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**Management of major bile duct injuries following laparoscopic
and open cholecystectomy – single center experience**

Збрињавање компликованих повреда жучних путева
након лапароскопске и отворене холецистектомије –
искуство једног центра

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Management of major bile duct injuries following laparoscopic and open cholecystectomy – single center experience

Збрињавање компликованих повреда жучних путева након лапароскопске и отворене холецистектомије – искуство једног центра

SUMMARY

Introduction/Objective Bile duct injuries represent a devastating and potentially life-threatening consequence of cholecystectomy. Although most cholecystectomies are currently performed laparoscopically, some complex cases require an open approach. The aim of this report is to present and analyze a single center experience regarding the management of these injuries.

Methods A retrospective study was conducted in a tertiary referral institution. During a 13-year period, we identified a total of 64 patients. Only patients requiring surgical reconstruction to repair bile duct injuries were included in the study. Patients were grouped according to the type of surgical approach, i.e. laparoscopic or open cholecystectomy.

Results Out of 64 patients with bile duct injuries, 38 (59.4%) incurred the injuries during open and 26 (40.6%) during laparoscopic cholecystectomy. No differences between groups were observed concerning the time of bile duct injury diagnosis, type of injury, incidence of concomitant vascular and bile duct injuries, type of reconstruction procedure or complication rates after the primary intervention. The latency of bile duct injury management was found to differ between the study groups. In the open cholecystectomy group bile duct injuries were managed significantly later than in the laparoscopic one.

Conclusion The results suggest that bile duct injuries occur with equal frequency after laparoscopic as well as open cholecystectomy. However, injuries are managed later after open than after laparoscopic cholecystectomy. Tertiary centers have satisfactory outcomes of major bile duct injury reconstruction, with both low rates of morbidity and mortality.

Keywords: bile duct injuries; laparoscopic cholecystectomy; open cholecystectomy; biliary reconstruction

САЖЕТАК

Увод/Циљ Повреде жучних путева представљају разарајућу и потенцијално смртоносну последицу холецистектомије. Иако се већина холецистектомија обавља лапароскопски, неки сложенији случајеви захтевају отворени приступ. Циљ овог рада је да представи и анализира искуство једног центра у вези са збрињавањем ових повреда.

Метод Спроведена је ретроспективна студија у терцијарној институцији. Током тринаестогодишњег периода идентификовали смо укупно 64 пацијента. У студију су били укључени само пацијенти којима је била потребна хируршка реконструкција жучних путева. Пацијенти су били груписани према врсти хируршког приступа, тј. лапароскопској или отвореној холецистектомији.

Резултати Од 64 пацијента са повредама жучних путева, 38 (59,4%) је било са повредама током отворене и 26 (40,6%) током лапароскопске холецистектомије. Нису примећене разлике између група у погледу времена дијагнозе повреда жучних путева, врсте повреде, инциденције истовремених повреда васкуларних и жучних путева, врсте поступка реконструкције или стопа компликација након примарне интервенције. Утврђено је да време реконструкције повреда жучних путева се разликује између студијских група. У групи са отвореном холецистектомијом повреде жучних путева су знатно касније збрињаване него у лапароскопској.

Закључак Резултати показују да до повреда жучних путева долази подједнако након лапароскопске као и отворене холецистектомије. Међутим, повреде се збрињавају касније након отворене него након лапароскопске холецистектомије. Терцијарни центри имају задовољавајући исход реконструкције великих повреда жучних канала, са ниским стопама морбидитета и морталитета.

Кључне речи: повреде жучних путева; лапароскопска холецистектомија; отворена холецистектомија; реконструкција жучних путева.

INTRODUCTION

According to recent studies, the incidence of bile duct injuries (BDIs) during cholecystectomy ranges from 0.4 to 0.9% [1, 2]. Although the rate of BDIs might be considered low in the era before laparoscopic cholecystectomy (LC), its incidence was even lower, and it ranged from 0.1 to 0.2% [3, 4]. On the other hand, since cholecystectomy represents one of the most commonly performed surgical procedures world-wide, BDIs are an important and potentially life-threatening surgical complication.

The vast majority of cholecystectomies are now done laparoscopically, but still some complex cases require the surgeon to perform an open cholecystectomy (OC) [5]. Nowadays, LC is the method of choice for uncomplicated gallstone disease and early acute cholecystitis. Depending on their degree and clinical significance, BDIs may be classified from minor to major. Approximately 20% of BDIs are neglected during cholecystectomy [6, 7]. They are diagnosed at various times postoperatively and may lead to serious consequences such as postoperative fluid collection, biliary peritonitis, sepsis, hepatic or multiple organ failure and even death. The aim of this study was to present and analyze a single center experience.

METHODS

A retrospective study was conducted in a single tertiary referral institution during a 13-year period between January 1st 2002 and December 31st 2014 in accord with standards of the institutional Committee on Ethics. We identified a total of 77 patients due to post-cholecystectomy BDIs and only those requiring surgical reconstruction to repair the bile duct injuries were included in the study. The patients were grouped according to the type of surgical approach, LC or OC. Out of 77 identified patients, 13 patients were excluded from the study: four patients were excluded due to minor BDIs, two patients due to contrast allergy, two patients due to kidney failure, four patients who were not surgically treated and one patient that was lost to follow-up.

Surgical bile duct repair was performed in the remaining 64 patients. Patients' medical records were retrospectively reviewed. The review included demographic and clinical characteristics, type of injury, complications due to the primary procedure, type of

reconstruction and the outcome. Variables extracted from the recorded data were compared between the LC and OC groups.

Preoperative preparation for surgical repair of BDIs in all patients included complete biochemical and hematological evaluations, the assessment of inflammatory parameters and detailed physical examinations. BDI characterization was performed by abdominal ultrasound, percutaneous transhepatic cholangiography, endoscopic retrograde pancreatocholangiography, magnetic resonance imaging of bile ducts and computed tomography angiography. BDIs were graded according to the Strasberg classification system. Biliary tree reconstruction was performed using the Hepp-Couinaud technique, Roux-en-Y hepaticojejunostomy, primary suture and T-drainage or hepatectomy. At the end of every procedure transjejunal drainage was placed and the drain was removed on the 10th postoperative day.

The success of biliary tree reconstruction was defined by the lack of post-surgical complications, including the need for further surgical treatment and biliary stricture with recurrent cholangitis. Patient follow-ups were performed 1, 3, 6 and 12 months after BDI reconstruction, and annually after that.

Statistical analyses were performed using SPSS20.0 (IBM Corp., Armonk, New York). Numerical variables are shown as mean \pm SD, while categorical variables are presented as absolute numbers and percentages. The Student's t test was used to compare parametric variables, Mann-Whitney test to compare non-parametric variables, and Pearson's Chi-square test and Fisher exact test to compare the differences in the frequency of categorical variables. A $p < 0.05$ was considered statistically significant.

RESULTS

BDIs occurred in 38 (59.4%) patients who underwent OC and in 26 (40.6%) patients who underwent LC. Out of 64 patients, 28 (43.8%) were male and 36 (56.2%) were female. The youngest patient was 23 and the oldest 77, with mean age 54 ± 12.2 (see Table 1). The two groups did not statistically significantly differ with respect to age ($p=0.112$).

BDIs were intraoperatively diagnosed in four (15.4%) patients operated by LC and in 11 (28.9%) patients during OC. This difference was not statistically significant ($p=0.208$; see Table 2). Moreover, no statistical difference in the type of BDIs (Strasberg classification) was found between patients operated by LC or OC ($p=0.744$; Table 2). Additionally, there was no difference in the incidence of concomitant vascular injuries and BDIs between the two groups ($p=0.204$). The overall incidence of vascular injury was 26.6% (see Table 2).

A comparison of the latency of post cholecystectomy BDI management revealed a statistically significant difference. OC patients were managed significantly later, with almost 58% of them being treated more than 40 days after the primary surgery ($p=0.004$; Table 3). The most commonly performed bile duct reconstruction procedure in both groups was Roux-Hepp (see Table 3). There was no statistical significance regarding the frequency of the reconstruction type between the groups ($p=0.724$). The incidence of complications (sepsis, thrombo-emboly, infections, etc.), abscess, biliary fistula, bile collection and hepatic necrosis were not statistically significantly different between the groups (Table 4; $p=0.672$).

The median patient follow-up time was 117.6 months, with a range of 12 to 168 months. During the follow-up period, satisfactory results were achieved after the primary reconstruction in 57 (89.0%) patients. Benign stenosis, as a late complication of the reconstruction, occurred in six (9.4%) patients. In those six patients, a secondary reconstruction was performed due to biliary stenosis. In two of the patients, the secondary reconstruction was performed two years after T tube placement. In the other four patients, the secondary reconstruction was performed two to seven years following the primary reconstruction, which was done within 24 hours of the injury. One lethal outcome was observed (mortality rate 1.6%), which was due to the consequences of purulent cholangitis, subhepatic abscess and biliary peritonitis. Actually, the patient developed signs of severe septic shock, liver, and multiorgan failure, ten days after the primary reconstruction in the primary referring institution.

DISCUSSION

Regardless of the relatively low incidence rate, BDIs still represent a significant source of perioperative morbidity and mortality in patients that have undergone cholecystectomy. This type of iatrogenic surgical complication can have serious consequences, and in the worst

case may lead to a lethal outcome. BDIs usually include bile duct laceration, thermal injury, occlusion, division and dissection of the bile tree and arise due to misinterpreted anatomical variations, pathological findings or surgical error [8]. The skill of the surgeon, emergency procedures, the type of surgical approach, operative field factors (inflammation, hemorrhage and field depth) and patient characteristics have been identified as factors that play an important role in the occurrence of BDIs [9].

In cases of complete bile duct transection, surgical treatment is the only option. Depending on the type of injury, several reconstruction methods are available. These included end-to-end anastomosis with the T tube, Roux-en-Y hepaticojejunostomy and several types of hepatic resections. Roux-en-Y hepaticojejunostomy is the most frequently performed biliary duct reconstruction procedure [10, 11].

Biliary duct reconstructions should be performed by experienced surgical teams in tertiary referral centers. Our institution represents one of few specialized high-volume centers for hepaticobiliary surgery in the Republic of Serbia. During the 12-year study period, data were collected concerning 77 patients referred to our institution. When 13 patients were excluded from the study (due to exclusion criteria), the final study group consisted of 64 patients.

The results of several recent studies suggest that patients aged 40 to 50 are most likely to undergo biliary tract reconstruction procedures [12-14]. In this study, the overall mean patient age was 54 ± 12.2 years and no age differences were observed between the study groups. The results of this study suggest that older patients are more likely to require post-cholecystectomy biliary reconstruction, which confirms the previous results [2, 15, 16].

In this study, no gender differences were observed with respect to the incidence of BDIs. This is in contrast to previous findings which suggested that these lesions are more frequently encountered in men and that gender represents an independent predictor of BDIs [16]. It is possible that the small available sample size obscured gender differences in this study.

In the LC group, 15.4% of BDIs were diagnosed during the initial surgery while 28.9% were recognized during OC. Our data are supported by the results of previously published studies which showed that BDIs were intraoperatively diagnosed in only one quarter of patients [11]. However, the incidence of intraoperatively diagnosed BDIs is still a matter of

debate as it was reported that the majority of BDIs were recognized during the primary surgery [6, 7].

When it comes to the type of surgical reconstruction, we did not find any significant differences between our groups of patients. Roux-en-Y hepaticojejunostomy was the most commonly performed type of reconstruction in both groups. It was performed in 50% of cases in the LC group and in 42.1% of cases in the OC group (see Table 3). This is in agreement with the generally accepted opinion that this procedure is the method of choice for the surgical treatment of major BDIs [10].

In our study, the time from injury to reconstruction was significantly different between the observed groups. The majority of patients in the LC group underwent the reconstruction less than 40 days after the initial surgery. On the other hand, the majority of reconstructions in the OC group were performed later than 40 days after the initial surgery. It was suggested that later reconstruction is more suitable since acute inflammation, infection and ischemia should be resolved prior to BDI repair or before fibrosis was established [17, 18]. Furthermore, Stilling et al. found that an early reconstruction increases the risk of stricture rate by 30% and negatively affects both short and long term mortality rate [19]. The immediate repair of injuries that are recognized during the primary surgery should only be performed by an experienced surgeon. The success rate of reconstruction performed by an experienced surgeon is estimated to be 90%, while the success rate of reconstruction done by surgeons not specialized in hepato-biliary pathology is 70% [20, 21]. If an experienced surgeon or surgeon specialized for this kind of procedure is not available, drainage should be placed and the patient should be transferred to a tertiary institution as soon as possible.

In this study, the time between the primary surgery and BDI reconstruction was shorter after LC than after OC. This might be explained by the fact that patients recover faster after LC and, therefore, the symptoms of complications become clinically apparent sooner than after OC. Additionally, certain postoperative complications such as sepsis, abscess, and thromboembolism dictate the timing of reconstruction. Also, abdominal cavity drainage after LC is specified by the laparoscopic ports, therefore the drains may not be placed as ideally as during OC. Furthermore, one of the main conditions of successful reconstruction is the usage of intraoperative cholangiography (IOH). BDI reconstruction without the use of IOH was shown to have a failure rate of 29%, while with the use of IOH, the failure rate is only 4%

[22]. In the present study, IOH was performed in all 64 cases, thus explaining the high reconstruction success rate.

Our study groups did not statistically significantly differ in terms of incidence of concomitant vascular injuries and BDIs. The overall incidence of joint vascular injury was 26.6%. Literature data reported that the incidence of joint lesions was between 12-32% in patients that underwent LC, and 14-42% in patients that underwent OC [23-25]. Although the exact incidence of these injuries is still unknown, the incidence in the present study is in the range of previously published results. As in the study of Bilge et al., in this study the vasculobiliary injuries did not affect mortality rate –concomitant injuries did not lead to any lethal outcome of our patients. On the contrary, some authors found that concomitant injuries resulted in a higher mortality rate [24, 26]. The mortality rate in the present study was 1.6%. This is in concordance with the published literature where it was shown that the mortality rate ranged from 0% to 4.2% [7, 21, 27-29]. Although BDIs represent a serious health problem, they generally have a very good outcome, even in major BDIs when Roux-en-Y hepaticojejunostomy reconstruction needs to be performed. In our study, only 6 patients required secondary reconstruction. Also, one large study by de Reuver et al. found that patient survival after BDI reconstruction in a referral institution was similar to that of the general population [30].

CONCLUSION

In conclusion, special attention should be paid to BDIs which, although uncommon, can have serious or life-threatening consequences. BDIs should be managed in tertiary institutions by experienced surgical teams familiar with hepato-biliary pathology. IOH represents “*conditio sine qua non*” in the prevention and intraoperative management of BDIs. Based on the results of this study, these injuries occur with equal frequency after laparoscopic and open cholecystectomy. Furthermore, with laparoscopic cholecystectomy there may be a tendency for reconstruction to be performed sooner after the primary surgery than after open cholecystectomy. Regardless of the approach or the timing of reconstruction, adequate reconstruction results in satisfactory outcomes with low rates of morbidity and mortality.

Conflict of interest: None declared

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Table 1. Distribution of patients according to age and sex

Parameter	LC	OC	Total	p
n	26 (40.6%)	38 (59.4%)	64	
Age (years)	51.2 ± 12.6	56.1 ± 11.7	54.1 ± 12.2	0.112
Sex				
Male	8 (28.6%)	20 (71.4%)	28 (56.2%)	0.08
Female	18 (50%)	18 (50%)	36 (43.8%)	

LC – laparoscopic cholecystectomy; OC – open cholecystectomy

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Table 2. Time of BDIs diagnosis, type of injury and concomitant vascular injury

Intraoperatively diagnosed	LC n = 26	OC n = 38	Total	p
		4 (15.4%)	11 (28.9%)	15 (23.4%)
Strasberg Classification				
C	0	1 (2.6%)	1 (1.6%)	0.744
D	4 (15.4%)	5 (13.2%)	9 (14.1%)	
E1	3 (11.5%)	6 (15.8%)	9 (14.1%)	
E2	9 (34.6%)	16 (42.1%)	25 (39.1%)	
E3	6 (23.1%)	4 (10.5%)	10 (15.6%)	
E4	4 (15.4%)	6 (15.8%)	10 (15.6%)	
Concomitant vascular injury	8 (30.7%)	9 (23.7%)	17 (26.6%)	0.204

LC – laparoscopic cholecystectomy; OC – open cholecystectomy

Table 3. Time of bile duct injuries' management and reconstruction types

Time of BDI management	LC n = 26	OC n = 38	Total	p
Within 24 hours	6 (23.1%)	7 (18.4%)	13 (20.3%)	0.004
1–5 days	4 (15.4%)	0	4 (6.3%)	
6–40 days	12 (46.2%)	9 (23.7%)	21 (32.8%)	
Late reconstruction	4 (15.4%)	22 (57.9%)	26 (40.6%)	
Type of reconstruction				
Primary suture and T drainage	3 (11.5%)	5 (13.2%)	8 (12.5%)	0.724
Roux-en-Y HJA	9 (34.6%)	12 (31.6%)	21 (32.8%)	
Roux–Hepp	13 (50%)	16 (42.1%)	29 (45.3%)	
Hepatectomy	1 (3.8%)	5 (13.2%)	6 (9.34%)	

LC – laparoscopic cholecystectomy; OC – open cholecystectomy; BDI – bile duct injuries

Table 4. Types of complications after primary surgery and mortality rate

Complications	LC n = 26	OC n = 38	Total	p
General complications	5 (19.2%)	9 (23.7%)	14 (21.9%)	0.672
Abscess	3 (11.5%)	8 (21.1%)	11 (17.2%)	0.322
Biliary fistula	12 (46.2%)	17 (44.7%)	29 (45.3%)	0.911
Biloma	11 (42.3%)	11 (28.9%)	22 (34.4%)	0.269
Liver necrosis	6 (23.1%)	4 (10.5%)	10 (15.6%)	0.174
Mortality	0	1 (2.6%)	1 (1.6%)	

LC – laparoscopic cholecystectomy; OC – open cholecystectomy