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Bedside Ultrasound-Guided Percutaneous Cholecystostomy in Critically Ill Patients—Outcomes in 51 Patients

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Abstract

Purpose The aim of this study was to report technical and clinical success of bedside ultrasound-guided percutaneous cholecystostomy (PC) tube placement in intensive care unit (ICU).

Materials and Methods This is a retrospective study of 51 patients (36 males:15 females, mean age: 67 years) who underwent ultrasound-guided PC from May 2015 to January 2020. The indication for cholecystostomy tube placement, comorbidities, imaging finding, technical success, clinical success, timing of surgery post-cholecystostomy tube placement, indwelling catheter time, complications, and follow-up were recorded.

Results Indications for cholecystostomy tube placement were acute calculous cholecystitis ($n = 43$; 84.3%), perforated cholecystitis ($n = 5$; 9.8%), and emphysematous cholecystitis ($n = 3$; 5.9%). Most of the patients had multiple comorbidities; these were diabetes mellitus, hypertension, cardiovascular disease, chronic renal disease, underlying malignancy, and multisystem disease with sepsis. All patients had undergone PC through transhepatic approach under ultrasound guidance in ICU. Technical success rate of the procedure was 100%. Clinical success rate was 92.1% (47/51) and among these 44/51 (86.2%) patients underwent definitive elective cholecystectomy, 3/51 (5.9%) patients had elective tube removal. Three of fifty-one (5.9%) patients did not improve; among these two underwent emergency surgery, while there was 1/51 (1.9%) mortality due to ongoing sepsis and multiorgan dysfunction. There were no procedure-related mortalities or procedure-related major complications. One patient had bile leak due to multiple attempts for cholecystostomy placement. Mean tube indwelling time was 13 days (range: 3–45 days).

Conclusion Ultrasound-guided PC can be safely performed in ICU in critically ill patients unfit for surgery with high technical and clinical success rates. Early laparoscopic cholecystectomy should be preferred after stabilization of clinical condition following cholecystostomy.

Keywords
- percutaneous cholecystostomy
- acute cholecystitis
- laparoscopic cholecystectomy

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Introduction

Acute cholecystitis refers to acute onset inflammation of the gallbladder (GB) and is one of the common surgical emergencies leading to hospital admission. Acute cholecystitis is due to gallstones obstructing the cystic duct in majority of cases (>90%) and is known as acute calculous cholecystitis. In some instances, GB inflammation can be seen in the absence of gallstones in critically ill patients, which is known as acalculous cholecystitis (<10%). The standard management of acute calculous cholecystitis is intravenous fluids, antibiotics, analgesia, and early laparoscopic cholecystectomy (LC).[1] LC is safe in early stage of presentation, but LC becomes challenging and hazardous if the time period between onset of acute symptoms and surgery increases.[2] However, increasing age with coexisting comorbidities renders a subset of cases high risk for general anesthesia and unfit for surgery at presentation. In patients who present with emphysematous or perforated GB, surgery in early stage is challenging and postoperative recoveries become lengthy. In patients with these issues, medical management along with drainage of bile/pus with percutaneous cholecystostomy (PC) is adequate alternative to tide over the acute crisis and sepsis, thus enabling the patient to undergo delayed cholecystectomy. When compared to urgent cholecystectomy, PC followed by cholecystectomy in selected patients had advantage of better clinical outcomes in setting of severe cholecystitis.[3–5] PC has proven to be a safe and effective procedure across studies with a high technical success rate being reported as 95 to 100%.[2,6] Most of the patients referred for PC are acutely ill and present a challenge to be shifted to the interventional radiology procedure room. The purpose of this article is to highlight the role of bedside ultrasound-guided PC, its efficacy and complication rate, and clinical outcomes.

Materials and Methods

Retrospective review of medical records of 57 consecutive patients was done. Fifty-one patients (36 males:15 females, mean age: 67 years) who underwent ultrasound-guided PC at bedside in the intensive care unit (ICU) from May 2015 to January 2020 were included in analysis. Local institutional review board approval was obtained. Only patients who underwent PC for acute calculous cholecystitis were included in the study. Six patients who underwent PC were excluded from the study; these included patients who underwent PC for other indications (acute obstructive cholangitis when endoscopic retrograde cholangiography or percutaneous transhepatic biliary drainage could not be done, $n=2$) and patients for whom follow-up was not available ($n=4$). The indication for cholecystostomy tube placement, medical comorbidities, technical success, timing of surgery post-cholecystostomy tube placement, clinical outcome, indwelling catheter time, complications, and follow-up were evaluated.

The diagnosis of acute cholecystitis was established as per TG18/13 diagnostic criteria[7] utilizing combination of local signs of inflammation (Murphy's sign and right upper quadrant pain), systemic signs of inflammation (fever, elevated C-reactive protein and white blood cell count) along with imaging findings. TG18/13 diagnostic criteria were able to establish a diagnosis of acute cholecystitis in all cases (100%). ►**Figs. 1A** and **2A** depict the ultrasound findings of acute calculous cholecystitis. Five of fifty-one (9.8%) patients

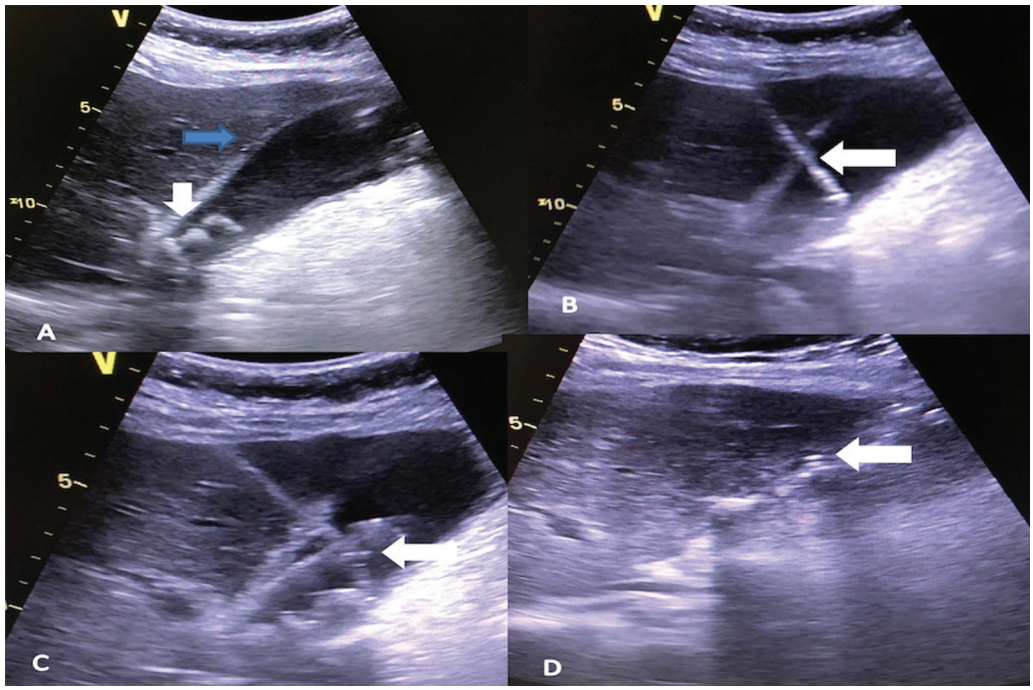

Fig. 1 Ultrasound images depicting (**A**) cholelithiasis causing acute cholecystitis (white arrow depicting gallstones and blue arrow showing gallbladder [GB] wall edema). (**B**) GB access with trocar through transhepatic route. (**C**) Placement of a stiff guidewire into the GB. (**D**) Tip of drainage catheter in a collapsed GB.

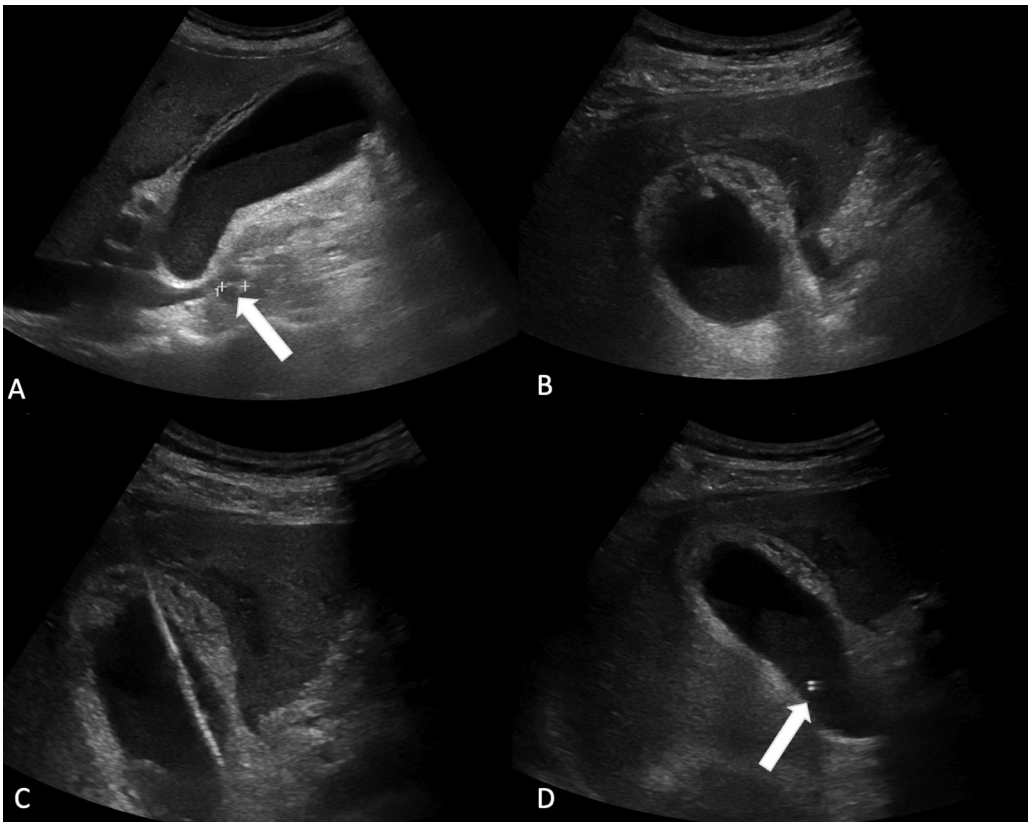

Fig. 2 Acute calculus cholecystitis causing (**A**) severe edema of gallbladder (GB) wall with tiny calculus (white arrow) obstructing cystic duct. (**B**) GB access with trocar through transhepatic route. (**C**) Placement of a stiff guidewire into the GB. (**D**) Tip of drainage catheter in the GB lumen (white arrow).

were not specific or equivocal on ultrasound, so contrast-enhanced computerized tomography scan was done that showed emphysematous or necrotic changes or perforation of GB (►**Fig. 3A**). Ten (19.6%) patients had grade II cholecystitis and 41 (80.3%) patients had grade III cholecystitis as per Tokyo classification. All the patients had laboratory workup

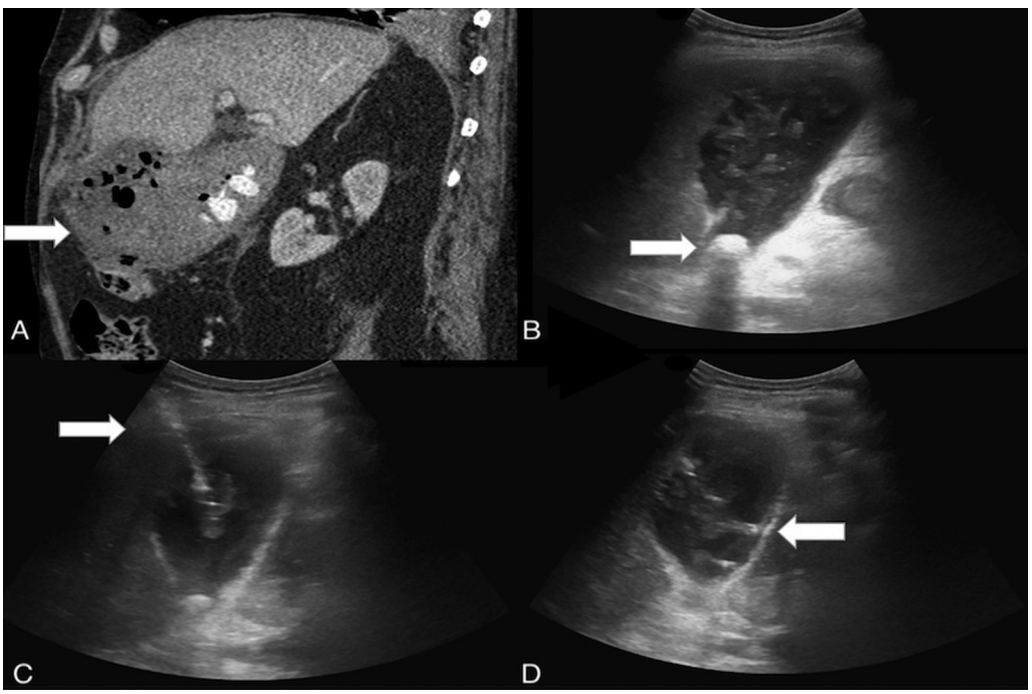

Fig. 3 (**A**) Contrast-enhanced computed tomography scan showing emphysematous cholecystitis with focal perforation (white arrow). (**B**) Ultrasound showing obstructing stones in neck of gallbladder with echogenic contents within (**C**) ultrasound-guided access into the gallbladder. (**D**) Tip of drainage catheter in the gallbladder.

prior to PC; this included complete blood count, liver function test, blood culture, and coagulation profile. If the platelet count was less than 50,000 or international normalized ratio more than 1.5, blood products were administered for correction of coagulopathy.[8] The procedure was done bedside with continuous monitoring of hemodynamic parameters. It was ensured that all the patients were started on empirical antibiotics prior to the procedure. The empirical antibiotics were intravenous ceftriaxone or co-amoxiclav with 500 mg metronidazole. After administering adequate local anesthetic up to the liver capsule, access was taken into the GB via transhepatic approach using 18G trocar needle; bile sample was aspirated and collected for microbiology, followed by insertion of a stiff guidewire over which a 7 to 8 French pigtail drainage catheter was inserted. Tract dilatation was not required considering small size of the drainage catheters placed. ►**Figs. 1B** to **D**, **2 B** to **D**, and **3 B** to **D** illustrate the steps of PC under ultrasound guidance. These pigtail catheters were secured to skin using 2-0 silk sutures to prevent accidental pulling out of catheters and connected to drainage bag. Routine flushing of the catheters was not practiced. In cases with insignificant output from the cholecystostomy tube who were not improving clinically, further evaluation was done with ultrasound and catheter flushed only if GB was found to be distended on ultrasound. Technical success is defined as successful placement of the pigtail catheter into the GB. Clinical success is defined as improvement in the symptoms in the form of resolution of fever and reduction in abdominal pain along with decrease in inflammatory markers (C-reactive protein).

Results

During the period May 2015 to January 2020, a total of 51 patients had a PC for acute cholecystitis. There were 36 men and 15 women with a median age of 67 years (range: 36–84 years). There was no previous history of biliary colic or acute cholecystitis. ►**Table 1** summarizes the patient demographics along with existing comorbidities.

Insertion of the drain was performed median 2 days after admittance to the hospital (range: 0–3 days).

►**Table 2** summarizes the outcomes and results. The technical success rate was 100%. The clinical success rate was 92.1% (47/51). Three of fifty-one (5.8%) patients failed to improve after PC, 2/51 (3.9%) underwent emergency open cholecystectomy, while 1/51 (1.9%) died due to sepsis and multiorgan failure. There was no procedure-related mortality. There were no major procedure-related complications (like bowel injury, hemorrhage). One of fifty-one (1.9%) patient had bile leak likely due to multiple attempts for cholecystostomy placement; he was operated on 4th day after cholecystostomy and gallbladder removed.

None of the patients required repositioning or reinsertion of drains. Few patients required intermittent flushing of tubes to prevent it from getting blocked. After procedure, many patients complained of stretching abdominal pain at the drain insertion site that was controlled by medications. Forty-four of fifty-one (86.2%) patients underwent elective cholecystectomy at follow-up, and 3/51 (5.8%) patients had elective tube removal.

The timing of elective cholecystectomy was decided by the surgeon and anesthetist as per patient's clinical condition

Table 1 Patient demographics

Total patients (*n*)	51
Age	36–84 years (mean: 67 years)
Gender	36 males, 15 females
Final diagnosis	
Acute calculous cholecystitis	43/51 (84.3%)
Acute calculous cholecystitis with ruptured gall bladder	05/51 (9.8%)
Acute emphysematous cholecystitis	03/51 (5.9%)
Severity of acute cholecystitis as per Tokyo classification[6]	
Grade II (moderate)	10/51(19.7%)
Grade III (severe)	41/51 (80.3%)
Comorbidities	
Diabetes mellitus	31
Hypertension	17
Ischemic and other cardiac comorbidities	13
Chronic kidney disease	05
Underlying malignancy	03
Systemic sepsis	33 (64.7%)

Table 2 Outcomes and results

Technical success rate	51/51 (100%)
Clinical success rate	47/51 (92.1%)
Overall mortality	01/51 (01.9%)
Procedure related mortality	00/51 (00.0%)
CRP preprocedure	29–202 mg/L (median: 58)
CRP 72 hours post-PC	04–34 mg/L (median: 11)
Complications	
Bile leak (requiring surgery)	01/51 (01.9%)
Elective interval cholecystectomy	44/51 (86.2%)
Timing of insertion of PC from hospital admission	0–3 days (median: 2 days)
$<$ 24 hours	06/51 (11.7%)
$>$ 24 hours (after trial of antibiotics)	45/51 (88.3%)
PC tube indwelling time	3–45 days (mean: 13 days)
Most common organism grown on bile culture	*Escherichia coli*, 40/51 (78.4%)

Abbreviations: CRP, C-reactive protein; PC, percutaneous cholecystostomy.

and resolution of sepsis to withstand surgery and general anesthesia. Mean tube indwelling time was 13 days (range: 3–45 days). We found that surgeon preference was toward early cholecystectomy ($<$ 2 weeks). Thirty-six of forty-four (81.8%) patients underwent cholecystectomy within 2 weeks of PC placement and among these only 2/36 (5.6%) had to be converted to open cholecystectomy. However, among 8/44 (18.2%) patients who underwent delayed cholecystectomy ($>$ 2 weeks), 2/8 (25%) were converted to open cholecystectomy; this was attributed to increased adhesions and fibrosis around the GB.

Discussion

The first cholecystostomy reported in literature was surgical cholecystostomy in 1967[9] however, PC under ultrasound guidance for acute cholecystitis was not performed until 1980.[10] In 2020, the SIR (Society of Interventional Radiology) revised its quality improvement guidelines document on PC.[6] Although majority of PC performed in any interventional radiology department are for acute cholecystitis, sometimes PC may be performed for additional indications like to obtain bile sample, decompress biliary tract, or divert bile flow in cases of bile leak. All the PCs (100%) in our study were performed for patients presenting with acute cholecystitis and unfit for surgery. All the comorbidities were recorded; presence of diabetes and hypertension solely was not considered as a contraindication to surgery. All the patients were not given a trial of conservative management. Although guidelines state that in patients unfit for surgery, trial of conservative medical management should be given and PC should be done if there is failure to improve[11,12] however, this algorithm is difficult to adhere to strictly as in some clinical scenarios urgent intervention is warranted. Six of fifty-one (11.7%) patients underwent PC within 24 hours of admission, and 45/51 (88.3%) patients of the PCs were done between 1 and 3 days (median 2 days) after hospital admission.

The technical success rate of bedside ultrasound-guided PC was 100%, while the clinical success rate was 92.1%. The technical and clinical success rates were compliant with the threshold suggested in SIR guidelines 2020 that suggested these to be 97.9 and 74.2%, respectively.[6] Sometimes even ultrasound-guided PC can be challenging and technical failure may be encountered in the setting of multiple stones filling the lumen of GB, emphysematous GB, perforation of GB resulting in partially collapsed GB and porcelain GB. Three of fifty-one (5.8%) patients failed to improve after PC that could have been due to inadequate drainage of infected GB contents or progressing sepsis, an attempt to upsize the drain can be performed if the clinical condition of patient permits the same.

There are two approaches to performing PC—the transhepatic and the direct transperitoneal approach. The SIR guidelines and most authors prefer transhepatic route[2,6] however, a study by Beland et al[13] concluded that transperitoneal approach does not increase the risk of bile leak and either of the two approaches that appears safer for an individual patient can be chosen. In this study, all the PCs were performed via the transhepatic route. The various complications related to PC described in the literature include bleeding, pneumothorax, bowel injury, bile leak, catheter blockage, and dislodgment.[14,15] There were no major complications or procedure-related mortality seen in our study. One of fifty-one (1.9%) patient had bile leak; this was technically challenging procedure with multiple attempts for PC. Although there are studies that have reported mortalities ranging from 8 to 36%, the mortality is not procedure-related mortality but attributed to patient comorbidities and worsening of clinical condition.[16,17]

The timing of cholecystectomy after PC has also been debated and most studies have concluded that early LC

should be done. The trend was toward early LC in our study also. Among the follow-up elective cholecystectomies, 36/44 (81.8%) patients underwent cholecystectomy within 2 weeks of PC placement, and 8/44 (18.2%) patients underwent delayed cholecystectomy (> 4 weeks). The WSES (World Society of Emergency Surgery) and AAST (American Association for the Surgery of Trauma) guidelines[11,12] recommend that LC should be performed within 10 days of symptom onset and if this cannot be performed then cholecystectomy should be delayed for 45 days. A large meta-analysis of 18,640 patients also concluded that early cholecystectomy preferably within 4 weeks after PC is preferable over late cholecystectomy.[18] A randomized trial by Akyürek et al concluded that PC followed by early LC was better compared to conservative treatment followed by delayed LC in high-risk patients.[19] The CHOCOLATE trial compared LC with PC in high-risk cases and concluded that the rate of major complications was less in LC compared to PC.[20] Endoscopic GB drainage is also described in the management of acute calculous cholecystitis for patients unfit for surgery. This can be either endoscopic transpapillary GB drainage or endoscopic ultrasound (EUS)-guided GB drainage. The procedure is described with high technical success rate of 90 to 97% with good clinical outcomes and complication rates 8 to 12%. Studies comparing EUS-guided GB drainage with PC have reported similar technical and clinical success rates with increased postprocedure morbidities mostly related to catheter care and re-interventions in the PC group.[21,22] However, EUS-guided GB drainage is available at high-volume endoscopic centers with high level expertise. Also, endoscopic drainage is done under general anesthesia or sedation, whereas PC is feasible to be performed bedside in ICU under local anesthetic. Lastly, cost-effectiveness of the two procedures is also debatable with EUS-guided GB drainage requiring more resources and dedicated devices.[23] The studies comparing EUS-guided GB drainage to PC report that main demerit of PC is morbidity related to catheter care and catheter dislodgement with high reinterventions rates that also highlights the importance of early LC in these patients to avoid these complications.

This study illustrated the role of ultrasound alone in insertion of PC tubes in high-risk patients unfit for surgery. Many of these patients are on cardiovascular and respiratory supports and therefore cannot be shifted to angiography suites or CT scanners. Ultrasound machines are available in ICU or can be shifted to patient bedside, thus allowing safe procedure without moving the patient. These patients were evaluated for definitive surgical cholecystectomy. In three patients who were deemed very high surgical risk even for elective cholecystectomy drain was removed. These patients received a trial of catheter clamping for 7 days prior to removal of PC tube. Another approach is to perform cholecystogram and confirm patency of cystic duct prior to PC removal, but this was not done in our study.

Major limitation of our study was it was retrospective. Also, all the patients were not given a trial of conservative management with antibiotics prior to PC. The details of sepsis induced organ failure and its resolution would have provided further objective evidence for outcomes. Long-term follow-up was not available to document the occurrence of recurrent cholecystitis in patients who underwent PC removal without cholecystectomy.

Conclusion

Ultrasound-guided PC can be safely performed bedside in ICU in critically ill patients unfit for surgery with high technical and clinical success rates. Early LC should be preferred after stabilization of clinical condition following cholecystostomy.

Note

The study was performed at the Sushrut Hospital, Ahmedabad. The authors wish to attribute the work to the same institute.

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None.

Conflict of Interest

None declared.

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