Research Article

Pamukkale Medical Journal 2026;19(3):641-652
doi:10.31362/patd.1949782

Factors affecting cholecystostomy tube removal and interval cholecystectomy timing after percutaneous cholecystostomy for acute cholecystitis

Akut kolesistit nedeniyle perkütan kolesistostomi uygulandıktan sonra kolesistostomi tüpünün çıkarılmasını ve aralıklı kolesistektomi zamanlamasını etkileyen faktörler

Sevda Yılmaz, Utku Özgen, Hamza Çınar, Serkan Giray, Betül Ohtamış, Halil Serdar Aslan, Onur Birsen

Received:20.05.2025 Accepted:17.06.2026

Abstract

Purpose: Percutaneous cholecystostomy (PC) is an established treatment option for high-risk patients with acute cholecystitis who are unsuitable for immediate surgery. However, the optimal timing of cholecystostomy tube removal and subsequent interval cholecystectomy (IC) remains controversial. This study aimed to evaluate factors influencing PC tube removal and IC timing and to identify predictors associated with surgical outcomes.
Materials and methods: This retrospective single-center study included patients who underwent PC for acute cholecystitis between 2015 and 2025. Demographic characteristics, comorbidities, American Society of Anesthesiologists (ASA) scores, Charlson Comorbidity Index (CCI), Tokyo 2018 acute cholecystitis grade, gallbladder perforation, operative status, surgical approach, and mortality were analyzed.
Results: A total of 102 patients were included, with a mean age of 64.4±15.4 years. Interval cholecystectomy was performed in 71 patients (69.6%), while 31 (30.4%) were managed non-operatively. Operated patients were significantly younger and had lower ASA and CCI scores than non-operated patients (p<0.05 for all). The mean cholecystostomy tube removal time was 38.1±20.4 days. Tube removal timing was not associated with sex, calculous cholecystitis, gallbladder perforation, operative approach, or conversion to open surgery. Likewise, IC timing did not significantly affect operative approach or conversion rates. Patients with acalculous cholecystitis had a significantly longer interval to surgery (p=0.034). Mortality was significantly higher among non-operated patients (25.8% vs. 1.4%, p<0.001). Advanced age, higher ASA scores, and gallbladder perforation were associated with increased mortality.
Conclusion: PC is an effective bridge-to-surgery strategy in high-risk patients with acute cholecystitis. Neither tube removal timing nor IC timing significantly influenced surgical outcomes. Surgical decision-making appears to be driven primarily by patient-related factors rather than a fixed procedural timeline, supporting an individualized management approach.

Keywords: Acute cholecystitis, percutaneous cholecystostomy, interval cholecystectomy, cholecystostomy tube, surgical timing.

Ozgen U, Yilmaz S, Cinar H, Giray S, Ohtamis B, Aslan HS, Birsen O. Factors affecting cholecystostomy tube removal and interval cholecystectomy timing after percutaneous cholecystostomy for acute cholecystitis. Pam Med J 2026;19:641-652.

Öz

Amaç: Perkütan kolesistostomi (PK), akut kolesistit nedeniyle acil cerrahiye uygun olmayan yüksek riskli hastalarda yaygın olarak kullanılan bir tedavi yöntemidir. Bununla birlikte, kolesistostomi tüpünün çıkarılma zamanı ve sonrasında uygulanacak interval kolesistektominin (İK) en uygun zamanlaması halen tartışmalıdır. Bu çalışmada, PK tüpünün çıkarılma süresi ve İK zamanlamasını etkileyen faktörlerin değerlendirilmesi ve cerrahi sonuçlarla ilişkili belirleyicilerin araştırılması amaçlandı.

Sevda Yılmaz, Assoc. Prof. Pamukkale University Faculty of Medicine, Department of General Surgery, Denizli, Türkiye, e-mail: syilmaz_md@hotmail.com (https://orcid.org/0000-0002-1309-0805)

Utku Özgen, Assoc. Prof. Pamukkale University Faculty of Medicine, Department of General Surgery, Denizli, Türkiye, e-mail: dr_utkuozgen@yahoo.com (https://orcid.org/0000-0002-6481-1473) (Corresponding Author)

Hamza Çınar, Assoc. Prof. Pamukkale University Faculty of Medicine, Department of General Surgery, Denizli, Türkiye, e-mail: hamzacinar@gmail.com (https://orcid.org/0000-0003-1748-1392)

Serkan Giray, Surgeon, Gaziantep National Capital Region International Hospital, General Surgery Clinic, Gaziantep, Türkiye, e-mail: drserkangiray@gmail.com (https://orcid.org/0009-0005-8959-6596)

Betül Ohtamış, M.D. General Surgery Department of Şanlıurfa Siverek State Hospital, Şanlıurfa, Türkiye, e-mail: betlohtms@gmail.com (https://orcid.org/0009-0005-3393-789X)

Halil Serdar Aslan, Asst. Prof. Pamukkale University Faculty of Medicine, Department of Radiology, Denizli, Türkiye, e-mail: hsaslan@pau.edu.tr (https://orcid.org/0000-0002-5255-8618)

Onur Birsen, Prof. Pamukkale University Faculty of Medicine, Department of General Surgery, Denizli, Türkiye, e-mail: birsenonur@yahoo.com (https://orcid.org/0000-0001-6064-5693)

Gereç ve yöntem: Bu retrospektif tek merkezli çalışmaya, 2015–2025 yılları arasında akut kolesistit nedeniyle perkütan kolesistostomi uygulanan hastalar dahil edildi. Hastaların demografik özellikleri, komorbiditeleri, Amerikan Anesteziyoloji Derneği (ASA) skorları, Charlson Komorbidite İndeksi (CKİ), Tokyo 2018 akut kolesistit derecesi, safra kesesi perforasyonu, cerrahi uygulanma durumu, cerrahi yaklaşım ve mortalite verileri analiz edildi.
Bulgular: Çalışmaya yaş ortalaması 64,4±15,4 yıl olan toplam 102 hasta dahil edildi. Hastaların 71'ine (%69,6) interval kolesistektomi uygulanırken, 31'i (%30,4) cerrahi dışı olarak takip edildi. Cerrahi uygulanan hastalar anlamlı olarak daha genç olup daha düşük ASA ve CKİ skorlarına sahipti (tüm karşılaştırmalar için *p*<0,05). Ortalama kolesistostomi tüpü çıkarılma süresi 38,1±20,4 gün olarak bulundu. Tüp çıkarılma zamanı ile cinsiyet, taşlı kolesistit varlığı, safra kesesi perforasyonu, cerrahi yaklaşım veya açık cerrahiye geçiş arasında anlamlı ilişki saptanmadı. Benzer şekilde, interval kolesistektomi zamanlamasının cerrahi yaklaşım veya konversiyon oranları üzerine anlamlı etkisi bulunmadı. Taşsız kolesistitli hastalarda cerrahiye kadar geçen sürenin daha uzun olduğu görüldü (*p*=0,034). Mortalitenin cerrahi uygulanmayan hastalarda anlamlı derecede daha yüksek olduğu saptandı (%25,8'e karşı %1,4; *p*<0,001). İleri yaş, yüksek ASA skoru ve safra kesesi perforasyonu artmış mortalite ile ilişkiliydi.
Sonuç: Perkütan kolesistostomi, akut kolesistitli yüksek riskli hastalarda etkili bir köprü tedavi yöntemidir. Bu çalışmada tüp çıkarılma zamanı ve interval kolesistektomi zamanlamasının cerrahi sonuçlar üzerinde anlamlı etkisi gösterilememiştir. Cerrahi karar verme sürecinin sabit zaman aralıklarından ziyade hastaya ait klinik özellikler tarafından yönlendirildiği görülmektedir. Bu nedenle, perkütan kolesistostomi sonrasında bireyselleştirilmiş zamanlama stratejileri daha uygun olabilir.

Anahtar kelimeler: Akut kolesistit, perkütan kolesistostomi, aralıklı kolesistektomi, kolesistostomi tüpü, cerrahi zamanlama.

Özgen U, Yılmaz S, Çınar H, Giray S, Ohtamış B, Aslan HS, Birsen O. Akut kolesistit nedeniyle perkütan kolesistostomi uygulandıktan sonra kolesistostomi tüpünün çıkarılmasını ve aralıklı kolesistektomi zamanlamasını etkileyen faktörler. Pam Tıp Derg 2026;19:641-652.

Introduction

Acute cholecystitis (AC) is one of the most common causes of abdominal pain encountered in emergency departments and general surgery outpatient clinics [1]. Laparoscopic cholecystectomy is currently accepted as the standard surgical treatment for this condition [2]. Traditionally, initial conservative management followed by elective interval cholecystectomy had been recommended for patients with acute cholecystitis. However, growing evidence over recent years has demonstrated that early cholecystectomy performed within the first 72 hours after symptom onset provides superior outcomes compared with delayed interval surgery.

In elderly patients, individuals with significant comorbidities, or those presenting with severe critical illness, perioperative mortality rates may reach up to 19% [3]. In this high-risk patient population, placement of a percutaneous cholecystostomy (PC) tube allows decompression of the gallbladder and may contribute to reducing mortality rates [3, 4]. Percutaneous cholecystostomy has emerged as a valuable bridging therapy, particularly in patients with hemodynamic instability, poor surgical tolerance, or a high risk of postoperative mortality, where rapid control of sepsis is essential [5, 6]. Nevertheless, tube-related complications are frequently encountered following the procedure, often necessitating additional interventions. Furthermore, approximately one-quarter of patients with calculous cholecystitis who do not undergo definitive cholecystectomy experience recurrent attacks within the first three weeks after removal of the percutaneous cholecystostomy tube. Therefore, interval cholecystectomy (IC) has become the standard treatment strategy for patients who recover from the acute inflammatory episode and subsequently become suitable surgical candidates. This approach has been shown to be effective in preventing both tube-related complications and recurrent biliary events [7].

Despite the widespread use of percutaneous cholecystostomy, there is still no clear consensus regarding the optimal timing of subsequent cholecystectomy, and the available evidence remains limited. The 2018 Tokyo Guidelines highlighted the lack of robust data on the timing of cholecystectomy after percutaneous cholecystostomy and identified this issue as a priority area for future research [8]. Although several cohort studies have been published, variations in the definitions of early versus delayed cholecystectomy, along with the heterogeneity of patient populations, make it difficult to generalize the findings and establish definitive recommendations. Based on recently published national and institutional data, Woodward et al. [9] suggested that the most favorable timing for interval cholecystectomy may be between 4 and 8 weeks after percutaneous cholecystostomy placement. In another study using healthcare data from New York State, the optimal timing of interval cholecystectomy following percutaneous cholecystostomy tube (PCT) placement was evaluated. The authors demonstrated that interval cholecystectomy performed within the first 8 weeks after PCT placement was associated with increased surgical morbidity and prolonged hospital stay. However, no significant differences were observed regarding 30-day readmission, emergency department visits, or common bile duct injury rates [10].

The present study aimed to investigate the factors influencing the timing of percutaneous cholecystostomy tube removal and interval cholecystectomy (IC), as well as to identify potential predictors affecting these intervals.

Materials and methods

This retrospective study was conducted at the General Surgery Department of Pamukkale University Hospital to evaluate patients who underwent percutaneous cholecystostomy (PC) for acute cholecystitis. Patients treated with percutaneous cholecystostomy between 2015 and 2025 were included in the study. Clinical data were retrospectively obtained from the hospital's electronic medical record system. Permission was obtained from the Pamukkale University Non-Interventional Clinical Research Ethics Committee for the study ((permission date: 12/05/2026 and permission number: E-60116787-020-872231).

Patients older than 18 years of age who underwent percutaneous cholecystostomy for acute cholecystitis were eligible for inclusion. Patients with incomplete clinical data, biliary obstruction secondary to malignancy, or those who underwent biliary drainage procedures for indications other than acute cholecystitis were excluded from the study.

Demographic and clinical variables including age, sex, Charlson Comorbidity Index (CCI), American Society of Anesthesiologists (ASA) score, severity grade of acute cholecystitis according to the Tokyo 2018 Guidelines, gallbladder wall thickness, gallbladder diameter, presence of gallbladder perforation, and calculous versus acalculous cholecystitis were recorded. In addition, the duration until percutaneous cholecystostomy tube removal, interval to cholecystectomy, surgical approach (laparoscopic or open), conversion to open surgery, intensive care unit requirement, length of hospital stay, and mortality outcomes were evaluated.

Statistical analyses were performed using SPSS Statistics for Windows Version 22.0 (IBM Corp., Armonk, NY, USA). Distribution of continuous variables was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Normally distributed variables were expressed as mean ± standard deviation. Continuous variables between two independent groups were compared using the Independent Samples t-test. Categorical variables were analyzed using the chi-square (χ^2) test or Fisher's exact test when appropriate.

Results

A total of 102 patients who underwent percutaneous cholecystostomy were included in the study. Of these, 56 patients (54.9%) were male and 46 (45.1%) were female. Calculous cholecystitis was present in 69.6% of cases, while gallbladder perforation was identified in 47.1% of patients. Interval cholecystectomy was performed in 71 patients (69.6%), whereas 31 patients (30.4%) did not undergo definitive surgical treatment. Among the operated patients, 41 (57.7%) underwent laparoscopic surgery and 30 (42.3%) underwent open surgery. The conversion rate to open surgery was 35.2% among patients who underwent operative management. The overall mortality rate was 8.8% (n=9) (Table 1).

Table 1. Baseline clinical and demographic characteristics of the study population

	n:102
Age (years), mean ± SD	64.40±15.44
Charlson Comorbidity Index, mean ± SD	3.03±2.21
ASA score, mean ± SD	2.53±0.63
Gallbladder diameter (mm), mean ± SD	46.08±9.86
Gallbladder wall thickness (mm), mean ± SD	6.28±3.77
Acute cholecystitis grade, mean ± SD	2.44±0.50
Cholecystostomy tube removal time (days), mean ± SD	38.15±20.44
Male sex, n (%)	56 (54.9)
Female sex, n (%)	46 (45.1)
Calculous cholecystitis, n (%)	71 (69.6)
Gallbladder perforation, n (%)	48 (47.1)
Operated patients, n (%)	71 (69.6)
Non-operated patients, n (%)	31 (30.4)
Laparoscopic surgery, n (%) †	41 (57.7)
Open surgery, n (%) †	30 (42.3)
Conversion to open surgery, n (%) †	25 (35.2)
Mortality, n (%)	9 (8.8)

Values are presented as mean ± standard deviation or number (%)

The mean age of the entire cohort was 64.40±15.44 years. The mean Charlson Comorbidity Index was 3.03±2.21, and the mean ASA score was 2.53±0.63. The mean gallbladder diameter and wall thickness were 46.08±9.86 mm and 6.28±3.77 mm, respectively. The mean acute cholecystitis severity grade was 2.44±0.50. The average duration until percutaneous cholecystostomy tube removal was 38.15±20.44 days.

Comparison between operated and non-operated patients demonstrated that patients who did not undergo surgery were significantly older (72.68±11.03 years vs. 60.79±15.75 years, p=0.001). Similarly, non-operated patients had significantly higher Charlson Comorbidity Index scores (4.45±2.10 vs. 2.41±1.96, p<0.001) and ASA scores (2.74±0.45 vs. 2.44±0.67, p=0.023). Acute cholecystitis severity grade was also significantly higher in the non-operated group (2.61±0.50 vs. 2.37±0.49, p=0.021). In addition, gallbladder diameter was significantly greater in patients who were not operated on (49.38±11.88 mm vs. 44.71±8.63 mm, p=0.041). However, no significant difference was observed between the groups regarding gallbladder wall thickness (p=0.439). No significant association was observed between operative management and sex, presence of calculous cholecystitis, or gallbladder perforation. Although 73.9% of female patients and 66.1% of male patients underwent surgery, this difference did not reach statistical significance (p=0.392). Similarly, the operative rate was 73.2% in patients with calculous cholecystitis compared with 61.3% in patients with acalculous cholecystitis, without a statistically significant difference (p=0.228). The proportion of patients undergoing surgery was also comparable between those with and without gallbladder perforation (70.8% vs. 68.5%, respectively; p=0.800) (Table 2).

Table 2. Comparison of clinicopathological characteristics according to operative status

	Non-operated (n=31)	Operated (n=71)	*p*
Age (years), mean ± SD	72.68±11.03	60.79±15.75	0.001* (t=3.809)
Charlson Comorbidity Index, mean ± SD	4.45±2.10	2.41±1.96	<0.001* (t=4.741)
ASA score, mean ± SD	2.74±0.45	2.44±0.67	0.023* (t=2.319)
Gallbladder diameter (mm), mean ± SD	49.38±11.88	44.71±8.63	0.041* (t=2.070)
Gallbladder wall thickness (mm), mean ± SD	6.93±5.20	5.97±2.91	0.439 (t=0.781)
Acute cholecystitis grade, mean ± SD	2.61±0.50	2.37±0.49	0.021* (t=2.347)
Female sex, n (%)	12 (38.7)	34 (47.9)	0.392 (χ^2=0.734)
Male sex, n (%)	19 (61.3)	37 (52.1)	
Calculous cholecystitis, n (%)	19 (61.3)	52 (73.2)	0.228 (χ^2=1.456)
Gallbladder perforation, n (%)	14 (45.2)	34 (47.9)	0.800 (χ^2=0.064)
Cholecystostomy removal time (days), mean ± SD	37.16±23.97	38.58±18.87	0.750 (t=-0.320)

χ^2: Chi-square test, t: Independent samples t-test, *p<0.05 considered statistically significant

Factors affecting the duration until percutaneous cholecystostomy tube removal were also evaluated. Female patients demonstrated a shorter catheter removal interval compared with male patients (34.65±15.68 days vs. 41.02±23.40 days); however, the difference was not statistically significant (p=0.118). Although patients with acalculous cholecystitis had a longer catheter removal time than those with calculous cholecystitis (42.81±22.43 days vs. 36.11±19.32 days), this finding did not achieve statistical significance (p=0.129). Likewise, patients with gallbladder perforation tended to have shorter catheter removal times compared with those without perforation (35.48±17.63 days vs. 40.52±22.55 days), although this difference was not significant (p=0.216).

No significant difference in catheter removal time was observed between patients undergoing open versus laparoscopic surgery (38.73±23.79 days vs. 38.46±14.58 days, p=0.953). Similarly, catheter removal times were comparable between patients with and without conversion to open surgery (p=0.894).

When factors affecting the timing of interval cholecystectomy were analyzed, the interval between catheter removal and surgery appeared longer in female patients compared with male patients (25.24±32.52 days vs. 18.51±20.83 days); however, this difference was not statistically significant (p=0.300). Similarly, patients with acalculous cholecystitis demonstrated a longer interval to surgery than those with calculous cholecystitis (26.00±24.55 days vs. 20.17±28.00 days), although this difference also failed to reach statistical significance (p=0.426). Gallbladder perforation, surgical approach, and conversion to open surgery did not significantly affect the interval to surgery (all p>0.05) (Table 3).

However, the total duration from percutaneous cholecystostomy placement to cholecystectomy was significantly longer in patients with acalculous cholecystitis compared with those with calculous cholecystitis (73.21±25.11 days vs. 55.60±31.99 days, p=0.034). This finding suggests that patients with acalculous cholecystitis tend to undergo delayed transition to interval surgery.

Table 3. Factors affecting cholecystostomy tube removal time and interval cholecystectomy

	Cholecystostomy removal time (days) Mean ± SD	*p*	Interval between tube removal and surgery (days) Mean ± SD	*p*
Female sex	34.65±15.68	0.118 (t=-1.577)	25.24±32.52	0.300 (t=1.046)
Male sex	41.02±23.40		18.51±20.83	
Calculous cholecystitis absent	42.81±22.43	0.129 (t=1.531)	26.00±24.55	0.426 (t=0.801)
Calculous cholecystitis present	36.11±19.32		20.17±28.00	
No perforation	40.52±22.55	0.216 (t=1.246)	23.57±31.93	0.555 (t=0.593)
Perforation present	35.48±17.63		19.74±20.86	
Open surgery	38.73±23.79	0.953 (t=0.059)	17.77±21.46	0.294 (t=-1.057)
Laparoscopic surgery	38.46±14.58		24.63±30.47	
No conversion to open surgery	37.40±18.72	0.894 (t=-0.135)	11.20±10.62	0.463 (t=-0.744)
Conversion to open surgery	39.00±25.00		19.08±22.95	
Age <65 years†	34.82±18.64	0.184	19.64±24.83	0.417
Age ≥65 years†	41.27±21.91		24.88±29.67	

t: Independent samples t-test,SD:Standart Deviation, **p*<0.05 considered statistically significant

The effect of percutaneous cholecystostomy tube removal timing on surgical approach was also evaluated. No significant difference was observed in catheter removal duration between patients undergoing open versus laparoscopic surgery. The mean catheter removal time was 38.73±23.79 days in the open surgery group and 38.46±14.58 days in the laparoscopic group (*p*=0.953). Likewise, the interval between catheter removal and surgery did not significantly differ between open and laparoscopic surgery groups (17.77±21.46 days vs. 24.63±30.47 days, *p*=0.294).

Furthermore, when patients with and without conversion to open surgery were compared, no significant difference was identified regarding the duration until percutaneous cholecystostomy tube removal (39.00±25.00 days vs. 37.40±18.72 days, *p*=0.894). Similarly, the interval between catheter removal and surgery did not significantly influence the likelihood of conversion to open surgery (19.08±22.95 days vs. 11.20±10.62 days, *p*=0.463). These findings suggest that neither the timing of percutaneous cholecystostomy tube removal nor the interval to cholecystectomy significantly affected the choice of surgical approach (open versus laparoscopic) or the risk of conversion to open surgery. The impact of age on percutaneous cholecystostomy tube removal time and interval cholecystectomy timing was also evaluated. Advanced age appeared to play a significant role, particularly in determining whether patients proceeded to definitive surgical treatment. Patients who did not undergo surgery were significantly older than those who underwent operative management (72.68±11.03 years vs. 60.79±15.75 years, *p*=0.001). This finding indicates that advanced age is an important clinical factor reducing the likelihood of surgical intervention.

However, among patients who underwent surgery, age was not found to have a direct significant effect on either the timing of percutaneous cholecystostomy tube removal or the interval to cholecystectomy. No statistically significant relationship was observed between age and catheter removal time. Likewise, age did not appear to be a determining factor for interval surgery timing. Collectively, these findings suggest that age primarily influences the decision to proceed with surgery rather than the timing of surgery itself in patients deemed suitable for operative management.

In the mortality analysis, mortality rates were found to be markedly higher among patients who did not undergo surgery. While 25.8% of non-operated patients died during follow-up, the mortality rate among operated patients was only 1.4% ($p<0.001$). Factors associated with mortality were further analyzed within the non-operated patient group. Patients who died were significantly older than survivors (80.13±6.69 years vs. 70.09±11.16 years, $p=0.022$). In addition, ASA scores were significantly higher in patients who developed mortality (3.00±0.00 vs. 2.65±0.49, $p=0.008$). Although the Charlson Comorbidity Index was also higher in the mortality group, this difference did not reach statistical significance (5.50±2.78 vs. 4.09±1.73, $p=0.102$). No significant association was observed between mortality and either sex or the presence of calculous cholecystitis (both $p=0.935$). In contrast, gallbladder perforation demonstrated a strong association with mortality. The mortality rate was 50.0% in patients with gallbladder perforation compared with 5.9% in those without perforation ($p=0.005$).

Discussion

In the present study, factors affecting the timing of percutaneous cholecystostomy tube removal and interval cholecystectomy (IC) following percutaneous cholecystostomy were investigated, with the aim of identifying potential predictors associated with these intervals. While the presence of calculous cholecystitis, severity of acute cholecystitis, and gallbladder perforation did not significantly influence the timing of catheter removal, the interval to cholecystectomy was found to be significantly shorter in patients with gallbladder perforation. Although no independent predictor was identified for catheter removal time, the presence of gallbladder perforation demonstrated a tendency toward earlier interval cholecystectomy.

Advanced age is one of the most important indications for percutaneous cholecystostomy in patients with acute cholecystitis. Previous studies have reported that the mean age of patients undergoing PC ranges from 54.7 to 83 years, with male patients accounting for 52.7%-78.3% of cases [11]. In a large-volume series comparing PC and cholecystectomy in patients with acute cholecystitis, the mean age was reported as 72.9 years in the PC group and 54.4 years in the cholecystectomy group. In the same study, the proportion of male patients was 52.7% in the PC group and 38.9% in the cholecystectomy group [12]. Consistent with these findings, the mean age of our cohort was 64 years, and males represented 54.8% of the study population. Comorbidity burden represents a major determinant in the decision to perform percutaneous cholecystostomy. Concomitant diseases substantially influence both surgical and anesthesia-related morbidity and mortality. Gallbladder decompression achieved through PC may contribute to reducing mortality in high-risk patients [3, 4]. In the literature, patient comorbidity burden is commonly assessed using the ASA classification and Charlson Comorbidity Index [11].

Kaya and Tahtabaşı [13] reported hypertension, coronary artery disease, and diabetes mellitus as the most common accompanying comorbidities among patients undergoing PC. Similarly, studies by Hsieh et al. [14] and Peters et al. [15] reported that approximately three-quarters of patients undergoing PC were classified as ASA III, while the remaining patients were ASA IV. In our study, the mean Charlson Comorbidity Index (CCI) was 3, and the mean ASA score was 2.5, with the majority of patients classified as ASA II–III.

Percutaneous cholecystostomy may serve either as definitive treatment in patients deemed unfit for surgery or as a bridge to delayed cholecystectomy in those who become suitable surgical candidates after resolution of the acute inflammatory process [16]. Reported rates of cholecystectomy following PC vary considerably across the literature. Leveau et al. [17] reported a cholecystectomy rate of 7.6%, Bundy et al. [18] 29.6%, and Pang et al. [19] 45.1%, whereas studies from Türkiye have demonstrated rates of 46.2% in the study by Kaya and Tahtabaşı [13] and 58.3% in the series reported by Arık et al. [20].

Younger age has consistently been identified as a predictive factor for undergoing cholecystectomy after PC [19, 21]. Pang et al. [19] reported that younger age, shorter hospital stay, and intensive care unit admission were associated with a greater likelihood of undergoing interval cholecystectomy, whereas advanced age and severe respiratory comorbidities reduced the probability of operative treatment. In that study, 32 of 71 patients (45.1%) who underwent PC subsequently underwent cholecystectomy; among them, 21 patients underwent laparoscopic and 11 underwent open cholecystectomy [19].

In the present study, cholecystectomy was performed in 69.6% of patients, a rate higher than that reported in most previous series. Of these, 61.8% underwent laparoscopic surgery, while the remaining patients required an open surgical approach. Consistent with the existing literature, patients who did not undergo surgery in our study were significantly older than those who underwent operative treatment. In addition, the non-operated group demonstrated higher Charlson Comorbidity Index and ASA scores. Furthermore, patients who were not operated on had higher acute cholecystitis severity grades and larger gallbladder diameters. These findings further support previous evidence suggesting that PC is more frequently preferred in elderly patients, in those with marked gallbladder distension, and in patients presenting with more severe acute cholecystitis. Among patients who underwent surgery, those requiring open surgery were significantly older than patients treated laparoscopically. Moreover, patients undergoing open surgery had higher CCI scores and slightly higher ASA scores compared with the laparoscopic group. These findings indicate that patients requiring an open surgical approach carried a greater comorbidity burden and represented a clinically more fragile population.

To date, no high-level prospective study has definitively established the optimal timing for percutaneous cholecystostomy tube removal [22]. One of the major concerns following tube removal is the potential development of bile leakage into the peritoneal cavity and subsequent biliary peritonitis, which may lead to serious clinical consequences [23]. D’Agostino et al. [24] suggested that the optimal timing for PC tube removal should correspond to consolidation of the cholecystocutaneous fistula tract in order to minimize the risk of bile leakage. However, the available evidence regarding the protective role of the cholecystocutaneous tract is largely limited to isolated case series.

In a recently published systematic review evaluating the timing of PC tube removal, the duration of catheter placement ranged widely from 1 to 427 days. Notably, most studies included in the review reported a mean catheter dwell time shorter than 1–2 weeks [25]. In contrast, Bundy et al. [18] reported a substantially longer mean catheter duration of 89 days, which exceeded the durations described in most previous studies. The authors attributed this prolonged catheterization period to the higher frequency of cholecystoscopic stone extraction procedures performed in their cohort.

In our study, the mean duration until PC catheter removal was 37.3 days. Catheter removal time did not significantly differ between male and female patients, and neither disease severity nor clinical presentation characteristics such as calculous cholecystitis or gallbladder perforation had a statistically significant impact on catheter removal timing. Demonstrated a longer catheter duration time compared with those who underwent open surgery.

Several studies have investigated the optimal timing of interval cholecystectomy following percutaneous cholecystostomy, with proposed intervals ranging from a few days to 4 or even 8 weeks after the procedure [9, 26, 27]. In an analysis of the New York Statewide Planning and Research Cooperative System (SPARCS) database conducted by Altieri et al. [10], an 8-week interval was used as the cutoff point for comparison after PC placement. Their findings demonstrated that patients who underwent interval cholecystectomy within 8 weeks experienced higher complication rates and longer hospital stays. However, no significant differences were observed regarding 30-day readmission rates or bile duct injuries within this cohort. Similarly, based on recently published national and institutional data, Woodward et al. [9] suggested that the most favorable timing for interval cholecystectomy may be between 4 and 8 weeks following percutaneous cholecystostomy.

A recent study investigating the effect of the interval between percutaneous cholecystostomy (PC) and interval cholecystectomy (IC) on perioperative outcomes reported that a longer PC–IC interval was associated with prolonged intensive care unit stay. However, no significant differences were identified in hospital length of stay, procedure-related readmissions, emergency department visits, reoperations, bile leaks, or reintervention rates. Interestingly, patients who underwent cholecystectomy more than 8 weeks after PC placement were more likely to be discharged directly home than those who underwent surgery within 8 weeks [28].

In our cohort, the mean duration until PC catheter removal was 37.3 days, while the mean total duration from percutaneous cholecystostomy placement to interval cholecystectomy was 76.5 days. We found that sex, disease severity, and the presence of calculous cholecystitis did not significantly affect the timing of cholecystectomy after PC. However, patients with gallbladder perforation underwent surgery within a shorter interval. In addition, patients who underwent laparoscopic cholecystectomy had a longer interval to surgery compared with those requiring open surgery.

One of the notable findings of the present study was the association of gallbladder perforation with both increased mortality and a shorter interval to definitive surgical treatment. Gallbladder perforation is generally regarded as an indicator of advanced disease severity and uncontrolled local inflammation and has been associated with worse clinical outcomes in patients with acute cholecystitis. Previous studies have shown that complicated acute cholecystitis, particularly when accompanied by perforation, is associated with increased morbidity, prolonged hospitalization, and higher mortality rates due to the risk of biliary peritonitis, sepsis, and systemic inflammatory response syndrome [8, 13]. Consistent with these observations, patients with gallbladder perforation in our cohort demonstrated significantly higher mortality rates. Interestingly, these patients also underwent interval cholecystectomy earlier than patients without perforation. This finding may reflect a more aggressive clinical approach by surgeons, who may prefer earlier definitive treatment after stabilization because of concerns regarding recurrent biliary events, persistent inflammation, or progression of disease-related complications [29].

Procedure-related morbidity following percutaneous cholecystostomy has been reported in the literature at rates ranging from 8% to 44%. These complications are most commonly minor events such as catheter malposition, catheter dislodgement, and intracystic bleeding, whereas major complications including bile leakage and bile duct injury occur less frequently [30, 31]. Since patients undergoing PC are typically considered high-risk surgical candidates with substantial comorbidity burden and poor overall clinical status, relatively high mortality rates have also been reported in the literature.

In a systematic review including 53 studies and 1,918 patients, mortality outcomes were evaluated as overall mortality, biliary mortality, and procedure-related mortality. The mortality rate attributable to biliary infection was reported as 3.6%, whereas procedure-related mortality was only 0.36%; the overall mortality rate was 15.4% [3]. In the study by Pang et al. [19], mortality was reported in 29 of 71 patients who underwent PC. Similarly, Kaya and Tahtabaşı [13] reported a mortality rate of 15.4%, identifying increased severity of cholecystitis, higher ASA scores, and advanced age as significant factors associated with mortality. In our cohort, the overall mortality rate was 12.2%. Mortality was markedly higher among patients who did not undergo surgery; while 25.8% of non-operated patients died, the mortality rate among operated patients was only 1.4%. Higher ASA scores and the presence of gallbladder perforation were identified as factors significantly associated with mortality.

Despite increasing evidence, no universally accepted timing strategy has yet been established, and current recommendations remain largely based on retrospective studies and expert opinion.

Limitations

This study has several limitations that should be acknowledged. First, due to its retrospective and single-center design, the possibility of selection bias and incomplete data collection cannot be entirely excluded. In addition, the relatively limited sample size may have reduced the ability to adequately evaluate rare complications.

Although no perioperative or postoperative bile duct injury was observed in our cohort, which is a favorable finding, this result should be interpreted cautiously given the low event rate and limited sample size. Bile duct injury is known to be a rare complication following laparoscopic cholecystectomy, occurring at relatively low frequencies in the literature. Therefore, the present cohort may not have been sufficiently powered to perform a meaningful risk analysis for this specific complication.

Furthermore, due to incomplete documentation in patient records, not all minor complications related to percutaneous cholecystostomy could be fully evaluated. Certain factors that may influence surgical timing, including surgeon experience and technical variations, could not be analyzed in a standardized manner. In addition, heterogeneity in follow-up duration limited the assessment of long-term outcomes.

Future prospective, multicenter studies with larger patient cohorts are needed to better define the optimal timing of interval cholecystectomy after percutaneous cholecystostomy and to more clearly identify predictors associated with postoperative complications and surgical timing.

Additionally, multivariable regression analyses were not performed because of the relatively limited sample size and the low number of outcome events, particularly mortality cases. Under these circumstances, multivariable models were considered susceptible to overfitting and unstable estimates. Therefore, the reported associations should be interpreted as findings derived from univariate analyses rather than independent predictors.

In conclusion, this study evaluated the clinical factors influencing the timing of percutaneous cholecystostomy tube removal and interval cholecystectomy following percutaneous cholecystostomy. Our findings demonstrated that advanced age, higher ASA scores, and increased comorbidity burden significantly reduced the likelihood of patients proceeding to definitive surgical treatment. In contrast, neither the timing of PC tube removal nor the interval to cholecystectomy had a significant impact on the choice of surgical approach (open versus laparoscopic) or on conversion to open surgery rates. One notable finding was the tendency toward earlier interval surgery in patients with gallbladder perforation. In addition, the markedly higher mortality observed among non-operated patients supports the continued importance of definitive surgical management in appropriately selected patients. The absence of perioperative or postoperative bile duct injury in our cohort further suggests that interval cholecystectomy can be performed safely in experienced centers.

Despite increasing evidence in the literature, there is still no clear consensus regarding the optimal timing of surgery after percutaneous cholecystostomy. Our findings suggest that surgical timing should not be determined solely according to a fixed time interval, but rather individualized based on patient age, comorbidity burden, clinical recovery, and inflammatory status. Larger prospective multicenter studies are warranted to better define the ideal timing of interval cholecystectomy following percutaneous cholecystostomy.

Ethics committee approval: Permission was obtained from the Pamukkale University Non-Interventional Clinical Research Ethics Committee for the study (permission date: 12/05/2026 and permission number: E-60116787-020-872231).

Acknowledgements: An artificial intelligence–based language assistant was used to improve the language quality of the manuscript.

Funding statement: None.

Authors contributions: S.Y., U.Ö. have constructed the main idea and hypothesis of the study. S.Y., U.Ö., H.Ç. They developed the theory and edited the material and method section. S.G., B.O., H.S.A. has done the evaluation of the data in the Results section. The discussion section of the article was written by S.Y., U.Ö., H.Ç. and B.O. reviewed, corrected and approved. In addition, all authors discussed the entire study and approved the final version.

Conflict of interest: The authors declare that they have no conflict of interest.

References

1. Peery AF, Crockett SD, Barritt AS, et al. Burden of gastrointestinal, liver, and pancreatic diseases in the United States. *Gastroenterology*. 2015;149(7):1731-1741.e3. doi:10.1053/j.gastro.2015.08.045

2. Gurusamy K, Junnarkar S, Farouk M, Davidson BR. Meta-analysis of randomized controlled trials on the safety and effectiveness of day-case laparoscopic cholecystectomy. *Br J Surg*. 2008;95(2):161-168. doi:10.1002/bjs.6105
3. Winbladh A, Gullstrand P, Svanvik J, Sandström P. Systematic review of cholecystostomy as a treatment option in acute cholecystitis. *HPB (Oxford)*. 2009;11(3):183-193. doi:10.1111/j.1477-2574.2009.00052.x
4. Gomes CA, Junior CS, Di Saverio S, et al. Acute calculous cholecystitis: review of current best practices. *World J Gastrointest Surg*. 2017;9(5):118-126. doi:10.4240/wjgs.v9.i5.118
5. Ansaloni L, Pisano M, Coccolini F, et al. 2016 WSES guidelines on acute calculous cholecystitis. *World J Emerg Surg*. 2016;11:25. doi:10.1186/s13017-016-0082-5
6. Li Y, Xiao WK, Li XJ, Dong HY. Evaluating effectiveness and safety of combined percutaneous transhepatic gallbladder drainage and laparoscopic cholecystectomy in acute cholecystitis patients: meta-analysis. *World J Gastrointest Surg*. 2024;16(5):1407-1419. doi:10.4240/wjgs.v16.i5.1407
7. Alvino DML, Fong ZV, McCarthy CJ, et al. Long-term outcomes following percutaneous cholecystostomy tube placement for treatment of acute calculous cholecystitis. *J Gastrointest Surg*. 2017;21(5):761-769. doi:10.1007/s11605-017-3375-4
8. Okamoto K, Suzuki K, Takada T, et al. Tokyo Guidelines 2018: flowchart for the management of acute cholecystitis. *J Hepatobiliary Pancreat Sci*. 2018;25(1):55-72. doi:10.1002/jhbp.516
9. Woodward SG, Rios Diaz AJ, Zheng R, et al. Finding the most favorable timing for cholecystectomy after percutaneous cholecystostomy tube placement: an analysis of institutional and national data. *J Am Coll Surg*. 2021;232(1):55-64. doi:10.1016/j.jamcollsurg.2020.10.010
10. Altieri MS, Yang J, Yin D, Brunt LM, Talamini MA, Pryor AD. Early cholecystectomy (≤8 weeks) following percutaneous cholecystostomy tube placement is associated with higher morbidity. *Surg Endosc*. 2020;34(7):3057-3063. doi:10.1007/s00464-019-07050-z
11. Elsharif M, Forouzanfar A, Oaikhinan K, Khetan N. Percutaneous cholecystostomy: why, when, what next? A systematic review of past decade. *Ann R Coll Surg Engl*. 2018;100(8):1-14. doi:10.1308/rcsann.2018.0150
12. Anderson JE, Chang DC, Talamini MA. A nationwide examination of outcomes of percutaneous cholecystostomy compared with cholecystectomy for acute cholecystitis, 1998-2010. *Surg Endosc*. 2013;27(9):3406-3411. doi:10.1007/s00464-013-2924-5
13. Kaya V, Tahtabaşi M. Akut kolesistitli hastaların tedavisinde perkütan kolesistostominin etkinliği ve klinik seyri. *Harran Üniversitesi Tıp Fak Dergisi*. 2023;20(2):326-332. doi:10.35440/hutfd.1292102
14. Hsieh YC, Chen CK, Su CW, et al. Outcome after percutaneous cholecystostomy for acute cholecystitis: a single-center experience. *J Gastrointest Surg*. 2012;16(10):1860-1868. doi:10.1007/s11605-012-1965-8
15. Peters R, Kolderman S, Peters B, Simoens M, Braak S. Percutaneous cholecystostomy: single centre experience in 111 patients with an acute cholecystitis. *JBR-BTR*. 2014;97(4):197-201. doi:10.5334/jbr-btr.101
16. Jang WS, Lim JU, Joo KR, et al. Outcome of conservative percutaneous cholecystostomy in high-risk patients with acute cholecystitis and risk factors leading to surgery. *Surg Endosc*. 2015;29(8):2359-2364. doi:10.1007/s00464-014-3961-4
17. Leveau P, Andersson E, Carlgren I, Willner J, Andersson R. Percutaneous cholecystostomy: a bridge to surgery or definite management of acute cholecystitis in high-risk patients? *Scand J Gastroenterol*. 2008;43(5):593-596. doi:10.1080/00365520701851673
18. Bundy J, Srinivasa RN, Gemmete JJ, Shields JJ, Chick JFB. Percutaneous cholecystostomy: long-term outcomes in 324 patients. *Cardiovasc Intervent Radiol*. 2018;41(6):928-934. doi:10.1007/s00270-018-1884-5
19. Pang KW, Tan CHN, Loh S, et al. Outcomes of percutaneous cholecystostomy for acute cholecystitis. *World J Surg*. 2016;40(11):2735-2744. doi:10.1007/s00268-016-3585-z
20. Arık E, Esenkaya A, Altıntoprak F. Perkütan Kolesistostominin Akut Kolesistit Tedavisindeki Yeri. *Sakarya Medical Journal*. 2023;13(1):70-83. doi:10.31832/smj.1215454
21. Cooper S, Donovan M, Grieve DA. Outcomes of percutaneous cholecystostomy and predictors of subsequent cholecystectomy. *ANZ J Surg*. 2018;88(7-8):E598-E601. doi:10.1111/ans.14251
22. Di Martino M, Miguel Mesa D, Lopesino González JM, et al. Safety of percutaneous cholecystostomy early removal: a retrospective cohort study. *Surg Laparosc Endosc Percutan Tech*. 2020;30(5):410-415. doi:10.1097/SLE.0000000000000799
23. van Sonnenberg E, D'Agostino HB, Goodacre BW, Sanchez RB, Casola G. Percutaneous gallbladder puncture and cholecystostomy: results, complications, and caveats for safety. *Radiology*. 1992;183(1):167-170. doi:10.1148/radiology.183.1.1549666
24. D'Agostino HB, vanSonnenberg E, Sanchez RB, Goodacre BW, Casola G. Imaging of the percutaneous cholecystostomy tract: observations and utility. *Radiology*. 1991;181(3):675-678. doi:10.1148/radiology.181.3.1947080

25. Macchini D, Degrate L, Oldani M, et al. Timing of percutaneous cholecystostomy tube removal: systematic review. *Minerva Chir*. 2016;71(6):415-426.

26. Han IW, Jang JY, Kang MJ, Lee KB, Lee SE, Kim SW. Early versus delayed laparoscopic cholecystectomy after percutaneous transhepatic gallbladder drainage. *J Hepatobiliary Pancreat Sci*. 2012;19(2):187-193. doi:10.1007/s00534-011-0458-6

27. Giannopoulos S, Makhecha K, Madduri S, et al. What is the ideal timing of cholecystectomy after percutaneous cholecystostomy for acute cholecystitis? *Surg Endosc*. 2023;37(11):8764-8770. doi:10.1007/s00464-023-10332-2

28. Giannopoulos S, Makhecha K, Madduri S, et al. What is the ideal timing of cholecystectomy after percutaneous cholecystostomy for acute cholecystitis? *Surg Endosc*. 2023;37(11):8764-8770. doi:10.1007/s00464-023-10332-2

29. Date RS, Thrumurthy SG, Whiteside S, et al. Gallbladder perforation: case series and systematic review. *Int J Surg*. 2012;10(2):63-68. doi:10.1016/j.ijsu.2011.12.004

30. Melloul E, Denys A, Demartines N, Calmes JM, Schäfer M. Percutaneous drainage versus emergency cholecystectomy for the treatment of acute cholecystitis in critically ill patients: does it matter? *World J Surg*. 2011;35(4):826-833. doi:10.1007/s00268-011-0985-y

31. Sanjay P, Mittapalli D, Marioud A, White RD, Ram R, Alijani A. Clinical outcomes of a percutaneous cholecystostomy for acute cholecystitis: a multicentre analysis. *HPB (Oxford)*. 2013;15(7):511-516. doi:10.1111/j.1477-2574.2012.00610.x