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Research Article

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A Comparison of Complication Rates between Transhepatic and Transperitoneal Percutaneous Cholecystostomy Routes in the Treatment of Acute Cholecystitis

Rebecca Hopkins[1], Alexandra Hodder[1*] and Andrew Dalton[2]

[1]Faculty of Medicine, Memorial University of Newfoundland, Canada
[2]Discipline of Radiology, Memorial University of Newfoundland, Canada

***Correspondence to:**
Alexandra Hodder
Faculty of Medicine,
Memorial University of Newfoundland,
Canada.
E-mail: acehodder@mun.ca

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Abstract

Percutaneous cholecystostomy (PC) is an interventional radiology procedure used to treat gallbladder-related complications in patients who are poor surgical candidates for cholecystectomy. It can be performed via a transperitoneal (TP) or transhepatic (TH) approach, though the literature remains inconclusive on which route is superior. This retrospective chart review assessed complication rates between the two approaches at two Canadian institutions from 2018 to 2022. Patients were included if they were poor surgical candidates, had a condition requiring gallbladder drainage, and underwent a successful PC. Cases were identified using the key term "Gall Bladder Drainage Perc" in the Picture Archiving and Communication System (PACS), with filters for interventional radiology images. Data on complications, such as repeat PC, catheter dislodgement, and sepsis, were collected with up to 12 months of follow-up. Statistical analyses included Fisher's exact test for categorical outcomes, independent t-tests for continuous variables, and multivariate logistic regression to account for clustering by staff and center, with $p < 0.05$ considered statistically significant. Of 101 patients included in the final analysis (TP: N = 63; TH: N = 38), no statistically significant differences in complication rates were found between the two groups (all p-values ≥ 0.05). However, significantly more cases were performed via the TP route ($p = 0.013$). These findings suggest that the PC route may not significantly impact complication rates, challenging previous studies that favor the TH route. PC route selection often depends on the interventional radiologist's preference, anatomy, and clinical context. Further research is warranted to inform future quality improvement endeavors and evidence-based guidelines for PC route selection.

Keywords

Interventional radiology, Percutaneous cholecystostomy, Transperitoneal, Transhepatic, Complication rates

Introduction

Acute cholecystitis and other gallbladder complications are frequent causes of hospital admission, which are increasing the strain on the western healthcare system [1]. To treat these conditions, physicians can choose to remove the gallbladder through performing a cholecystectomy, or a catheter may be placed inside the gallbladder to drain its contents. PC is a minimally invasive, image-guided technique that places a catheter directly into the gallbladder to decompress it, allowing for the drainage of its contents, reduction of inflammation, and improvement in the patient's clinical symptoms [2]. It can be used either as a standalone treatment or as a bridging intervention until a definitive treatment plan is determined [2].

Laparoscopic cholecystectomy is considered the gold standard for the treatment of symptomatic gallbladder disease in patients who are eligible for surgery

[3]. PC can be considered for patients who are poor candidates for surgical cholecystectomy [3]. Medical conditions that may render a patient a poor candidate for surgery include hemodynamic instability, severe cardiac ischemia, respiratory distress, renal failure, and significant central nervous system disease [4]. Cholecystectomy in such populations has been documented to produce higher complication and mortality rates than PC [5]. PC allows avoidance of general anesthesia-related risks in these patients [5]. Technical rates of success of PC have been documented at 95% to 100% [6]. PC can be performed as a treatment for patients presenting with concerns such as calculous and acalculous cholecystitis, cholangitis, biliary obstruction, or opacification of biliary ducts [7]. Notably, special populations such as pregnant patients may present with unique types of gallbladders or hepatic dysfunction, such as acute fatty liver disease of pregnancy [8], where PC may also be used as an alternative to high-risk cholecystectomy.

Two access routes can be used for PC: TH and TP. The TH approach involves needle access that traverses a portion of the liver closer to the bare area before being placed into the gallbladder neck [9]. The TP approach allows direct access to the gallbladder fundus without traversing the liver by inserting the catheter into the exposed surface of the gallbladder [9] (Figure 1).

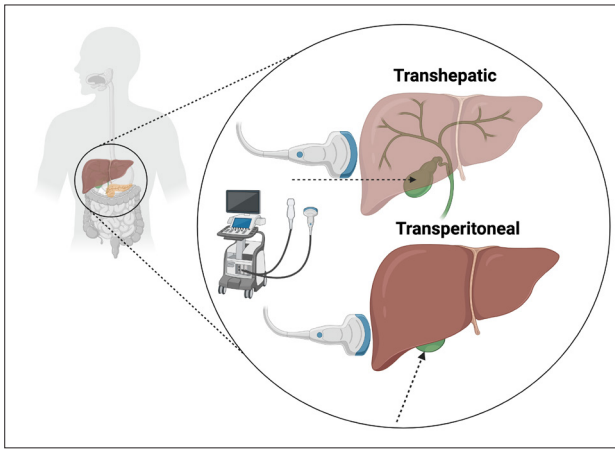


Figure 1: Schematic illustrating transhepatic and transperitoneal routes of PC.

Some studies have shown that the TH approach may be more favourable due to producing slightly lower rates of complications [10-12]. However, others have determined there to be no significant difference between these methods [13, 14]. The primary outcome of this study was to compare complication rates between TP and TH PC routes. We hypothesized that the TH route would be shown to yield significantly lower complication rates than the TP route, based on findings within the literature.

Methods

This project was granted full ethics approval from the relevant provincial Health Research Ethics Association. Any work conducted regarding this study was in accordance with the Helsinki Declaration of 1975, as revised in 2000.

The population under study included patients who had undergone PC at either of two Canadian institutions between January 2018 to December 2022. To initially identify all charts meeting these criteria for conduction of the retrospective chart review, the local PACS (GE Healthcare, Chicago, Illinois, USA) medical imaging database was searched using the key term "Gall Bladder Drainage Perc", with an applied filter to produce images from interventional radiology only. All relevant patients were identified using the accession number associated with images retrieved from the PACS search. Radiological reports on PACS and the relevant images were then used to identify the route of PC conducted for each patient case (TP vs TH). Once all relevant patients and the PC route conducted for each were identified, data on post-procedural complications were collected using the local electronic medical records database, Meditech (Medical Information Technology Inc., Westwood, Massachusetts, USA). Regarding selection bias, the retrospective review consisted of a systematic approach whereby all patients meeting the inclusion criteria identified within the timeline of January 2018 to December 2022 were included. Patients were not excluded based on any information found within the chart review of PACS and Meditech that did not meet the specified exclusion criteria below, such as demographics. Further, as a retrospective chart review, the sample size was not predetermined and was instead dictated by the total number of patients identified within the specified timeline that met the inclusion criteria and did not fulfill any exclusion criteria.

Several inclusion and exclusion criteria were applied to identify relevant patients. The inclusion criteria specified patients who were determined unsuitable candidates for cholecystectomy, had been diagnosed with acute cholecystitis or an equivalent illness requiring gallbladder drainage, had a successful PC procedure conducted, and had at least one year of post-procedure follow-up data available on Meditech. Exclusion criteria included patients who underwent severe trauma requiring PC thereafter (which would be considered a confounding factor in determining the cause of complications), as well as any patients without appropriate follow-up documentation, both immediately and 12 months post-procedure, available on Meditech. All patients who met the inclusion criteria were reviewed to collect information on patient demographics (age and sex), PC-related complications, and whether cholecystectomy was conducted at any point following PC. The relevant data was compiled, stored, and accessed electronically for analysis using a secure local database.

Relevant patient data was included up to 12 months after the PC procedure or until the removal of the PC catheter was documented. The primary endpoint analyzed was the occurrence of PC-related complications, including repeat PC, catheter dislodgement (either having been pulled out inadvertently by the patient or having fallen out), catheter blockage, bile leakage, sepsis, pain requiring catheter removal, and subsequent cholecystectomy. Cases with no documented PC complications were also noted. All cases of bile leakage, catheter blockage, and catheter dislodgement were confirmed by a cholangiogram and documented by the healthcare provider. A catheter was considered dislodged if there was imaging evidence showing that the catheter was placed outside the lumen

of the gallbladder but remained within the patient. Catheter-related sepsis was defined as any new or worsening sepsis documented shortly after PC insertion, as noted by the treating clinician. Significant pain was defined as any patient-reported or clinician-documented pain at the cholecystostomy site or if the drain was removed due to pain. No standardized or objective criteria could be applied, as these definitions reflect the documentation available in the local medical records.

The results of this study were statistically analyzed using Statistical Package for the Social Sciences software version 29.1.0 (IBM Corp., Armonk, New York, USA), designed to test the hypothesis that rates of complications were expected to be significantly lower in the TH approach than the TP approach. Patient demographics were compared using independent t-tests for continuous variables and Chi-square tests for categorical variables. Complication rates and other binary outcomes were analyzed between the two routes using Fisher's exact test. Multilevel logistic regression models were used to assess associations with overall complications, adjusting for age, sex, and indication, and accounting for clustering by staff and center. All data are presented as counts, percentages, and 95% confidence intervals (CI), with $p < 0.05$ considered statistically significant (Figure 2).

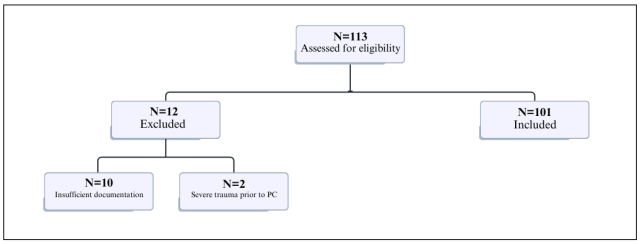


Figure 2: Study flowchart of patient selection for PC.

Note: Flowchart depicting the identification, exclusion, and inclusion of patients undergoing PC between January 2018 and December 2022. Reasons for exclusion are shown.

Results

A total of 101 patients underwent PC, with 63 patients (62%) receiving a TP approach and 38 patients (38%) receiving a TH approach ($p = 0.013$). The mean age was 73.7 ± 10.4 years in the TP group and 68.8 ± 14.1 years in the TH group. Overall, 62% of patients were male (TP: 58.7%, TH: 65.8%) and 38% were female (TP: 41.3%, TH: 34.2%). Repeat PC was required in 17.5% of TP patients, compared to 7.9% of TH patients. The most common indications were calculous cholecystitis, followed by acalculous cholecystitis, perforation, and other gallbladder-related complications (including malignancy, necrosis, emphysematous cholecystitis, and more) (Table 1).

Table 1: Baseline characteristics and indications by PC route.

Variable	TP (N = 63)	TH (N = 38)
Mean age, years ± SD	73.7 ± 10.4	68.8 ± 14.1
Male, N (%)	37 (58.7)	25 (65.8)
Female, N (%)	26 (41.3)	13 (34.2)
Repeat PC, N (%)	11 (17.5)	3 (7.9)
Calculous cholecystitis, N (%)	41 (65.1)	25 (65.8)
Acalculous cholecystitis, N (%)	6 (9.5)	4 (10.5)
Perforation, N (%)	6 (9.5)	6 (15.8)
Other gallbladder complications, N (%)	10 (15.9)	3 (7.9)

Overall, 39.7% of TP patients and 44.7% of TH patients experienced at least one complication, with no statistically significant difference between groups (Fisher's exact test, $p = 0.68$; odds ratio (OR) 0.81, 95% CI 0.36 – 1.84) (Table 2). Due to the small number of events for individual complications, cell counts were often very low, limiting the precision and stability of statistical estimates. As a result, formal multivariable or stratified analyses for individual complication types were not feasible; therefore, we primarily report overall complication rates along with unadjusted OR. Individual complications were also similar between the TP and TH approaches. Catheter dislodgement occurred in 19.0% vs 15.8% of cases (OR 1.25, 95% CI 0.43 – 3.68), repeat PC occurred in 17.5% vs 7.9% (OR 2.47, 95% CI 0.64 – 9.49), the catheter fell out naturally in 3.2% vs 7.9% (OR 0.38, 95% CI 0.06 – 2.40), the patient pulled the catheter out in 4.8% vs 7.9% (OR 0.58, 95% CI 0.11 – 3.05), catheter blockage occurred in 6.4% vs 0% (OR 5.82, 95% CI 0.30 – 111.24), bile leakage occurred in 4.8% vs 2.6% (OR 0.54, 95% CI 0.01 – 7.06), sepsis occurred in 1.6% vs 2.6% (OR 0.60, 95% CI 0.04 – 9.83), pain requiring catheter removal occurred in 4.8% vs 7.9% (OR 0.58, 95% CI 0.11 – 3.05), and subsequent cholecystectomy within 12 months occurred in 22.2% vs 26.3% (OR 0.80, 95% CI 0.31 – 2.04) (Table 2). None of these differences were statistically significant (all p-values > 0.05).

In a multivariate logistic regression model adjusting for age, sex, and indication, with random intercepts for staff and center, procedural route was not significantly associated with

Table 2: Unadjusted complication rates by PC route.

Outcome	TP N (%)	TH N (%)	OR (95% CI)	p-value
Overall complications	25 (39.7)	17 (44.7)	0.81 (0.36 – 1.84)	0.68
Catheter dislodgement	12 (19.0)	6 (15.8)	1.25 (0.43 – 3.68)	0.79
Repeat PC	11 (17.5)	3 (7.9)	2.47 (0.64 – 9.49)	0.24
Catheter fell out	2 (3.2)	3 (7.9)	0.38 (0.06 – 2.40)	0.36
Catheter pulled out	3 (4.8)	3 (7.9)	0.58 (0.11 – 3.05)	0.67
Catheter blockage	4 (6.4)	0 (0)	5.82 (0.30 – 111.24)	0.29
Bile leakage	3 (4.8)	1 (2.6)	0.54 (0.01 – 7.06)	1.00
Sepsis	1 (1.6)	1 (2.6)	0.60 (0.04 – 9.83)	1.00
Pain requiring catheter removal	3 (4.8)	3 (7.9)	0.58 (0.11 – 3.05)	0.67
Subsequent cholecystectomy	14 (22.2)	10 (26.3)	0.80 (0.31 – 2.04)	0.64

Table 3: Multivariate logistic regression - overall complication rates adjusted for age, sex, and indication.

Predictor	Adjusted OR	95% CI	p-value
Route (TH vs TP)	1.36	0.46 – 4.01	0.58
Age (per year)	1.02	0.98 – 1.06	0.33
Sex (female vs male)	0.40	0.15 – 1.05	0.063
Indication: acalculous vs calculous	0.31	0.06 – 1.72	0.18
Indication: perforation vs calculous	1.92	0.45 – 8.12	0.37
Indication: other vs calculous	1.05	0.27 – 4.10	0.94

Note: Random effects: Staff variance 0.475 (SD 0.689); Center variance ~ 0 (SD ~ 0).

overall complications (TH vs TP: OR 1.36, 95% CI 0.46 – 4.01, p = 0.58). Female sex showed a trend toward lower odds of complications (OR 0.40, 95% CI 0.15 – 1.05, p = 0.063); however, no predictors reached statistical significance (Table 3).

Stratified analyses by indication using Firth logistic regression showed no statistically significant differences in overall complication rates within any subgroup (likelihood ratio test: p = 0.26). In patients with calculous cholecystitis, 46.3% of TP patients vs 36.0% of TH patients experienced complications (OR 1.53, 95% CI 0.50 – 4.90, Fisher's exact test: p = 0.45). Among acalculous cholecystitis patients, 0% of TP patients vs 50% of TH patients experienced complications (OR 0, 95% CI 0 – 3.23, p = 0.13). In patients with gallbladder perforation, both TP and TH groups had 50% complication rates (OR 1.0, 95% CI 0.06 – 15.64, p = 1.00), and in non-perforated cases, 38.6% of TP patients vs 43.8% of TH patients experienced complications (OR 0.81, 95% CI 0.31 – 2.15, Fisher's exact test: p = 0.66) (Table 4). Small event counts in some subgroups limited the precision of the OR estimates.

Sensitivity analyses demonstrated that complication rates were generally consistent across centers and staff, including high-volume operators, with overall rates around 40%. Some variation was observed between individual staff members, with the highest observed rate of 88.9% and the lowest 20%, but excluding low-volume operators did not materially alter overall patterns. These findings suggest that the main results were not strongly influenced by center or operator effects (Table 5 and table 6).

Table 4: Firth logistic regression - overall complication rates by indication subgroup.

Indication	TP N (%)	TH N (%)	OR (95% CI)	p-value
Calculous	19/41 (46.3)	9/25 (36.0)	1.53 (0.50 – 4.90)	0.45
Acalculous	0/6 (0)	2/4 (50)	0 (0 – 3.23)	0.13
Perforation	3/6 (50)	3/6 (50)	1.0 (0.06 – 15.64)	1.00
Non-perforation	22/57 (38.6)	14/32 (43.8)	0.81 (0.31 – 2.15)	0.66

Table 5: Sensitivity analyses - overall complication rates by centre.

Center	Route	N	Cases with complications	Percent (%)
1	TP	43	18	41.9
	TH	20	9	45.0
2	TP	20	7	35.0
	TH	18	8	44.4

Table 6: Sensitivity analyses – overall complication rates by staff (high-volume, ≥ 5 cases).

Staff	Route	N	Cases with complications	Percent (%)
1	TP	5	5	100
	TH	4	3	75
2	TP	20	7	35
4	TP	14	7	50
	TH	2	1	50
5	TP	7	3	42.9
	TH	1	1	100
6	TP	5	1	20
	TH	5	1	20
7	TP	1	0	0
	TH	16	7	43.8
8	TP	7	2	28.6
	TH	10	4	40

Discussion

The primary aim of this study was to compare complication rates between the TP and TH routes for PC. We hypothesized that the TH route would result in lower complication rates; however, in this retrospective analysis, no statistically significant differences were observed between TP and TH approaches across all complications assessed, including repeat PC, catheter dislodgement, catheter blockage, bile leakage, pain, sepsis, subsequent cholecystectomy, and overall presence of at least one complication. Despite numerical differences in some complications, both approaches were associated with low rates of infection-related complications and comparable long-term outcomes.

Historically, the TH route has been preferred in some settings due to proposed advantages such as fewer catheter-related complications and a lower likelihood of requiring further interventions [10]. However, our findings, consistent with more recent studies [13, 14], suggest that complication rates may be comparable between the two routes. The choice of route in clinical practice may be influenced more by operator judgment, institutional protocols, and patient anatomy than by clear evidence favouring one approach. Our multivariate, stratified, and sensitivity analyses did not determine any of these factors to serve as clear confounding variables.

There was a statistically significant difference in route utilization in our cohort, with more patients undergoing the TP approach (p = 0.013). This likely reflects operator preference

or local practice patterns rather than differences in safety or efficacy and should not be interpreted as evidence that TP is superior. Differences in experience, technique, and institutional protocols may have influenced outcomes, though the study's statistical analyses did not identify any significant confounders, and the multicenter nature of the study increases generalizability.

Certain patient characteristics may influence the choice of PC route. For example, the TH route may be limited in patients with liver disease, anatomical constraints, or anticoagulation, whereas the TP route may be preferred in patients with an enlarged gallbladder positioned closer to the anterior abdominal wall [15, 16]. While prior studies have suggested differences in complications or catheter stability based on route (such as the TH route being associated with lower dislodgement or bile leakage rates), in our cohort, no statistically significant differences were observed for these parameters. This reinforces the need for caution in extrapolating the advantages of either approach without further prospective validation.

Some studies have suggested that the TH route is associated with faster catheter tract maturation and shorter catheter dwell times [12, 13]. However, our study could not assess time to cholecystectomy or catheter dwell time due to limitations in the available data. Similarly, no differences in subsequent cholecystectomy rates were observed between the TP and TH routes (22.2% vs 26.3%; p = 0.64), which is consistent with the prior literature [17].

Other complications, such as catheter blockage, site pain, or sepsis, were also observed at low rates, with no statistically significant differences between routes. Given the retrospective design and reliance on electronic medical record documentation, these findings should be interpreted as largely descriptive rather than definitive.

This study has addressed a clinically relevant question in interventional radiology and highlights that no standardized guidelines currently dictate route selection for PC. Our findings suggest potential comparable safety between TP and TH approaches; however, they should be interpreted in light of additional unmeasured confounders, small sample size, and retrospective design.

Important limitations of this study include the retrospective design, relatively small sample size of 101 patients, and the inability to control for variables such as patient comorbidities, body mass index, specific presenting symptoms, laboratory values, length of hospital stay, blood loss, or interventional radiologist preferences; these may have introduced unmeasured confounding.

Future prospective studies would benefit from investigating further patient- and procedure-specific factors influencing the choice of TP vs TH routes. Such studies would help clarify potential additional confounding variables and guide more standardized clinical decision-making.

Conclusion

Many studies have evaluated the efficacy of PC vs cholecystectomy, as well as the outcomes of TH vs TP approaches to PC. Evidence suggests that complication rates are generally comparable between the TH and TP routes, though some data indicate potential differences in specific outcomes. These findings, along with those of the present study, highlight that the choice of PC route is often determined by the interventional radiologist based on patient anatomy, clinical circumstances, and individual preference. Given the availability of multiple approaches, establishing clear practice guidelines is essential to support healthcare providers in making safe and effective procedural decisions. Further research is needed to clarify the indications, benefits, and risks associated with each approach and to inform the development of standardized recommendations for PC route selection.

Acknowledgements

None.

Conflict of Interest

None.

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