

Biliary Complications in Living Donors after Living Donor Liver Transplantation: A Systematic Review and Meta-Analysis

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Introduction: Liver transplantation (LT) is the optimal treatment for many patients with advanced liver disease, including decompensated cirrhosis, hepatocellular carcinoma and acute liver failure. In the past, the vast majority of liver transplant involves the use of organs from deceased donors but organ shortage remains a major obstacle and is the main determinant of death on the waiting list. Consequently, living donor liver transplantation has been introduced to overcome the problem of organ shortage.

Ain of work: To evaluate the outcomes regarding biliary complications in donors after liver transplantation to identify possible risk factors for these complications.

Patients and methods: This systematic review and meta-analysis was conducted at Ain Shams Organ Transplantation Centre (ASCOT), Faculty of Medicine, Ain Shams University Hospitals on Donors who underwent liver transplantations in the period from 2008 until 2021 in Ain Shams Organ Transplantation Centre. This systematic review was prepared with a careful following of the Cochrane Handbook for Systematic Reviews of Interventions. We also adhered to The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines during the design of our study.

Results: During the study period, 500 living donors were included. Biliary complications occurred in 17 living donors, 15 (88.2%) of whom were males (Male predominance) and two (11.8%) were females. The mean \pm SD age for the donors suffering biliary complications was 29.9 ± 7.3 years and ranged from 17.5 years to 40 years. The overall incidence of biliary complications was 3.4% (17/500) in the studied cohort. Fourteen (2.8%) donors suffered biliary leakage (Main complication), one (0.2%) donor suffered biliary stricture, one (0.2%) donor had biliary collection, and one (0.2%) donor had cholangitis. None of the donors had hyperbilirubinemia.

Conclusion: biliary complications were few among these donors mostly due to good donor selection and experienced surgeons and good surgical techniques.

Key words: Liver transplantation.

Introduction

Liver transplantation (LT) is the optimal treatment for many patients with advanced liver disease, including decompensated cirrhosis, hepatocellular carcinoma and acute liver failure.¹

In the past, the vast majority of liver transplant involves the use of organs from deceased donors but organ shortage remains a major obstacle and is the main determinant of death on the waiting list. Consequently, living donor liver transplantation has been introduced to overcome the problem of organ shortage².

Although a high level of technical expertise and potential risks to a living donor may have limited the expansion of living donor liver transplantation, there are still many advantages to this procedure.³ It is elective, thereby reducing wait time and allowing for optimization, and as such, transplantation can occur before significant clinical deterioration.⁴

A major priority in living donor liver transplant is donor safety, strict donor selection according to structured protocols and centre experience are the main factors that determine donor safety.⁵

Biliary complications are a major source of morbidity

after transplantation, this attributed to vulnerable blood supply of the bile ducts.⁶ Complications include strictures, leaks, casts, sludge, stones and strictures. Manifestation of these complications is either seen at the anastomotic region or at multiple locations of the donor biliary system, termed as non- anastomotic biliary strictures.⁷

Major risk factors include old donor age, marginal grafts and prolonged ischemia time. Moreover, partial liver transplantation or living donor liver transplantation bear a markedly higher risk of biliary complications so accumulation of several risk factors is critical and should be avoided.⁸

Donor biliary complications generally present within two weeks of surgery. Bile leaks can be noted from bilious drain output or present with pain or suspicion for an intra-abdominal collection, imaging can also be helpful, while strictures present with elevated cholestatic liver enzymes or jaundice.⁹

There is evidence which suggest that bile leaks and biliary fistulas are more common in the donor than strictures. In contrast to the recipient.¹⁰ A study showed that patients who donated the right lobe had an incidence of 9% of bile leak compared to 0.5%-1.5% incidence of post-operative biliary

strictures. This is due to no biliary anastomosis is required in the donor.¹¹

But the evidence regarding biliary complication in donors is heterogeneous with no consistence or clear evidence about. Therefore in this article, we will evaluate the impact of liver transplantation on donors to provide objective evidence regarding the magnitude of these complications.

Aim of work

We aim in this review to evaluate the outcomes regarding biliary complications in donors after liver transplantation to identify possible risk factors for these complications.

Patients and methods

This systematic review and meta-analysis was conducted at Ain Shams Organ Transplantation Centre (ASCOT), Faculty of Medicine, Ain Shams University Hospitals.

Study population: Donors underwent liver transplantations in the period from 2008 until 2021 in Ain Shams Organ Transplantation Centre.

Study Methods: This systematic review was prepared with a careful following of the Cochrane Handbook for Systematic Reviews of Interventions. We also adhered to The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines during the design of our study.

Ethical consideration: Confidentiality: only the patient initials were recorded in the case report form, and when the patient's name appeared on any other document, it was kept in a secure place by the investigators. The investigators maintained a personal patient identification list (patient initials with the corresponding patient names) to enable record to be identified. Protocol approval: before the beginning of the study and any accordance with the local regulation followed, the protocol and all the corresponding documents were declared for ethical and research approval by the council of general surgery department and Ain Shams Organ Transplantation Centre (ASCOT),

Ain Shams University. Concerning safety and efficacy: no evidence of harmful effects of study procedures.

Study design: Clinical trials retrospective were analyzed. We excluded animal or cadaveric studies, reviews, book chapters, thesis, editorial letters and papers with overlapped dataset.

Methods of the review: Eligibility screening was conducted in a two step-wise manner (title/abstract screening and full-text screening). Each step was done by two reviewers independently

according to the predetermined criteria. There was no restriction on race, sex, year but when it comes to age it was recommended ages from (21-45) but if the donor was daughter or son age of 18 was accepted. The duplicated articles were removed primarily using Endnote X8 program (Thompson Reuter, USA) and manually using titles and abstracts screening. Disagreements at any stage was resolved by consensus.

Data extraction: A standardized extraction form was prepared by MS Excel. Authors independently extracted the following data from data files in ain shams organ transplantation center:

1) Participants' baseline characteristics; 2) Endpoint outcomes whether primary or secondary.

Study outcomes: Primary outcome: Biliary complications (Leak and stricture). Secondary outcomes: Other surgery related complications and quality of life outcomes.

Statistical analysis

Where data were reported consistently across studies for certain outcomes, they were pooled together in quantitative synthesis. Continuous data was pooled as mean difference (MD) and 95% confidence interval, while dichotomous outcomes were pooled as odds ratio (OR) and 95% confidence interval. Review Manager (RevMan, Cochrane Collaboration) version 5.3 or Open Meta-analyst software were used to pool studies. We used I square value and its P value to quantify degree of heterogeneity. We used random effect model when I square value was more than 50%.

Publication bias: We assessed publication bias using Egger test and funnel plot methods (Egger et al. 1997; Terrin et al. 2003)

Study tools

All donor candidates will be subjected to: Donor evaluation

Full clinical assessment. Laboratory investigations: CBC, coagulation profile, liver function

tests, kidney function tests, lipid profiles, diabetes profile, serum electrolytes, viral markers and tumor markers, lab for bilharzias, autoimmune and for metabolic liver disease. Radiological investigations: tri-phasic pelviabdominal CT volumetry and angiography; portography, venography and arteriography, MRCP, CT chest, X-RAY and Pulmonary function test for all cases. Medical consultations: cardiological, chest, psychological, consultations and gynaecological consultation for females. Liver biopsy to ensure that there is no occult hepatic pathology and to establish the degree of steatosis that should be less than 20%.

Operative Details: Donors were admitted to the hospital one day before the operation. After disinfection and draping J-shaped hockey stick incision was done, including a small upper midline incision and a right subcostal incision to enter the abdomen.

Harvesting of the right graft: After thorough exploration of the abdominal cavity and exclusion of any intraperitoneal disease, investigation of left to right lobar volume relationship and quality of the liver was achieved. Afterwards, cholecystectomy and cholangiography via the cystic duct were performed to rule out anatomical bile duct variations as shown in **(Fig. 1)**.

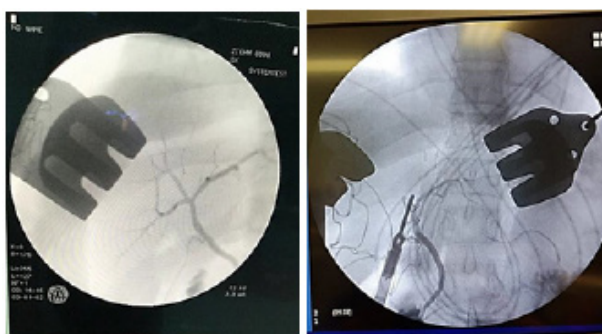


Fig 1: Intraoperative cholangiogram before resection to assure adequate length of the bile duct with good stump.

At this point, the final decision what type of donor operation (Left or right lobe) should be performed. If harvesting of the right graft was chosen, dissection had to be limited right to the main bile duct. Any disturbance of the blood supply of the main bile duct had to be avoided to minimize the risk of later bile duct stenosis. The right hepatic artery and right portal vein were isolated and marked with a vessel loop. Care was taken to preserve the arterial supply to segment IV. The right liver was mobilized from the diaphragm and from the retro hepatic vena cava. Retro hepatic veins with a diameter more than 5 mm had to be isolated and preserved to allow separate anastomosis of these veins in the recipient. The right hepatic vein had also to be isolated in the donor to allow later on vessel loop guided parenchymal transection (Hanging technique). The level of transection had to be identified by short clamping of the right hepatic artery and right portal vein with consecutive demarcation of the right lobe. An ultrasound examination was performed intraoperatively, to determine line of Cantilie and mark it and to show presence of major hepatic veins crossing the line of Cantilie (V5 and V8). A harmonic scalpel (J&J, New Jersey, USA) and cavitron ultrasonic surgical aspirator (CUSA System 200 macrodissector; Cavitron Surgical Systems, Stamford, Connecticut,

USA) were used for parenchymal division. During parenchymal transection, the central venous pressure should be kept below 5 mmHg to minimize blood loss. A device for parenchymal transection such as CUSA should have been used to facilitate atraumatic careful parenchymal transection, which reduces the risk of blood loss and bile leakage. Preservation of the middle hepatic vein to the left to avoid any venous outflow obstruction in the donor. Large veins crossing line of Cantilie had to be isolated to allow later anastomosis in the recipient with interposition grafts. The transection of the right bile duct is one of the most delicate steps of the operation. Any effort had been made to achieve a single bile duct opening on the grafts side while avoiding the risk of opening of the main bile duct of the donor. Once the division of the parenchyma reaches the hilar plate, cholangiography was done to assess good stump before transection as shown in figure (1) then sharp transection of the Right bile duct was done. Heparin (5000 units) was given intravenously before the clamping of the right hepatic artery after transection of the parenchyma. After parenchymal transection is completed as shown in **(Fig. 2)**, the right hepatic artery, right portal and right hepatic vein are clamped, and cut.

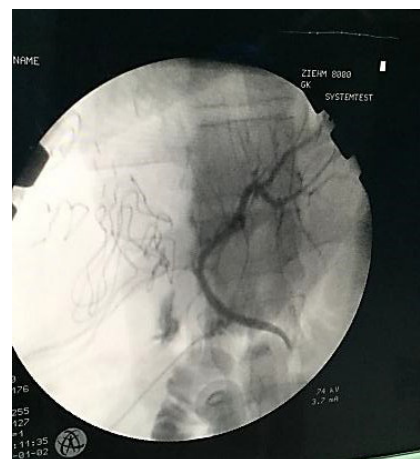


Fig 2: Completion cholangiogram after resection showing good stump.

The graft was washed after removal followed by immediate flushing through right portal vein by ~3 L of histidine–tryptophan–ketoglutarate solution (HTK) on the back table, and then the graft was weighed. After removal of the graft, vessel stumps were closed with continuous, nonabsorbable sutures. The stump of the biliary duct was closed with interrupted, absorbable 6/0 PDS sutures. Completion cholangiography was done to detect any leak after transection and for assessment of divided site of bile duct whether there was a good stump or it was cut flushed with the common hepatic duct as shown in **(Fig. 3)**.



Fig 3: Liver after completing formal parenchymal resection.

Harvesting of the left graft

Same approach as the right graft with the following differences:

Dissection of the Left coronary ligament, left triangular ligament and lesser omentum was done. The lesser omentum was checked for the presence of an accessory or replaced left hepatic artery (Aberrant left hepatic artery) arising from the left gastric artery and then lesser omentum was opened. The left portal vein is isolated at the bifurcation, Parenchymal transection advances along a plane placed 1 cm to the right of the MHV and finally is directed to the center of the IVC; transection behind the hilar plate is continued, taking care to avoid injury of the small vessels of the caudate lobe. Dissection of the common stump of middle and left hepatic veins was done. Resection was done in the same steps of identification of the Cantilie line as right graft. Once the division of the parenchyma reaches the hilar plate, sharp transection was done of the left bile duct. The left hepatic artery, left portal and left hepatic vein with middle hepatic vein are clamped, and cut.

In Harvesting of the left lateral graft;

Same approach as the left graft with the following differences:

The parenchymal bridge between the left lateral lobe and segment 4 was divided and the left portal vein was exposed. The left hepatic artery as well as the left main portal vein were isolated and marked with a vessel loop. The branches arising from the left portal vein to segment 4 were cut between suture ligations. Although one should try to avoid it, it may be necessary to sacrifice the artery to segment 4 (complications of this are very unusual). After complete mobilization of the left portal vein, the hilar plate containing the left main bile duct was exposed. The left hepatic vein was isolated and marked with a vessel loop. Parenchymal transection few millimetres to the right of the falciform ligament was performed. Once the division of the parenchyma reaches the hilar plate, sharp transection was done of the left bile duct. After parenchymal transection was completed, the left hepatic artery, left portal and left hepatic vein were clamped, and cut in sequence. The right half of the hepatoduodenal

ligament remained untouched during the whole procedure.

After partial liver resection, bleeding from the liver surface was controlled, and the visible points of bile leakage was secured using interrupted sutures applied by an atraumatic needle. Both the conventional saline test was done on 30 cases and the White test was then conducted in the other

30 cases. To perform the tests, a catheter or cannula was inserted through the cystic duct into the common bile duct. For the conventional bile leakage test, 10–20mL of isotonic cold saline solution was injected via the catheter while manually occluding the distal common bile duct. The transected liver surface was then inspected for the leakage of any isotonic cold saline solution. After finishing the test, the detected bile leakages were closed with interrupted sutures. To do the White test, 10–

20mL of a 5% sterile fat emulsion (SMOFlipid 20%) was slowly injected while manually occluding the distal common bile duct. The presence of the white fluid was then noted at bile leakage sites on the transected liver surface. After finishing the test, the detected bile leakage points were closed with interrupted sutures. Rinsing and injection were repeated until no leakage was seen. After the test, saline was injected into cystic duct to rinse the fat emulsion from the biliary tract. The number of bile leakage sites found were recorded in each test as shown in (Fig. 4). Drainage of the operative field was performed with a silicone drain connected to a closed drainage system.

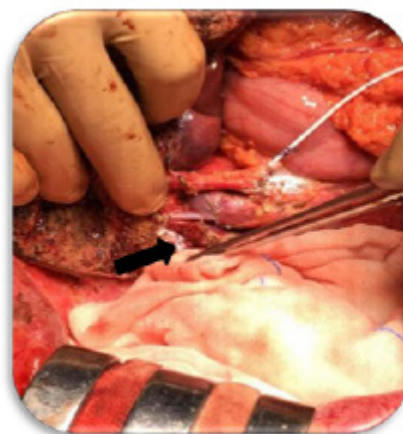


Fig 4: Intraoperative white test show area of leakage at the cut surface and hilar plate.

Post-operative workup for donor:

Work up: Daily follow up with Vital data including pulse, blood pressure, temperature and respiratory rate to detect any hemodynamic instability and respiratory complications until discharge. Bowel habits. Drain: amount and color of the drain. Drain was removed when the amount of the drain fluid

was less than 50ml within 24h and it was clear fluid whether the patient still hospitalized or discharged. If there was any bile ting drain was not removed. Wound care: wound discharge would be sent for culture and sensitivity. Daily follow up full labs in 1st 3 days and then every other

day until discharge and pelvi-abdominal US every other day until discharge then weekly for 1 month. IF there is biloma was found pig tail insertion was done. If there is any suspicious of stricture or leak, we do MRCP. Postoperative bile leakage is defined as bilirubin concentration in the drain fluid at least 3 times the serum bilirubin concentration on or after postoperative day 3 or at the need for radiologic or operative intervention resulting from biliary collections or biliary peritonitis.

Statistical methods

Statistical analysis was done using the Comprehensive Meta-Analysis© version 3.3 (Borenstein M, Hedges L, Higgins J, & Rothstein H. Biostat, Englewood, NJ 2022) and MedCalc© version 20.104 (MedCalc© Software bv, Ostend, Belgium) softwares.

Risk of methodological bias assessment

Quality assessment of included studies was done using the modified New Castle-Ottawa (NCO) Quality Scale for cross sectional studies (Modesti et al., 2016).

Studies scored 8 to 9 out of 10 points on the modified NCO Quality Scale were considered at low risk of methodological bias. Studies scored 6 to 7 were considered at medium risk, while those scored 5 or less were considered at high risk of bias (Dreier et al., 2014).

Meta-Analysis

Quality assessment of included studies was done using the modified New Castle-Ottawa Quality Scale.

Assessment of heterogeneity

Studies included in meta-analysis were tested for heterogeneity of the estimates using the following tests: Cochran Q chi square test: A statistically significant test (P-value <0.1) denoted heterogeneity among the studies. I-square (I²) index which is interpreted as follows: I² = 0% to 40%: unimportant heterogeneity. I² = 30% to 60%: moderate heterogeneity. I² = 50% to 90%: substantial heterogeneity. I² = 75% to 100%: considerable heterogeneity.

Assessment of publication bias

Publication bias was assessed by: Examination of funnel plots of the estimated effect size on the horizontal axis versus a measure of study size (Standard error for the effect size) on the vertical axis. Begg's rank correlation test. Egger's regression test.

Pooling of estimates: Binary outcomes are expressed as proportions 95% confidence intervals (95% CI). Estimates from included studies were pooled using the DerSimonian-Laird random-effects model (REM).

Analytical statistics: Descriptive statistics for categorical variables are presented as counts and percentages and comparisons of independent data are done using Fisher's exact test. Two-sided P <.05 is considered statistically significant.

Results

I. Incidence of complications in living donors at ain shams university

During the study period, 500 living donors were included. Biliary complications occurred in 17 living donors, 15 (88.2%) of whom were males and two (11.8%) were females. The mean \pm SD age for the donors suffering biliary complications was 29.9 \pm 7.3 years and ranged from 17.5 years to 40 years.

The demographic characteristics of living donors suffering biliary complications are shown in **Table 1**.

The overall incidence of biliary complications was 3.4% (17/500) in the studied cohort. Fourteen (2.8%) donors suffered biliary leakage, one (0.2%) donor suffered biliary stricture, one (0.2%) donor had biliary collection, and one (0.2%) donor had cholangitis. None of the donors had hyperbilirubinemia (**Table 2, Fig. 5**).

On the other hand, 23 (4.60%) donors had non-biliary complications. The most frequent complications were hematoma formation (7/500, 1.4%), abdominal fluid collection (5/500, 1.0%), cut-surface collection (3/500, 0.6%), and intestinal obstruction (2/500, 0.4%).

The incidence of hepatic vein thrombosis, elevated pancreatic enzymes, fever, raw surface collection, hemorrhage, subphrenic collection or pancreatitis were all low on the order of 0.2% each (**Table 3, Fig. 6**).

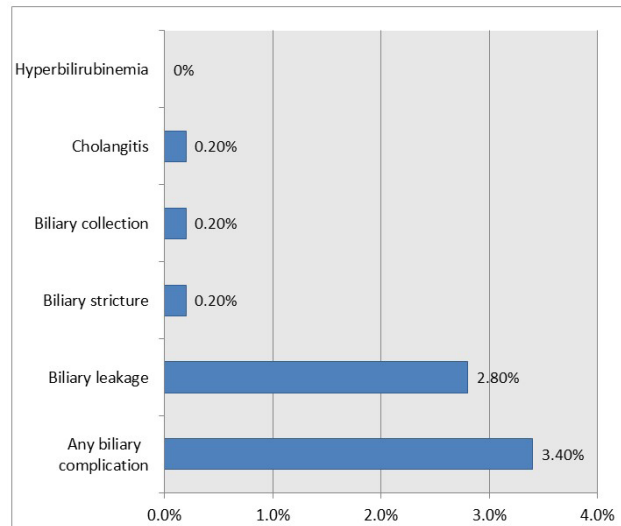


Fig 5: Incidence of Biliary Complications in Living Donors at Ain Shams University.

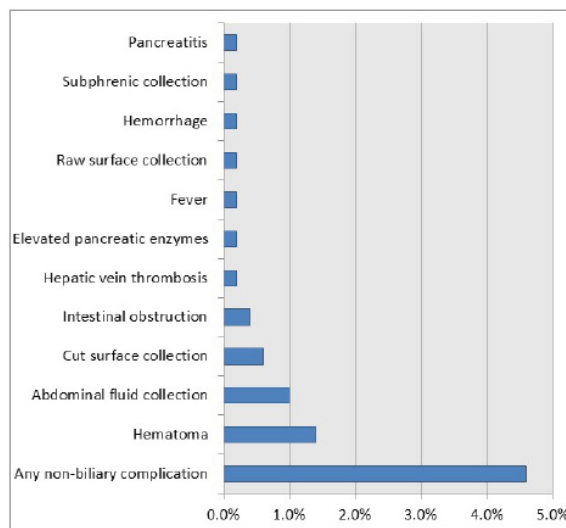


Fig 6: Incidence of Non-Biliary Complications in Living Donors at Ain Shams University.

Table 1: Demographic characteristics of living donors suffering biliary complications

Variable	Value
Age (years), mean \pm SD	29.9 \pm 7.3
Sex, n/N (%)	
Female	2/17 (11.8%)
Male	15/17 (88.2%)

SD = standard deviation, n/N = proportion.

Table 2: Incidence of biliary complications in living donors at Ain Shams University

Biliary complication	Count	Percentage
Biliary leakage	14	2.80%
Biliary stricture	1	0.20%
Biliary collection	1	0.20%
Cholangitis	1	0.20%
Hyperbilirubinemia	0	0.0%
Any biliary complication	17	3.40%

Table 3: Incidence of non-biliary complications in living donors at Ain Shams University

Complication	Count	Percentage
Any Non-Biliary complication	23	4.60%
Hematoma	7	1.40%
Abdominal fluid collection	5	1.00%
Cut surface collection	3	0.60%
Intestinal obstruction	2	0.40%
Hepatic vein thrombosis	1	0.20%
Elevated pancreatic enzymes	1	0.20%
Fever	1	0.20%
Raw surface collection	1	0.20%
Hemorrhage	1	0.20%
Subphrenic collection	1	0.20%
Pancreatitis	1	0.20%

Discussion

The first successful adult-to-adult right lobe living donor liver transplantation (LDLT) was performed in Japan in 1994; since then, this procedure has been widely and increasingly performed.¹²

A worldwide shortage of deceased donors has resulted in LDLT becoming a major treatment strategy for end-stage liver diseases, including hepatocellular carcinoma.¹³

Donor safety is as important as recipient safety and efficacy, resulting in donor ethical issues with regard to this procedure.¹⁴

The morbidity and mortality rates for liver graft donors have been reported to be about 21% and 0.2% to 0.5%, respectively.¹⁵

The most frequent donor complications following LDLT are biliary complications. Recent studies have reported that 6% to 9% of donors experience biliary complications following LDLT and that these complications are more common in right lobe than in left lobe donors.¹⁶

Although most biliary complications are minor or transient and improve with conservative care, some require endoscopic, percutaneous, or surgical treatment and even long-term hospitalization. To date, however, few reports have assessed biliary complications experienced by right lobe donors after partial liver resection.¹⁷

Consequently, this study was conducted and aimed to summarize the current evidence regarding biliary complications in donors after liver transplantation.

This systematic review and meta-analysis was conducted at Ain Shams Organ Transplantation Centre (ASCOT), Faculty of Medicine, Ain Shams University Hospitals on Donors who underwent liver transplantations in the period from 2008 until

2021 in Ain Shams Organ Transplantation Centre. This systematic review was prepared with a careful following of the Cochrane Handbook for Systematic Reviews of Interventions. We also adhered to The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines during the design of our study.

During the study period, 500 living donors were included. Biliary complications occurred in 17 living donors, 15 (88.2%) of whom were males (Male predominance) and two (11.8%) were females. The mean \pm SD age for the donors suffering biliary complications was 29.9 ± 7.3 years and ranged from 17.5 years to 40 years.

The overall incidence of biliary complications was 3.4% (17/500) in the studied cohort. Fourteen (2.8%) donors suffered biliary leakage (main complication), one (0.2%) donor suffered biliary stricture, one (0.2%) donor had biliary collection, and one (0.2%) donor had cholangitis. None of the donors had hyperbilirubinemia. Although right liver LDLT is regarded as the primary treatment for selected adult patients with end-stage liver disease, concerns have been raised about donor safety. LDLT donors can experience various complications, with biliary complications being the most frequent. However, a multicenter survey of several recent large scale studies showed that donor hepatectomy can be performed successfully, with minimal and easily controlled complications, by using a meticulous and well-standardized technique as reported by Lauterio et al. (2017) and Lee et al. (2017).^{18,19}

In contrast to largescale studies, single center studies like ours have several advantages. First, specific complications such as biliary complications could be handled in a more detailed and standardized fashion. Second, unexpected intraoperative factors and/or pathologic factors may be identified as important predictors during the investigation. Therefore, this

study is one of few focusing on the clinical course of biliary complications and the outcomes of endoscopic management of these complications in LDLT donors at a single center.

Biliary leakage has been found to occur more frequently in earlier than in late phase, with most of these patients showing improvements with conservative care. Biliary strictures develop later, with most requiring specific interventional treatment.^{20,21}

Bile leakage after right hepatic duct resection during donor hepatectomy that does not improve with conservative care can be treated initially by endoscopic methods. Endoscopic treatment can reduce the bile duct-duodenal pressure gradient, bridge the defect at the leak site, divert bile away from the leak site, and prevent stricture formation during healing as reported by Agarwal et al.²²

ENBD can provide visual confirmation of biliary healing using repeat cholangiography and can be easily removed. Therefore, temporary use of ENBD is a safe and feasible method of following up leakage in patients with minor biliary leakage during a relatively short admission period. However, potential drawbacks of ENBD include patient discomfort, displacement, and electrolyte imbalance, drawbacks not observed following endobiliary stent insertion. Therefore, because of possible patient discomfort and the need for longer hospitalization, none of the donors in this study underwent ENBD for leakage. Rather, drainage with endobiliary stents was tried in patients who did not improve with conservative care. Biliary leakage is a risk factor for stricture, or is often associated with stricture as reported by Ostroff²³ and Verdonk et al.²⁴

Some patients who failed ERC or did not show improvement with ERC were successfully managed with percutaneous drainage, suggesting that percutaneous transhepatic treatment is effective for treating bile leaks when endoscopic treatments have failed or are contraindicated as reported by Hwang et al.,²⁵ Amesur and Zajko²⁶ and Chang et al.²⁷

Furthermore, percutaneous transhepatic biliary drainage (PTBD) was useful for treating long lasting combined complications. These include long-term maintenance of a large-profile catheter (12- to 14-Fr) through the percutaneous transhepatic tract during the indwelling period of the PTBD catheter. In contrast, endoscopic treatment requires cannulation of the ampulla of Vater during every procedural session, making the endoscopic approach more time-consuming and difficult. Right lobe donors have been reported to be more susceptible to leakage than left lobe donors because the biliary tract anatomy is more complex in the right lobe. About

half of right-lobe grafts have multiple biliary orifices, whereas left-lobe grafts usually have a single orifice as reported by Yazumi and Chiba.²⁸

Biliary complication has been reported from centers in Japan, United States, and Europe, with incidences of 4%, 7%, and 8%, respectively as regard Sevmis et al. in 2008.

On the other hand, in a study by Rafik et al. (2008), the most common postoperative complication was infections (12.5%).

Biliary complications are most frequent complications post living donor liver transplantation to 18,6% in the retrospective analysis by Fujits et al (2000), Trotter et al (2001)^{30,31}

In another study by Rafik et al. (2008),³² biliary leak was found to be (9.2%). Improvement in surgical technique is required to avoid such a complication especially for the bare surface area of the remaining liver.

Conclusion

We can conclude that biliary complications were few among these donors mostly due to good donor selection and experienced surgeons and good surgical techniques.

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