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PROCEEDINGS OF THE LATVIAN ACADEMY OF SCIENCES. Section B,
Vol. 76 (2022), No. 5/6 (740/741), pp. 641–649.

DOI: 10.2478/prolas-2022-0099

Original Paper

IMPACT OF IATROGENIC POST-CHOLECYSTECTOMY BILIARY DUCT INJURY ON QUANTITY OF DIAGNOSTIC IMAGING AND HOSPITAL RE-ADMISSION

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Communicated by Aivars Lejnieks

Although the risk of persistent biliary duct injury is low, cholecystectomy is one of the most commonly performed procedures worldwide. The occurrence of bile duct injury (BDI) results in complicated reconstructions, prolonged hospitalisation, repeated diagnostic examinations, and a high risk of long-term complications, leading to cost increase. A wide range of diagnostic methods are used to identify the damage and the associated complications. The aim of the study was to evaluate the impact of iatrogenic post-cholecystectomy BDI on the amount of diagnostic imaging and hospital re-admission rate. The retrospective cross-sectional study included the analysis of records of 38 patients undergoing laparoscopic cholecystectomy, referred to the Diagnostic Radiology Institute, Pauls Stradiņš Clinical University Hospital, who underwent diagnostic imaging. Among those who had iatrogenic BDI due to cholecystectomy, 57.9% (22 patients) underwent abdominal ultrasonography, 47.4% (18 patients) underwent endoscopic retrograde cholangiopancreatography, 47.4% (18 patients) underwent percutaneous transhepatic cholangiography (PTCA), 44.7% (17 patients) underwent computed tomography, 42.1% (16 patients) underwent magnetic resonance imaging, 13.2% (five patients) underwent US-guided puncture after cholecystectomy, and 15.8% (six patients) underwent fistulography. 18.4% (seven patients) were re-admitted to hospital once due to post-cholecystectomy complications, 34.2% (13 patients) twice, 15.8% (six patients) three times, 5.3% (two patients) four times, 13.2% (five patients) five times, 2.6% (one patient) seven times, 2.6% (one patient) ten times, 5.3% (two patients) eleven times and 2.6% (one patient) was re-admitted twenty-five times. Statistically significant strong correlation between hospital re-admission rate and PTCA ($r_s = 0.682$, $p < 0.001$) was found. Iatrogenic post-cholecystectomy BDI significantly affects repeated diagnostic imaging and the hospital re-admission rate and, therefore, negatively affects hospital economics and patient welfare.

Keywords: *magnetic resonance imaging, computed tomography, endoscopic retrograde cholangiopancreatography, percutaneous transhepatic cholangiography.*

INTRODUCTION

Bile duct injury (BDI) is a complication following gallbladder surgery. Although recent studies reported that major BDI incidence varies between 0.08 and 0.3% (Halbert *et al.*, 2016; Rystedt *et al.*, 2016; Mangieri *et al.*, 2019;) and moderate BDI reported incidence between 0.3 to 1.5% (Törnqvist *et al.*, 2012; Klaske *et al.*, 2015), cholecystec-

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tomy is one of the most performed procedures worldwide, which is why the total number of BDI patients is still considerable (Schreuder *et al.*, 2020).

This study mainly aimed to evaluate the impact of iatrogenic post-cholecystectomy BDI on the amount of a wide array of diagnostic imaging and hospital re-admission rate. The occurrence of BDI results in complicated reconstructions, prolonged hospitalisation, and a high risk of long-term complications was studied by Machado (2011). The severity of BDI ranges from relatively simple leakage of the cystic duct or liver surface to complete transection or even resection of one or more bile ducts, sometimes accompanied by vascular injuries, mainly with involvement of the right hepatic artery and right portal vein (Schreuder *et al.,* 2020). Several classification systems exist for BDI, with the Strasberg classification being generally accepted. The Strasberg classification is a modified version of the Bismuth classification, but allows differentiation between small (bile leakage from the cystic duct or aberrant right sectoral branch) and serious injuries performed during laparoscopic cholecystectomy as type A to D (Chun, 2014). Type E of the Strasberg classification is an analogue of the Bismuth classification. The Strasberg classification, summarised in Fig. 1, is straightforward and can be easily applied to bile duct injuries. The major disadvantage of the Strasberg classification is a missing description of concomitant vascular involvement (Chun, 2014). Treatment is often highly individualised, as the type of injury, the timing of injury detection, comorbidity, the clinical condition of the patient, and diagnosis confine treatment (Schreuder *et al.,* 2020). A multidisciplinary approach including abdominal surgeons, gastroenterologists, and radiologists (including interventional specialists) is essential to achieve optimal outcome.

A wide range of diagnostic methods are used to identify the injury and the associated complications (Machado, 2011). The initial investigation method is abdominal ultrasound imaging, which may demonstrate fluid collection within the right subhepatic space. It also can reveal a proximal dilated biliary system in patients with a complete division of the common bile duct (Machado, 2011). Further investigation is necessary to evaluate the cause of this collection or suspected biliary obstruction. Endoscopic retrograde cholangiography (ERCP) and magnetic resonance cholangiography (MRCP) examinations are likely to demonstrate the presence of a biliary leak and often provide the level of duct laceration or transection (Lohan *et al*., 2005). If sphincterectomy and endobiliary stenting are considered, ERCP can provide these therapeutic options. Percutaneous transhepatic cholangiography, transhepatic biliary drainage, percutaneous drainage of the intra-abdominal collection are other therapeutic interventions that are commonly used (Machado, 2011). The surgical reconstruction of iatrogenic BDI can be done using several methods — the surgery involves a bilioenteric anastomosis (usually a proximal hepaticojejunostomy with a Roux-en-Y jejunal), end-to-end biliary anastomosis, and hepatico-duodenostomy. Reconstruction of the proper flow of bile to the alimentary tract is the main aim of surgical treatment (Shaker *et al*., 2020).

Fluid up to 60 ml in the removed gallbladder bed should be considered normal in certain patients in the first week following surgery, as the fluid will gradually absorb (Smereczyński *et al*., 2014). Some single cases show that slight amounts of fluid detected in the peritoneal cavity should not be alarming, as the carbon dioxide absorbs within two days. Haemostatic material obstructs ultrasound assessment of the surgical bed after cholecystectomy. In this case, its presentation may mimic an abscess (Smereczyński *et al*., 2014). At first, magnetic resonance is the most precise examination, and, secondly, computed tomography.

Quickly accumulating fluid around the liver is an alarming symptom, mainly when there is inadequate blood supply or when peritoneum irritation symptoms develop (Smereczyński *et al*., 2014). Ultrasound guided aspiration and drainage can be helpful to characterise the fluid collection. Moreover, transabdominal ultrasound examination after laparoscopic cholecystectomy may help to identify existing

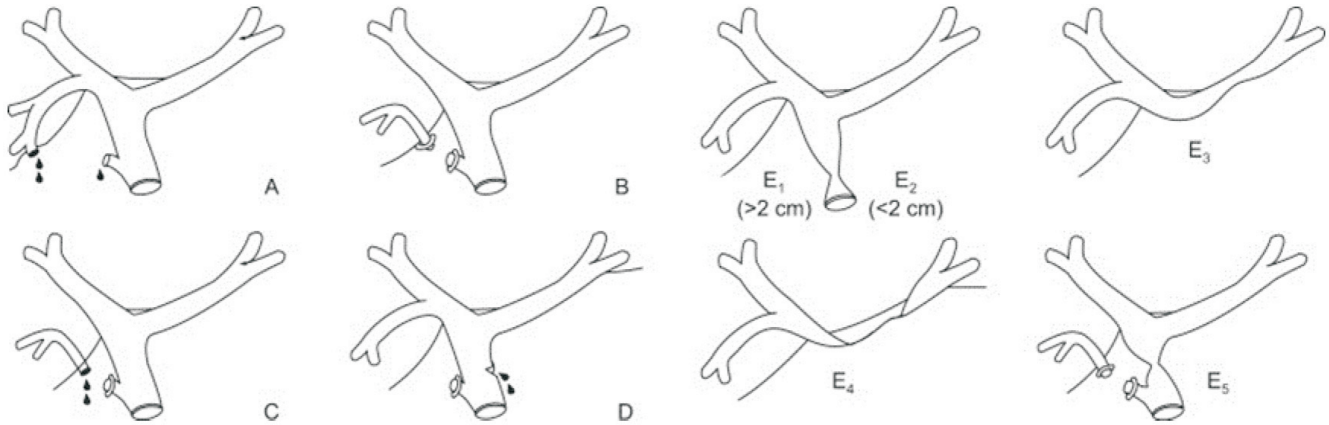


Fig. 1. Strasberg classification. (A) Bile leak from cystic duct stump or minor biliary radical in gallbladder fossa. (B) Occluded right posterior sectoral duct. (C) Bile leak from divided right posterior sectoral duct. (D) Bile leak from main bile duct without major tissue loss. (E_1) Transected main bile duct with a stricture more than 2 cm from the hilus. (E_2) Transected main bile duct with a stricture less than 2 cm from the hilus. (E_3) Stricture of the hilus with right and left ducts in communication. (E_4) Stricture of the hilus with separation of right and left ducts. (E_5) Stricture of the main bile duct and the right posterior sectoral duct (after Chun, 2014).

cholestasis, undiagnosed choledocholithiasis, pseudoaneurysm of the hepatic artery, portal vein thrombosis, haematoma, dropped stones in the right hypochondriac region, a residual fragment of the gallbladder with possible concretions, as well as hernias of the abdominal walls. Ultrasound examination helps identify optimal sites in the abdominal integuments, enabling collision-free access to the peritoneal cavity (Smereczyński *et al.,* 2014). Computed tomography (CT) and ultrasonography (US) can depict fluid collections and biliary duct dilatation. It has been shown that sensitivity is higher for CT (96%) than for US (70%) for detecting fluid collections (Stewart and Way, 2000). MRCP is a non-invasive modality and provides excellent anatomical information of the biliary anatomy proximal and distal to the level of injury. Several studies confirmed that the additional use of contrast-enhanced MRCP at the hepatobiliary phase after hepato-specific contrast agent injection using 3D and 2D T1-weighted images acquired improves the accuracy of bile anatomy depiction and bile leak detection (DeAngelis *et al.,* 2021). A study of 99 patients that included 24 patients after cholecystectomy, 20 after surgical reconstruction of traumatic BDI, and 16 after hydatid cystectomy, concluded that the use of contrast-enhanced MRCP increased the sensitivity, specificity, and accuracy with ranges of 76–82%, 100%, and 75–91% compared to 53–63%, 51–66%, and 55–63% observed with conventional MRCP (Park *et al.,* 2004; An *et al*., 2006; Lee *et al.,* 2009; Cieszanowski *et al*., 2013; ; Kantarc *et al.,* 2013; Wong *et al.,* 2018; Ribeiro *et al.,* 2019). The optimal timing for hepatobiliary phase acquisitions with contrast-enhanced MRCP appears to range between 60 and 90 min when looking for bile leaks (Cieszanowski *et al*., 2013; Wong *et al*., 2018)

The main aim of this study was to evaluate the impact of iatrogenic post-cholecystectomy BDI on the amount of a wide array of diagnostic imaging and hospital re-admission rate.

MATERIALS AND METHODS

This retrospective cross-sectional study included 38 patients undergoing laparoscopic cholecystectomy from January 2004 to December 2020, who were referred to the Diagnostic Radiology Institute, Pauls Stradiņš Clinical University Hospital. The only criterion for inclusion was iatrogenic BDI, regardless of location or time of diagnosis. The patients underwent abdominal US, CT, magnetic resonance imaging (MRI), endoscopic retrograde cholangiopancreatography (ERCP), percutaneous transhepatic cholangiography (PTCA), ultrasound-guided puncture and/or fistulography due to complications after iatrogenic BDI. Bile duct injury was classified according to the Strasberg classification (Fig. 1). Time of hospital re-admission and diagnostic imaging use were analysed and summarised using hospital information systems. We also studied the correlation between re-hospitalisation due to iatrogenic BDI during cholecystectomy and the number of times a particular diagnostic imaging technique was used. Data are presented in numbers and percentages. Means (SD) or median values with range or interquartile range are presented when appropriate. Pearson's correlation of re-hospitalisation frequency and frequency of performed diagnostic imaging was performed. Data analyses were conducted using IBM SPSS statistics, version 28.0.

The study was approved by the Institute of Cardiology and Regenerative Medicine of the University of Latvia, Scientific Research Ethics Committee (No. 92/2021).

RESULTS

A total of 38 patients with complications after cholecystectomy due to iatrogenic BDI, diagnosed by clinical and imaging examination, were operated by laparoscopy, 14 of them male (36.8%) and 24 female (63.2%) (Table 1).

The age of patients with iatrogenic BDI ranged from 26 to 83 years (mean 56.4) (Table 1). Among those who had iatrogenic BDI due to cholecystectomy, underwent one or more of the following diagnostic imaging techniques: 57.9% (22 patients) had abdominal ultrasonography, 44.7% (17 patients) underwent computed tomography, 42.1% (16 patients) — magnetic resonance imaging, 47.4% (18 patients) — endoscopic retrograde cholangiopancreatography, 47.4% (18 patients) — percutaneous transhepatic cholangiography, 13.2% (five patients) — ultrasound-guided puncture after cholecystectomy, and 15.8% (six patients) — fistulography (Table 2). All patients underwent these imaging techniques and procedures due to complications after iatrogenic BDI.

Among all patients who were included in study, 31.6% (12 patients) underwent abdominal ultrasonography once, 10.5% (four patients) had US twice, 7.9% (three patients)

Table 1. Patient characteristics

Characteristics	Years
Median age (min-max)	59 (26–83)
IQR	41–68.25
Sex	number (per cent)
Females	24 (63.5%)
Males	14 (36.8%)

IQR, interquartile range

Table 2. Frequency of diagnostic imaging methods after cholecystectomy

Imaging methods	Frequency (%)	
	Yes	No
CT	17 (44.7)	21 (55.3)
MRI	16 (42.1)	22 (57.9)
ERCP	18 (47.4)	20 (52.6)
PTCA	18 (47.4)	20 (52.6)
Ultrasound-guided puncture	5 (13.2)	33 (86.8)
fistulography	6 (15.8)	32 (84.2)

CT, computed tomography; MRI, magnetic resonance imaging; ERCP, endoscopic retrograde cholangiography; PTCA, percutaneous transhepatic cholangiography

underwent US three times, 5.3% (two patients) underwent US four times, 2.6% (one patient) underwent US 15 times; 23.7% (nine patients) underwent abdominal computed tomography once, 15.8% underwent CT twice, 5.3% underwent CT three times; 34.2% (13 patients) underwent magnetic resonance imaging once, 7.9% (three patients) underwent MRI four times; 7.9% (three patients) underwent percutaneous transhepatic cholangiography once, 10.5% (four patients) underwent PTCA twice, 10.5% (four patients) underwent PTCA three times, 5.3% (two patients) underwent PTCA five times, 5.3% (two patients) underwent PTCA six times, 2.6% (one patient) underwent PTCA seven times; 5.3% (two patients) underwent PTCA eight times, and 2.6% (one patient) underwent PTCA nine times; 10.5% (four patients) underwent fistulography once, 5.3% (two patients) underwent fistulography twice; 5.3% (two patients) underwent ultrasound- guided puncture once, 2.6% (one patient) twice and 5.3% (two patients) underwent ultrasound-guided puncture three times; 36.8% (14 patients) underwent endoscopic retrograde cholangiopancreatography, and 10.5% (four patients) underwent ERCP twice (Table 3).

The classification by Strasberg is popular and is the most widely accepted. The most commonly detected Strasberg classification type of BDI was E1 – 26.30% (ten patients), followed by type A – 21.10% (eight patients), E4 – 18.40% (seven patients), D – 15.80% (six patients), E3 – 10.50% (four patients), and E2 – 7.90% (three patients) (Table 4).

18.4% (seven patients) of the patients were re-admitted to hospital once due to post-cholecystectomy complications, 34.2% (13 patients) twice, 15.8% (six patients) three times, 5.3% (two patients) four times, 13.2% (five patients) five times, 2.6% (one patient) seven times, 2.6% (one patient) ten times, 5.3% (two patients) eleven times, 2.6% (one patient) twenty-five times.

Eight patients in this study were diagnosed with anastomotic stenosis.

One patient, who was included in this study, had Mirizzi syndrome with a Strasberg classification type E4 BDI. The injury was found during surgery and hepaticojejunal anastomosis was made. Percutaneous transhepatic cholangiography was done for this patient immediately after cholecystectomy, and bile duct obstruction at the site of anastomosis was found. This patient had a fatal outcome the same day due to pulmonary embolism.

Another patient was diagnosed with chronic stenosing cholangitis, chronic fistula, secondary biliary cirrhosis, portal hypertension, esophageal varices and liver left lobe atrophy due to type E1 BDI, biliodigestive anastomosis dilatation due to stricture. For this patient, dilatation was repeated several times. Imaging techniques that were performed during a period of six years for this patient were: US fifteen times, CT twice, MRCP four times, and PTCA six times. The patient was re-admitted to hospital twenty-five times due to complications after BDI. The following imaging techniques were performed for Patient Nr.1: US four times, MRCP once, PTCA once, and fistulography once. The patient was re-admitted to hospital five times after cholecystectomy. Patient No. 2 received: CT once, US three times, MRCP once, and PTCA once. The patient was re-hospitalised once after cholecystectomy. Patient No. 3 received: MRCP four times, and PTCA nine times. The patient was re-admitted to hospital eleven times. Patient No. 4 received: MRCP four times, and PTCA seven times. The patient was re-admitted to hospital ten times. Patient No. 5

Table 3. Frequency of each imaging method per patient

Times	Patient (%)
US examination count per patient	
0	16 (42.1)
1	12 (31.6)
2	4 (10.5)
3	3 (7.9)
4	2 (5.3)
15	1 (2.6)
CT examination count per patient	
0	21 (55.3)
1	9 (23.7)
2	6 (15.8)
3	2 (5.3)
MRI examination count per patient	
0	22 (57.9)
1	13 (34.2)
4	3 (7.9)
PTCA examination count per patient	
0	19 (50)
1	3 (7.9)
2	4 (10.5)
3	4 (10.5)
5	2 (5.3)
6	2 (5.3)
7	1 (2.6)
8	2 (5.3)
9	1 (2.6)
Fistulography examination count per patient	
0	32 (84.2)
1	4 (10.5)
2	2 (5.3)
US-guided puncture examination count per patient	
0	33 (86.8)
1	2 (5.3)
2	1 (2.6)
3	2 (5.3)

For abbreviations see Table 2

Table 4. Detected Strasberg classification types of bile duct injury

Strasberg classification grade	Frequency (%)
A	8 (21.10)
D	6 (15.80)
E1	10 (26.30)
E2	3 (7.90)
E3	4 (10.50)
E4	7 (18.40)

received: US twice, MRCP once, ERCP once, and PTCA five times. The patient was re-admitted to hospital six times.

Bile duct damage was diagnosed on day 5, day 10 (two patients), day 26, and day 30 after surgery. Two of them had Strasberg classification type E4 BDI, one had type E2 BDI, and two had type E1 BDI.

Two patients in our study had secondary biliary cirrhosis due to BDI.

We evaluated correlation between re-hospitalisation due to iatrogenic BDI during cholecystectomy and number of times that each diagnostic imaging technique was employed. The only statistically significant correlation frequency of a diagnostic imaging technique with re-hospitalisation was for PTCA (Table 5). We found a statistically significant strong correlation between re-hospitalisation and PTCA frequency ($r_s = 0.682$, $p < 0.001$) (Fig. 2).

DISCUSSION

During laparoscopic cholecystectomy, the leading causes of biliary duct injury (BDI) are inadvertently placed clips or ligatures, and thermal injury owing to electrocautery (Sureka and Mukund, 2017). BDI can lead to either bile leak or obstruction because of stricture formation due to periductal fibrosis. Radiologists should be aware of the best possible imaging modality or their combinations — ultrasound (US), computed tomography (CT), endoscopic retrograde cholangiopancreatography (ERCP), magnetic resonance cholangiography (MRCP), and percutaneous transhepatic cholangiography (PTCA) — to determine the type and correct location of postoperative complications (Sureka and Mukund, 2017).

Table 5. Correlation between re-hospitalisation and each imaging method

Imaging methods	Correlation with re-hospitalisation, r_s (p value)
US	0.004 (0.979)
CT	–0.128 (0.444)
MRI	0.267 (0.106)
ERCP	0.104 (0.535)
PTCA	0.682 (.001)
Fistulography	0.179 (0.283)
US-guided puncture	–0.084 (0.615)

For abbreviations see Table 2

A total of 38 patients with complications after cholecystectomy due to iatrogenic BDI, diagnosed by clinical and imaging examination, were operated by a laparoscopic approach. Similar incidence of iatrogenic BDI was reported in a retrospective study that included 40 patients with iatrogenic BDI. Of the patients, 13 (32.5%) were males and 27 (67.5%) were females (Shaker *et al.,* 2020), so there might also be sex-specific risk factors for developing symptoms after cholecystectomy.

BDI can lead to long-term severe clinical complications and conditions, including bile leak, fistula, sepsis, biliary peritonitis, jaundice, cholangitis, and eventually biliary cirrhosis. Diagnostic imaging helps establish the diagnosis, delineate the extent of injury, and plan appropriate intervention. The various imaging modalities are complementary, and no single imaging modality is specific for a particular complication. In general, patients with evidence of pain, fever, jaundice, or biliary fistula should have an imaging study to look for fluid collection (e.g., abscess, biloma) in the upper abdomen, either by ultrasound or an abdominal CT scan (Sureka and Mukund, 2017) CT is a more sensitive method than US, especially for detecting small fluid collections and associated vascular complications (Lee *et al.,* 2000; Laurent *et al.,* 2009; Mule *et al.,* 2015). In addition to US and CT, the first method of choice in imaging biliary tree and gallbladder pathology is the MRI/MRCP. The most precise imaging method for complete morphological evaluation of the biliary tree is MRCP, as it is non-invasive, without ionising radiation, and also provides excellent anatomical information on the biliary tree (Jablonska and Lampe 2009;

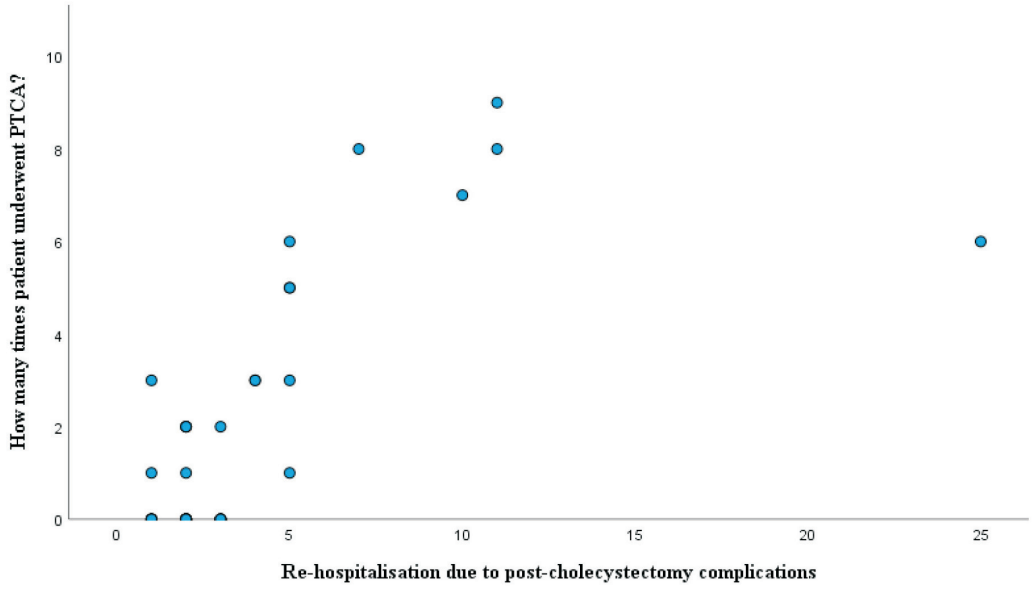


Fig. 2. Correlation between re-admission to hospital and times of percutaneous transhepatic cholangiography.

Linhares *et al.,* 2011; Mungai *et al.,* 2013). Dynamic contrast-enhanced magnetic resonance using a hepato-specific contrast agent allows assessing the functional assessment of the biliary tree. Contrast-enhanced magnetic resonance shows an accuracy close to 100% of detection and localisation of bile leaks (Aduna *et al.,* 2005). PTCA and ERCP should be performed as therapeutic procedures and should not be used for primary diagnosis (Sureka and Mukund, 2017). If the injury to the duct is less than 5 mm, success using ERCP may be more likely if the injury is extrahepatic and when there is no associated abscess or biloma (McGahan and Stein, 1995). In the case of ERCP failure, PTCA is a valuable option to accurately depict the location and nature of BDI accurately and perform an extraluminal percutaneous endoscopic procedure with stent placement to restore continuity of the bile duct (Fidelman *et al.,* 2011). However, PTCA can be technically challenging because intrahepatic bile ducts are usually not dilated (Tripathi *et al.,* 2004). Also, one should be aware that ERCP and PTCA are invasive techniques associated with risk of complications. Most severe complications include severe acute pancreatitis, mainly after ERCP, bleeding, and cholangitis, and after PTCA (Freeman *et al*., 2001; Matsubayashi *et al*., 2009). The initial investigation of choice — abdominal ultrasonography — may demonstrate fluid collection within the right subhepatic space, in addition to revealing dilation of the biliary ducts and possibly associated vascular lesions by using Doppler evaluation (Jablonska and Lampe, 2009; Linhares *et al.,* 2011; Wigham and Grant, 2013; Sureka and Mukund, 2017).

Further investigation is needed to evaluate the cause of suspicious collection or suspected obstruction. ERCP and MRCP are likely to demonstrate the presence of a biliary leak and often provide the level of duct laceration or transaction (Chathadi *et al.,* 2015). ERCP, in addition, provides a therapeutic option in this scenario when sphincterotomy and endobiliary stenting may be considered. ERCP helps identify the site of a bile leak and allows internal biliary drainage if the diagnosis of minor BDI is confirmed. That is why now the key tool in BDIs is ERCP. Incidental diagnoses, for example, choledocholithiasis or bile duct stricture, may also be treated in a single procedure (Chathadi *et al.,* 2015), so ERCP nowadays is widely recommended as first-line therapy for postoperative biliary leaks (Chathadi *et al.,* 2015). Studies have reported a different success rate of ERCP, with a range between 87.1% and 100%, depending on the grade and the location of the leak (Bourke *et al.,* 2004; Sandha *et al*., 2004; Agarwal *et al.,* 2005; de Reuver *et al.,* 2007; Canena *et al.,* 2015; Dumonceau *et al*., 2018). Percutaneous transhepatic cholangiography, percutaneous drainage, and transhepatic biliary drainage are commonly used as therapeutic interventions for intra-abdominal collections (Smereczyński *et al*., 2014).

Twelve patients underwent hepaticojejunostomy, two of whom underwent surgery repeatedly due to anastomotic insufficiency. Three of these twelve patients underwent ERCP prior to HJA, but did not produce the desired results. After HJA, eight of these patients underwent PTHA because of anastomotic stenosis. Anastomotic stenosis is the most common late complication, developing a few months to years after cholecystectomy. Typical strictures are in the common bile duct near the insertion of the cystic duct or at the hepatic confluence due to inadvertent ligation, chronic irritation from surgical clips, or thermal injury (Smereczyński *et al.,* 2014). The median time to stricture formation varies between 11 and 30 months. This means that patients who underwent hepaticojejunostomy for BDI require a long follow-up period (Schreuder *et al.,* 2020). Strictures may eventually lead to secondary biliary cirrhosis, portal hypertension, end-stage liver disease, and death. The reported incidences of biliary cirrhosis are relatively low, varying between 2.4 and 10.9%. However, this is a disastrous complication. If secondary biliary cirrhosis occurs, liver transplantation is the last option for patients (Schreuder *et al.,* 2020). Secondary biliary cirrhosis resulting in associated hepatic failure or digestive tract bleeding due to portal hypertension is a substantial risk factor for morbidity and mortality after bile duct repair. Respectively, morbidity ranges from 9.3% to 43% for series published after 2000 (Barbiera *et al*., 2014), and early mortality ranges between 0% and 1.7% (Alves *et al.,* 2003; Sicklick *et al.,* 2005). One study reported that of seven patients who required emergency liver transplantation for acute liver failure, two patients died while on the waiting list, and only one patient survived past 30 days; of a further 13 patients who underwent elective liver transplantation for secondary biliary cirrhosis, the five-year survival rate was 68% (Parrilla *et al.,* 2014). MRCP allows accurate diagnosis, whereas ERCP provides diagnostic and therapeutic options (Smereczyński *et al*., 2014).

If there is an acute local inflammatory response, primary surgical repair of the bile ducts should be avoided because of the high rate of breakdown or stricture formation. In all cases, the surgery involves a bilioenteric anastomosis, usually a proximal hepaticojejunostomy with a Roux-en-Y jejunal to prevent ascending cholangitis; these operations can be difficult and time-consuming (Crespi *et al*., 2016). Injuries over the biliary bifurcation cause a high risk of early and late complications.

Multiple mechanisms can cause post-cholecystectomy Mirizzi syndrome — stones in the remnant cystic duct or long remnant cystic duct parallel to the common hepatic duct can compress the common hepatic duct (Sureka and Mukund, 2017).

We also studied the correlation between re-hospitalisation due to iatrogenic BDI during cholecystectomy and the frequency of each diagnostic imaging technique. A statistically significant strong correlation was found between re-admission to hospital and PTCA frequency. The choice of this procedure is likely to indicate a severe patient condition and extensive changes in the biliary tract, and prolonged complications with strictures. Hence, patients return repeatedly and require re-hospitalisation. PTCA with balloon dilatation and internal drainage is generally applied for a non-surgical approach. PTCA in this situation usually requires 1–4 repeat dilatations and a period of biliary drainage of approximately three months (Janssen *et al.,* 2014). Overall success rates of 66–76% and low procedural morbidity of 11–13% have been reported (Lillemoe *et al.,* 2000; Lee *et al.,* 2012;

Janssen *et al.,* 2014), making PTCA with balloon dilatation a reasonable first step in treatment before moving on to surgical revision (Schreuder *et al*., 2020).

The first study on quality-of-life following BDI was done in 2001 (Boerma *et al.* 2001). Several reports have examined the long-term effect of BDI on health-related quality-of-life (Schreuder *et al.,* 2020). Although some authors claim that in the long term, BDI does not affect the quality of life (Sarmiento *et al.,* 2004; Hogan *et al.,* 2009), most studies show an impaired quality-of-life even many years after treatment of the injury (Boerma *et al.,* 2001; Melton *et al*., 2001; Moore *et al.,* 2004; de Reuver *et al.,* 2007; 2008; Schreuder *et al.,* 2020). Interestingly, there was also no evidence found that the type of injury, type of treatment (surgical/endoscopic/radiological), and duration of treatment were correlated to quality-of-life (de Reuver *et al.,* 2008; Schreuder *et al*., 2022).

The severity of complications after BDI requires that it be part of preoperative informed consent (Schreuder *et al.,* 2020). However, a survey (McManus *et al.,* 2003) of almost half of the surgeons in the United Kingdom found that BDI rarely discussed or never preoperatively. It was reported (de Reuver *et al.,* 2008) that the possibility of BDI was noted only in 9.7% of patient files as part of informed consent (Schreuder *et al.,* 2020). In another study (Perera *et al.,* 2010), among patients with BDI, 70% of patients felt that they had been inadequately informed prior to the cholecystectomy. Direct and honest information/communication is of utmost importance once the damage has been detected (Schreuder *et al*., 2020).

CONCLUSIONS

This retrospective study shows that the iatrogenic postcholecystectomy BDI has a significant impact on repeated diagnostic imaging and the hospital re-admission rate and, therefore, negatively affects hospital economics and patient welfare. Even when clinical outcomes and surgical treatment of BDI are primarily successful, quality of life still can be impaired. Diagnostic imaging guidelines in the case of BDI could be beneficial, and further studies are necessary at this point. It is essential to communicate clearly with the patient both preoperatively during the informed consent procedure for cholecystectomy and postoperatively after detection of the BDI.

CONFLICT OF INTEREST

Authors do not report any financial or personal links with other persons or organisations, which might affect negatively the content of this publication and/or claim authorship rights to this publication.

ETHICAL COMPLIANCE

This article does not contain any studies involving human participants or animals performed by any of the authors.

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Received 24 February 2022
Accepted in the final form 20 March 2022

PĒC HOLECISTEKTOMIJAS JATROGĒNI IZRAISĪTU ŽULTSCEĻU BOJĀJUMU IETEKME UZ ATKĀRTOTU DIAGNOSTISKO IZMEKLĒJUMU UN HOSPITALIZĀCIJAS BIEŽUMU

Lai gan hronisku žultsvadu bojājumu risks ir zems, holecistektomija ir viena no visbiežāk veiktajām procedūrām pasaulē. Žultsvadu bojājumi noved pie sarežģītām rekonstrukcijas operācijām, ilgstošas hospitalizācijas, atkārtotām diagnostiskām pārbaudēm un augsta ilgstošu komplikāciju riska, kas ir izmaksu pieauguma iemesls. Lai identificētu bojājumus un ar to saistītās komplikācijas, tiek izmantots plašs diagnostikas metožu klāsts. Pētījuma mērķis bija novērtēt, kā jatrogēns žultsvadu bojājums (BDI, no angļu *biliary duct injury*) pēc holecistektomijas ietekmē diagnostisko izmeklējumu apjomu un atkārtotas hospitalizācijas biežumu. Šis bija retrospektīvs šķērsgriezuma pētījums ar ierakstu analīzi par 38 pacientiem, kuriem veikta laparoskopiskā holecistektomija un kuri tika nosūtīti uz Paula Stradiņa Klīniskās universitātes slimnīcas Diagnostiskās radioloģijas institūtu diagnostiskai izmeklēšanai. No pacientiem, kuriem holecistektomijas rezultātā radies jatrogēns žultsvada bojājums, 57,9% (22 pacientiem) tika veikts transabdominmāls USG izmeklējums, 47,4% (18 pacientiem) tika veikta ERHP, 47,4% (18 pacientiem) tika veikta PTHA, 44,7% (17 pacientiem) tika veikta datortomogrāfija (DT), 42,1% (16 pacientiem) tika veikta MRI, 13,2% (5 pacientiem) tika veikta punkcija USG kontrolē pēc holecistektomijas un 15,8% (6 pacientiem) tika veikta fistulogrāfija. 18,4% (7 pacienti) holecistektomijas komplikāciju dēļ atkārtoti ievietoti slimnīcā vienu reizi, 34,2% (13 pacienti) divas reizes, 15,8% (6 pacienti) trīs reizes, 5,3% (2 pacienti) četras reizes, 13,2% (5 pacienti) piecas reizes, 2,6% (1 pacients) septiņas reizes, 2,6% (1 pacients) desmit reizes, 5,3% (2 pacienti) vienpadsmit reizes un 2,6% (1 pacients) tika atkārtoti hospitalizēti divdesmit piecas reizes. Tika konstatēta statistiski nozīmīga spēcīga korelācija starp atkārtotas hospitalizācijas biežumu un PTHA ($rs = 0{,}682$, $p < 0{,}001$). Jatrogēns BDI pēc holecistektomijas būtiski ietekmē atkārtotu attēldiagnostisko izmeklējumu un atkārtotas hospitalizācijas biežumu un tādējādi negatīvi ietekmē slimnīcas ekonomiku un pacientu labklājību.