



# Management of acute cholecystitis after biliary stenting for malignant obstruction: comparison of percutaneous gallbladder drainage and aspiration

Yugo Imai<sup>1</sup> · Takaaki Hasegawa<sup>1</sup> · Yozo Sato<sup>1</sup> · Hidekazu Yamaura<sup>1</sup> · Shinichi Murata<sup>1</sup> · Mina Kato<sup>1</sup> · Kazuo Hara<sup>2</sup> · Norihisa Nitta<sup>3</sup> · Yoshitaka Inaba<sup>1</sup>

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## Abstract

**Purpose** To evaluate and compare the clinical outcomes between percutaneous gallbladder drainage (PGBD) and percutaneous gallbladder aspiration (PGBA) for acute cholecystitis after biliary stenting for malignant biliary obstruction.

**Materials and methods** Twenty-six and 14 patients underwent PGBD and PGBA, respectively, for acute cholecystitis after biliary stenting for malignant obstruction. The technical success rate, clinical effectiveness, and safety were compared between the 2 groups.

**Results** Technical success was achieved in all patients. Clinical effectiveness rate was significantly higher in the PGBD group than in the PGBA group [100% (26/26) vs. 57% (8/14),  $p < 0.01$ ]. In the PGBA group, clinical effectiveness rate was significantly lower in patients with tumor involvement of the cystic duct [13% (1/8) with involvement vs. 83% (5/6) without involvement,  $p = 0.03$ ]. There were no deaths related to the procedure or acute cholecystitis aggravation. Pleural effusion and biliary peritonitis occurred in 1 patient each after PGBD and intra-abdominal bleeding occurred in 1 patient after PGBA as complications requiring treatment.

**Conclusion** Although PGBD was a more effective treatment for acute cholecystitis after biliary stenting for malignant obstruction, PGBA may be a less invasive option for high-risk patients without tumor involvement of the cystic duct.

**Keywords** Cholecystitis · Biliary stenting · Percutaneous gallbladder drainage · Percutaneous gallbladder aspiration

## Introduction

Although laparoscopic or open cholecystectomy is the standard treatment for acute cholecystitis [1, 2], the mortality rate of cholecystectomy has been reported to be up to 30% in patients at high surgical risk due to advanced age or comorbid diseases [3–5]. Therefore, these patients are often initially treated with a combination of broad-spectrum

antibiotics and gallbladder decompression, such as percutaneous gallbladder drainage (PGBD) or percutaneous gallbladder aspiration (PGBA) [6].

One randomized controlled trial (RCT) has indicated that PGBD was more effective than PGBA for gallbladder decompression in acute cholecystitis [7]. However, complication rate has been reported to be higher after PGBD than after PGBA [6]. In addition, PGBD has some disadvantages over PGBA, such as the need for catheter management and more restricted activities of daily living [8]. Therefore, some have suggested PGBA as an initial treatment strategy and to consider repeated PGBA or salvage PGBD in clinically unsuccessful cases [6, 9].

Endoscopic or transhepatic biliary stenting is a well-established treatment for the palliation of jaundice in patients with malignant biliary obstruction [10–12]. However, cystic duct occlusion can sometimes cause acute cholecystitis after biliary stent placement [13, 14] and may prove fatal [15]. Because cholecystectomy is usually not indicated

✉ Yugo Imai  
yugo@belle.shiga-med.ac.jp

<sup>1</sup> Department of Diagnostic and Interventional Radiology, Aichi Cancer Center Hospital, 1-1 Kanokoden, Chikusa-ku, Nagoya 464-8681, Aichi, Japan

<sup>2</sup> Department of Gastroenterology, Aichi Cancer Center Hospital, Nagoya, Japan

<sup>3</sup> Departments of Radiology, Shiga University of Medical Science, Otsu, Japan

in such patients, gallbladder decompression is frequently performed. In general, PGBD was thought to be more effective for common acute cholecystitis, but PGBA may be more advantageous in patients with advanced malignancy, lower performance status, and less reserve power [3, 16, 17]. Nevertheless, the better drainage procedure for the treatment of acute cholecystitis in patients with biliary stent has not been evaluated.

The purpose of this study was to evaluate and compare the clinical outcomes between PGBD and PGBA for acute cholecystitis after biliary stenting.

## Materials and methods

### Patients

This retrospective study was approved by our institutional review board. The necessity of informed consent for inclusion in this study was waived, but informed consent to perform PGBD or PGBA was obtained from all patients before the procedure.

Between October 2009 and June 2016, 1132 patients underwent biliary stenting for malignant biliary obstruction at our institution. Among them, 40 patients (4%, 40/1132)

developed acute cholecystitis and underwent percutaneous gallbladder decompression. The patient characteristics are shown in Table 1. Biliary stent was placed by endoscopic approach in 38 patients and percutaneous transhepatic approach in 2 patients. Covered metallic stents [BONA STENT (Sewoon Medical Co. Ltd., Cheonan, Korea), Niti-S biliary stent (Century Medical Inc., Tokyo, Japan), or Wallflex (Boston Scientific Co, Boston, MA)], uncovered metallic stents [BILERUSH (PIOLAX Medical Devices, Inc., Yokohama, Japan) or ZILVER635 (Cook Medical, Bloomington, IN)], and tube stents [Flexima Biliary Stent System (Boston scientific)] were placed in 20, 7, and 13 patients, respectively. The stent type was determined by the operator. Immediate cholecystectomy was not considered to be indicated in all patients due to the underlying advanced malignancy.

### Diagnosis of acute cholecystitis

The diagnosis of acute cholecystitis was made based on local signs of inflammation (Murphy's sign and right upper abdominal quadrant pain and tenderness) and systemic signs of inflammation (fever, leukocytosis, and elevated C-reactive protein). Ultrasound or computed tomography (CT) was performed in all 40 patients to confirm gallbladder dilation or

**Table 1** Patient characteristics

Variables	PGBD group (n = 26)	PGBA group (n = 14)	p value
Median age (years)	65	66	0.48
Sex (male/female)	17/9	5/9	0.10
Causative disease			0.45
Pancreatic cancer	10	7	
Bile duct cancer	8	1	
Lymph node metastasis	4	4	
Gallbladder cancer	2	0	
Cholangiocarcinoma	1	1	
Peritoneal dissemination	1	1	
Stent type			0.16
Covered MS	12	8	
Uncovered MS	3	4	
Tube stent	11	2	
Grade of acute cholecystitis			0.22
I (mild)	19	13	
II (moderate)	7	1	
III (severe)	0	0	
Median period between stent placement and onset of acute cholecystitis (days)	6	7	0.90
Tumor involvement of the cystic duct (yes/no)	17/9	6/8	0.19
Gallbladder stone (yes/no)	3/23	1/13	> 0.99
Turbid bile (yes/no)	18/8	4/10	0.02

PGBD Percutaneous gallbladder drainage, PGBA percutaneous gallbladder aspiration, MS metallic stent

wall thickening (Figs. 1a, 2a). All patients met the diagnostic criteria for acute cholecystitis of the Tokyo Guidelines 2018; definite diagnosis was achieved when one item in local signs of inflammation, one item in systemic signs of inflammation, and imaging findings such as gallbladder dilation or wall thickening were present [2].

### Gallbladder decompression technique

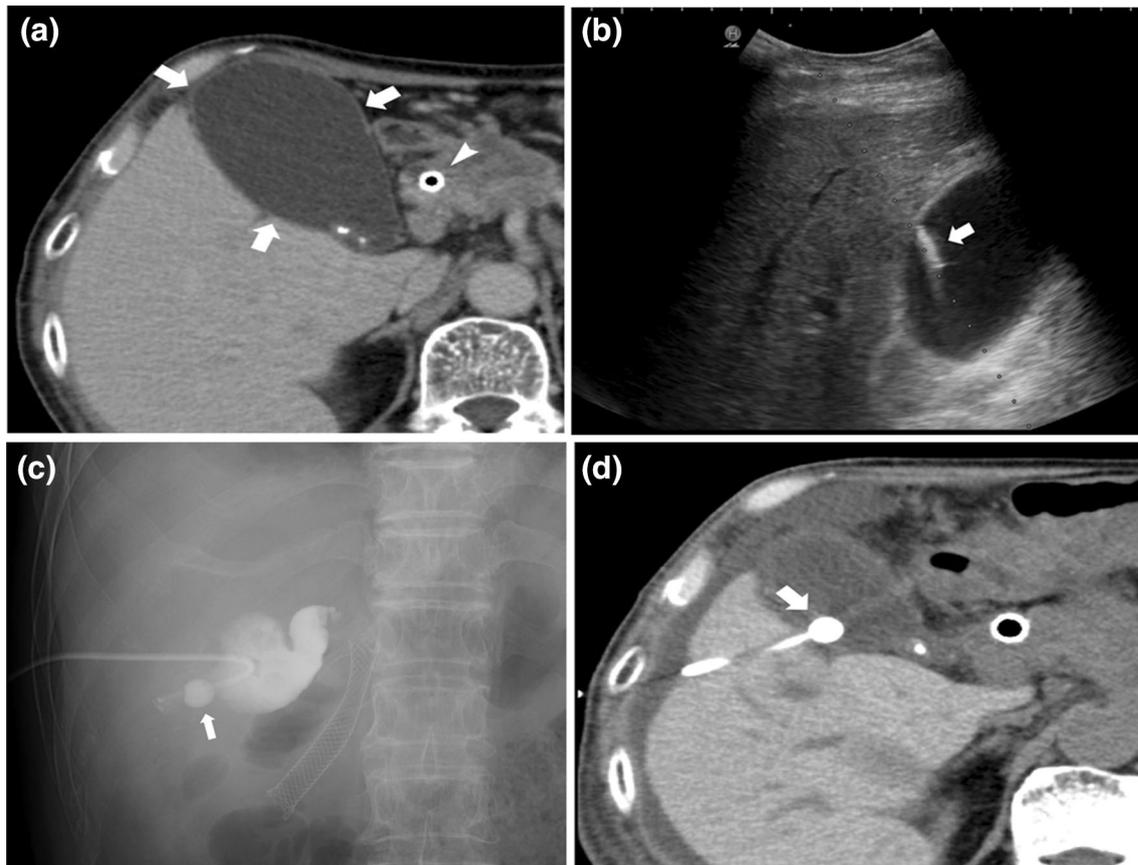
Twenty-six patients underwent PGBD (65%, 26/40) and 14 patients underwent PGBA (35%, 14/40) for gallbladder decompression. The procedural technique was determined on the spot after discussion between the interventional radiologist and the attending physician, after considering the severity of symptoms, turbidity of the aspirated bile, and the performance status of the patients.

All procedures were performed under local anesthesia with conscious sedation. Pentazocine (Sosegon; Maruishi

Pharmaceutical Co. Ltd., Osaka, Japan) was used for analgesia and lidocaine (Xylocaine; Astellas Pharma Inc., Tokyo, Japan) was used for local anesthesia.

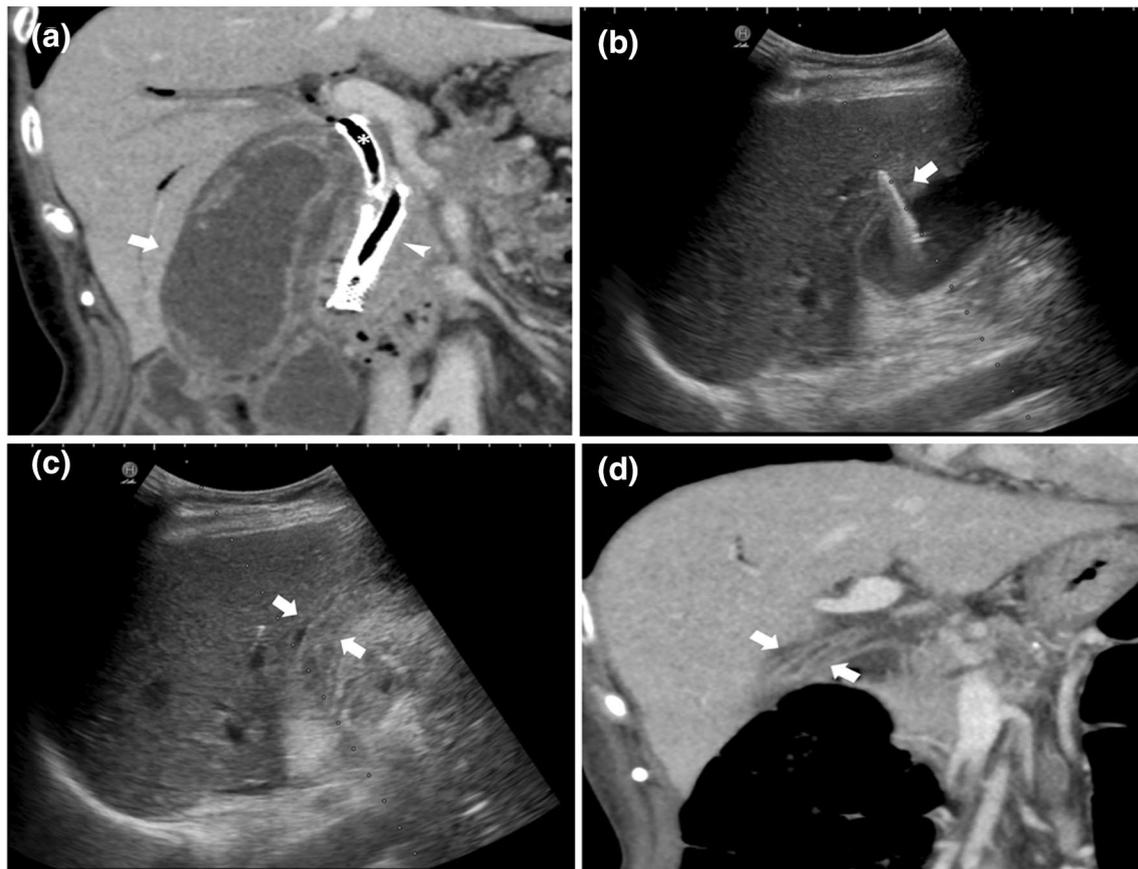
### Procedure of PGBD

PGBD was performed with the Seldinger technique [18]. The gallbladder was punctured transhepatically with an 18-G needle (Majima Needle; TOP Corp., Tokyo, Japan) under ultrasound guidance (Fig. 1b). This was followed by insertion of an 8-F pigtail catheter (SKATER SINGLE STEP; PBN Medicals Denmark A/S, Stenlose, Denmark) or a 7- or 8-F balloon catheter (PTCD Balloon Catheter, Gallbladder Type; Sumitomo Bakelite, Tokyo, Japan) into the gallbladder using a 0.035-inch guidewire (Fixed-Core Wire Guide Safe-T-J Curved; Cook Japan, Tokyo, Japan) under fluoroscopy (Fig. 1c).



**Fig. 1** **a** A 61-year-old man received covered metallic stent (Wall-flex; size, 10 mm; length, 60 mm; arrowhead) placement for common bile duct obstruction by pancreatic cancer. The cystic duct was occluded by the stent. He complained about right upper quadrant pain and high fever up to 40 °C 2 days after stent placement. Blood exam test revealed elevation of C-reactive protein to 22.40 mg/dL. Gallbladder dilatation (arrow) was seen on axial image of CT and he was

diagnosed as acute cholecystitis. **b** The gallbladder was punctured by 18-G needle (arrow) under ultrasound guidance. **c** A balloon catheter (PTCD Balloon Catheter; size, 8F; balloon size, 8 mm; arrow) was placed in the gallbladder and continuous drainage was performed. The symptoms of acute cholecystitis were improved after procedure. **d** Gallbladder dilatation was improved on CT obtained 1 month after balloon catheter (arrow) placement



**Fig. 2** **a** A 60-year-old man received covered metallic stent (Wall-flex; size, 10 mm; length, 40 mm; arrowhead) placement for common biliary duct obstruction by pancreatic cancer. The posterior segment branch was arising from common hepatic duct independently, and another covered metallic stent (Niti-S biliary stent; size, 6 mm; length, 80 mm; asterisk) was placed to posterior segment branch. The cystic duct was occluded by the stents. He had high fever of 38.0 °C 22 days after stent placement. He did not complain about abdominal pain, but Murphy's sign was positive, and blood exam test revealed

elevation of C-reactive protein to 20.01 mg/dL. Gallbladder dilatation with edematous wall thickness with lack of contrast enhancement (arrow) was seen on coronal image of CT and he was diagnosed as acute cholecystitis. **b** The gallbladder was punctured by 18-G needle (arrow) under ultrasound guidance. **c** Shrinkage of the gallbladder (arrow) was confirmed on ultrasound after aspiration of the gallbladder contents. The symptoms of acute cholecystitis were improved after procedure. **d** There was no relapse of dilatation on coronal image of CT obtained 4 months after gallbladder aspiration (arrow)

### Procedure of PGBA

PGBA was performed by puncturing the gallbladder transhepatically by an 18-G needle (Majima Needle) under ultrasound guidance (Fig. 2b); the needle was withdrawn after aspirating as much bile as possible (Fig. 2c).

### Assessment

The background of all patients in both groups was compared in terms of age, sex, causative disease, stent type, severity grading of acute cholecystitis, median period between stenting and developing acute cholecystitis, tumor involvement of the cystic duct, existence of gallbladder stone, and bile turbidity. Tumor involvement of the cystic duct was confirmed and evaluated by imaging modalities, including CT,

magnetic resonance imaging (MRI), endoscopic retrograde cholangiopancreatography (ERCP), intraductal ultrasound (IDUS) during ERCP, or endoscopic ultrasound (EUS) before stenting. Tumor involvement of the cystic duct was diagnosed when at least one of the following findings was seen: (1) wall thickening of the cystic duct or intramural or extramural mass on the CT, MRI, or EUS images, (2) the cystic duct branching from the biliary stricture or irregular narrowing of the cystic duct on the ERCP images, or (3) tumor invasion to the cystic duct orifice (CDO) or tumor extending across the CDO in the bile duct on the IUDS images.

The technical success rate, clinical effectiveness rate, and safety of the initial procedure were also compared between the PGBD and PGBA groups. Technical success was defined as the adequate placement of the catheter in the gallbladder

in PGBD group (Fig. 1d) and as sufficient aspiration of gallbladder contents in the PGBA group (Fig. 2d). Clinical effectiveness was defined as the improvement of at least 2 of the 3 clinical parameters of acute cholecystitis (i.e., abdominal pain, fever, and leukocytosis), without recurrence for at least 30 days. The factors for clinical effectiveness were also evaluated. Safety was evaluated based on the Common Terminology Criteria for Adverse Events v4.0 [19]. Any patient death within 30 days after the procedure was designated as grade 5. The incidence of grade 2 or more adverse events (AEs) was compared between the 2 groups. The median duration of catheter placement and the rate of catheter removal were evaluated in the PGBD group.

The Mann–Whitney *U* test was used for continuous variables and the Fisher’s exact test was used for categorical variables. A *p* value of less than 0.05 was inferred as statistically significant. Statistical analyses were performed using SPSS (SPSS for Windows, ver. 21; IBM, Armonk, NY, USA).

## Results

### Patient characteristics

PGBD was frequently chosen when the aspirated bile was turbid at the initial procedure ( $p=0.02$ ). No significant difference was detected in the other patient characteristics between the 2 groups.

### Gallbladder decompression procedure

Technical success was achieved in all patients of the two groups. Clinical effectiveness was achieved in 26 patients (100%, 26/26) of the PGBD group and in 8 patients (57%, 8/14) of the PGBA group (Fig. 3) and was significantly higher in the PGBD group ( $p < 0.01$ ). Four patients did not show improvement of the clinical parameters of acute cholecystitis after PGBA and underwent additional PGBD ( $n=3$ ) or PGBA ( $n=1$ ) after 1–4 days of the initial PGBA. Although the symptoms initially improved, 2 other patients required repeated PGBD for recurrence of acute cholecystitis at 19 and 20 days, respectively, after the first PGBA. The symptoms of these 6 patients improved after the additional

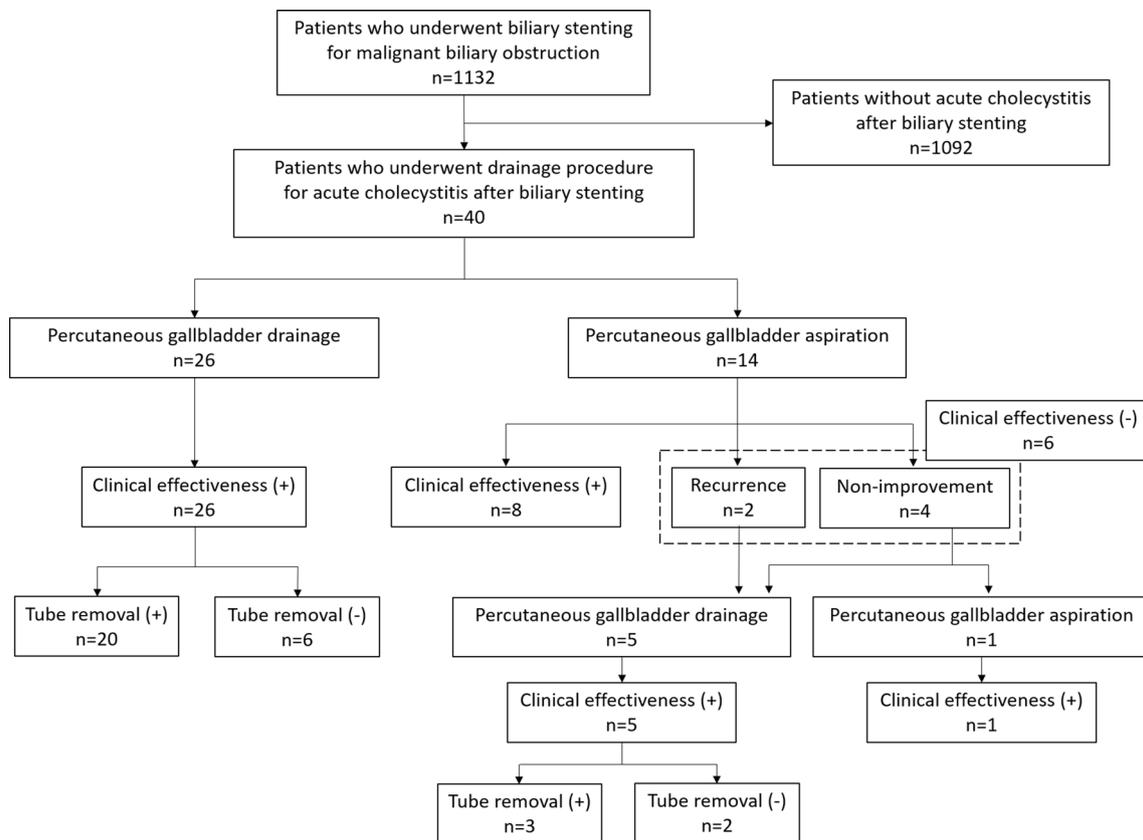


Fig. 3 Flowchart of the clinical course after drainage procedure

procedures. In the PGBA group, the clinical effectiveness rate was significantly lower in patients with tumor involvement of the cystic duct than in those without tumor involvement ( $p = 0.03$ ) (Table 2).

The AEs are summarized in Table 3. Three patients in the PGBD group died of cancer progression ( $n = 2$ ) or pulmonary embolism ( $n = 1$ ) and 1 patient in the PGBA group died of cancer progression within 30 days after the drainage procedure. There were no deaths related to procedure or worsening of acute cholecystitis. Grade 3 pleural effusion and biliary peritonitis occurred in 1 patient each after PGBD and they were treated by a drainage procedure. Grade 2 self-limiting pleural effusion occurred in 2 patients after PGBD. On the other hand, Grade 3 intra-abdominal bleeding requiring red blood cell transfusion occurred in 1 patient after PGBA.

### Clinical course

In the PGBD group, the drainage catheter could be removed after 6 to 75 days (median, 22 days) in 20 patients (77%, 20/26). Among them, 5 patients had subsequent surgery for malignancy at 20 to 59 days (median, 38 days) after the PGBD procedure; 7 patients received chemotherapy; and 8 patients received best supportive care (BSC). The drainage catheter could not be removed in the remaining 6 patients. One patient died of respiratory failure following pulmonary embolism 7 days after PGBD and 5 patients died of cancer progression at 21–61 days (median, 34 days) after PGBD, although their cholecystitis symptoms improved.

**Table 2** Factors affecting the clinical effectiveness of gallbladder aspiration

Variables	Clinical effectiveness (–)	Clinical effectiveness (+)	<i>p</i> value	OR	95% CI
Stent type					
Covered MS	3	5	> 0.99	0.60	0.08–4.61
Uncovered MS or tube stent	3	3			
Tumor involvement of the cystic duct					
Yes	5	1	0.03	35.00	2.19–559.88
No	1	7			
Gallbladder stone					
Yes	1	0	0.43	NA	NA
No	5	8			
Turbid bile					
Yes	3	1	0.25	7.00	0.63–68.91
No	3	7			
Positive bile culture					
Yes	3	4	> 0.99	1.00	0.13–7.54
No	3	4			
Total	6	8			

MS metallic stent, NA not applicable

**Table 3** Adverse events after the procedure

Grade	PGBD group ( $n = 26$ ) Adverse events	PGBA group ( $n = 14$ ) Adverse events
Grade 5	Cancer progression ( $n = 2$ ) Pulmonary embolism ( $n = 1$ )	Cancer progression ( $n = 1$ )
Grade 3	Pleural effusion ( $n = 1$ ) Biliary peritonitis ( $n = 1$ )	Intraabdominal bleeding ( $n = 1$ )
Grade 2	Pleural effusion ( $n = 2$ )	

No patient developed multiple complications

PGBD percutaneous gallbladder drainage, PGBA percutaneous gallbladder aspiration

In the PGBA group, 1 patient had subsequent surgery for malignancy 21 days later, 6 patients received chemotherapy, and 7 patients received BSC after improvement of cholecystitis.

### Discussion

This study showed that both PGBD and PGBA were feasible and relatively safe gallbladder decompression techniques for patients with acute cholecystitis after biliary stenting for malignant biliary obstruction. The clinical effectiveness rate was significantly higher with PGBD than with PGBA. This result was consistent with that of the RCT by Ito et al. [7]. However, the requirement for catheter management after PGBD and some AEs related to catheter placement were reported [20]. In previous reports, approximately 5% of patients experienced catheter

migration or accidental dislodgement of the catheter after PGBD [9, 21, 22]. In this study, biliary peritonitis following catheter displacement occurred in 1 patient; therefore, we must pay attention to the risk of complications related to catheter migration after PGBD.

The clinical effectiveness rate of PGBA was significantly worse in patients with tumor involvement of the cystic duct. Tumor involvement of the cystic duct has been reported to be associated with a high risk of acute cholecystitis after biliary stenting [10, 15]. Continuous gallbladder drainage might be important in such situations and one-time PGBA may be insufficient. Indeed, this study showed that additional PGBD and PGBA achieved good clinical response in clinically unsuccessful cases after the initial PGBA. PGBA does not require catheter management and restriction of the patient's activities of daily living. It was reported that catheter management worsens the quality of life of patients [23], so PGBA is said to be less invasive than PGBD. In addition, PGBA does not cause any AEs related to catheter placement [8]. Therefore, high-risk patients are good candidates for PGBA. Considering these facts, Chopra et al. recommended that in high-risk patients, the strategy of performing PGBA first and reserving PGBD as a salvage procedure might be acceptable [6]. However, in this study, grade 3 intra-abdominal bleeding occurred in 1 case after PGBA. Therefore, we must remember that there are risks of such complications when performing PGBA.

This study had several limitations. First, with the retrospective nature of this study and selection bias could not be avoided. Another confounding variable might have been the general indication for PGBD in patients with turbid bile in this population. However, the technique was determined by the attending physician considering patients' condition totally, thus the result may reflect standard clinical judgement. The small sample size in a single center was another limitation. Studies with larger patients are required to confirm our results.

In conclusion, PGBD was more effective than PGBA for the treatment of acute cholecystitis after biliary stenting for malignant biliary obstruction. Nevertheless, PGBA can be considered as a less invasive option, especially in high-risk patients with less bile turbidity and those without tumor involvement of the cystic duct.

## Compliance with ethical standards

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

**Ethical statement** All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964

Helsinki Declaration and its later amendments or comparable ethical standards.

**Informed consent** This retrospective study was approved by our institutional review board and the necessity of informed consent for inclusion in this study was waived. Informed consent to perform PGBD or PGBA was obtained from all patients before the procedure.

## References

1. Purkayastha S, Tilney HS, Georgiou P, Athanasiou T, Tekkis PP, Darzi AW. Laparoscopic cholecystectomy versus mini-laparotomy cholecystectomy: a meta-analysis of randomized control trials. *Surg Endosc*. 2007;21(8):1294–300.
2. Yokoe M, Hata J, Strasberg SM, Asbun HA, Wakabayashi G, Kozaka K, Guidelines Tokyo, et al. diagnostic and severity grading of acute cholecystitis (with videos). *J Hepatobiliary Pancreat Sci*. 2018. <https://doi.org/10.1002/jhbp.515>.
3. Tsutsui K, Uchida N, Hirabayashi S, Kamada H, Ono M, Ogawa M, et al. Usefulness of single and repetitive percutaneous transhepatic gallbladder aspiration for the treatment of acute cholecystitis. *J Gastroenterol*. 2007;42(7):583–8.
4. Houghton PW, Jenkinson LR, Donaldson LA. Cholecystectomy in the elderly: a prospective study. *Br J Surg*. 1985;72(3):220–2.
5. Frazee RC, Nagorny DM, Mucha P Jr. Acute acalculous cholecystitis. *Mayo Clin Proc*. 1989;64(2):163–7.
6. Chopra S, Dodd GD 3rd, Mumbower AL, Chintapalli KN, Schwesinger KR, Dorman JP, et al. Treatment of acute cholecystitis in non-critically ill patients at high surgical risk: comparison of clinical outcomes after gallbladder aspiration and after percutaneous cholecystostomy. *Am J Roentgenol*. 2001;176(4):1025–31.
7. Ito K, Fujita N, Noda Y, Kobayashi G, Kimura K, Sugawara T, et al. Percutaneous cholecystostomy versus gallbladder aspiration for acute cholecystitis: a prospective randomized controlled trial. *Am J Roentgenol*. 2004;183(1):193–6.
8. Tsuyuguchi T, Takada T, Kawaharada Y, Nimura Y, Wada K, Nagino M, et al. Techniques of biliary drainage for acute cholecystitis: Tokyo Guidelines. *J Hepatobiliary Pancreat Surg*. 2007. <https://doi.org/10.1007/s00534-006-1155-8>.
9. Komatsu S, Tsukamoto T, Iwasaki T, Toyokawa A, Hasegawa Y, Tsuchida S, et al. Role of percutaneous transhepatic gallbladder aspiration in the early management of acute cholecystitis. *J Dig Dis*. 2014. <https://doi.org/10.1111/1751-2980.12198>.
10. Isayama H, Kawabe T, Nakai Y, Tsujino T, Sasahira N, Yamamoto N, et al. Cholecystitis after metallic stent placement in patients with malignant distal biliary obstruction. *Clin Gastroenterol Hepatol*. 2006;4(9):1148–53.
11. Smith AC, Dowsett JF, Russell RC, Hatfield AR, Cotton PB. Randomized trial of endoscopic stenting versus surgical bypass in malignant low bileduct obstruction. *Lancet*. 1994;344(8938):1655–60.
12. Andersen JR, Sørensen S, Kruse A, Rokkjaer M, Matzen P. Randomized trial of endoscopic endoprosthesis versus operative bypass in malignant obstructive jaundice. *Gut*. 1989;30(8):1132–5.
13. Bezzi M, Zolovkins A, Cantisani V, Salvatori FM, Rossi M, Fanelli F, et al. New ePTFE/FEP-covered stent in the palliative treatment of malignant biliary obstruction. *J Vasc Interv Radiol*. 2002;13(6):581–9.
14. Schöfl R, Brownstone E, Reichel W, Fount W, Samec HJ, et al. Malignant bile-duct obstruction: experience with self-expanding metal endoprostheses (Wallstents) in Austria. *Endoscopy*. 1994;26(7):592–6.

15. Suk KT, Kim HS, Kim JW, Baik SK, Kwon SO, Kim HG, et al. Risk factors for cholecystitis after metal stent placement in malignant biliary obstruction. *Gastrointest Endosc.* 2006;64(4):522–9.
16. Verbanck JJ, Demol JW, Ghillebert GL, Rutgeerts LJ, Surmont IP. Ultrasound-guided puncture of the gallbladder for acute cholecystitis. *Lancet.* 1993;341(8853):1132–3.
17. Tazawa J, Sanada K, Maekawa S, Sakai Y, Yamane M, Kusano F, et al. Gallbladder aspiration for acute cholecystitis in high-surgical-risk patients. *J Gastroenterol Hepatol.* 2003;18(4):463–5.
18. Seldinger SI. Catheter replacement of the needle in percutaneous arteriography; a new technique. *Acta radiol.* 1953;39(5):368–76.
19. Common Terminology Criteria for Adverse Events v4.03 (CTCAE) 2010. [https://www.eortc.be/services/doc/CTC/CTCAE\\_4.03\\_2010-06-14\\_QuickReference\\_5x7.pdf](https://www.eortc.be/services/doc/CTC/CTCAE_4.03_2010-06-14_QuickReference_5x7.pdf).
20. Rassameehiran S, Tantrachoti P, Nugent K. Percutaneous gallbladder aspiration for acute cholecystitis. *Bayl Univ Med Cent Proc.* 2016;29(4):381–4.
21. Borzellino G, de Manzoni G, Ricci F, Castaldini G, Guglielmi A, Cordiano C. Emergency cholecystectomy and subsequent cholecystectomy for acute gallstone cholecystitis in the elderly. *Br J Surg.* 1999;86(12):1521–5.
22. Han IW, Jang JY, Kang MJ, Lee KB, Kim SW. Early versus delayed laparoscopic cholecystectomy after percutaneous transhepatic gallbladder drainage. *J Hepatobiliary Pancreat Sci.* 2012. <https://doi.org/10.1007/s00534-011-0458-6>.
23. Choi JH, Kim HW, Lee JC, et al. Percutaneous transhepatic versus EUS-guided gallbladder drainage for malignant cystic duct obstruction. *Gastrointest Endosc.* 2017;85(2):357–64.

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