

## ORIGINAL PAPER

doi: 10.5455/medarch.2022.76.29-33

MED ARCH. 2022 FEB; 76(1): 29-33

RECEIVED: JAN 05, 2022

ACCEPTED: FEB 02, 2022

<sup>1</sup>Radiology Center, Hanoi Medical University Hospital, Hanoi, Vietnam

<sup>2</sup>Department of Radiology, Hanoi Medical University, Hanoi, Vietnam

<sup>3</sup>Department of Radiology, Pham Ngoc Thach University of Medicine, Hanoi, Vietnam

**Corresponding author:** Nguyen Minh Duc, MD. Department of Radiology, Pham Ngoc Thach University of Medicine, 2 Duong Quang Trung, Ward 12, District 10, Ho Chi Minh City 700000, Vietnam. Phone: +84902886899. E-mail: bsnguyenminhduduc@pnt.edu.vn. ORCID ID: <https://orcid.org/0000-0001-5411-1492>.

# Percutaneous Transhepatic Cholecystolithotomy by Holmium Laser for Non-high-Risk Patients with Symptomatic Gallbladder Stones

Nguyen Thai Binh<sup>1</sup>, Ngo-Thi Ly Ly<sup>1</sup>, Phan Nhan Hien<sup>2</sup>, Le Tuan Linh<sup>2</sup>, Bui-Van Lenh<sup>2</sup>, Nguyen Minh Duc<sup>3</sup>

## ABSTRACT

**Background:** The development of gallstones, also known as cholelithiasis, is one of the most common diseases associated with the gastrointestinal tract. In developing countries 10% to 15% of men and >25% of women experience gallstones. **Objective:** The aim of the study was to evaluate the outcomes following percutaneous transhepatic cholecystolithotomy by holmium laser in non-high-risk patients with symptomatic gallbladder stones. **Methods:** This was an intervention study without control and with longitudinal follow-up. Subjects included patients who had only gallbladder stones, a normal gallbladder contractility index, and required a conservative treatment. **Results:** The study included 44 patients (20 men, 24 women), with a mean age of 41.5 ± 13.4 years. The success rate was 97.7%, and only 1 of 44 patients required follow-up laparoscopic cholecystectomy. Gallstones were successfully removed from 43 of 44 patients (97.7%). The complication rate was 13.6% (6/44 patients), and only minor complications were reported for 5 of the 6 patients with complications. In 34 of 43 patients, follow-up examinations were performed after 1 and 6 months. The gallstone recurrence rate at six-month follow-up was 11.8%, and a collapsed gallbladder was detected in 1 of 34 patients, with the remaining 33 patients retaining normal gallbladder contractility indices (>40%). **Conclusion:** Percutaneous transhepatic cholecystolithotomy by holmium laser has a high gallstone removal rate (97.7%); however, recurrence remains a major problem. The complication rate was about 13.6%, most of which were minor complications. Cases associated with treatment failure or serious complications should be detected and treated promptly.

**Keywords:** cholecystolithotomy, transhepatic, holmium laser.

## 1. BACKGROUND

The development of gallstones, also known as cholelithiasis, is one of the most common diseases associated with the gastrointestinal tract. In developing countries, 10% to 15% of men and >25% of women experience gallstones (1, 2). In Vietnam, gallstones occur in approximately 2.14% to 6.11% of the population (3).

In most individuals, gallstones are asymptomatic, and treatment is only required when clinical symptoms develop, including right upper abdominal pain, digestive disorders, and cholecystitis (fever, right upper abdominal pain, and a palpable, enlarged gallbladder) (4). Currently, a common treatment for gallstones is endoscopic cholecystectomy; however, recently, the function of the gallbladder has been questioned by many studies. Although the gallbladder does not produce bile, it appears to play important roles in digestion, maintaining the balance of gut flora, and regulating bile duct pressure (by storing and concentrating bile) (5). The performance of cholecystectomy can alter the physiology and composition of the bile duct, causing digestive disorders and increasing the risk of gastrointestinal cancer (6, 7). Therefore, patients with mild symptoms due to gallstones typically choose non-invasive treatments, such as orally administered drugs designed to dissolve gallstones or cholecystolithotomy; however, these treatments have been associated with low efficacy and high recurrence rates (6). Transhepatic cholecystolithotomy is a minimally invasive technique that has been reported to result in higher ef-

© 2022 Nguyen Thai Binh, Ngo-Thi Ly Ly, Phan Nhan Hien, Le Tuan Linh, Bui-Van Lenh, Nguyen Minh Duc

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ficacy and fewer complications. According to a study by Zou *et al.*, the success rate of this technique was 90% in 439 patients (7). Another study by Kim *et al.* performed percutaneous cholecystolithotomy in 63 patients, with a high technical success rate (94%) but a higher mortality rate (8). In Vietnam, percutaneous cholecystolithotomy has been performed at Hanoi Medical University Hospital since August 2018; however, only a case series was reported. Therefore, we conducted this study to assess the initial outcomes associated with this technique.

## 2. OBJECTIVE

The aim of this study was to evaluate the outcomes following percutaneous transhepatic cholecystolithotomy by holmium laser in non-high-risk patients with symptomatic gallbladder stones.

## 3. PATIENTS AND METHODS

### Patients

This retrospective study was approved by the ethical committee of Hanoi Medical University Hospital. Due to the retrospective nature of this study, the requirement for obtaining written informed consent from patients was waived. From August 2018 to June 2020, percutaneous cholecystolithotomy was performed on 44 patients (20 men and 24 women) with a mean age of  $41.5 \pm 13.4$  years. All treated patients reported symptoms of stomachache, with no reported incidents of fever or jaundice. Patients were considered candidates for cholecystolithotomy if they had symptomatic gallstones with a gallbladder contractility index  $>40\%$  and without evidence of acute cholecystitis, any abnormalities in gallbladder morphology or pathology, liver abnormalities, or dyslipidemia.

### Methodology

#### Intervention process

Percutaneous transhepatic cholecystolithotomy by holmium laser was performed in either one or two 3-step phases, and the entire procedure was performed with local anesthesia and moderate sedation.

**Step 1: Percutaneous cholecystostomy** (under the guidance of ultrasound or digital subtraction angiography [DSA]): Using the Seldinger technique, a 6–9F catheter was placed into the gallbladder lumen, and a contrast material was injected to assess the sizes and locations of the gallstones and the condition of the common bile duct.

**Step 2: Tract dilation and cholecystolithotomy** (under the guidance of DSA, either immediately following Step 1 [one-phase] or 3–5 days after Step 1 [two-phase]): We performed coaxial dilatation with a 14F Amplatz dilator set (Cook Medical, Bloomington, IN), and the endoscope used for cholecystoscopy is 9.5F in diameter. The holmium laser was used to fragment the stones into sufficiently small pieces for removal through the sheath. If the stone is smaller than the cholecystolithotomy portal, it can be collected by using a stone basket to grasp and extract the stones through the sheath without requiring holmium laser applications.

Step 2 is repeated until no stones remain.

**Step 3: Amplatz and catheter removal:** The Amplatz dilator was removed 2–3 days after the intervention, and the catheter was removed 7–10 days after the intervention. Prior to catheter removal, we routinely inject contrast material into the cholecystostomy tract to confirm tract integrity.

#### Follow – up process

Gallstone recurrence and gallbladder contractility index were evaluated by follow-up ultrasonography in 1 month and 6 months.

#### Statistical analysis

Descriptive statistics were used to summaries patient characteristic. Gallbladder contraction index was calculated as the percentage change in volume at each period using the fasting volume as baseline volume. Comparisons of the characteristics of two group (one - phase and two - phase) were performed using the independent t-test or Chi-square test utilized where appropriate. Two -sided values of  $P < 0.05$  were considered statistically significant. Statistical analysis was performed using IBM SPSS version 16.0 software.

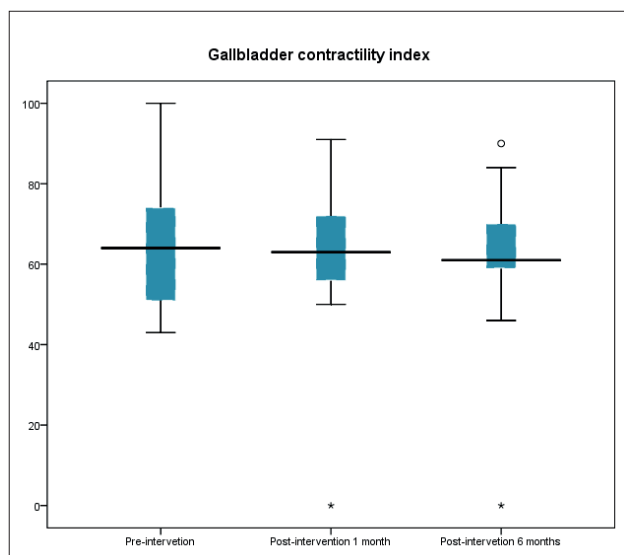
## 4. RESULTS

The current retrospective study included 44 patients (20 men, 24 women) with a mean age of  $41.5 \pm 13.4$  years. Basic features of population were introduced in Table 1. Gallstones were successfully removed from 43 out of 44 patients (97.7%), with one patient retaining a gallstone after the procedure. The complication rate was 13.6% (6/44 patients), and complications included severe bleeding (1 patient, 2.3%), minor bleeding (1 patient, 2.3%), bile leakage (3 patients, 6.7%), and pleural effusion (1 patient, 2.3%). No significant difference in the complication rates was observed between the one-phase (22 patients) and two-phase (22 patients) intervention groups. Laparoscopic cholecystectomy was performed in 1 out of 44 patients due to severe bleeding complications. No significant difference in mean hospitalization duration was observed for the one-phase intervention group ( $8.7 \pm 7.9$  days) and the two-phase intervention group ( $9.8 \pm 5.0$  days).

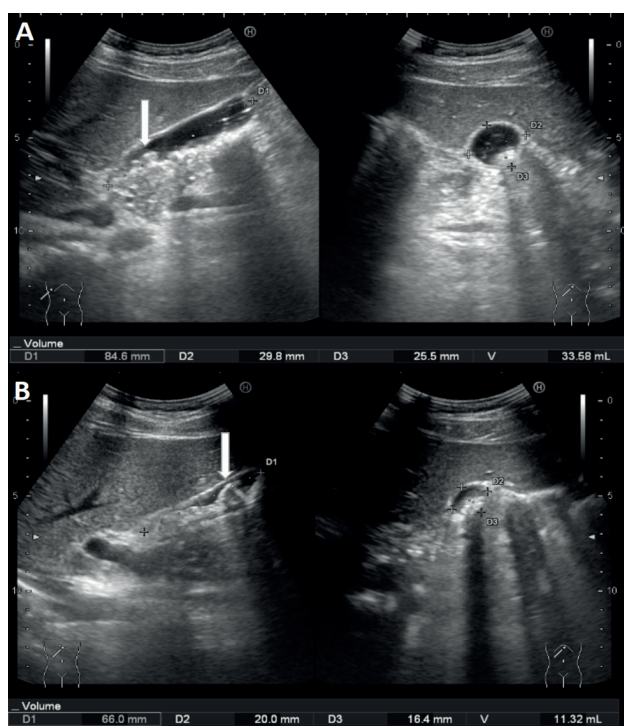
Among the 42 successful cases, 34 patients received follow-up ultrasounds 1 and 6 months after the intervention to evaluate recurrence and measure the gall-

Characterization	Patient (n)	Percentage (%)
Gallstone number		
1	20	45.4%
2	3	6.8%
>2	21	47.8
Size (mm)		
Mean	$13 \pm 6.5$	
Maximal	31	
Minimal	5	
Tract maturation time (day)	$3.9 \pm 1.8$	
Stone removal method		
Stone basket	3	6.8
Laser + stone basket	41	93.2

**Table 1. Characterization of patients and interventions.**



**Figure 1.** Gallbladder contractility indices pre-intervention and 1- and 6-months post-intervention

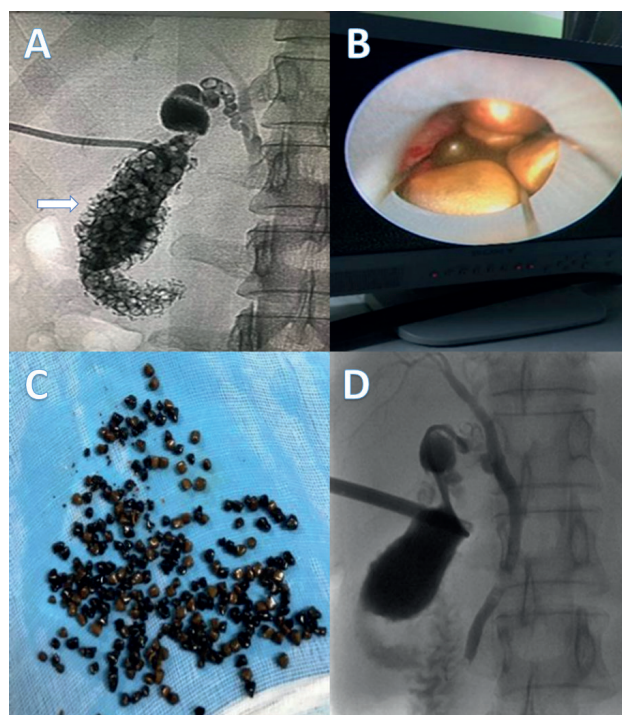


**Figure 2.** A 30-year-old woman with multiple gallstones (arrow) and a pre-intervention contractility index of 66%: **A.** Fasting gallbladder volume. **B.** Postprandial gallbladder volume.

bladder contractility index. A 4-mm stone was retained in one patient.

After a follow-up period of 1 month, only one patient experienced a completely collapsed gallbladder, whereas the remaining patients were assessed as having normal gallbladder contractility indices (Figure 1), with no evidence of gallstone recurrence in any patient (Figures 2 and 3).

After a follow-up period of 6 months, 4 of 34 patients (11.7%) developed recurrent gallstones, including 3 patients with 4–5-mm stones. The patient who experienced complete gallbladder collapse developed several recurrent gallstones.



**Figure 3.** Representative images from a 40-year-old woman **A.** DSA-guided percutaneous cholecystostomy revealing multiple gallstones inside the gallbladder (arrow). **B.** Endoscope view. **C.** The removed gallstones. **D.** Post-cholecystolithotomy examination revealed that the gallstones were completely removed, and the gallbladder was empty.

## 5. DISCUSSION

Right upper abdominal pain is the most common clinical symptom associated with gallstones and was reported for all of the patients included in this study. Of 44 patients, 20 had a single stone (45.4%), 3 had two stones (6.8%), and 21 had multiple stones (47.8%). The mean stone diameter was  $13 \pm 6.5$  mm. Several studies from around the world have reported similar results as those found in our study, with a mean gallstone diameter of 14.4 mm (Ohasi *et al.*) (9) and 65.4% of patients presenting with more than 2 stones (Zou *et al.*) (7). Percutaneous transhepatic cholecystolithotomy could be indicated for patients who have large and multiple gallstones. The number of stones and their sizes have major impacts on treatment outcomes, including the necessary techniques to achieve complete stone clearance and stone removal. For example, stones that are smaller than the cholecystolithotomy portal can be collected by using a stone basket to grasp and extract the stones through the sheath without requiring holmium laser applications to reduce their sizes.

A gallbladder contractility index greater than 40% is considered indicative of the continued ability of the gallbladder to store and excrete bile. According to Zou *et al.*, the recurrence rate after 10 years for patients with contractile index values  $<40\%$  and those with values  $\geq 40\%$  are 77.42% and 27.30%, respectively, representing a significant difference ( $p < 0.001$ ) (7). According to Colak *et al.*, patients with gallbladder contractility index values below 40% had a higher probability of gallstone recurrence (10). Therefore, one of the selection criteria

applied in this study was a pre-intervention contractility index higher than 40% to ensure the safety of percutaneous cholecystolithotomy and to minimize the recurrence rate after treatment.

The technical success rate of one-phase percutaneous cholecystolithotomy was 97.7%, which was similar to the rate reported by Picus *et al.* (97%) (11), but higher than those reported by Kim *et al.* (94%) (8) and Donald *et al.* (88.5%) (12).

The procedure-related complication rate among all 44 patients was 13.6%, and common complications included bleeding, bile leakage, bile peritonitis, and infection. Less common complications included pleural effusion and pancreatitis. The cholecystostomy approach, the cholecystolithotomy sheath size, and the time required for tract maturation might also be associated with complications. A transhepatic approach into the gallbladder is considered more stable and likely to reduce bile leakage into the peritoneum compared with a transperitoneal approach (13); therefore, all of the patients in our study were accessed using the transhepatic path. We performed coaxial dilatation with a 14F Amplatz dilator set (Cook Medical, Bloomington, IN), which has the minimum diameter necessary to insert a 9.5F endoscope. Among patients treated with the two-phase intervention, the mean time for tract maturation was 3.9 ± 1.8 days. Studies that applied dilation greater than 16F required maturation times of 10–14 days to minimize the risks of hemorrhage and bile leakage. The reported complication rate was 9.1%, which was lower than the complication rate observed in our study (14). To reduce the time required for the intervention process, we performed the intervention in one phase, without waiting for tract maturation, similar to the approach described by Kim *et al.*, except that their study used a smaller dilation diameter of 12F. The selection criteria for one-phase and two-phase interventions remain controversial. No significant differences in the complication rate and mean hospitalization duration was observed between the two groups in our study. Kim *et al.* suggested that no bleeding or bile leakage complications were experienced due to the use of a small sheath (12F). The primary disadvantages of using a smaller sheath without an endoscope included the difficulty of fragmenting large and hard gallstones into pieces small enough to pass through the sheath and the possibility of missing smaller stones. Consequently, 13 of 63 patients in the study by Kim *et al.* required multiple sessions to remove all stones (8).

Recurrent gallstones development is the main complication and must be closely monitored. Several major risk factors contribute to gallstone recurrence, including age, sex, family history, diet, endocrine function, metabolic disorders, and the characteristics of the gallstones (size, number, and composition). The recurrence rate after 6 months in our study has higher than that reported by Zou *et al.*, which was 9.57% in a sample of 439 patients. Zou *et al.* reported that gallstone recurrence is most likely to occur 5 or 6 years after treatment (7). Therefore, patients require long-term follow-up to assess the recurrence rate and associated factors.

This study may be associated with some limitations. First, the sample size was quite small. Second, gallstone recurrence was not evaluated over a long-term follow-up. Third, we did not establish detailed selection criteria for patients who received one-phase and two-phase interventions, which generally depended on the patient's age and physical condition, and the intervention was determined at the discretion of the interventional radiologists.

## 6. CONCLUSION

Percutaneous transhepatic cholecystolithotomy by holmium laser is a safe treatment for patients with symptomatic gallstones who require intervention, associated with a high clearance rate without requiring the use of general anesthesia. Common complications included bleeding and bile leakage, which must be detected and treated in a timely manner.

- **Author's contribution:** Nguyen Thai Binh and Ngo-Thi Ly Ly performed the acquisition, analysis, and interpretation of data. Ngo-Thi Ly Ly and Nguyen Minh Duc had a part in preparing the article and revising it critically for important intellectual content. Each author gave final approval of the version to be published and agreed to be accountable for all aspects of the work to ensure that any questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
- **Conflict of interest:** There are no conflicts of interest to declare.
- **Financial support and sponsorship:** Nil.

## REFERENCES

1. Schirmer BD, Winters KL, Edlich RF. Cholelithiasis and cholecystitis. *J Long Term Eff Med Implants*. 2005; 15(3): 329-338. doi: 10.1615/jlongtermeffmedimplants.v15.i3.90.
2. Stinton LM, Shaffer EA. Epidemiology of Gallbladder Disease: Cholelithiasis and Cancer. *Gut Liver*. 2012; 6(2): 172-187. doi: 10.5009/gnl.2012.6.2.172.
3. Nguyen DTT, Nguyen HTT. Assessment of Post-Laparoscopic Cholecystectomy Pain at Viet Duc Hospital, Vietnam. *Health*. 2015; 7, 346-354. doi: 10.4236/health.2015.73039.
4. Tazuma S. Gallstone disease: Epidemiology, pathogenesis, and classification of biliary stones (common bile duct and intrahepatic). *Best Pract Res Clin Gastroenterol*. 2006; 20(6): 1075-1083. doi:10.1016/j.bpg.2006.05.009.
5. Housset C, Chrétien Y, Debray D, Chignard N. Functions of the Gallbladder. *Compr Physiol*. 2016; 6(3): 1549-1577. doi: 10.1002/cphy.c150050.
6. Konikoff FM. Gallstones—approach to medical management. *MedGenMed Medscape Gen Med*. 2003; 5(4): 8.
7. Zou Y-P, Du JD, Li WM, Xiao YQ, Xu HB, Zheng F, Huang H, Liu HR, Li HC. Gallstone recurrence after successful percutaneous cholecystolithotomy: a 10-year follow-up of 439 cases. *Hepatobiliary Pancreat Dis Int HBPD INT*. 2007; 6(2): 199-203.
8. Kim YH, Kim YJ, Shin TB. Fluoroscopy-Guided Percutaneous Gallstone Removal Using a 12-Fr Sheath in High-Risk Surgical Patients with Acute Cholecystitis. *Korean J Radiol*. 2011; 12(2): 210-215. doi: 10.3348/kjr.2011.12.2.210.

9. Ohashi S. Percutaneous Transhepatic Cholecystoscopic Lithotomy in the Management of Acute Cholecystitis Caused by Gallbladder Stones. *Diagn Ther Endosc.* 1998; 5(1): 19-29. doi: 10.1155/DTE.5.19.
10. Colak Y, Bozbey G, Erim T, Caklili OT, Ulasoglu C, Senates E, Mutlu HH, Mesci B, Doğan MS, Tasan G, Enc FY, Tuncer I. Impaired Gallbladder Motility and Increased Gallbladder Wall Thickness in Patients with Nonalcoholic Fatty Liver Disease. *J Neurogastroenterol Motil.* 2016; 22(3): 470-476. doi: 10.5056/jnm15159.
11. Picus D, Hicks ME, Darcy MD, Vesely TM, Kleinhoffer MA, Aliperti G, Edmundowicz SA. Percutaneous cholecystolithotomy: analysis of results and complications in 58 consecutive patients. *Radiology.* 1992; 183(3): 779-784. doi: 10.1148/radiology.183.3.1533946.
12. Donald JJ, Cheslyn-Curtis S, Gillams AR, Russell RC, Lees WR. Percutaneous cholecystolithotomy: is gall stone recurrence inevitable? *Gut.* 1994; 35(5): 692-695.
13. Nemcek AA, Bernstein JE, Vogelzang RL. Percutaneous Cholecystostomy: Does Transhepatic Puncture Preclude a Transperitoneal Catheter Route? *J Vasc Interv Radiol.* 1991; 2(4): 543-547. doi: 10.1016/S1051-0443(91)72239-2
14. Kim HJ, Lee SK, Kim MH, Yoo KS, Lim BC, Seo DW, Min YI. Safety and usefulness of percutaneous transhepatic cholecystoscopy examination in high-risk surgical patients with acute cholecystitis. *Gastrointest Endosc.* 2000; 52(5): 645-649. doi: 10.1067/mge.2000.107286.