equally contributed and are considered as the co-first authors.

Ethical Approval

The study was performed conforming to the Helsinki Declaration of 1975, as revised in 2000 and 2008 concerning human and animal rights. Ethical approval was waived off as per the institute's policy as it was a retrospective study.

Patient Consent

Informed consent was not required as it was a retrospective study.

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None.

Conflict of Interest

None declared.

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