BJR

© 2023 The Authors. Published by the British Institute of Radiology

https://doi.org/10.1259/bjr.20220943

Received: 04 October 2022 | Accepted: 01 January 2023 | Published online: 25 May 2023

Cite this article as:
Do YA, Yoon CJ, Lee JH, Choi WS, Lee C. Percutaneous cholecystostomy as a definitive treatment for acute acalculous cholecystitis: clinical outcomes and risk factors for recurrent cholecystitis. *Br J Radiol* (2023) 10.1259/bjr.20220943.

FULL PAPER

Percutaneous cholecystostomy as a definitive treatment for acute acalculous cholecystitis: clinical outcomes and risk factors for recurrent cholecystitis

[1]YOON AH DO, [1,2]CHANG JIN YOON, [1,2]JAE HWAN LEE, [1]WON SEOK CHOI and [1]CHONG-HO LEE

[1]Department of Radiology, Seoul National University Bundang Hospital, Seongnam, Republic of Korea
[2]Seoul National University College of Medicine, Seoul, Republic of Korea

Address correspondence to: Professor Chang Jin Yoon
E-mail: *yooncj1@gmail.com*

Objective: To investigate the outcomes of percutaneous cholecystostomy (PC) as a definitive treatment for acute acalculous cholecystitis (AAC) and to identify the risk factors for cholecystitis recurrence after catheter removal.
Methods: Between January 2008 and December 2017, 124 patients who had undergone PC as definitive treatment for moderate or severe AAC. The initial clinical success, complications, and recurrent cholecystitis after PC removal were retrospectively assessed. Twenty-one relevant variables were analyzed to identify risk factors for recurrent cholecystitis.
Results: Clinical effectiveness was achieved in 107 patients (86.3%) at 3 days and in all patients (100%) at 5 days after PC placement. Six Grade 2 adverse events occurred, including catheter dislodgement (n = 3) and clogging (n = 3), which required catheter exchange. The PC catheter was removed in 123 patients (99.2%), with a median indwelling duration of 18 days (range 5–116 days). During the follow-up period (median, 1624 days; range, 40–4945 days), five patients experienced recurrent cholecystitis (4.1%). The cumulative recurrence rates were 3.3%, 4.1%, and 4.1% at 6 months, 1 year, and 5 years, respectively. Multivariate analysis revealed that an age-adjusted Charlson comorbidity index (aCCI)≥7 positively correlated with recurrence (OR, 1.97; 95% confidence interval, 1.07–3.64; p = 0.029).
Conclusions: Definitive PC is a safe and effective treatment option for patients with AAC. The PC catheters can be safely removed in most patients. An aCCI≥7 was a risk factor for cholecystitis recurrence after catheter removal.
Advances in knowledge: 1. Percutaneous cholecystostomy (PC) is a safe and effective as a definitive treatment in patients with acute acalculous cholecystitis (AAC).
2. PC can be safely removed after recover from AAC in the majority of patients (99.2%) with low rate of recurrence of cholecystitis (4.1%).
3. Age-adjusted Charlson comorbidity index ≥7 was a risk factor for recurrence of cholecystitis after PC removal.

INTRODUCTION

Acute acalculous cholecystitis (AAC) is defined as acute gallbladder (GB) inflammation without biliary calculi or sludge. It accounts for 5–10% of acute cholecystitis cases and often occurs in critically ill patients after major surgery, trauma, burn, cerebral infarction, or terminal malignancy.[1] Early recognition and treatment are mandatory to avoid fulminant progression and complications, such as gangrene or perforation, which have a high mortality rate of up to 30%.[2]

Percutaneous cholecystostomy (PC) has been widely used as a bridge treatment followed by interval cholecystectomy or as a definitive treatment for acute cholecystitis in patients who are unfit for surgery. PC can play a key role in the treatment of AAC, in which emergency surgery is more frequently ineligible due to severe medical comorbidities. Several studies have demonstrated that PC can be a definitive treatment for AAC that does not require subsequent cholecystectomy.[3–7] However, a major concern regarding definitive PC is the possibility of recurrent cholecystitis after catheter removal. Although recurrent cholecystitis after PC in AAC is less common than acute calculous cholecystitis (ACC),[3] it has been reported in up to 14% of cases.[4] Therefore, the prediction of recurrent cholecystitis after PC would be greatly helpful for patient selection and treatment planning for AAC. This study aimed to investigate the outcomes of PC as a definitive treatment for AAC and to identify the risk factors for cholecystitis recurrence after catheter removal.

METHODS AND MATERIALS

Patient selection

This single-institution retrospective study was approved by our institutional review board, which waived the requirement for informed consent. A computerized keyword-based search of electronic medical record using "acute cholecystitis" and "percutaneous cholecystostomy" identified 1338 patients who underwent PC for acute cholecystitis from January 2010 to December 2017. The diagnosis of acute cholecystitis was based on clinical symptoms and signs (fever, abdominal pain, positive sonographic Murphy's sign, or elevated inflammatory markers such as white blood cells) and radiologic studies of abdominal US, MRCP, and/or CT. The diagnostic criteria and severity grading of acute cholecystitis were based on the Tokyo Guidelines (TG) 18.[8] The exclusion criteria were i) gallstones (including sludge) identified by imaging and/or surgical specimens (n = 1075), ii) concurrent common bile duct stones (n = 42), iii) PC as a bridge treatment for interval cholecystectomy (n = 37), iv) biliary obstruction by malignancy (n = 24), v) mild cholecystitis (Grade 1) based on the TG18 (n = 12), vi) concurrent pancreatitis (n = 8), and vii) loss to follow-up within 12 months after PC removal (n = 16). Finally, 124 patients (mean age, 71.9 years; range, 26–94 years; males, n = 74) who had undergone definitive PC for moderate or severe AAC were included in this study.

PC procedure

All patients with acute cholecystitis were initially treated with intravenous fluids, electrolyte correction, and broad-spectrum antibiotics. The eligibility for surgery was evaluated by hepatobiliary surgeons and anesthesiologists. When considered unsuitable for emergency surgery, patients were referred to interventional radiologists for PC. When patients had an international normalization ratio (INR)>1.5 and/or platelet count<50,000 /mm^3, transfusions were performed before PC, with the exception of patients with uncorrectable coagulopathy or sepsis.

All PC procedures were performed under ultrasound and fluoroscopic guidance by one of five board-certified interventional radiologists. The procedures were performed under conscious sedation using intravenous fentanyl (50–100 µg) and midazolam (1–3 mg). The GB was percutaneously punctured using a 21-gauge needle (Cook, Bloomington, USA) under US guidance. A 5 F introducer (Cook) was advanced into the GB over a 0.018-inch guidewire (Cook) and an 8.5 F drainage catheter (Cook) was inserted over a 0.035-inch guidewire (Terumo, Tokyo, Japan). The procedures were performed using a transhepatic approach, when technically feasible.

When the clinical symptoms and laboratory findings improved, the catheter was clamped and left in place for 1–7 days before removal. The decision to perform interval cholecystectomy was made by hepatobiliary surgeons on an individual basis for each patient.

Definitions and statistical analysis

We collected patient demographic data, the last laboratory examination before PC, maximum body temperature within 3 days before PC, laboratory examination 3–5 days after PC (the highest value was selected when there were multiple results), maximum body temperature 3–5 days after PC, resolution of abdominal pain, length of antibiotic treatment before PC, postprocedural complications, length of intensive care unit (ICU) stay and admission, and duration of PC indwelling. Baseline comorbidities were evaluated using the age-adjusted Charlson comorbidity index (aCCI). The evaluation of PC outcomes included clinical effectiveness, complications, catheter removal, and cholecystitis recurrence. Clinical effectiveness was defined as the resolution of abdominal pain, normalized white blood cell (WBC) count, and temperature within 5 days after PC and no recurrence within at least 30 days. Adverse events were classified according to the Common Terminology Criteria for Adverse Events, version 5.0.

The paired-sample t-test was used to compare pre- and post-PC laboratory findings. The independent samples t-test was used to compare pairs of independent continuous variables between groups. Fisher's exact test was used to compare categorical variables between the groups. The rate of recurrent cholecystitis after PC removal was calculated using Kaplan–Meier estimation. Data were considered censored for analysis if no biliary event was observed to the point of death or loss to follow-up. Twenty-one relevant variables were included in the logistic regression analyses to identify risk factors for recurrent cholecystitis. Variables with a $p < 0.10$ on univariate analyses were included in the multivariate analysis. All statistical analyses were performed using the SPSS software (version 14.0. SPSS, Chicago, IL, USA). Statistical significance was set at $p < 0.05$.

RESULTS

Patient characteristics

The demographic and clinical characteristics of the patients are summarized in Table 1. There were 74 men and 50 women with a mean age of 71.9 years. There were 57 (46.0%) moderate and 67 (54.0%) severe AAC cases. Organ dysfunction included cardiovascular (n = 44), neurological (n = 23), respiratory (n = 25), and renal (n = 14). AAC was complicated by gangrenous (n = 8), perforated (n = 6), and emphysematous (n = 4) lesions on pre-procedural CT. The mean aCCI was 6.0 (range 1–13). The most common comorbidities were cerebrovascular disease (n = 45), followed by malignancy (n = 34), and diabetes (n = 33). Sixty-five patients with AAC were diagnosed at admission and 59 developed AAC during hospitalization. Fifty-nine patients were hospitalized for cerebrovascular disease (n = 25), respiratory failure (n = 12), major surgery (n = 12), malignancy (n = 7), and renal failure (n = 3).

Clinical effectiveness

PC was technically successful in all patients. All procedures were performed using the transhepatic approach. Clinical effectiveness was achieved in 107 patients (86.3%) at 3 days and in all patients (100%) at 5 days after PC placement. The mean WBC count was 13,600 ± 7,200 /mm^3 before PC and 8,700 ± 3,200 / mm^3 5 days after PC ($p < 0.001$). The mean value of C-reactive protein decreased from 15.7 ± 9.2 mg dl^{-1} before PC to 5.1 ± 3.8 mg dl^{-1} 5 days after PC ($p < 0.001$). The median length of admission was 16.0 days (range 5–128), and the median post-PC length of admission was 14.5 days (range 5–113). Twenty-three

Table 1. Demographic and clinical characteristics of the patients

variable	AAC patients receiving PC (n = 124)
Sex (M:F)	74:50
Age (mean, range)	71.9 years (26-94)
Duration of admission (mean, range)	16.0 days (3-128)
ICU stay	27 (21.8%)
Sepsis	44 (35.5%)
TG13/18 grade II/III	57 (46.0%)/67 (54.0%)
Cardiovascular dysfunction	44 (35.5%)
Neurological dysfunction	23 (18.5%)
Respiratory dysfunction	25 (20.2%)
Renal dysfunction	14 (11.3%)
Hepatic dysfunction	5 (4.0%)
Hematological dysfunction	18 (14.5%)
Complicated cholecystitis[a]	39 (31.5%)
Age-adjusted Charlson comorbidity index (mesn, range)	6.0 (1-13)
Prior myocardial infarction or CHF	45 (36.3%)
Cerebrovascular disease	45 (36.3%)
Malignancy	34 (27.4%)
Diabetes	33 (26.6%)
Chronic pulmonary disease	21 (16.9%)
Moderate or severe renal disease	17 (13.7%)
Initial laboratory tests (mean ± SD)	
WBC ($\times 10\ l^{-1}$)	13.6 ± 7.2
Platelet ($\times 10\ l^{-1}$)	222.4 ± 138.3
ALT (U/L)	61.7 ± 87.7
Total bilirubin (μmol/L)	2.4 ± 2.4
Creatinine (μmol/L)	1.5 ± 2.7
INR (μmol/L)	1.3 ± 0.7
CRP (mg/dl)	15.7 ± 9.2
PC Indwelling duration (median, range)	18.0 days (3-116)

TG, Tokyo guidelines; aCCI, age-adjusted Charlson comorbidity index; CHD, coronary heart disease; CHF, congestive heart failure; WBC, White blood cells; ALT, alanine aminotransferase; INR, international normalized ratio; CRP, C-reactive protein

[a]based on CT features of gangrenous, perforated, or emphysematous cholecystitis.

patients required ICU management with a median stay of 5 days (range 1–28 days). The PC catheter was removed in 123 patients with a median indwelling duration of 18 days (range, 5–116 days). In one patient with hypoxic encephalopathy, AAC-related symptoms and abnormal laboratory test results resolved, but the catheter was retained *in situ* until death (55 days after placement). Six Grade 2 adverse events occurred, including catheter dislodgement (n = 3) and clogging (n = 3), which required catheter exchange.

Recurrent cholecystitis

The median follow-up duration was 1624 days (range 40–4945 days) after PC. Five patients experienced cholecystitis recurrence at 26, 117, 127, 139, and 349 days after catheter removal (4.1%, 5/123). Patients were treated with cholecystectomy (n = 2) or repeat PC (n = 3). During follow-up, 29 patients died 40–3908 days (median, 641 days) after PC placement. The causes of death were malignancy (n = 14; gastric cancer [n = 5], lung cancer [n = 3], biliary cancer [n = 2], leukemia [n = 2], hepatocellular carcinoma [n = 1], and angiosarcoma [n = 1]), pneumonia (n = 7), congestive heart failure (n = 3), ischemic colitis (n = 1), trauma (n = 1), urosepsis (n = 1), hypoxic encephalopathy (n = 1), and unknown (n = 1). Forty-six patients were lost to follow-up (median 980 days, range 366–4481) and 49 patients were still alive.

The results of univariate and multivariate analyses of the risk factors for recurrent cholecystitis are shown in Table 2. Four factors (aCCI, diabetes, cerebrovascular disease, and complicated cholecystitis) were associated with recurrence in univariate analysis. However, in multivariate analysis, aCCI≥7 was the only risk factor positively associated with recurrence (odds ratio [OR], 1.97; 95% Confidence interval, 1.07–3.64; p = 0.029).

DISCUSSION

PC has been used as an alternative treatment for cholecystectomy in patients with high perioperative risk.[9] Many studies have demonstrated that PC is safe and effective as a bride treatment for interval cholecystectomy or even a definitive treatment in patients with severe sepsis, shock, or multiple comorbidities.[10–13] However, the majority of these studies included ACC and AAC and did not distinguish between them in their analyses. The primary pathogenesis of AAC is bile stasis and ischemic change in the GB, which is different from that of ACC with GB inflammation caused by cystic duct obstruction.[1] Therefore, the role of PC may need to be defined differently in AAC and ACC. Furthermore, PC as a definitive treatment may be suitable in patients with AAC because many patients with AAC have serious comorbidities and are frequently unfit for surgery even after acute inflammation has subsided. However, studies on PC in patients with AAC are limited,[3–7] and no consensus guidelines or recommendations advocate definitive PC for patients with AAC.

This study demonstrated that PC can be a rescue treatment for AAC in patients who are unfit for emergency surgery. Clinical effectiveness was achieved in 86.3% of the patients at 3 days and 100% at 5 days after PC placement. This result is comparable to previously published data.[4,5] In a recent retrospective study,[5] symptomatic and laboratory improvements were achieved in 235 of 271 patients with AAC (86.7%) within 4 days after PC. The reported 30-day mortality was 8.5–10.7%,[3–7] whereas no early mortality occurred in this study. This discrepancy may be explained by the exclusion criteria used for the study population. In previous studies, terminal malignancy was the major cause

Table 2. Comparison of the nonrecurrent and recurrent patient groups

variable	No recurrence (n = 119)	Recurrence (n = 5)	Univariate p-value	Multivariate OR (95% CI), p-value
Sex [male (%)]	60 (50.4%)	4 (80%)	0.647	
Age (≥72 years)	57 (47.9%)	3 (60%)	0.979	
Duration of admission (≥16 days)	15.0 ± 30.7	13.0 ± 18.3	0.875	
TG18 grade (III)	65 (54.6%)	2 (40%)	0.660	
aCCI (≥7)	41 (34.4%)	4 (80%)	0.037	1.97 (1.07–3.64), 0.029
Sepsis	43 (36.1%)	1 (20%)	0.655	
Initial laboratory values				
White blood cells ($\times 10\ l^{-1}$)	13.6 ± 7.2	14.9 ± 7.3	0.398	
Platelets ($\times 10\ l^{-1}$)	225.2 ± 139.9	154.6 ± 70.6	0.204	
ALT (U/L)	61.9 ± 92.6	51.3 ± 32.1	0.388	
Total bilirubin (μmol/L)	2.5 ± 2.5	1.7 ± 0.8	0.210	
Creatinine (μmol/L)	1.5 ± 2.8	1.7 ± 2.2	0.255	
INR (μmol/L)	1.3 ± 0.3	2.6 ± 3.1	0.269	
CRP (mg/dl)	15.6 ± 9.2	19.2 ± 9.4	0.180	
Prior myocardial infarction or CHF	43 (36.1%)	2 (40%)	0.231	
Cerebrovascular disease	41 (34.5%)	4 (80%)	0.058	5.66 (0.19–164.47), 0.313
Malignancy	33 (27.7%)	1 (20%)	1.00	
Diabetes	30 (25.2%)	3 (60%)	0.117	0.74 (0.05–10.54), 0.825
Chronic pulmonary disease	20 (16.8%)	1 (20%)	1.00	
Moderate or severe renal disease	16 (13.4%)	1 (20%)	0.528	
Complicated cholecystitis	36 (30.3)	3 (60%)	0.179	
PC indwelling duration (≥18 days)	49 (41.2%)	3 (60%)	0.649	

of death.[5,7] In contrast, cholecystitis caused by malignant biliary obstruction was excluded from this study because its pathophysiology and prognosis are completely different from those of benign primary AAC, which is the main disease of interest in this study. Other exclusions, including common bile duct stones, Grade one cholecystitis, and pancreatitis, were similar to these reported in previous studies.[3–7]

A major concern regarding PC is the management of the drainage catheter. Long-term or permanent indwelling of the catheter inevitably causes catheter-related complications and discomfort. Therefore, the drainage catheter should be removed, whenever possible. However, controversy remains regarding the removal of PC catheters. In a meta-analysis,[14] there was no correlation was found between PC indwelling duration and clinical outcomes. Currently, PC catheter removal is generally recommended after at least 2 weeks of indwelling for tract maturation using a transhepatic approach; but the optimal timing of catheter removal remains unclear. In this study, the drainage catheter was successfully removed in all patients, except one (99.2%), following a successful trial of catheter clamping.

The recurrence of cholecystitis is a major drawback of PC compared with cholecystectomy. In this study, there were five patients who experienced recurrent cholecystitis, and all recurrences occurred within 1 year after PC removal (4.1%, 5/123). With the exception of one study[7] with a relatively high recurrence rate (17.4%), most previous studies reported recurrence rates of less than 10% (2.3–9.1%).[3–5,15] According to current guidelines, cholecystectomy is recommended whenever possible regardless of ACC or AAC.[9] Therefore, once patients stabilize after PC, interval cholecystectomy should be considered. However, recurrence rates lower than 10% raise the question of whether interval cholecystectomy is necessary. A recent study revealed that AAC patients had a lower likelihood of interval cholecystectomy than ACC patients did (adjusted HR, 2.35). To our knowledge, no study has compared the outcomes of definitive PC and interval cholecystitis in patients with AAC. Further studies comparing the clinical outcomes and cost-effectiveness between the two groups are needed.

Identification of risk factors would be helpful determining management options after stabilization with PC (interval cholecystectomy, removal of drainage catheter, or permanent PC indwelling). Chen et al[4] investigated the risk factors for recurrence in AAC, in which a multivariate analysis showed that coronary heart disease or congestive heart failure was positively correlated with recurrence (OR, 26.50). In this study, potential risk factors similar to those in Chen's study were tested, and aCCI≥7 was a risk factor for cholecystitis recurrence. Although the risk factors found in these two studies were not identical, underlying comorbidities seemed to have a greater effect than those of the other factors (demographic, severity of cholecystitis, and laboratory tests). Therefore, patients with severe comorbidities may be better to undergo interval cholecystectomy. If patients are ineligible for surgery even after recovery from AAC, the removal of the drainage catheter should be more cautious or a permanent PC indwelling should be considered.

This study had several major limitations. First, retrospective data collection from a single institution might have resulted in selection bias in the patient cohort. Although the study population (n = 124) might have been insufficient in size, this is currently one of the largest studies dealing with definitive PC in AAC patients. Second, many patients were lost to follow-up (n = 46, 37.1%). This was mainly because patients are frequently transferred to regional hospitals for terminal care. This may have underestimated the rate of cholecystitis recurrence. However, patients were lost after at least 1 year of follow-up, whereas most recurrences occurred within 1 year in previous studies.[3–5] Third, the number of patients with recurrent cholecystitis in this study was small (n = 5, 4.1%). This may limit the statistical power of multivariate analysis for risk factors.

In conclusion, definitive PC is a safe and effective treatment option for patients with AAC. The PC catheter can be safely removed after recovery from AAC in most patients. An aCCI≥7 was a risk factor for cholecystitis recurrence after catheter removal.

FUNDING

This research was supported by grant no 14-2022-0049 from the Seoul National University Bundang Hospital Research Fund.

REFERENCES

1. Gallaher JR, Charles A. Acute cholecystitis: a review. *JAMA* 2022; **327**: 965–75. https://doi.org/10.1001/jama.2022.7771
2. Kim SB, Gu MG, Kim KH, Kim TN. Long-Term outcomes of acute acalculous cholecystitis treated by non-surgical management. *Medicine (Baltimore)* 2020; **99**(7): e19057. https://doi.org/10.1097/MD.0000000000019057
3. Chen SY, Huang R, Kallini J, Wachsman AM, Van Allan RJ, Margulies DR, et al. Correction to: outcomes following percutaneous cholecystostomy tube placement for acalculous versus calculous cholecystitis. *World J Surg* 2022; **46**: 1886–95. https://doi.org/10.1007/s00268-022-06632-8
4. Chen B-Q, Chen G-D, Xie F, Li X, Mao X, Jia B. Percutaneous cholecystostomy as a definitive treatment for moderate and severe acute acalculous cholecystitis: a retrospective observational study. *BMC Surg* 2021; **21**: 439. https://doi.org/10.1186/s12893-021-01411-z
5. Noh SY, Gwon DI, Ko GY, Yoon HK, Sung KB. Role of percutaneous cholecystostomy for acute acalculous cholecystitis: clinical outcomes of 271 patients. *Eur Radiol* 2018; **28**: 1449–55. https://doi.org/10.1007/s00330-017-5112-5
6. Abbas SH, Ghazanfar MA, Gordon-Weeks AN, Reddy SR, Soonawalla Z, Silva MA. Acalculous cholecystitis: Is an elective interval cholecystectomy necessary. *Dig Surg* 2018; **35**: 171–76. https://doi.org/10.1159/000477780
7. Kirkegård J, Horn T, Christensen SD, Larsen LP, Knudsen AR, Mortensen FV. Percutaneous cholecystostomy is an effective definitive treatment option for acute acalculous cholecystitis. *Scand J Surg* 2015; **104**: 238–43. https://doi.org/10.1177/1457496914564107
8. Yokoe M, Hata J, Takada T, Strasberg SM, Asbun HJ, Wakabayashi G, et al. Tokyo guidelines 2018: Diagnostic criteria and severity grading of acute cholecystitis (with videos). *J Hepatobiliary Pancreat Sci* 2018; **25**: 41–54. https://doi.org/10.1002/jhbp.515
9. Okamoto K, Suzuki K, Takada T, Strasberg SM, Asbun HJ, Endo I, et al. Tokyo guidelines 2018: flowchart for the management of acute cholecystitis. *J Hepatobiliary Pancreat Sci* 2018; **25**: 55–72. https://doi.org/10.1002/jhbp.516
10. Park JK, Yang J-I, Wi JW, Park JK, Lee KH, Lee KT, et al. Long-Term outcome and recurrence factors after percutaneous cholecystostomy as a definitive treatment for acute cholecystitis. *J Gastroenterol Hepatol* 2019; **34**: 784–90. https://doi.org/10.1111/jgh.14611
11. Bundy J, Srinivasa RN, Gemmete JJ, Shields JJ, Chick JFB. Percutaneous cholecystostomy: Long-term outcomes in 324 patients. *Cardiovasc Intervent Radiol* 2018; **41**: 928–34. https://doi.org/10.1007/s00270-018-1884-5
12. Kim D, Iqbal SI, Ahari HK, Molgaard CP, Flacke S, Davison BD. Expanding role of percutaneous cholecystostomy and interventional radiology for the management of acute cholecystitis: an analysis of 144 patients. *Diagn Interv Imaging* 2018; **99**: 15–21. https://doi.org/10.1016/j.diii.2017.04.006
13. Hung Y-L, Sung C-M, Fu C-Y, Liao C-H, Wang S-Y, Hsu J-T, et al. Management of patients with acute cholecystitis after percutaneous cholecystostomy: from the acute stage to definitive surgical treatment. *Front Surg* 2021; **8**: 616320. https://doi.org/10.3389/fsurg.2021.616320
14. Macchini D, Degrate L, Oldani M, Leni D, Padalino P, Romano F, et al. Timing of percutaneous cholecystostomy tube removal: systematic review. *Minerva Chir* 2016; **71**: 415–26. https://doi.org/10.1097/MCG.0b013e3182274375
15. Chung YH, Choi ER, Kim KM, Kim MJ, Lee JK, Lee KT, et al. Can percutaneous cholecystostomy be a definitive management for acute acalculous cholecystitis? *J Clin Gastroenterol* 2012; **46**: 216–19. doi: https://doi.org/10.1097/MCG.0b013e3182274375