Consequences of the spilled gallstones during laparoscopic cholecystectomy: a systematic review

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Abstract

Introduction: Complications secondary to spilled gallstones can be classified in the category of disease of medical progress because prior to advent of laparoscopic cholecystectomy very few reports published on the topic. The aim of the present study was to investigate the predisposing factors and the complication rate of spilled gallstones during laparoscopic cholecystectomy over the past 21 years.

Methods: Embase, Pubmed, Medline, Google scholar and Cochrane library were systematically searched for pertinent literature.

Results: Seventy five out of 181 articles were selected including 85 patients; of those 38% were men and 62% women. The median age of the cohort was 64 years old and ranged between 33 and 87 years. Only 23(27%) of the authors reported the incident of spillage of the gallstones during the operation. Time of onset of symptoms varied widely from the second postoperative day to 15 years later. Ten of 85 patients were asymptomatic and diagnosed with spilled gallstones incidentally. The rest of the patients presented with complications of severe morbidity and almost, 87% of the patients needed to be treated with surgical intervention and 12% with US±CT scan guidance drainage. Only one perioperative death reported.

Conclusions: Symptomatic patients with lost gallstones present with severe morbidity complications and required mostly major surgical procedures. Therefore, standardisation of the management of spilled gallstones is needed urgently. Hospitals need to review their policy with audits and recommendations and clinical guidelines are needed urgently.

Keywords: Spilled, Lost, Gallstones, Laparoscopic cholecystectomy, Systematic review

Introduction

Since 1992, laparoscopic cholecystectomy accepted as a treatment of choice for symptomatic cholelithiasis by consensus statement from the National Institute of health conference [1]. It has been reported that the incidence rate of perforation of gallbladder during laparoscopic cholecystectomy (LC) ranges from 6 to 40% [2, 3]. The incidence rate of spillage of gallstones secondary to perforation reported 16% [4]. In addition, 16 to 50% of spilled stones remained un-retrieved [4, 5]. They may migrate in different regions and the reported complication rate varies from 0.08 to 0.3% [6]. However, most recent evidence reported that the incidence rate of complications of spilled gallstones may ranges from 0.04 to 19% [7]. The management of the spilled gallstones varies widely. Notably, studies which analyse complications of the LCs did not mention perforation of the gallbladder and spillage of stones as complication [8]. In addition, a...
study from the UK reported that only one fifth of the surgeons document spillage of the gallstones as a potential complication in the consent form. Moreover, only half of them in case of spillage and un-retrieved stones inform the patient. They are reluctant to do that because this may lead to unnecessary stress and repeated examinations for presumed complications of low risk [9]. However, most recent evidence demonstrated that gallbladder perforation and spillage of stones may lead to complications of severe morbidity. In particular, acute cases, older age, male sex, number of spilled stones more than 15 with diameter >1.5 cm, pigment stones and perihepatic localisation are predicting factors for developing severe complications [3].

Because of lack of consensus recommendations and guidelines the management of spilled gallstones vary widely between institutions and individual surgeons. Therefore, the need for further evaluation of the accumulated evidence is needed urgently.

The aim of the present study was to evaluate the evidence of the complications rate of the spilled gallstones overtime by conducting a systematic review.

Methods

Literature search strategy

From 2000 until today a literature search was performed in Embase, Medline (Pubmed), Cochrane library, Google scholar, and National Institute for Health and clinical Excellence (NICE) databases using free and MeSH terms (spilled, lost gallstones, complications during laparoscopic cholecystectomy, late complications after laparoscopic cholecystectomy, intraabdominal abscess, retroperitoneal abscess, flank abscess, pigment gallstones, cholesterol gallstones). The search strategy was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [10].

Study, selection, and inclusion and exclusion criteria

Publications evaluating the complications of spilled gallstones during laparoscopic cholecystectomy were included. Studies referred to open cholecystectomy and editorials without original data were excluded.

Data extraction and outcomes

Two reviewers (PG and NDA) independently extracted the following data from the included studies: name of authors, country, year of publication, age, gender, indication for laparoscopic cholecystectomy, reference to spilled gallstones, type of lost stones, number of stones spilled, size of lost stones, location of lost stones, presenting symptoms, time of onset of symptoms after the laparoscopic cholecystectomy, complications caused by lost stones and location found, type of reintervention, 90-day perioperative mortality.

Results

Seventy-five articles from a pool of 181 articles were selected including 85 patients [11–85], (Fig. 1, Table 1). The median age of the cohort was 64 years and ranged between 33 and 87 years. The percentage of males and females were of 38% and 62%, respectively. The acute cases were 26(31%). Only 23(27%) of the surgeons reported the perforation of the gallbladder and consequently, spillage of the gallstones in the operative notes. The median time of onset of symptoms was 36 months and ranged between 1 and 180 months; the mode was 24 months. The most common site of lost stones was the right subhepatic, perihepatic, retroperitoneal, right flank and pelvis. Ten (12%) out of 85 cases of lost stones discovered incidentally [18, 19, 23, 39, 47, 49, 52, 58, 71, 75]. Type of lost gallstones discovered during the re-intervention reported by 17 authors(20%), [18–20, 24, 31, 35, 39, 42, 43, 53, 54, 63, 80]; of those 7 (41%) were pigment and 8 (47%) cholesterol gallstones. Seventeen(20%) of authors reported the number of discovered gallstones [18, 25, 27–29, 31, 35, 38, 39, 44, 45, 50, 54, 57, 70, 80, 83]. The size of discovered gallstones was reported by 12(14.11%) authors [18, 19, 25, 28, 31, 35, 37, 52, 63]. The most prevalent presenting symptoms were pain, fever, nausea, vomiting, abdominal swelling, fistula formation, and loss of weight. The most prevalent complications were intrabdominal abscesses 31(36.5%), abdominal wall abscesses 9(10.6%), retroperitoneal abscesses 8(9.4%), thus abscesses in total consisted of 48(56.5%) cases. Notably, 87% of patients underwent a surgical procedure and 12% treated with US±CT scan guidance drainage, two cases that diagnosed incidentally and were asymptomatic scheduled for regular follow-ups (Table 1). One patient died on the 11th postoperative day after lung decortication for thoracic empyema secondary to lost gallstones [15].

Discussion

Complications of the spilled gallstones can be described under the umbrella eponym, disease of the medical progress DOMP. There is a contrasting difference with the open cholecystectomy; because spillage of gallstones during open cholecystectomy is more easier identified and retrieved there are very few reports with the above complication [86, 87].

At the present 96% of all cholecystectomies are performed laparoscopically [88]. In general, the characteristics of the cohorts of patients who underwent laparoscopic and open cholecystectomies differ essentially. The laparoscopic cohort is consisted of younger and healthier patients whereas the open cohort tend
to be older, less well, and generally the open cholecystectomy is performed in higher-risk patients [89, 90]. Another important characteristic of the laparoscopic era is the broadening of the indications and the dramatic increase in the number of LCs performed for acalculous disease [91]. Taking into account that present studies reported that older age is a predicting factor for developing
# Table 1: Study characteristics of the publications for the complications of the spilled gallstones

| Author, country, year | Number of patients | Age | Indication for LC | Reference to the spilled stones | Presenting symptoms | Time of onset of symptoms after LC | Complications caused by Lost stones and location found | Type of reintervention |
|-----------------------|--------------------|-----|-------------------|---------------------------------|---------------------|-------------------------------|-----------------------------------------------|-----------------------|
| Ray S India, 2021     | 1                  | 48  | NR                | NR                              | Low-grade fever and swelling on the site of the axillary port | 39 months | Tender swelling on the site of the axillary port | Surgical removal |
| Mehmood UK, 2021      | 1                  | 65  | Symptomatic cholecystitis | Yes | Long standing dry cough, fever and painful swelling over the back in the right paraspin area | 8 years | Large abscess in the right paraspin area and retroperitoneal abscess | I+D |
| Guruvaiah USA, 2021   | 1                  | 61  | Acute cholecystitis | Yes | 1-year history of intermittent RUQ pain, recurrent bronchitis and pneumonia with mucopurulent cough and sputum since his LC | Recurrent pneumonia since his LC | Bronchobiliary fistula Trans-diaphragmatic takedown of the BBF and right hepatic middle lobe wedge resection |
| Djelassi Belgium, 2021| 1                  | 82  | Perforated necrotic cholecystitis | NR | Chronic fistula at the RUQ | 8 years | Abscess between the right internal oblique and transverses abdominis | Fistulectomy and drainage |
| Tchercansky Argentina, 2020 | 1 | 69 | Gallbladder empyema | Yes | Loculated pleural effusion of the Right Hemithorax in posterior cost-diaphragmatic recess | 5 months | Pleural effusion CT guided thoracic drainage initially and then Lung decortication by Video Assisted Thoracoscopy |
| Kaşdadar Turkey, 2020 | 1                  | 42  | NR                | NR                              | Painful swelling in suprapubic region persistent for 3 days | 10 years | Omental granuloma | Partial omentectomy |
| Marçal Portugal, 2020 | 1                  | 79  | Symptomatic cholecystitis | NR | Emergent admission for Right subcutaneous lumbar abscess 10 cm with no retroperitoneal extension and renal involvement | 3 years | Right subcutaneous lumbar abscess | Surgical drainage |
| Bolat Turkey, 2020    | 1                  | 62  | Acute Cholecystitis | NR | Incidental finding in the right inguinal hernial sac | 5 months | Incidental finding in the right inguinal hernial sac | Surgical excision |
| Heywood Australia, 2019 | 1 | 70 | Emergency LC | NR | Incidental finding in the right inguinal hernial sac | 5 years | Incidental finding in the right inguinal hernial sac | Surgical excision |
| Author, country, year  | Number of patients | Age | Indication for LC | Reference to the spilled stones | Presenting symptoms | Time of onset of symptoms after LC | Complications caused by lost stones and location found | Type of reintervention |
|-----------------------|--------------------|-----|-------------------|----------------------------------|---------------------|----------------------------------|---------------------------------------------------|------------------------|
| Cummings USA, 2019    | 1                  | 70  | Emphysematous cholecystitis and liver abscess | Yes                  | vague abdominal discomfort | 2 years                      | Sub hepatic                                      | Surgical exploration + drainage |
| Akhtar Pakistan, 2018 | 1                  | 78  | NR                | NR                               | Recurrent bouts of abdominal pain and fever for the previous 2 weeks in the RUQ | 10 years                  | 19 cm Right subdiaphragmatic and retroperitoneal abscess | CT-guided drainage |
| Tyagi USA, 2018       | 1                  | 70  | Acute Cholecystitis | Yes                             | Septic shock CT scan: two partly calcified soft tissue masses associated with the right iliopsoas and obturator internal muscles | 2 months                  | Iliopsoas abscess and periprosthetic hip infection | Surgical drainage |
| Capolupo Italy, 2018  | 1                  | 73  | Chronic cholecystitis | Yes                             | Peritoneal nodule detected during FU for kidney stones | 16 months                  | Peritoneum, NO complications            | Laparoscopic excision |
| Urade Japan, 2018     | 1                  | 68  | Gangrenous Cholecystitis | Yes                             | CT findings of omental abscess and ascites around the spleen | 7 months                  | Omental abscess                                   | Laparoscopic partial omentectomy |
| Ologun 2018           | 1                  | 52  | Biliary colic      | NR                              | Occasional post-prandial epigastric pain | 4 years                   | Calculated intraabdominal mass within the omentum detected in routine FU for Lap sleeve gastrectomy | Laparoscopic resection of the mass |
| Stroobants Belgium, 2018 | 1                | 72  | Symptomatic cholelithiasis | NR                              | Intermittent complaints for RUQ pain | NR                       | Subhepatic abscess                              | Open drainage |
| Kaplan Israel, 2018   | 1                  | 73  | NR                | NR                              | Six months vague RUQ pain | 10 years                  | Perihepatic abscess                             | Lap drainage |
| Kaplan B 2018         | 1                  | 41  | NR                | NR                              | One-month vague RUQ pain | 3 years                   | Perihepatic abscess                             | Lap drainage |
| Author, country, year | Number of patients | Age | Indication for LC | Reference to the spilled stones | Presenting symptoms | Time of onset of symptoms after LC | Complications caused by lost stones and location found | Type of reintervention |
|-----------------------|--------------------|-----|------------------|---------------------------------|---------------------|-----------------------------------|-----------------------------------------------------|-----------------------|
| Koichopolos Canada, 2017 | 1 | 80 | NR | NR | Gastric outlet obstruction, 30 pounds weight loss, progressively worsening nausea, vomiting and significant gastroesophageal reflux | NR | Intramural obstruction of pylorus | Billroth II Distal gastrectomy |
| Canna UK, 2017 | 1 | 79 | Chronic cholecystitis | NR | Painful and firm mass on the right flank | 5 years | Retroperitoneal abscess | Surgical drainage |
| Lentz USA, 2017 | 1 | 57 | Symptomatic cholelithiasis | NR | Cough and right flank pain | 2 years | Perihepatic, pulmonary and renal abscesses | Thoracic drainage |
| Faour Syria, 2017 | 1 | 44 | Symptomatic cholelithiasis | NR | Mass in the RUQ associated with pain, nausea and early satiety for the last 6 months | 6 years | Intra-abdominal cystic mass | Surgical excision |
| Ragozzino Italy, 2016 | 1 | 63 | Chronic cholecystitis | NR | Intermittent vague discomfort of RUQ | 2 years | Subphrenic abscess | 3 x 3 cm mass excised |
| Kim Korea, 2016 | 1 | 59 | NR | NR | Constant RUQ pain | 5 months | Retroperitoneal mass | 5 x 5 cm retroperitoneal mass was excised |
| Goodman USA, 2016 | 1 | 87 | Acute Cholecystitis | NR | Right flank pain and tenderness | 4 years | Right flank soft tissue tumour | Surgical excision |
| Moga Romania, 2016 | 1 | 66 | Acute Cholecystitis | NR | Fever and large abscess in the right lumbar region | 4 years | Right lumbar region abscess and subhepatic abscess | Lap drainage |
| Bedell USA, 2015 | 1 | 41 | Symptomatic cholelithiasis | NR | Dysmenorrhea progressed to chronic pelvic pain unrelated to menses | 9 years | Pelvic abscess | Lap drainage |
| Binagi USA, 2015 | 1 | 58 | Symptomatic cholelithiasis | NR | Continuous but waxed and waned pain, reaching levels eight out of ten of Likert scale | 3 years | Perihepatic abscess | Lap drainage |
| Author, country, year | Number of patients | Age | Indication for LC | Reference to the spilled stones | Presenting symptoms | Time of onset of symptoms after LC | Complications caused by lost stones and location found | Type of reintervention |
|-----------------------|--------------------|-----|------------------|---------------------------------|-------------------|-------------------------------|----------------------------------------------------|------------------------|
| Grass Switzerland, 2015 | 1                  | 75  | Acute cholecystitis | NR                              | Periumbilical redness and tenderness | 3 years | Abdominal wall abscess in the periumbilical port site | Drainage |
| Noda Japan 2014       | 1                  | 52  | Symptomatic cholecystolithiasis | NR                              | Incidental US finding during medical check up | 7 months | Sub hepatic abscess | Percutaneous abscess drainage |
| Noda Japan 2014       | 1                  | 41  | Symptomatic cholecystolithiasis | NR                              | RUQ pain          | 13 months | A rounded mass in the subhepatic space | Open drainage |
| Ahmad UK, 2014        | 1                  | 37  | Symptomatic cholecystolithiasis, incidental pT1a gallbladder cancer | Yes                | Recurrent pain two year after LC | 2 years | Multiple tumour embedded gallstones on the diaphragm and lesion in segment VI of the liver | Surgical excision of diaphragmatic nodules and liver segmentectomy VI |
| Lee Korea, 2013       | 5                  | 65/55/48/72/80 | 1. recurrent ac ch/tis 2. Gangrenous Ch/tis 3. Recurrent ac ch/tis 4. Gangrenous ch/tis 5. Recurrent ac ch/tis | Yes                | NR               | 7/18/31/4 months 2nd post day | Subhepatic abscess/cul de sac abscess/umbilical fistula/portal fistula/peritonitis | Drainage/drainage/prolonged wound care/antibiotic administration |
| Morris USA, 2013      | 1                  | 71  | NR                | Pulmonary complaints of diffuse abdominal pain, associated with nausea and emesis lasted for 24 h | 15 years | Dense mesenteric cicatrix causing ileocolic torsion and cecal volvulus | Ileocectomy |
| Peravali UK, 2013     | 1                  | 61  | Acute Cholecystitis | Yes                | 12-month history of persistent RUQ pain, 8 KG weight loss, anorexia, night sweats, intermittent pyrexical episodes | 3 years | Sub hepatic abscess | Lap drainage |
| Peravali UK, 2013     | 1                  | 86  | Acute cholecystitis | Yes                | Chronically discharged right back fistula | 5 years | Subphrenic abscess with atmospheric fistula | Lap drainage |
| Dobradin 2013         | 1                  | 82  | Elective cholecystectomy | NR                | RUQ pain lasting for 2 months | 8 years | Right flank abscess | I+ D |
Table 1 (continued)

| Author, country, year | Number of patients | Age | Indication for LC | Reference to the spilled stones | Presenting symptoms | Time of onset of symptoms after LC | Complications caused by Lost stones and location found | Type of reintervention |
|-----------------------|--------------------|-----|-------------------|---------------------------------|---------------------|----------------------------------|------------------------------------------------------|-----------------------|
| Chatzimavroudis Greece, 2012 | 1                  | 72  | Symptomatic cholecystolithias | Yes                           | High fever, chills and constanct pain in the Right lumbar region for 2 days | 6 months | Retropertioneal abscess | CT-guided drainage |
| Gorospe Spain, 2013   | 1                  | 63  | Acute Cholecystitis         | NR                            | Fever, malaise, weight loss | 6w    | Fever of unknown aetiology | NR |
| Anrique Chile, 2013   | 1                  | 60  | NR                          | NR                            | Incidental finding during Lap Gynaecologic procedure | 14 years | Multiple gall stones incrusted in the Douglas’ pouch | Surgical removal |
| Arai Colon Japan, 2013 | 1                  | 65  | Symptomatic cholecystolithias | NR                            | Referred by GP for further investigation of an abnormal liver mass | 4 years | Subphrenic abscess | Wedge resection of the liver and diaphragm |
| Papadopoulos Greece, 2012 | 1                | 86  | Symptomatic cholecystolithias | NR                            | Incidental finding during right hemicolectomy | 8 years | Gallstones embedded in the omentum | Removal during right hemicolectomy |
| Singh USA, 2012       | 1                  | 42  | NR                          | NR                            | Worsening Right-sided tenderness and pain, low grade fever, night chills | 7 years | 50 pounds weight loss over 5 months | Surgical excision of 4 x 6 cm |
| Rammohan India, 2012  | 1                  | 50  | NR                          | NR                            | Minimally painful, slow progressing mass in the RUQ for the last two years | 4 years | 10 x 5 cm organised extrahepatic mass in the sub-diaphragmatic space extending onto the soft tissues of parietal wall | Laparoscopic piece-meal excision |
| Kayashima Japan, 2011 | 1                  | 57  | Acute cholecystitis         | Yes                           | Incidental abdominal US showed 3 liver lesions | 3 years | Inflammatory pseudotumour of the liver | Posterior segmentectomy and concomitant resection of the diaphragm |
| Hussain Saudi Arabia, 2010 | 1                | 33  | Acute cholecystitis         | Yes                           | Intermittent attacks of pain RUQ, nausea, vomiting for 7 months | 9 years | Discharging abdominal wall abscess extending to the retropitoneum | I+D |
| Pottakkat India, 2010 | 1                  | 57  | Symptomatic cholecystolithias | NR                            | Fever, malaise | 11 years | Dumbbell abscess in the perihilar area | Open drainage |
| Bouasker Tunisia, 2010 | 1                  | 57  | Acute cholecystitis         | NR                            | RIF painful swelling | 8 years | Subcutaneous collection | I+D |
| Author, country, year | Number of patients | Age | Indication for LC | Reference to the spilled stones | Presenting symptoms | Time of onset of symptoms after LC | Complications caused by Lost stones and location found | Type of reintervention |
|-----------------------|--------------------|-----|-------------------|---------------------------------|--------------------|----------------------------------|---------------------------------------------------|------------------------|
| Gooneratne New Zealand, 2010 | 1 | 54 | Acute cholecystitis | NR | Recurrent urinary tract infections | 14 years | Colovesical fistula | Surgical repair of the fistula |
| Helme 2009 | 1 | 77 | NR | NR | Night sweats, right back pain and loin swelling for 2 weeks | 5 years | Complex subphrenic, subhepatic and subcutaneous abscesses | US-guided drainage. Patient declined operation to remove the offending gallstones |
| Morishita Japan, 2009 | 1 | 67 | Symptomatic cholelithiasis | NR | Incidental finding during FU for aneurysm | 1 year | Granuloma | Conservative treatment |
| Dasari UK, 2009 | 1 | 67 | Acute cholecystitis | Repeat laparoscopy for sepsicaemia and drainage of fluid collection | Recurrent lower abdominal pain | 2 years | Nodules mimicking peritoneal metastases | Lap excision |
| Maempel UK, 2009 | 1 | 42 | Symptomatic cholelithiasis | NR | Strangulated recurrent paraumbilical hernia | 10 years | Abdominal wall abscess | I+ D |
| Hougdard Denmark, 2008 | 1 | 64 | Acute cholecystitis | Yes | Referred for Management of abdominal fistulas | 7 years | Atmospheric fistula | Surgical excision |
| Arishi Saudi Arabia, 2008 | 1 | 45 | Symptomatic cholelithiasis | NR | Central colicky abdominal pains and swelling lasted for 6 months | 15 years | Cystic mass of the rectus abdominis | Surgical excision |
| De Hingh the Netherlands, 2007 | 1 | 41 | Acute Cholecystitis | Yes | NR | 1 year | Rectovaginal pouch abscess | Surgical excision |
| Stupak USA, 2007 | 1 | 72 | NR | Yes | Fever, nausea, anorexia, and pain in the RUQ lasting for 3 weeks | 11 years | Subhepatic collection | US-guided percutaneous drainage |
| Pantamowitz USA, 2007 | 1 | 53 | Symptomatic cholelithiasis | NR | Pelvic pain | 7 years | Left overs granuloma | Surgical excision |
| Wehbe Australia, 2007 | 1 | 80 | Symptomatic cholelithiasis | NR | Abdominal pain, nausea, diarrhoea | 10 years | Mass in the right lower quadrant | Lap excision |
| Author, country, year | Number of patients | Age | Indication for LC | Reference to the spilled stones | Presenting symptoms | Time of onset of symptoms after LC | Complications caused by lost stones and location found | Type of reintervention |
|-----------------------|--------------------|-----|------------------|--------------------------------|-------------------|----------------------------------|-----------------------------------------------------|------------------------|
| Wittich USA, 2007     | 1                  | 42  | Symptomatic cholecystitis | NR                             | Severe metrorrhagia, dysmenorrhea | 13 months                       | Abscess in the pouch of Douglas                     | 16 gallstones discovered after transvaginal hysterectomy for severe dysmenorrhea and metrorrhagia |
| Bhati UK, 2006 A      | 1                  | 52  | Symptomatic cholecystitis | NR                             | Upper abdominal pain | 1w                               | CT: cystic mass in the left lobe of the liver        | Open drainage          |
| Bhati UK, 2006 B      | 1                  | 60  | Symptomatic cholecystitis | NR                             | Fever and pain in her back | 28 months                       | Subdiaphragmatic abscess                          | Open drainage          |
| Bhati UK, 2006 C      | 1                  | 56  | Symptomatic cholecystitis | NR                             | Fever and pain of the upper abdomen | 7 years                        | Subdiaphragmatic abscess                          | 1+ D                  |
| Ianniti USA, 2006     | 1                  | 70  | Symptomatic cholecystitis | NR                             | Generalised aches and pains | 18 months                       | Subphrenic + pleural abscess                       | Open and US guided drainage, due to recurrence open removal |
| Hand USA, 2006        | 1                  | 50  | Biliary pancreatitis     | NR                             | Pain, fever, large fluctuant mass lateral to umbilicus | 2 years                        | Abdominal wall cystic mass                         | US-guided drainage, later local exploration and excision of the abscess |
| Viera Italy, 2006     | 1                  | 72  | Symptomatic cholecystitis | NR                             | Fever, general malaise and weight loss | 18 months                       | 3 inflammatory lesions in seg II and VII           | Open excision          |
| Viera Italy, 2006     | 1                  | 70  | Acute Cholecystitis      | Yes                            | Patient asymptomatic, incidental US finding | 2 months                        | Asymptomatic                                      | Watch and see approach |
| AlSamkari USA, 2004   | 1                  | 36  | Symptomatic cholecystitis | Yes                            | Diffuse abdominal pain nausea, vomiting and weakness | 11 years                       | Necrotic transverse colon from mid ascending to just distal the splenic flexure | Surgical excision |
| Koç Turkey, 2004      | 1                  | 75  | Symptomatic cholecystitis | NR                             | NR                             | 6 years                          | Retropertoneal abscess                             | Percutaneous drainage  |
| Stevens, 2003         | 1                  | 68  | Gallstone pancreatitis   | NR                             | 30-pound weight loss and acholic stools | 1 year                          | Subhepatic abscess                                 | Open drainage          |
| Author, country, year | Number of patients | Age | Indication for LC | Reference to the spilled stones | Presenting symptoms | Time of onset of symptoms after LC | Complications caused by lost stones and location found | Type of reintervention |
|----------------------|-------------------|-----|-------------------|---------------------------------|---------------------|---------------------------------|--------------------------------------------------------|-------------------------|
| Aspelung, Iceland 2003 | 1                 | NR  | NR                | NR                             | Incidental finding during routine hernioplasty | days 10              | Gallstones in the hernial sac    | Removal during hernia repair |
| Papasavas, Greece, 2002 | 1                 | 77  | Symptomatic cholecystolithiasis | Yes                            | Fever, pain         | 15 months                      | Right flank abscess                      | Surgical removal         |
| Yadav, 2002          | 1                 | NR  | Symptomatic cholecystolithiasis | NR                             | NR                  | 1 year                          | Subphrenic abscess                       | Open drainage            |
| Van Mierlo, 2002     | 1                 | 48  | Symptomatic cholecystolithiasis | Yes                            | Pain in the RUQ, nausea, vomiting | 2 years                   | Subhepatic abscess                     | Open drainage            |
| Hawasli, 2002 A      | 1                 | 75  | Symptomatic cholecystolithiasis | NR                             | Pain, fever          | 4 years                         | Abdominal wall abscess                  | Open drainage            |
| Hawasli, 2002 B      | 1                 | 43  | Symptomatic cholecystolithiasis | NR                             | Pain, fever          | 2 months                        | Subdiaphragmatic and subhepatic abscesses | Open drainage            |
| Famulari, 2002       | 1                 | NR  | Symptomatic cholecystolithiasis | NR                             | Dysuria, pollakiuria, vesical tenesmus | 2 years                   | Urinary bladder granuloma              | Partial cystectomy       |
| Werber, USA, 2001    | 1                 | 64  | Symptomatic cholecystolithiasis | Yes                            | Low-grade fever with chills, night sweats, weight loss, fatigue | 1 month                   | Sub hepatic abscess and 3 cm round mass with speculated borders in the right lower lobe of the lung | Right thoracotomy       |
| Yao, China, 2001     | 1                 | NR  | Symptomatic cholecystolithiasis | NR                             | NR                  | 2 years                         | Periumbilical abscess                   | Surgical excision        |
| Battaglia, Italy, 2001 | 1               | 39  | Symptomatic cholecystolithiasis | NR                             | Fever and pain       | 9 years                         | Abdominal wall abscess                  | Surgical excision        |
| OK E, Turkey, 2000   | 1                 | NR  | Symptomatic cholecystolithiasis | NR                             | Umbilical port site hernia | 3 months                  | Incisional umbilical port site hernia   | Surgical excision        |
| Bebawi, USA, 2000    | 1                 | 56  | Chronic cholecystitis        | Yes                            | Incidental finding   | 2 months                        | Gallstones in the hernial sac           | Removed during hernia repair |
| Total                | 85 cases          | 64(33–87) | Acute cases 26(31%) | 23 authors (27%) | Most prevalent Fever and pain | 36 months (1–180) | TA: 48(56.5%) IAA: 31(36.5%) RPA: 8(9.4%) AWA: 9(10.6%) IF: 10(11.8%) | Open procedure 61 (72%) Lap procedure: 13 (15%) US or CT drainage: 9(11%) 2 watch and see approach |

IAA: intraabdominal abscesses, RPA: retroperitoneal abscesses, AWA: abdominal wall abscesses, TA: total abscesses, IF: incidental findings: incidental findings, Seg: segment, LC: laparoscopic cholecystectomy, NR: nonreported
complications following spillage of gallstones [3]. We can see a controversy with the above evidence that demonstrates that the LC cohort includes younger and healthier patients. Therefore, there is a strong indication for further investigation and identification of the co-factors (e.g., comorbidities, type of gallstones, acute vs chronic cases) that predispose to above complications. In the present study the median age was 64 years and varied widely from 33 to 87 years (Table 1).

An analysis performed at American College of Surgeons-National Surgical Quality Improvement Program hospitals found the rates of severe morbidity of laparoscopic and open cholecystectomy to be 1.4% and 11.1%, respectively [92].

Notably, the Swiss Association of Laparoscopic and Thoracoscopic Surgeons (SALTS) database defined the rates following LC for patients only with diagnosis of acute or chronic cholecystitis for intraoperative complications at 7%, postoperative local complications at 4%, and postoperative systemic complications at 2.3% [93]. The above comparison demonstrates that when the investigation is further focused to acute vs chronic cases the incidence rate of severe morbidity of LC increases dramatically from 1.4 to 7% [92, 93]. Although, it is reported that the acute cholecystitis is predisposing factor for complications of spilled gallstones [3]; in the present study only 31% were the acute cases. Therefore, future studies need to shed further light on the above topic. Moreover, in the present study, only 23(27%) of the surgeons reported the incidence of gallbladder perforation and spillage of gallstones in the operative notes. Furthermore, Mullerat et al. reported that only one fifth of the surgeons included in the consent form spillage of the gallstones as a potential complication. In addition, if this occurred during the operation they do not report it to GPs and patient because they consider it an innocent complication; although this information is going to help colleagues to resolve future diagnostic dilemmas [9].

Although, it is reported that the number of spilled gallstones more than 15, size > 1.5 cm and pigment type gallstones are predicting factors of complications of spilled gallstones [3]; in the present study, type of lost gallstones, number, and size of discovered gallstones during the re-intervention reported at 17(20%), 17(20%), and 12(14.11%), respectively. In particular, pigmented and cholesterol gallstones consisted 41% and 47%, respectively. Therefore, future studies should be more meticulous regarding describing type, size, and number of discovered gallstones because the accumulated information will further help describing in details the predicting risk factors and furthermore, this will help in the standardisation of the management of spilled gallstones.

The median time to onset of symptoms was 36 months and ranged from 1 to 180 months. It is obvious that was ranged widely. Considering the above finding and the widely ranged follow-up, the results of the incidence rates of complications should be treated cautiously because time, follow-up, and institutions bias might have influenced the results.

Notably, vast majority of the cases of undiscovered gallstones required open intervention. In particular, 61(72%) patients underwent open surgery and 13(15%) patient laparoscopic procedure, 9(11%) treated either with US and/or CT scan guided drainage. Two cases that detected early postoperatively and were asymptomatic scheduled for regular follow-ups. These finding underlines that although the incidence rate of the complications is low when they become symptomatic the treatment of choice is surgical intervention Therefore, there is urgent need for standardisation and clinical guidelines for the management of spilled gallstones.

Limitations
The results of the present study should be treated cautiously because all the included studies were case reports. Therefore, institutional, national, underpowered sample size, learning curve, performance and follow-up bias might have influenced the results. Another topic that needs special attention is the incidence rate. Usually, the cases with most complicated presentation and with worst outcomes published as case reports. On the contrary cases with mild symptoms and better outcomes, usually are not publishable. Therefore, an international registry and audit may help to define precisely the incidence rate, and severity of complications of spilled gallstones.

Conclusions
The current evidence demonstrates that although the incidence rate of complications varies widely the majority of the patients demonstrated severe morbidity and required surgical interventions. Therefore, urgent standardisation of the management of spilled gallstones is needed. Surgeons must document all cases of spilled stones in the operative notes. Moreover, GPs and patients should be informed about the incidence, this will help to resolve diagnostic dilemmas in the future. Hospitals should review their policy by conducting audits and surgical societies should use the above information and national databases in order urgently to formulate clinical guidelines.

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