Hartmann's Pouch Stones and Laparoscopic Cholecystectomy: The Challenges and the Solutions

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ABSTRACT

Background & Objective: Hartmann's pouch stones (HPS) encountered during laparoscopic cholecystectomy (LC) may hinder safe dissection of the cystic pedicle or be complicated by mucocele, empyema, or Mirizzi syndrome; distorting the anatomy and increasing the risk of bile duct injury. We studied the incidence, presentations, operative challenges, and outcomes of HPS.

Methods: A cohort study of a prospectively maintained database of LCs and bile duct explorations performed by a single surgeon. Patients were divided into two groups: those with HPS and those without. Patients' demographics, clinical presentation, intra-operative findings, and postoperative outcomes were compared.

Results: Of the 5136 patients, 612 (11.9%) had HPS. The HPS group were more likely to present with acute cholecystitis (27.9% vs 5.9%, $P = .000$) and more patients underwent emergency LC (50.7% vs 41.5%, $P = .000$). The HPS group had more difficult cholecystectomies, with 46.1% vs 11.8% in the non-HPS group being operative difficulty grade 4 and 5. Mucocele, empyema, and Mirizzi syndrome were more common in the HPS group (24.0% vs 3.7% $P = .000$, 30.9% vs 3.7% $P = .000$, 1.8% vs 0.9% $P = .000$, respectively). There was no significant difference in the open conversion rate or complications.

Conclusion: HPS increase the difficulty of LC. Surgeons should be aware of their presence and should employ appropriate dissection strategies. Sharp or diathermy dissection should be avoided. Dislodging the stone into the gall bladder, stone removal, swab dissection, and cholangiography are useful measures to avoid ductal injury and reduce the conversion rate.

Key Words: Cholecystectomy difficulty grading, Complications, Hartmann's pouch stones, Laparoscopic cholecystectomy, Mirizzi syndrome, Mucocele, Empyema.

propriate dissection strategies. Sharp or diathermy dissection should be avoided. Dislodging the stone into the gall bladder, stone removal, swab dissection, and cholangiography are useful measures to avoid ductal injury and reduce the conversion rate.

INTRODUCTION

Hartmann's pouch (HP) was originally described in 1884, and was the subject of a paper published in *The Lancet* in 1942,[1,2] in which Davies and Harding describe a dilatation of the gallbladder neck. Whether the HP is a constant anatomical feature or a product of pathological change to the gallbladder,[2,3] there seems to be a significant association between the presence of stones and the existence of HP.[4]

Stones may become lodged in the HP causing it to enlarge or become inflamed and adherent to surrounding structures. This can result in obscuring the cystic duct (CD) or the whole of the cystic pedicle. The HP can be found adherent to the lateral wall of the common bile duct or the common hepatic duct. Impaction, inflammation, and adhesions can lead to various pathological consequences e.g., acute cholecystitis, mucocele, empyema, Mirizzi syndrome, and fistulation into the bile duct, duodenum, or colon.

The HP can therefore pose potential technical challenges during LC. The HP is often grasped and retracted laterally and caudally when present to reveal the anatomy of the cystic pedicle. This aids safe dissection, creating a space between the CD and the common bile duct (CBD) to allow better identification of the two structures. A large impacted HPS may hamper grasping the HP, causing this step to become difficult. A short or thin CD can become hidden or may be mistaken for an adherent CBD when the gallbladder is retracted. A severe inflammatory or fibrotic reaction to HPS at the cystic pedicle can lead to a difficult dissection and, subsequently, an increased risk of complications.

It would seem that large HPS make LC and laparoscopic common bile duct exploration (LCBDE) more difficult,

increasing the operative time and complications rate. We reviewed our series to identify the incidence, presentations, operative findings, and postoperative outcomes associated with HPS and to describe technical solutions for HPS encountered during LC.

METHODS

An analysis of a prospectively maintained database of all consecutive LCs and LCBDE performed by a single surgeon in multiple units over 26 years was conducted. There were no exclusions. Patients were divided into two groups; those with HPS and those with no HPS, used as a control based on the operative findings. The two groups were compared for patient demographics, clinical presentation, intraoperative findings, pathology encountered, operative time, and conversion to open surgery. The operative difficulty grade on the Nassar Scale,[5] complications and postoperative outcomes were analyzed. For the purpose of this study an HP was defined as an out-pouching of the gallbladder wall at the junction between the gallbladder neck and the CD, whether or not it contained stones. The presence of HPS hindering the grasping of the gallbladder to commence the dissection of the cystic pedicle, or its separation from the duodenum, or the lateral wall of the bile duct was noted and declared as a determining element of the LC difficulty grade.

Operative Technique

All patients were operated on with the senior surgeon (AHMN) scrubbed at the operating table. LC with or without bile duct exploration was carried out in the supine position using a standard four port technique. Modified open access was carried out to insert a 12 mm infraumbilical port, establishing pneumoperitoneum, and inserting a further three 5 mm ports under vision. A blunt "Duckbill" dissector was used as the instrument of choice except in the first few cases where the "L hook" was used, but permanently abandoned for the rest of the series as a protocol. In this series, the use of endo-clips to secure the CD and cystic artery was also stopped 23 y ago in favor of intracorporial 2/0 Polysorb ties. A 5FR ureteral catheter was used through an open cannula inserted into the right subcostal port to obtain an intraoperative cholangiogram (IOC) through the right subcostal port.[6] IOC was carried out in over 90% of the cases.[7] The 12 mm umbilical port was closed with 1/0 Polysorb suture on a 5/8 circle needle under laparoscopic vision using two blunt hooks to lift the corners of the defect.[8]

All patients received prophylactic antibiotics according to the hospital policy. All patients received mechanical antithrombotic measures. Patients did not receive low-molec-

ular-weight heparin (LMWH) at induction of anaesthesia. However, postoperative prophylactic LMWH was given on the evening after the operation provided there was no concerns about postoperative bleeding.

Biliary Service Pathway

All acute patients proven to have symptomatic gallstone disease with or without complications are referred to the biliary team on the index admission. Magnetic resonance cholangiopancreatography (MRCP) is not a routine part of our diagnostic protocol and endoscopic retrograde cholangio pancreatography (ERCP) is not relied upon for preoperative bile duct clearance except in those unfit for general anesthesia. Computerized tomography (CT) scan is only performed when malignancy is suspected and in some patients with sepsis or pancreatitis. All patients deemed fit for general anesthesia will undergo LC with routine IOC and if necessary LCBDE during their index admission by a dedicated biliary firm.

Research ethics committee approval was not required as the clinical study followed established standard protocols. Informed consent was obtained from all patients.

The "number of episodes" was defined as the total number of admission(s) or intervention(s) an individual patient had until complete resolution of the underlying pathology. "Presentation to resolution" was defined as the interval between the first day of elective or emergency admission to hospital and discharge with complete resolution of symptoms, complications, or reinterventions following biliary surgery. These parameters included all previous admission episodes under other units or hospitals prior to the index admission.

Statistical Analysis

Pearson Uncorrected Chi-Square Test was used to calculate the P value and odds ratio (OR) with 95% confidence interval (CI). A P value of < 0.05 was considered statistically significant.

RESULTS

In the study period, 5136 patients had LC +/− LCBDE. Six hundred twelve (11.9%) patients were prospectively identified as having HPS intra-operatively. Patients' demographics are shown in **Table 1**. Preoperative data is detailed in **Table 2**. Patients with HPS are more likely to present as an emergency as compared to the non-HPS group. Acute cholecystitis was four times more common in the HPS group. Risk factors for CBD stones, including jaundice, was not significantly different in the two groups, while acute pancreatitis was more common in the non-HPS group.

A similar proportion of patients in both groups had MRCP

Table 1.
Patients Demographics

	HPS (n = 612)	non-HPS (n = 4,524)	*P* value	OR (95% CI)
Sex				
Male	179 (29.2%)	1097 (24.2%)	0.007	1.291 (1.071, 1.557)
Female	432 (70.6%)	3406 (75.3%)	**0.012**	0.788 (0.654, 0.949)
Not recorded	1 (0.2%)	21 (0.5%)	0.285	0.351 (0.047, 2.614)
Age (years)				
Mean	52.1	50.8		
Median	53	51		
Range	14–86	13–91		

HPS, Hartmann's pouch stone; OR, odds ration; CI, confidence interval.

Table 2.
Pre-operative Data

	HPS (n = 612)	non-HPS (n = 4,524)	*P* value	OR (95% CI)
Urgency				
Elective	293 (47.9%)	2563 (56.7%)	**<0.001**	0.703 (0.593, 0.832)
Emergency	310 (50.7%)	1877 (41.5%)	**<0.001**	1.448 (1.222, 1.714)
Not Recorded	9 (1.5%)	84 (1.8%)	0.501	0.789 (0.395, 1.577)
Clinical Presentation				
Chronic Biliary Symptoms	295 (48.2%)	2742 (60.6%)	**<0.001**	0.605 (0.511, 0.716)
Acute Biliary Pain	159 (26.0%)	1292 (28.6%)	0.184	0.878 (0.725, 1.064)
Acute Cholecystitis	171 (27.9%)	265 (5.9%)	**<0.001**	6.232 (5.022, 7.733)
Acute Pancreatitis	23 (3.8%)	355 (7.8%)	**<0.001**	0.459 (0.298, 0.705)
Acute Cholangitis	7 (1.1%)	107 (2.4%)	0.054	0.478 (0.201, 1.031)
Jaundice	98 (16.0%)	797 (17.6%)	0.326	0.892 (0.709, 1.121)
CBD Risk Factors	186 (30.4%)	1590 (35.1%)	**0.020**	0.806 (0.671, 0.967)
Previous Upper Abdominal Surgery	14 (2.3%)	91 (2.0%)	0.651	1.140 (0.646, 2.015)

HPS, Hartmann's pouch stone; OR, odds ration; CI, confidence interval; CBD, common bile duct.

(3.3% vs 4.2%, OR 0.766, CI 0.480 to 1.225; *P* = .264). A small proportion of patients in both groups had CT scans (1.3% vs 1.7%, OR 0.745, CI 0.358 to 1.550; *P* = .430). Patients were more likely to have had a preoperative ERCP in the non-HPS group (3.5% vs 1.8%, OR 0.506, CI 0.273 to 0.937; *P* = .027). The great majority of these were carried out at other hospitals before referral to the biliary unit.

There was a statistically significant difference in the cholecystectomy difficulty grade between the two groups, **Table 3**. The HPS group had more difficult cholecystectomies as compared to non-HPS group. More adhesiolysis was required to the gallbladder, duodenum, and hepatic flexure in the presence of HPS. Calot's triangle was more likely to be abnormal, difficult, and have accessory arteries in the presence of HPS. However, CD stones were more common in the non-HPS group.

The presence of mucoceles and empyemas of the gallbladder were significantly more common in the HPS group and,

Table 3.
Intra-operative Findings

	HPS (n = 612)	Non-HPS (n = 4,524)	P value	OR (95% CI)
Cholecystectomy difficulty grade				
1	8 (1.3%)	1697 (37.5%)	**<0.001**	0.022 (0.011, 0.044)
2	74 (12.1%)	1509 (33.4%)	**<0.001**	0.275 (0.214, 0.353)
3	247 (40.4%)	782 (17.3%)	**<0.001**	3.238 (2.708, 3.873)
4	252 (41.2%)	474 (10.5%)	**<0.001**	5.981 (4.961, 7.211)
5	30 (4.9%)	59 (1.3%)	**<0.001**	3.901 (2.493, 6.105)
Not Recorded	1 (0.2%)	3 (0.1%)	0.419	2.466 (0.256, 23.749)
Adhesiolysis				
Gallbladder	531 (86.8%)	2723 (60.2%)	**<0.001**	4.336 (3.406, 5.519)
Hepatic flexure	283 (46.2%)	740 (16.4%)	**<0.001**	4.399 (3.684, 5.252)
Duodenum	458 (74.8%)	1917 (42.4%)	**<0.001**	4.044 (3.338, 4.900)
Distant	80 (13.1%)	589 (13.0%)	0.971	1.005 (0.782, 1.291)
Calot's Triangle				
Normal	345 (56.4%)	3852 (85.1%)	**<0.001**	0.225 (0.188, 0.270)
Easy	87 (14.2%)	3049 (67.4%)	**<0.001**	0.082 (0.065, 0.103)
Accessory Artery	284 (46.4%)	1132 (25.0%)	**<0.001**	2.595 (2.183, 3.083)
Wide Cystic Duct	100 (16.3%)	599 (13.2%)	**0.036**	1.280 (1.016, 1.612)
Cystic Duct Stones	78 (12.7%)	731 (16.2%)	**0.030**	0.758 (0.590, 0.974)
Gallbladder Operative Morphology				
Acute Cholecystitis	100 (16.3%)	221 (4.9%)	**<0.001**	3.803 (2.952, 4.899)
Chronic	63 (10.3%)	3423 (75.7%)	**<0.001**	0.037 (0.028, 0.048)
Contracted	124 (20.3%)	507 (11.2%)	**<0.001**	2.013 (1.619, 2.503)
Mucocele	147 (24.0%)	169 (3.7%)	**<0.001**	8.146 (6.403, 10.365)
Empyema	189 (30.9%)	166 (3.7%)	**<0.001**	11.730 (9.309, 14.780)
Mirizzi syndrome	11 (1.8%)	40 (0.9%)	**0.032**	2.052 (1.047, 4.020)
Single gallstone				
Ultrasound Scan	107 (17.5%)	484 (10.7%)	**<0.001**	1.769 (1.407, 2.224)
Intraoperative	138 (22.5%)	564 (12.5%)	**<0.001**	2.044 (1.658, 2.520)
Sub-hepatic Drain(s)	435 (71.1%)	2164 (47.8%)	**<0.001**	2.680 (2.229, 3.222)
Length of Surgery (mins)				
Mean	86.1	70.2		
Median	75	60		
Range	22–345	15–570		
Conversion to Open	2 (0.3%)	25 (0.6%)	0.468	0.590 (0.139, 2.497)
Fundus First Dissection	45 (7.4%)	105 (2.3%)	**<0.001**	3.340 (2.330, 4.787)
CBD Stone(s)	93 (15.2%)	969 (21.4%)	**<0.001**	0.657 (0.521, 0.829)

HPS, Hartmann's pouch stone; OR, odds ration; CI, confidence interval; CBD, common bile duct.

as a result, resorting to fundus first dissection (FFD) was more likely. IOC was performed in 584 patients in the HPS group (95.4%, 73.6% being normal) compared to 4,088 (90.4%, 64.5% normal) in the non-HPS group, where CBD stones were more likely. The majority (88.9% versus 85.5%) of patients had LC +/- LCBDE in the index admission.

The median length of surgery was 15 min longer in the HPS group (75 min vs 60 min). There was no significant difference in the open conversion rate in both groups.

No significant differences were noted in the hospital stay, presentation to resolution interval, or the total number of admission episodes **Table 4**. The median postoperative stay in both groups was 2 d; 0–17 d for the HPS group and 0–41 d in the non-HPS group.

The overall morbidity rate in this series was 4.5% and the 30 d mortality was 0.1%. **Table 5** compares the complications according to the Clavien-Dindo classification. There were no statistically significant differences between the two groups in Clavien-Dindo grades 1 to 3. More patients in the non-HPS group had Clavien-Dindo grades 4a and 5. No operative or postoperative complications or deaths were directly related to the presence of HPS. There were two bile

duct injuries in this series, both in the non-HPS group. Both occurred in relatively easy LC; difficulty grades I and II with anomalous duct configurations. Cholangiographies were carried out confirming the injuries and the duct configuration, stents were inserted into the ends of the divided ducts, and the procedures were completed laparoscopically. Both patients were immediately referred to the regional liver surgery unit where biliary reconstruction was carried out within 24 h. Both patients remain well 16 and 8 y later.

DISCUSSION

Preoperative Symptoms and Risk Factors

There are no clear predictive risk factors or symptoms identified with HPS in our series. However, patients with HPS were more likely to present as emergency admissions than in the non-HPS group. This is probably due to the different sequelae of obstruction caused by impacted HPS resulting in acute episodes of biliary pain or the subsequent inflammatory reaction causing acute cholecystitis requiring admission. The pathogenesis of 90% of cases of acute calculus cholecystitis is thought to be ischemic or

Table 4.
Hospital Stay, Number of Episodes, and Presentation to Resolution

	HPS (n = 352, 57.5%)	non-HPS (n = 2,900, 64.1%)	P value	OR (95% CI)
Total Hospital Stay (days)				
Mean	5.0	5.6		
Median	4	3		
Range	1–34	1–160		
Number of Episodes				
1	313 (88.9%)	2480 (85.5%)	0.083	1.359 (0.959–1.926)
2	35 (9.9%)	358 (12.3%)	0.192	0.784 (0.544–1.131)
3	4 (1.1%)	52 (1.8%)	0.371	0.630 (0.226–1.751)
4	0	6 (0.2%)	0.393	0.000 (0.000–NaN)
5	0	3 (0.1%)	0.546	0.000 (0.000–NaN)
6	0	1 (0.0%)	0.728	0.000 (0.000–NaN)
Presentation to Resolution (weeks)				
Mean	2.0	2.4		
Median	1	1		
Range	1–28*	1–140*		

HPS, Hartmann's pouch stone; OR, odds ration; CI, confidence interval; NaN, not a number.

*Including previous admissions under the care of other units or hospitals prior to the index admission.

Table 5.
Complications

Clavien-Dindo Classification	HPS (n = 612)	Non-HPS (n = 4,524)	*P* value	OR (95% CI)
Grade I	5 (0.8%)	32 (0.7%)	0.763	1.156 (0.449–2.979)
Grade II	14 (2.3%)	100 (2.2%)	0.903	1.036 (0.588–1.824)
Grade IIIa	7 (1.1%)	42 (0.9%)	0.607	1.235 (0.552–2.761)
Grade IIIb	1 (0.2%)	19 (0.4%)	0.339	0.388 (0.052–2.904)
Grade IVa	0 (0%)	13 (0.3%)	0.184	0.000 (0.000–NaN)
Grade IVb	0 (0%)	0 (0%)	1.000	NaN (NaN–NaN)
Grade V	0 (0%)	5 (0.1%)	0.411	0.000 (0.000–NaN)
Readmission	8 (1.3%)	101 (2.2%)	0.136	0.580 (0.281, 1.197)

HPS, Hartmann's pouch stone; OR, odds ration; CI, confidence interval; NaN, not a number.

chemical, rather than infectious, and is almost always related to a stone impacted in the CD or HC.[9] Such impaction may lead to interference with the venous drainage of the gallbladder by the tortuous channels surrounding the CD and changes in the concentration and composition of bile. Repeated inflammation resulting from impacted HPS may also induce a fibrous reaction or result in a mucocele of the gallbladder. In our series mucoceles were recorded in 24.0% of the HPS group compared to 3.7% non-HPS group. An empyema of the gallbladder results if bacterial infection occurs.

Preoperative Imaging

An ultrasound scan is the first imaging modality used when a clinical presentation is suggestive of biliary pathology. However, a preoperative diagnosis of HPS may be difficult. The sensitivity of ultrasound to diagnose gallbladder neck or CD stones is low, in one study ultrasound failed to detect any of the 64 patients with CD stones.[10] MRCP, on the other hand, has a higher sensitivity for detecting the location of stones in the biliary tree of 85%.[11] In this series, preoperative MRCP was not commonly employed. However, when preoperative MRCP is carried out the surgeon should study the images for the possibility of HPS due to its importance.

Single gallstones were more common in the HPS group as were the findings of thick-walled and contracted gallbladders compared to the control highlighting the importance of HPS impaction in repeated inflammation and a fibrous reaction.

Operative Difficulty and Technical Strategies

This study highlighted the technical difficulties associated with HPS, showing a higher operative difficulty grade and a longer median operative time. The longer time of surgery in the HPS group reflects the statistically significant increase in operative difficulty since bile duct explorations, usually requiring more time, were less frequent in this group. The incidence of iatrogenic gallbladder perforation in the literature varies, but one systematic review found it to be about 20%.[12] Our series showed similar figures for the HPS and non-HPS groups.

The difficulties encountered as a result of HPS are related to defining the anatomy, grasping the gallbladder neck, lateral retraction, separation of the duodenum, or adherence of the HP to the CHD/CBD and obtaining IOC. The main factors leading to difficult dissection were gallbladder distention and the distortion of the cystic pedicle. Decompression of a distended and tense gallbladder not only facilitates its grasping and retraction but will also allow intravesical space for any HPS to be dislodged into the gallbladder body, making the dissection of the cystic pedicle easier and safer. When associated with acute cholecystitis or empyema of the gallbladder subserosal access over the HP will allow the dissection to proceed close to the gallbladder wall and a safe approach to the infundibulum. While this will in most cases facilitate the display of an otherwise unobtainable critical view of safety it will also ensure access to the neck of the gallbladder and the distal CD, thus helping the infundibular approach alternative. The CD can lie hidden behind the distended HP or stretched inferiorly over it in many cases. As isolation of the CD–HP junction is key to a safe cholecystectomy, this vital step may be hampered by a large impacted HPS. Simple dislodgement of the stones back into the gallbladder, as done in most cases, may not be possible in a shrunken "burnt out" gallbladder or one which is packed with stones. Opening the HP to remove the impacted

stone(s) and facilitating the grasping of the neck, is a good technical option to avoid pedicle dissection over a hard object. Nevertheless, a very large gallbladder may become flaccid after the removal of stones, folding over the dissection field and potentially posing difficulties. In our practice, most dissection was carried out using a blunt, flat-jawed forceps, "Duckbill grasper." If the HP was found to be adherent to either the bile duct or the duodenum, we employed swab dissection. In our practice we do not use diathermy hook dissection and in our view it should have no place in negotiating an inflamed or fibrotic cystic pedicle, particularly in the presence of stones in the HP or CD.

FFD is a useful and safe alternative in cases with dense adhesions around the pedicle or a HPS. This technique can reduce the conversion rate in such cases to 1.2% from a potential 5.2%.[13] In our series, FFD was used to in 45 (7.4%) of HPS cases with no operative complications. However, care must be taken when using this technique, particularly when approaching the cystic pedicle. Swab dissection should be used and dividing the HP circumferentially would facilitate access to the posterior wall of the HP. This "funnel technique" helps to develop the cystic stump further; safeguarding a potential cystic artery, sectoral duct, or an extrahepatic right hepatic duct, excluding the presence of stones in the stump and allowing the excision of as much as possible to avoid a significant remnant. A recent statement on preventing bile duct injury suggests that subtotal cholecystectomy is safer than FFD when a hostile cysto-hepatic window is encountered.[14] The fenestrating subtotal cholecystectomy is more suitable for cases where HPS have resulted in the HP wall being tightly adhered to the cystic plate and, subsequently, difficult to separate. Other salvage strategies to consider are the reconstituting subtotal cholecystectomy and tube cholecystostomy. When using any salvage strategies, we perform IOC to confirm the integrity of the biliary system and exclude retained stones in the gallbladder remnant or the CBD. IOC was performed in over 90% in our series, with normal findings in 73.6% of the HPS group vs 64.5% in the non-HPS group. The surgeon's judgement will be used to determine whether to seek advice from a more experienced surgeon, if open conversion may make such cases easier and safer, or whether to resort to abandon the procedure in favor of a later attempt at LC once inflammation has subsided.

CONCLUSION

Preoperative predication of HPS is difficult, with no significant clinical or radiological risk factors identified. HPS greatly increase the difficulty in grasping and manipulating the HP and the risk of adhesions to surrounding structures. In spite of the difficulties, technical modifications including gallbladder decompression and stone removal, can facilitate safe LC in most cases.

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