European Review for Medical and Pharmacological Sciences 2020; 24: 10696-10702

Percutaneous cholecystostomy in the treatment of acute cholecystitis: is there still a role? A 20-year literature review

A. CRUCITTI[1], A. LA GRECA[2], G. PEPE[2], S. MAGALINI[2], D. GUI[2], G. SGANGA[2], M. BOSSOLA[2]

[1]General and Minimally Invasive Surgery Unit, Cristo Re Hospital, Rome, Italy
[2]Department of Medical and Surgical Sciences, Fondazione Policlinico Universitario "Agostino Gemelli", IRCSS, Università Cattolica del Sacro Cuore, Rome, Italy

Abstract. – OBJECTIVE: Percutaneous cholecystostomy (PC) is used for the treatment of acute cholecystitis in patients with high surgical risk due to the severity of cholecystitis and/or the underlying acute or chronic medical comorbidities. The evidence for this strategy is unclear.

MATERIALS AND METHODS: We searched PubMed and the Cochrane databases for English-language studies published from January 1979 through December 31, 2019, for randomized clinical trials (RCTs), meta-analyses, systematic reviews, and observational studies.

RESULTS: The two randomized studies that have compared PC with cholecystectomy (CCY) or conservative treatment have shown that the clinical outcomes did not differ significantly between the groups. Similar results have been found in the large majority of retrospective cohorts or single-center studies that have compared PC with CCY.

CONCLUSIONS: PC does not seem to offer any benefit compared with CCY in the treatment of acute cholecystitis in patients with high surgical risk due to the severity of cholecystitis and/or the underlying acute or chronic medical comorbidities. A large, prospective, randomized study that compares percutaneous PC and CCY in patients with high surgical risk and/or moderate to severe cholecystitis is warranted.

Key Words:
Cholecystostomy, Cholecystectomy, Acute cholecystitis.

Introduction

Since 1980, percutaneous cholecystostomy (PC) has been proposed and used for the treatment of acute cholecystitis in patients with high surgical risk due to the severity of cholecystitis and/or the underlying acute or chronic medical comorbidities[1-20]. In particular, PC has been proposed for patients with acalculous cholecystitis, a typical complication of an existing disease in a critically ill patient or after surgery, trauma, anorexia, or burns.

PC is usually performed under local anesthesia and under ultrasound or CT scan guidance. The drainage of the infected bile through the PC leads to a decrease of the inflammatory status and to an improvement of the clinical conditions of the patient. PC may be a definitive treatment in patients whose general conditions are not expected to improve or may represent a bridge to eventual delayed elective CCY. Generally, the PC procedure has a high successful rate defined as the clinical improvement within 48-72 hours after the PC itself. Not rarely, the slippage of the PC catheter may occur[21].

Many studies of single institutions have reported the short-term and long-term results associated with the use of PC[2-21]. Recently, a systematic review that included the only two available randomized studies has concluded that it was impossible to determine the role of PC in the management of high-risk surgical patients with acute cholecystitis[22]. However, some retrospective studies have compared PC and CCY (CCY) in terms of clinical outcomes, such as in-hospital mortality, postoperative morbidity, hospital stay and readmission rate[23-30].

The aim of the present narrative review is to review all these studies, to define whether PC offers real advantages with respect to CCY and to determine if there is evidence to consider PC the procedure of choice in the treatment of acute cholecystitis in high risk surgical patients.

Corresponding Author: Gabriele Sganga, MD; e-mail: gabriele.sganga@policlinicogemelli.it

Materials and Methods

We searched PubMed and the Cochrane databases for English-language studies published from January 1979 through December 31, 2019, for randomized clinical trials (RCTs), meta-analyses, systematic reviews, and observational studies. We also manually searched the references of selected articles, reviews, meta-analyses, and practice guidelines. Selected articles were mutually agreed upon by the authors.

Results

Single-Arm Studies

A large number of single-arm studies[2-21] has described the clinical outcome of PC in patients with acute cholecystitis. These studies have been the object of an excellent recent systematic review[22]. This review has shown that mortality resulting from the PC was low (0.36%) and the 30-day or in-hospital mortality was 15.4%. In addition, it is suggested that the 0.96% mortality rate of elective CCY following cholecystostomy should be added. Interestingly, the mortality rate of PC significantly decreased from 22.1% to 13.3% for studies published before and after 1995, respectively[22].

Retrospective Single-Center Studies

Four studies have retrospectively evaluated the clinical outcomes of PC and CCY using databases of a single surgical institution (Table I). In the study of Abi-Hadar et al[23], compared with CCY, PC patients had longer intensive care unit stays, more complications per patient, and higher readmission rates. La Greca et al[24] studied 646 patients with acute cholecystitis, 90 had placement of a PC at their index hospitalization, and 556 underwent CCY. In the ASA score 1-2 group, patients with PC were significantly older and had a longer postoperative stay while their mortality and morbidity were similar to patients who underwent CCY. In patients with ASA score of 3, PC and CCY did not differ significantly for demographic variables and clinical outcomes, such as hospital stay, in-hospital mortality postoperative complications and distribution of complications. In general, in mild, moderate and severe cholecystitis, the clinical outcomes did not differ significantly between patients who received PC and CCY. Morbidity was higher in patients with mild cholecystitis who underwent PC. Of the 77 patients dismissed from the hospital with drainage, 12 (15.6%) developed biliary complications and 5 needed substitutions of the drainage itself. The 10-year retrospective cohort analysis of patients with acute cholecystitis managed by PC (n = 114) or CCY (n = 234) of Loftus et al[25] demonstrated that, after matching for age, comorbidity and cholecystitis severity grade, PC patients had higher 30-day mortality (14.3 *vs.* 2.4%, $p = 0.109$) and 180-day mortality (28.6 *vs.* 7.1%, $p = 0.048$). In the study of Garces-Albir et al[26], including 461 patients, the results of PC were worse compared to EC: 30-day mortality (8.6 *vs.* 1.7%, OR 18.4), 90-day mortality (10.4 *vs.* 2.1%, OR 10.3), length of stay (days) (13.21 ± 8.2 *vs.* 7.48 ± 7.67, OR 8.7) and readmission rate (35.1 *vs.* 12.6%, OR 4.7).

Retrospective Studies Using National Databases

Some studies have utilized national discharge database to examine the difference in outcomes for patients who received PC compared with CCY, in patients with acalculous or calculus cholecystitis (Table II)[27-33]. Simorov et al[27] showed that the severely ill elderly patients of the University Health System Consortium, undergoing PC, compared with those who received laparoscopic CCY, showed decrease morbidity, fewer intensive care unit admission, decreased length of stay and lower costs. Conversely, Anderson et al[28], who retrospectively studied about 307,000 patients with acute cholecystitis of the US Nationwide Inpatient Sample database from 1998-2010, have shown that patients who received PC had a decreased complication rate but an increased odds of death and longer length of stay and higher total charges compared with patients with CCY[27]. The same authors analyzed the California Office of Statewide Health Planning and Development Patient Discharge Data. They found that in patients with severe sepsis and shock, after adjusting for age, comorbidities and other variables, there was no difference in survival with cholecystostomy versus no intervention (hazard ratio [HR] 1.13, $p = 0.256$), although patients with CCY (with or without prior cholecystostomy) improved survival (HR 0.29, $p < 0.001$; HR 0.56, $p < 0.001$)[29]. According to Dimou et al[30], in 8,818 elderly patients of the Medicare database hospitalized for grade III cholecystitis, percutaneous CCY was associated with higher 30-day and 90-day mortality, longer length of hospital stays, and higher

Table I. Single-center studies comparing cholecystostomy with cholecystectomy in the treatment of acute cholecystitis.

Author	Type of study	Type and number of patients	Mortality (%)	Postoperative complications (%)	Hospital stay (days)
Abi-Haidar et al[23]	Retrospective	PC = 51 CCY = 150	PC = 5.9 CCY = 0 I < 0.01	PC = 84.3 CCY = 72 *p* = 0.08	PC = 5.9 ± 8.5 CCY = 2.3 ± 6.2 *p* = 0.008
Loftus et al[24]	Retrospective	PC: 114 CCY: 234 Matched PC and CCY by age and severity of cholecystitis PC = 42 CCY = 42	At 30 days: PC: 14.3; CCY: 2.4; *p* = 0.109 At 180 days: PC: 28.6%; CCY: 7.1%; *p* = 0.048 Matched PC and CCY by age and severity of cholecystitis At 30 days: PC: 5.5; CCY: 6.8; *p* = 0.228 At 180 days: PC: 14%; CCY: 16.5%; *p* = 0.382		
La Greca et al[25]	Retrospective	Patients with ASA 3 score PC = 59 CCY = 58 Patients with Grade III cholecystitis PC = 29 CCY = 28	Patients with ASA 3 score PC = 6.7 CCY = 1.7 *p* = 0.366 Patients with Grade III cholecystitis PC = 10.3 CCY = 0 *p* = 0.236	Patients with ASA 3 score PC = 33.8 CCY = 25.9 *p* = 0.420 Patients with Grade III cholecystitis PC = 44.8 CCY = 17.8 *p* = 0.177	Patients with ASA 3 score PC = 11.8 ± 10.7 CCY = 12.1 ± 10.7 *p* = 0.879 Patients with Grade III cholecystitis PC = 12.9 ± 12.6 CCY = 13 ± 8.3 *p* = 0.972
Garces-Albir[26]	Retrospective	PC = 222 CCY = 239 CCY = 1.7	30-day mortality PC = 8.6 *p* = 0.017 *p* = 0.001 90-day mortality PC = 10.4 CCY = 2.1 *p* ≤ 0.001	PC = 14 CCY = 22.6 *p* ≤ 0.001	PC = 13.2 ± 8.2 CCY = 7.4 ± 7.6

PC, percutaneous Cholecystostomy; CCY; cholecystectomy.

complication and readmission rates. Hall et al[31] analyzed the Vizient UHC database for high-risk patients with calculous cholecystitis who underwent percutaneous cholecystostomy (20% of patients), laparoscopic CCY (67.5%), open CCY (6.8%) or laparoscopic CCY converted to open (7.9%). Mortality was significantly higher for PC (10.7%) and OC (8.3%) than for CONV (2.2%) and LC (0.8%). The overall incidence of postoperative complications was similar for PC (13.2%), OC (18.5%), and CONV (15.4%) but significantly lower for LC (4.8%). Similarly, the length of the hospital was significantly lower for LC (7.2±6.5) than for PC (14±14.9), CONV (12.3±15) and OC (17.2±15).

A recent study[32] conducted in Taiwan, including 236,742 patients, 11,184 of whom undergone PC and 225,558 of whom undergone CCY, has shown that PC was associated with higher mortality, higher rate of cholecystitis recurrence, higher frequency of readmission for complications, longer hospital stays and generated higher costs.

Sanaiha et al[33] retrospectively analyzed the cohort of non-elective admissions for acute cholecystitis from 2010 to 2015 using the nationwide readmissions database for adults ≥ 65 years with evidence of end-organ dysfunction (grade 3). As result, they found that of the estimated 358,624 patients, 14.9% underwent PC, 15.7% OCY and 69.4% laparoscopic CCY. PC had significant-

Table II. Large database studies comparing cholecystostomy with cholecystectomy in the treatment of acute cholecystitis.

Author	Type of study	Type and number of patients	Mortality (%)	Postoperative complications (%)	Hospital stay (days)	Readmission (%)
Simorov et al[27]	Cohort	Elderly patients PC = 704 CCY = 1021	PC = 2.6 CCY=2.1 *p* = NS	PC = 5 CCY=8 *p* < 0.05	PC = 7 (5-10)* CCY = 8 (5-12)*	PC = 29 CCY = 16.1 *p* < 0.05
Anderson et al[28]*	Cohort	PC = 3691 CCY = 244538	PC= 11.5 CCY= 1.1 *p* < 0.001	PC = 4.1 CCY=8.5 *p* < 0.001	PC = 12.7 (12.2-13.1) CCY = 5.1 (5.1-5.1) *p* < 0.001	Not reported
Anderson et al[28]**	Cohort	PC = 4329 CCY = 54189	PC = 14.2 CCY = 2.6 *p* < 0.001	PC = 6.9 CCY = 10.4 *p* < 0.001	PC=14.9 (14.4-15.4) CCY = 6.7 (6.6-6.8) *p* < 0.001	Not reported
Anderson et al[29]**	Cohort	PC=1216 CCY=27578 PC+CCY=521 CT=14115	PC = 61.7 CCY = 23 PC+CCY=34.5 CT=42 *p* < 0.0001	Not reported	Not reported	Not reported
Dimou et al[30]	Cohort	Grade 3 cholecystitis CCY = 22.6; PC: 563 CCY: 1689	In-hospital: PC = 24 *vs.* PC=6.4 P = NS 30-day: PC = 38.9 vs. CCY = 32.7; *p* = 0.008 90-day: PC = 64.8 *vs.* CCY = 59.1; *p* = 0.016	Surgical site infection: *p* < 0.001 CCY=3.9 Pneumonia: PC = 34.1 CCY = 36	PC = 13 CCY = 10 *p* < 0.001	PC = 14.6 CCY = 5.3
Hall et al[31]	Cohort	High risk patients PC = 1682 CCY = 658 LC = 6456 CONV = 765	PC = 10.7 CCY = 2.22 LC = 0.85 CONV=8.63 *p* < 0.05	PC = 13.2 CCY = 18.5 LC = 4.8 CONV = 15.4 *p* < 0.05	PC = 14 ± 14.9 CCY = 17.2 ± 15 LC = 7.2 ± 6.5 CONV = 12.3 ± 15 *p* < 0.05	PC = 0.54 CCY = 0 LC = 0 CONV = 0 *p* < 0.05
Lu et al[32]	Cohort	Elderly or critically ill PC = 11184 CCY = 225558	PC = 16.3 CCY = 2.2 *p* < 0.001	PC = 2.07 CCY = 4.03 *p* < 0.001	PC = 17.2 ± 7.2 CCY = 9.5 ± 1.1 *p* = 0.001	PC = 3.4 CCY = 1.3 *p* < 0.001
Sanaiha et al[33]	Cohort	Grade 3 cholecystitis PC = 15884 OC = 16801 LC = 74144	PC = 15 OC = 7 LC = 2.5 *p* < 0.001	PC = 60 OC = 45 LC = 25 *p* < 0.001	PC = 10 OC = 10 LC = 6 *p* < 0.001	PC = 1.8 OC = 1.1 LC = 1.0 *p* < 0.001

PC, percutaneous cholecystostomy; CCY; cholecystectomy; OC, open cholecystectomy; LC, laparoscopic cholecystectomy; CT, conservative treatment. *calculous cholecystitis; **acalculous cholecystitis.

ly higher odds of mortality (AOR 5.8, 95% CI 5.1-6.6), composite morbidity (AOR 3.8, 95% CI 3.5-4.1), early (AOR 1.9, 95% CI 1.7-2.0) and intermediate (AOR 2.2, 95% CI 2.0-2.5) readmission compared to LC and OC. After adjusting for institutional cholecystectomy volume, transfer status, frailty, and patient comorbidities, including malignancy, acute pancreatitis, and cholangitis, PC and OC had significantly higher odds of inpatient mortality and composite morbidity compared to LC. After risk-adjustment, PC and OC had greater odds of early readmission compared to LC, while only PC was associated with increased odds of 31-90-day rehospitalization.

Table III. Prospective, randomized studies. PC, percutaneous cholecystostomy; CCY; cholecystectomy.

Author	Type of study	Type and number of patients	Mortality (%)	Postoperative complications (%)	Hospital stay (days)
Hatzidakis et al[34]	Randomized	High risk patients PC=63 Control: 60	PC = 17.5 Control = 13.3 $p = 0.621$	PC = 13.6 Control = 7.1 $p = 0.325$	Not reported
Akyurek et al[35]	Randomized	High risk patients PC = 31 CCY = 30	PC = 0 CCY = 3.3 $p = 0.652$	PC = 2.7 Control = 6.1 $p = 0.385$	Shorter after PC

Prospective, Randomized Studies

Two randomized studies only have compared PC with CCY or conservative treatment (Table III). In the study of Hatzidakis et al[34], patients were randomized to PC with antibiotics or antibiotics alone. The 30-day mortality (17.5% *vs.* 13.3%) and the overall morbidity (13.6% *vs.* 7.1%) did not differ between the two groups. Akyurek et al[35] randomized 61 patients with acute cholecystitis to PC followed by an early laparoscopic CCY (N=31) or to conservative treatment followed by a delayed laparoscopic CCY (N=30). The 30-day mortality (0% *vs.* 3.3%) and the overall morbidity (2.7% *vs.* 6.1%) were similar in the two groups.

Discussion

According to the Tokyo Guidelines, patients affected by acute cholecystitis with organ dysfunction, who represent a very high-risk cohort who may be unfit for cholecystectomy, should be treated by early PC performed in local anesthesia. By the analysis of the data of many national cohorts[27-33], there is evidence that PC has been performed with higher frequency in the last years.

However, the present narrative review shows that PC does not seem to offer any benefit compared with CCY in the treatment of acute cholecystitis in patients with high surgical risk due to the severity of cholecystitis and/or the underlying acute or chronic medical comorbidities.

Two randomized studies[34,35], the ones conducted so far, have shown that mortality and morbidity did not differ between patients with acute cholecystitis who received PC or CCY.

In addition, numerous large database studies have shown that PC, when compared with CCY, was associated with higher morbidity and mortality and longer hospital stay. In addition, readmission rate was also significantly higher and exposed the patients to further risk of morbidity and mortality[27-33].

In particular, two recent large cohort studies[32,33] including thousands of patients deserve great attention. These studies, including elderly/critically patients in one case or patients with grade 3 cholecystitis in the other case, clearly demonstrate that PC is associated with significantly higher 30-day mortality, postoperative complications, readmission rate, as well as with a significantly longer hospital stay, also after adjustment for comorbidities and other risk factors. Nevertheless, it is clear that such studies have several important limitations inherent to their retrospective nature and use of an administrative database.

Cautiously, the results of the present narrative review question if PC may reasonably continue to be offered to patients affected by acute cholecystitis and strongly suggest that there is the urgent need for a prospective, randomized study that compares percutaneous PC and CCY in patients with high surgical risk and/or moderate to severe cholecystitis.

The role of percutaneous cholecystostomy in the treatment of cholecystitis in patients who are defined “unstable” or “not surgical candidates for operative therapy” in the routine clinical practice, a condition more severe than high risk surgical patient, remains also to be defined.

Conclusions

The role of cholecystostomy in the treatment of acute cholecystitis seems controversial, today. A large, prospective, randomized study that compares percutaneous PC and CCY in patients with high surgical risk and/or moderate to severe cholecystitis is warranted in the next future.

Conflict of Interest

Dr. Antonio Crucitti, Dr. Maurizio Bossola, Dr. Sabina Magalini, Dr. Daniele Gui, Dr. Antonio La Greca, have no conflicts of interest or financial ties to disclose.

Authors' Contribution

All authors contributed to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; drafting the work or revising it critically for important intellectual content; and final approval of the version to be published.

References

1) Radder RW. Ultrasonically guided percutaneous catheter drainage for gallbladder empyema. Diagn Imaging 1980; 49: 330-333.
2) Tolan HK, Semiz Oysu A, Başak F, Atak İ, Özbağriaçik M, Özpek A, Kaskal M, Ezberci F, Baş G. Percutaneous cholecystostomy: a curative treatment modality for elderly and high ASA score acute cholecystitis patients. Ulus Travma Acil Cerrahi Derg 2017; 23: 34-38.
3) Zarour S, Imam A, Kouniavsky G, Lin G, Zbar A, Mavor E. Percutaneous cholecystostomy in the management of high-risk patients presenting with acute cholecystitis: timing and outcome at a single institution. Am J Surg 2017; 214: 456-461.
4) Alvino Dm, Fong Zv, Mccarthy Cj, Velmahos G, Lillemoe Kd, Mueller Pr, Fagenholz Pj. Long-term outcomes following percutaneous cholecystostomy tube placement for treatment of acute calculous cholecystitis. J Gastrointest Surg 2014; 21: 761-769.
5) Kim Sy, Yoo Ks. Efficacy of preoperative percutaneous cholecystostomy in the management of acute cholecystitis according to severity grades. Korean J Intern Med 2018; 33: 497-505.
6) Gulaya K, Desai Ss, Sato K. Percutaneous cholecystostomy: evidence-based current clinical practice. Semin Intervent Radiol 2016; 33: 291-296.
7) Amirthalingam V, Low Jk, Woon W, Shelat V. Tokyo Guidelines 2013 may be too restrictive and patients with moderate and severe acute cholecystitis can be managed by early cholecystectomy too. [published online November 1, 2016] Surg Endosc PubMed PMID: 27804044.
8) Pang Kw, Tan Ch, Loh S, Chang Ky, Iyer Sg, Madhavan K, Kow Wc. Outcomes of percutaneous cholecystostomy for acute cholecystitis. World J Surg 2016; 40: 2735-2744.
9) Lin Wc, Chang Cw, Chu Ch. Percutaneous cholecystostomy for acute cholecystitis in high-risk elderly patients. Kaohsiung J Med Sci 2016; 32: 518-525.
10) Ambe Pc, Kaptanis S, Papadakis M, Weber Sa, Jansen S, Zirngibl H. The treatment of critically ill patients with acute cholecystitis. Dtsch Arztebl Int 2016; 113: 545-551.
11) Popowicz A, Lundell L, Gerber P, Gustafsson U, Pieniowski E, Sinabulya H, Sjödahl K, Tsekrekos A, Sandblom G. Cholecystostomy as bridge to surgery and as definitive treatment or acute cholecystectomy in patients with acutecholecystitis. Gastroenterol Res Pract 2016; 2016: 3672416.
12) Wang Ch, Wu Cy, Yang Jc, Lien Wc, Wang Hp, Liu Kl, Wu Ym, Chen Sc. Long-term outcomes of patients with acute cholecystitis after successful percutaneous cholecystostomy treatment and the risk factors for recurrence: a decade experience at a single center. PLoS One 2016; 11: e0148017.
13) Furtado R, Le Page P, Dunn G, Falk Gl. High rate of common bile duct stones and postoperative abscess following percutaneous cholecystostomy. Ann R Coll Surg Engl 2016; 98: 102-106.
14) Ambe Pc, Zirngibl H. The fate of patients managed with percutaneous cholecystostomy for acute cholecystitis. Surgery 2016; 159: 1479-1480.
15) Yeo Cs, Tay Vw, Low Jk, Woon Ww, Punamiya Sj, Shelat Vg. Outcomes of percutaneous cholecystostomy and predictors of eventual cholecystectomy. J Hepatobiliary Pancreat Sci 2016; 23: 65-73.
16) Jung Wh, Park De. Timing of cholecystectomy after percutaneous cholecystostomy for acute cholecystitis. Korean J Gastroenterol 2015; 66: 209-214.
17) Viste A, Jensen D, Angelsen J, Hoem D. Percutaneous cholecystostomy in acute cholecystitis; a retrospective analysis of a large series of 104 patients. BMC Surg 2015; 15: 17.
18) Suzuki K, Bower M, Cassaro S, Patel Ri, Karpeh Ms, Leitman Im. Tube cholecystostomy before cholecystectomy for the treatment of acute cholecystitis. JSLS 2015; 19: e2014.00200.
19) Peters R, Kolderman S, Peters B, Simoens M, Braak S. Percutaneous cholecystostomy: single center experience in 111 patients with an acute cholecystitis. JBR-BTR 2014; 97: 197-201.
20) 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: 238-223.
21) Winbladh A, Gullstrand P, Svanvik J, Sandström P. Systematic review of cholecystostomy as a treatment option in acute cholecystitis. HPB (Oxford) 2009; 11: 183-193.
22) Gurusamy KS, Rossi M, Davidson Br. Percutaneous cholecystostomy for high-risk surgical patients with acute calculous cholecystitis. Cochrane Database Syst Rev 2013; 12: CD007088.
23) Abi-Haidar Y, Sanchez V, Williams SA, Itani KM. Revisiting percutaneous cholecystostomy for acute cholecystitis based on a 10-year experience. Arch Surg 2012; 147: 416-422.
24) La Greca A, Di Grezia M, Magalini S, Di Giorgio A, Lodoli C, Di Flumeri G, Cozza V, Pepe G, Foco M, Bossola M, Gui D. Comparison of cholecystecto-

my and percutaneous cholecystostomy in acute cholecystitis: results of a retrospective study. Eur Rev Med Pharmacol Sci 2017; 21: 4668-4674.

25) Loftus TJ, Collins EM, Dessaigne CG, Himmler AN, Mohr AM, Thomas RM, Hobson CE, Sarosi GA Jr, Zingarelli WJ. Percutaneous cholecystostomy: prognostic factors and comparison to cholecystectomy. Surg Endosc 2017; 31: 4568-4575.

26) Garcés-Albir M, Martín-Gorgojo V, Perdomo R, Molina-Rodríguez JL, Muñoz-Forner E, Dorcaratto D, Ortega J, Sabater L. Acute cholecystitis in elderly and high-risk surgical patients: is percutaneous cholecystostomy preferable to emergency cholecystectomy? J Gastrointest Surg 2019. Doi: 10.1007/s11605-019-04424-5 [online ahead of print].

27) Simorov A, Ranade A, Parcells J, Shaligram A, Shostrom V, Boilesen E, Goede M, Oleynikov D Emergent cholecystostomy is superior to open cholecystectomy in extremely ill patients with acalculous cholecystitis: a large multicenter outcome study. Am J Surg 2013; 206: 935-940.

28) 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: 3406-3412.

29) Anderson JE, Inui T, Talamini MA, Chang DC. Cholecystostomy offers no survival benefit in patients with acute acalculous cholecystitis and severe sepsis and shock. J Surg Res 2014; 190: 517-521.

30) Dimou FM, Adhikari D, Mehta HB, Riall TS. Outcomes in older patients with grade III cholecystitis and cholecystostomy tube placement: a propensity score analysis. J Am Coll Surg 2017; 224: 504-511.

31) Hall BR, Armijo PR, Krause C, Burnett T, Oleynikov D. Emergent cholecystectomy is superior to percutaneous cholecystostomy tube placement in critically ill patients with emergent calculous cholecystitis. Am J Surg 2018; 16: 116-119.

32) Lu P, Chan CL, Yang NP, Chang NT, Lin KB, Lai KR. Outcome comparison between percutaneous cholecystostomy and cholecystectomy: a 10-year population-based analysis. BMC Surg 2017; 17: 130.

33) Sanaiha Y, Juo YY, Rudasill SE, Jaman R, Sareh S, de Virgilio C, Benharash P. Percutaneous cholecystostomy for grade III acute cholecystitis is associated with worse outcomes. Am J Surg 2020; 220: 197-202.

34) Hatzidakis AA, Prassopoulos P, Petinarakis I, Sanidas E, Chrysos E, Chalkiadakis G, Tsiftsis D, Gourtsoyiannis NC. Acute cholecystitis in high-risk patients: percutaneous cholecystostomy vs conservative treatment. Eur Radiol 2002; 2: 1778-1784.

35) Akyürek N, Salman B, Yüksel O, Tezcaner T, Irkörücü O, Yücel C, Oktar S, TatlicioÐlu E. Management of acute calculous cholecystitis in high-risk patients: percutaneous cholecystotomy followed by early laparoscopic cholecystectomy. Surg Laparosc Endosc Percutan Tech 2005; 15: 315-320.