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SURGICAL ENDOSCOPY
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Peritoneal gallstones following laparoscopic cholecystectomy

Incidence, complications, and management

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Abstract
Background: Gallstone spillage during laparoscopic cholecystectomy (LC) is a common intraoperative event. Although gallstones left in the peritoneal cavity were initially considered harmless, a significant number of complications have been reported. Our aim was to quantify the likelihood, and to document the range, of subsequent complications.
Methods: A Medline search from 1987 to January 2003 was performed. Articles with more than 500 LCs that quantified the frequency of complications due to peritoneal gallstones were reviewed, as were representative case studies of different stated complications.
Results: Six studies, covering 18,280 LCs, were found. The incidence of gallbladder perforation was 18.3%, that of gallstone spillage was 7.3%, and that of unretrieved peritoneal gallstones was estimated to be 2.4%. There were 27 patients with complications. The likelihood of a complication when gallstone spillage occurred was 2.3%, which increased to 7.0% when unretrieved peritoneal gallstones were documented.
Conclusion: Spilt gallstones have a small but quantifiably real risk of causing a wide range of significant postoperative problems.

Key words: Gallbladder perforation — Laparoscopic cholecystectomy — Spilt gallstone — Peritoneal gallstone

Two problems that are more common after laparoscopic cholecystectomy (LC) than open cholecystectomy are injury to the common bile duct and complications from peritoneal gallstones. Although the increased incidence of common bile duct injury [49] has received considerable attention, this has not been the case for the spillage and retention of gallstones following LC. Although initially considered harmless [35, 46], stones left in the peritoneal cavity can be associated with infrequent but significant complications. Figure 1 summarizes a recent example of this.

The goals of this review are to determine the incidence of peritoneal gallstones and to describe the subsequent complications. Strategies for the retrieval of spilt gallstones and for the management of complications are also discussed.

Methods

A literature search was undertaken between December 1987 and January 2003. The key words used for the primary search included laparoscopic cholecystectomy, abscess, bile, complication, fistula, gallstone, loss, lost, perforation, pigment, retrieve, retrieval, spillage, spilled, spilt, stone, and unretrieved. No limitations were placed on the search. Abstracts were reviewed to quantify the frequency of complications due to spilt gallstones and to define the range of such complications. Because this is a rare complication, any study, prospective or retrospective, that involved the review of more than 500 LCs for complications of peritoneal stones were reviewed in detail.

The definitions used for this study are as follows:

Perforated gall bladder: when a hole was made in the gallbladder wall
Spilt gallstone: when a gallstone was spilt from the gallbladder into the peritoneal cavity
Unretrieved peritoneal gallstone: when a spilt gallstone was knowingly left in the peritoneal cavity
The more generic term, ''peritoneal gallstone,'' refers to any gallstone in the peritoneal cavity, regardless of whether stone spillage or retrieval were recognized.Several assumptions were made because of the limitations of the available data. First, accurate observation and recording of perforation of the gallbladder and gallstone spillage occurred. The accuracy of observation and recording is supported by the description of the methods used in the six studies.

Second, the follow-up for the different studies was equivalent. There were differences in both the method of follow-up and the subgroup of patients who were being followed up in the different studies. The methods used included questionnaires in four studies [21, 31, 39, 44], an ongoing prospective clinic assessment in one study [43], and a review of the notes in another study [11]. Studies reassessed all the patients [11, 21, 39], those with gallbladder perforation [43], or those with spilt stones [31, 44]. Studies also may have concentrated on different

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Fig. 1. An 80-year-old man presented 4 years after an uncomplicated LC with a 1-year history of mild right upper quadrant pain, which had worsened in the previous 2 months, and 1 month of intermittent right pleuritic pain. On examination, there was mild tenderness and a fullness in the right upper quadrant. His C-reactive protein was elevated at 100 units. A CT scan showed a 22 × 10-cm superficial cyst, with a hyperemic margin, between the liver and abdominal wall (*arrow*). There was some distortion of the underlying liver. The provisional diagnosis was a liver cyst, however, at radiological aspiration 1,500 ml of pus was drained. A transhepatic pigtail catheter was placed, and intravenous broad-spectrum antibiotics were commenced. His recovery was complicated by a loculated pleural effusion, which required chest tube drainage. Cultures from the abscess grew *Escherichia coli*. The collection reaccumulated over 5 months. At laparotomy, a 20 × 15-cm abscess was found between the right lobe of the liver and the diaphragm. In its base, there was a 1.5-cm faceted gallstone. The stone was removed, the abscess cavity was washed out, and large bore drains were placed. He made an uneventful recovery.

complications; for example, only two studies [11, 44] identified any wound complications due to peritoneal stones. If retrospective questionnaires concentrating on serious postoperative complications [44] and the need for further surgery were used, then more "minor" wound complications may not have been identified.

Third, the ratio of cases of gallbladder perforation with spilt gallstones could be extrapolated from two studies [11, 39] to the other studies. The frequency of gallstone spillage following gallbladder perforation in these two studies was 38% [39] and 40.5% [11]. There were significant differences in the rate of gallbladder perforation, but because the mechanism of gallbladder injuries would be similar, the ratio of cases in which gallstones were spilt should also be similar.

Fourth, one in three cases with split gallstones, some stones were not retrieved [4, 11, 43]. Although the definition of unretrieved peritoneal gallstones is clear, in practical terms this may vary significantly. Identification of an unretrieved stone may depend on how assiduously the laparoscopist attempts to retrieve all spilt gallstones and the level of certainty that a surgeon accepts before stating that a gallstone has not been retrieved. In view of this and the widely distributed results in the three sources reported previously, it was determined that a "best estimation" was all that was possible. Complication rates are given for both spilt gallstones and unretrieved peritoneal gallstones.

Results

Eight studies [11, 19–21, 31, 39, 43, 44] were identified with more than 500 patients undergoing LC that attempted to define the incidence of peritoneal gallstones and the risk of complications. Five of these studies involved some form of patient review for late complications. The completeness of late follow-up was >90% in two studies [39, 44] and between 44 and 84% in three studies [21, 31, 43]. One study reviewed the notes of all patients for subsequent complications [11]. Because no attempt was made to review for late complications in the other two studies [19, 20], these were not included in any further analysis.

Table 1 summarizes the six studies used in quantifying the incidence of complications. Because there are four possible denominators for reporting complication rates, it is not surprising that there was variation in how the data were presented. The denominators used in the different studies were all LCs [11, 21, 39], cases with perforated gall bladder [11, 21, 39, 43], cases with spilt gallstone [11, 31, 39, 44], and cases with unretrieved peritoneal gallstones [11, 43].

Incidence of perforation of the gallbladder

The incidence of perforation of the gallbladder is listed in Table 1. This was directly reported in four studies. This can be estimated in the other two studies [31, 44] because when both gallbladder perforation and stone spillage were reported [11, 39], stones were spilt in 40% of cases. This resulted in 1,368/10,140 [44], 306/1,059 [39], 131/1,127 [43], 412/856 [31], 512/1,412 [21], and 627/3,686 [11] cases of perforated gallbladder/number of LCs, with a summated total of 3,356 cases of perforated gallbladder in 18,280 LCs, giving an 18.3% incidence of gallbladder perforation.

Incidence of spilt gallstones

The incidence of spilt gallstones is listed in Table 1. This was reported in four studies and estimated in two [21, 43], again from the observation that in 40% of cases of perforated gallbladder stones are spilt [11, 39]. This resulted in 547 [44], 115 [39], 52.4 [43], 165 [31], 204.8 [21], and 254 [11] cases of spilt gallstones. This results in a total of 1,338 patients with spilt gallstones from 18,280 LCs, giving a 7.3% incidence of gallstone spillage.

Incidence of unretrieved peritoneal gallstones

The incidence of unretrieved peritoneal gallstones is listed in Table 1. This was reported in only two studies [11, 43]. In the first [43], it was estimated that there were 52 spilt gallstones. In 26 cases (50%), these were not fully retrieved. In the second [11], gallstones were not retrieved in 16% of cases with spilt gallstones. One review [4] estimated that in 37% of cases stones were not retrieved. Based on this evidence, the best estimate of the incidence of unretrieved gallstones was determined to be 33%.

Complications of peritoneal gallstones

The number of complications identified due to a peritoneal gallstone is listed in Table 1. The complication rate in the different studies ranged between 0 and 5 per

Table 1. Summary of articles reviewing complications of peritoneal galltones

	Study						
	Schafer et al. [44]	Rice et al. [39]	Sarli et al. [43]	Memon et al. [31]	Hui et al. [21]	Diez et al. [11]	Summary
Study method							
Operative data	Prospective database	Prospective database	Prospective database	Prospective database	Prospective database	Prospective database	
Follow-up data							
Group followed up	SG	All cases	PGB	SG	All cases	All cases	
Method	Retrospective postal or phone questionnaire, note review	Retrospective postal or phone questionnaire, note review	Clinical follow-up at 6 mo and 1 yr	Retrospective postal or phone questionnaire	Retrospective postal or phone questionnaire	Retrospective note review	
Completeness	100%	Questionnaire, 92% Note review,100%	110/131 (84%)	106/165 (64%)	623/1,412 (44%)	100%	
Time (mos)	16–56	25–60	8–67 (mean, 43)	5–92 (mean, 45)	6–86 (mean, 48)	NS	
Operative results							
LCs	10,174	1,139	1,239				
Conversions and exclusions	34	80	112				
No. of LCs included in study	10,140	1,059	1,127	856	1,412	3,686	1,000
No of PGB (%)	NS	306/1,059 (29)	131/1,127 (11.6)	NS	512/1,412 (36)	627/3,686 (17)	183
No of SG(%)	547 (≈5.4)	115/1,059 (10.9)	NS	165/856 (19)	NS	254/3,686 (6.9)	73
No of Unretrieved peritoneal stones	NS	NS	26/1,127 (2.3)	NS	NS	40/3,686 (1.1)	24
Documented complications caused by peritoneal stones							
Denominator	SG (547)	PGB (306)	PGB with follow-up (110)	SG with follow-up (106)	All cases with follow-up (623)	Peritoneal stones (40)	
No. of cases	8	5	0	2	0	12	1.7
IAA	6	5		1		4	
Other abdominal	2					2	
Wound	1 (fistula)					7 (6 sinus, 1 fistula)	
Extra abdominal		2 (empyema)		1 (stone erosion)			

LC, laparoscopic cholecystectomy; PGB, perforated gallbladder; SG, spilt gallstones; NS, not stated; IAA, intra-abdominal abscess

1,000 LCs performed. Identification of other early and late complications of LCs was outside the scope of this review. Overall, there were 27 patients with complications in 18,280 LCs. With an incomplete long-term follow-up, this resulted in a complication rate of 1.5 complications per 1,000 LCs. Intraperitoneal abscess formation and wound sinus or fistula formation accounted for 60 and 30% of these complications, respectively. Other complications included empyema on two occasions and one episode of each of the following complications: small bowel obstruction, small bowel fistula, colonic fistula, diaphragmatic irritation, and stone erosion through the flank. In four cases, peritoneal calculi resulted in more than one complication. There were eight patients with an intraabdominal collection or abscess [11, 21, 39] that were assessed to not be caused by peritoneal gallstones. Wound infections were not identified as being due to peritoneal gallstones unless there was an associated sinus or fistula [11, 44]. Unfortunately, none of these six studies identified a wound infection secondary to spillage of a gallstone or gallstone fragments into the wound at the time of gallbladder extraction.

When an adjustment for incomplete follow-up is made, for cases with documented spilt gallstones, the numbers of cases with long-term follow-up were 547 [44], 115 [39], 44 [43], 106 [31], 90 [21], and 254 [11], resulting in a total of 1,156 cases. With 27 patients with complications in 1156 cases, the complication rate is 2.3%. If spilt gallstones are not fully retrieved in 1 in 3 patients, then when a stone is knowingly left in the peritoneal cavity the likelihood of subsequent complications is approximately 7.0%.

In summary, from the six identified studies it was estimated that for every 1,000 LCs the gallbladder was perforated in 183 cases, stones were spilt in 73 cases, and they were incompletely retrieved in 24 cases. The risk of a complication due to a peritoneal gallstone was 2.3% when a spilt gallstone was documented and 7.0% when an unretrieved peritoneal gallstone was documented. Because there were 73 stones spilt per 1,000 LCs with a complication rate of 2.3%, the risk of complications due to spilt stones is 1.7 cases per 1,000 LCs.

Discussion

Likelihood of stone spillage and subsequent complications

This study provides the best available estimate of the incidence of gallbladder perforation, spilt gallstone, and unretrieved peritoneal gallstones after LCs and the risk of subsequent complications. However, these estimates should be accepted with caution because of the assumptions that were necessary to derive them.

A review article of more than 17,000 LCs reported similar results, with the incidence of perforated gallbladder during LCs varying from 8 to 39.9% (mean, 20), that of spilt gallstones varying from 0.1 to 20% (mean, 8.8), and successful retrieval of lost stones being possible in only 63% of cases [4].

The estimation of the complication rate due to peritoneal gallstones per 1,000 completed LCs was 1.5 when the denominator was the total number of LCs and 1.7 when it was the number of spilt gallstones. Three factors contributed to this difference. Two studies [31, 44] followed up only those patients with documented spilt stones. Therefore, patients with unrecognized spilt stones would not have been identified, resulting in a lower incidence of complications for total number of LCs. In at least 20% of patients who develop complications due to peritoneal gallstones, gallstone spillage was not recognized at the time of surgery [4]. Second, follow-up for late complications was incomplete in three of the six studies. Third, in the study by Schafer et al. [44] the number of completed LCs was probably overstated. There were 34 conversions in patients who had spilt stones, but it is likely that conversions for other reasons were not reported. For these reasons, the more accurate figure is probably 1.7 complications for every 1000 completed LCs.

Risk factors for perforation of the gallbladder

The principal mechanisms of gallbladder perforation during LCs are injury to the gallbladder during diathermy dissection from the hepatic fossa [21, 39, 43] and traction injury to Hartmann's pouch [21, 43]. Less frequent causes include slippage of the endoclip from Hartmann's pouch and tearing of the gallbladder as it is removed through the umbilical port site [21, 24, 43]. Risk factors for gallbladder perforation have been reviewed in a number of studies. Statistically significant risk factors include the experience of the surgeon [43] and the difficulty of the operation (acute cholecystitis [21, 43], adhesions in the right upper quadrant [21, 39], preoperative pain >96 h [1], and palpable gallbladder preoperatively [1]). Patient characteristics include obesity [21, 39, 46], older age [21, 39, 43], and being a male [21, 39, 43]. By confirming that peritoneal gallstone can cause subsequent problems, this study highlights the importance of using a surgical technique that minimizes the risk of gallbladder perforation. This includes establishing the correct plane in dissecting the gallbladder from the liver, minimizing diathermy injury, and having a low threshold for using hydrodissection in Calot's triangle.

The natural history of peritoneal gallstones

The natural history of peritoneal gallstones is for the local inflammatory response to cause it to be walled off by omentum and local fibrosis [45], with partial reabsorption sometimes occurring [52]. The inflammatory response is greater in the presence of infection [2, 57], stone fragmentation [57], and with pigmented stones [18, 20]. Pigment stones are more likely to be infected than cholesterol stones. Up to 80–90% of pigment stones contain bacteria [8, 19, 48], such as *Escherichia coli*, *Klebsiella penumoniae*, and *Enterococcus* [20]. When infection is present, there is a greater risk of

adhesions and abscess formation. The local inflammation may also cause a foreign body-type granulomatous reaction [51]. Gallstones are treated as a foreign body, resulting in erosion into adjacent organs [30, 47] and the abdominal wall [17]. This can result in unexpected complications, both within and outside the peritoneal cavity.

Risk factors for complications

The significant risk factors for complications due to peritoneal gallstones include acute cholecystitis with infected bile [4, 44], spillage of pigment stones [4], multiple stones (>15) [4], stone size >1.5 cm [4], and elderly patients [4, 44]. It is interesting to note that in epidemiological studies less than 20% of stones in Western countries are pigment stones, but these stones account for approximately 90% of spilt gallstones involved in subsequent complications [4].

The time course of complications

Complications caused by a peritoneal gallstone may occur many months following surgery, with the longest reported delay being 20 years after an open cholecystectomy [42]. Different studies have reported a mean time to complications of 4 or 5 [5], 6 [7] and 9 months [39]. In a retrospective review [4], the median and mean times from LC until the first onset of symptoms were 3 months (range, 0–78) and 5.5 months, respectively. However, it took an additional 4.5–4.8 months until the diagnosis was made and definitive treatment commenced. The mean time between LC and reintervention was therefore 10.4 months. In the illustrative case (Fig. 1), there was a 36-month delay until symptoms developed and an additional 12 months until the correct diagnosis was made.

Complications within the peritoneal cavity

The most frequent complication of intraperitoneal gallstones is abscess formation [20, 54, 56], accounting for 60% of complications [4]. The most common sites for intraperitoneal abscesses are in the subhepatic and subphrenic spaces [4, 31]. Less frequently, there may be a symptomatic inflammatory mass or a ''sterile collection'' [31] with a gallstone in the base of it. Such inflammatory masses have been reported to cause extrinsic obstruction of the duodenum when in the subhepatic space [37] and diaphragmatic irritation [44] when in the subphrenic space. Other reported sites for abscesses and inflammatory masses include the pouch of Douglas, pericecal and omental positions [4], and in paraumbilical and inguinal hernias [14, 41]. Peritoneal stones in the pelvis have also been reported to cause ovarian implantation [50], tubalithiasis [16], dyspareunia, and chronic pelvic pain [26]. Enteric complications include small bowel obstruction and enteric fistulae. Small bowel obstruction may be caused by the secondary effects of a peritoneal stone, such as adhesion and intra-abdominal abscesses formation [9]. Stone erosion into the small bowel [55], sigmoid colon [32], and colocutaneous fistulae [31] has also been reported. Biliary complications due to extrinsic pressure on the biliary tree may present with biliary obstruction, cholangitis, and jaundice [36]. Other biliary complications include biliary–cutaneous fistulae [27], intrahepatic abscess formation [30, 47, 56], and a case of ''spontaneous'' hepatic hemorrhage secondary to stone erosion into the hepatic parenchyma [8, 22]. Overall, fistulae account for 12% of complications caused by spilt gallstones [4]. These have been reported to involve any combination of the small bowel, colon, biliary system, bladder, and skin [10, 27, 30, 31].

Complications port sites

The second most frequent complication from spilt gallstones is abscess formation at port sites, which accounts for approximately 14% of complications [4, 20, 31]. Complications including early and late port site abscess formation, inflammatory masses [12], and even a late mass mimicking a port site metastasis have been reported [20]. These complications are mainly due to the spillage of stones when the gallbladder is being removed through the port site. Unfortunately, this is not mentioned in any of the six studies that form the basis of our study. Other port site complications, which are included in this study, are those related to the migration of an underlying peritoneal stone [31], with a communication being present between the port site and an underlying sinus, fistula, or intraabdominal abscess [31].

Other extraperitoneal complications

Extraperitoneal problems include abdominal wall and flank abscesses, masses, and sinuses distant to port sites in both extraperitoneal and subcutaneous positions [5, 15, 31, 36, 53]. Retroperitoneal complications include inflammatory masses and abscesses, with inflammatory masses occasionally being very difficult to distinguish from an underlying neoplastic process [40].

Ongoing stone migration [17] can result in stone extravasation through the skin [31], and even displacement into the thoracic cavity or pelvis. Cardiothoracic complications include a sympathetic pleural collection secondary to a subphrenic abscess [23] and empyema formation. An empyema may be related to the transdiaphragmatic extension of a subphrenic abscess [34, 38] or to intrapleural calculi [3]. Cholelithoptysis (coughing up of stones) [42] with an underlying bronchopleural fistula has also been reported [28, 42]. Urological complications include bladder irritation, erosion of gallstones into the bladder [6], vesical granuloma [13], and passing stones in the urine [29]. Stone migration has even been reported to present with symptoms of hip disease [7].

Systemic complications

Although septicemia secondary to retained gallstones is rare, there is a case report of septic shock resulting in death 2.5 months following LC [36].

Diagnostic challenge of complications

Because the complications of peritoneal stones are infrequent, usually with the delayed presentation of an unexpected clinical problem, there is often a prolonged period of symptoms and investigation before the diagnosis is made. The clinical problem may present as an inflammatory or neoplastic process that is not obviously related to the biliary tract at the time of presentation. This is reflected in the mean time of 4.8 months between the onset of symptoms and the diagnosis being made and also in the average of 3.1 diagnostic procedures being performed [4]. CT scan and ultrasound scan (USS) are reported to be the most useful diagnostic tests [4]. The key to an early diagnosis is a high index of suspicion that the underlying problem is due to retained gallstones. A retained gallstone should be considered in any patient presenting with an intraabdominal (or even thoracic) abscess or an idiopathic inflammatory mass and also a history of cholecystectomy, regardless of the time interval.

Intraoperative management of spilt gallstones

With respect to the intraoperative management of spilt gallstones, there are no comparative studies that show an advantage for any specific intervention. However, because unretrieved peritoneal gallstones are a source of infrequent (up to 7%) but potentially severe complications, it is widely recommended that every reasonable effort should be made to retrieve as many gallstones as possible during LC [4, 11, 19–21, 31, 39, 43, 44]. Although most authors do not advise conversion to open surgery [19, 21, 31, 43, 44], in some circumstances, such as when there is significant contamination and spillage of multiple stones, this may be indicated [11, 39]. Intraoperative laparoscopic techniques for managing spilt stones include minimizing further spillage by closing the defect in the gallbladder with an endoloop or clip and placing the gallbladder and loose stones into an intraperitoneal bag. A sample of bile, and a retrieved stone, should be sent for microbiological analysis because pathogens grown are usually the same as those that cause subsequent infections [4]. The retrieval of free intraperitoneal gallstones is aided by a lapaproscopic spoon, laparoscopic graspers, a 10-mm suction device, or a shuttle stone collector [25]. Extensive peritoneal lavage is widely recommended, but care must be taken not to spread gallstones into more inaccessible sites, making retrievel even more difficult. Placing the irrigating instrument beyond the stones so that they are flushed into view can be helpful. Occasionally, a fan retractor is necessary to expose the subhepatic space when the patient has a bulky transverse colon and omentum. Because stone spillage and implantation into the wound can occur upon removing the gallbladder, placing the gallbladder into a bag has the additional advantage of decreasing the risk of port site contamination at the time of gallbladder extraction. When gallbladder perforation and/or stone spillage occur, it is recommended that intravenous antibiotics [4, 43] be administered, and that these be continued for up to 24 h [43]. A prospective study that followed these recommendations demonstrated no increase in complications [43]; however, it is not possible to extrapolate from this that 24 h of antibiotics reduced the risk of subsequent complications. Clear documentation of intraoperative gallstone spillage, the type of gallstones spilt, and the various efforts made to retrieve them is important because this will help to alert the clinician to the possibility of stones causing any subsequent problems, and it may reduce the medicolegal risk should there be subsequent complications.

Management of late complications

Abscess formation secondary to unretrieved gallstones requires drainage, stone removal, and antibiotics. Stones removal will usually involve open surgery [39, 45, 56, 58]; however, laparoscopic [26] and thorascopic [3] techniques are occasionally successful in retrieving stones. Percutaneous techniques have also been used to remove stones from subphrenic collections [54] and sinus tracts [33]. Initial percutaneous drainage of an abscess followed by dilatation of the track and insertion of a choledoscope or nephroscope may enable visualization of the offending gallstone and basket retrieval. The use of minimally invasive techniques without stone removal should be avoided because this often results in ongoing clinical problems, including further abscess formation [4, 39], until the underlying problem is eliminated (Fig. 1).

Summary

Complications of peritoneal gallstones are infrequent, occurring in approximately 1.7 per 1,000 LCs, in approximately 2.3% of cases in which stones are spilt, and in 7% of cases in which stones are knowingly left unretrieved in the peritoneal cavity. Retrieving spilt stones and vigorous peritoneal lavage should reduce the chance of subsequent complications. Because of the frequently atypical presentation of complications, a high index of suspicion is required to avoid the common delay in diagnosis. Definitive treatment requires both drainage of any abscess and removal of the offending gallstone.

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