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Outcomes of Left-Lobe Donor Hepatectomy for Living-Donor Liver Transplantation: A Single-Center Experience

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ABSTRACT

Living-donor liver transplantation (LDLT) is an excellent option for patients with end-stage liver disease in situations of donor shortage. The aims of this study were to evaluate our experience with left-lobe donor hepatectomy for LDLT and to grade postoperative complications using the 5-tier Clavien classification system. Data from medical records of 60 adult living liver donors (30 men, 30 women) who underwent left-lobe hepatectomy between November 2006 and April 2012 were reviewed. The median donor age was 31.7 ± 8.9 (range, 19–63) years. Sixteen complications were observed in 12/60 (20%) donors. Complications developed in 6/15 (40%) donors who underwent left hepatectomy and in 6/45 (13.3%) donors who underwent left lateral segmentectomy. Seven of 16 (43.7%) complications were Grade I and 2 (12.5%) were Grade II. Major complications consisted of 4 (25%) Grade IIIa and 3 (18.7%) Grade IIIb complications; no Grade IVb or V complications occurred. The most common complication was biliary, occurring in 7 (11.6%) donors and comprising 43.7% of all 16 complications. The mean duration of follow-up was 30 ± 7.1 (range, 2–58) months. No donor mortality occurred. Left-lobe donor hepatectomy for LDLT, which does not benefit the completely healthy donor, was performed safely and with low complication rates, but carries the risk of morbidity. Low morbidity rates following living-donor hepatectomy can be expected when surgical and clinical monitoring and follow-up are adequate and the surgeon has gained increased experience.

LIVER transplantation (LT) is the only definitive treatment modality with well-demonstrated efficacy in patients with end-stage liver disease. Living-donor liver transplantation (LDLT) is an excellent option for patients with end-stage liver disease in situations of donor shortage. LDLT is an alternative method that enlarges donor pools in countries with limited cadaveric donor pools.[1,2] First performed in 1989, LDLT is currently applied as an alternative therapy for patients with liver failure.[3]

Transplantation of a liver graft from an adult donor to an infant or young-adult recipient through left-lobe or left-lateral segmentectomy is accepted worldwide. LDLT differs from other surgical procedures because the donor hepatectomy must be performed safely and the benefit to the recipient must be optimized. Donor safety is the primary concern.[4] Nineteen donor deaths have been reported recently, 2 of which occurred after left-lateral segmentectomy.[5] Although a high volume of living-donor hepatectomies for LDLT is performed safely at centers with experienced surgeons, this procedure, which does not benefit the completely healthy donor, carries low risks of donor morbidity (8.7%) and mortality (0.1%).[6–8]

Among other countries, Turkey suffers greatly from a shortage of donor organs; the organ donation rate was 3.2/1 million population in 2008.[9] A LT program was initiated in 2006 at Turgut Ozal Medical Center, and LDLTs (78.9% of LTs), 9.8% of which have been left-lobe LDLTs, have been performed with no donor mortality to-date. In this study, we evaluated the results of left-lobe donor hepatectomies for LDLT performed in our clinic and graded postoperative complications using the 5-tier Clavien classification system.

MATERIALS AND METHODS

The outcomes of left-lobe donor hepatectomies for LDLT performed at Turgut Ozal Medical Center between November 2006

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and April 2012 were reviewed retrospectively. The study protocol (no. 2012/64) was approved by the ethics committee and institutional review board of Inonu University's School of Medicine.

Donor Selection and Evaluation

All donors were informed preoperatively about the risks associated with the procedure and signed surgical consent forms. Donor candidates were evaluated, and inappropriate donors were excluded, in 3 phases: (1) clinical assessment and serological testing, (2) abdominal Doppler ultrasonography (USG) to detect preoperative steatosis and radiological assessment using magnetic resonance cholangiopancreatography (MRCP) and multislice computed tomography (CT), and (3) percutaneous liver biopsy and CT to detect stenosis in obese (body mass index [BMI] ≥28) donors. All donor candidates underwent routine assessment to determine blood group and to obtain hemograms, biochemistry values, viral serological panels, and blood and urinary cultures. After physical and psychiatric evaluations, abdominal USG was performed to detect liver steatosis and multislice CT was used to calculate liver volume and assess the vascular structures of the liver. Donor candidates with BMI ≥28 and >20% steatosis, as determined by CT, underwent liver biopsies. Candidates with mismatched blood groups, positive findings on viral serological tests, and/or >20% hepatosteatosis were not selected as donors.

Surgical Technique for Left Lobe Hepatectomy

In all patients, the abdomen was entered through a "J" incision after the induction of general anesthesia. The falciform ligaments were separated and retractors/ecarteurs were then placed. The left triangular and coronary ligaments were dissected and the left lobe of the liver was mobilized. The hepatic artery configuration was assessed. Hilar dissection of the gastrohepatic ligament was performed. The left hepatic artery and left portal vein branches were dissected and exhibited. Segments 2–3 and 4 were used as grafts from donors who underwent left hepatectomy, and segments 2–3 were used as grafts from those who underwent left lateral segmentectomy. Although a small portion of the caudate lobe remained, it was harvested from some donors, increasing the graft weight by 2%. The left hepatic vein was preserved at the left lobe and parenchymal dissection was performed with a Cavitron ultrasonic surgical aspirator (Valleylab, Boulder, Col, United States). Electrocautery was performed with no vascular inflow interruption on either side of the liver. The bile duct was cut after dissection was completed, and cholangiography was performed. The short hepatic veins and left hepatic veins were reconstructed when required.

Postoperative Care, Follow-Up, and Data Collection

The patients stayed in the intensive care unit for at least 1 postoperative day to monitor the development of any early bleeding complication. Epidural anesthesia was applied to patients routinely. Postoperative regimens were initiated on the first postoperative day. Low–molecular-weight heparin was not used routinely. Abdominal drains were removed if no abnormality was detected during postoperative follow-up or by physical examination, and if the amount of drainage was <50 mL. Prothrombin time and levels of alanine aminotransferase, aspartate aminotransferase, and bilirubin were determined daily. Postoperative complications were classified according to the modified 5-tier Clavien system.[10] After hospital discharge, the patients returned for polyclinical follow-up examinations in months 1, 3, 6, and 12.

Statistical Analyses

Data are expressed as means ± standard deviations for continuous variables and as percentages for categorical variables. Fischer exact test was used to evaluate differences among postoperative complications.

RESULTS

During the study period, 782 LTs were performed at the clinic; 617 (78.9%) procedures were LDLTs, of which 60 (9.8%) were left-lobe donor hepatectomies included in this study. The mean age of these 60 donors (30 men, 30 women) was 31.7 ± 8.8 years. Fifty-five (91.6%) donors were at least 4th-degree relatives of the recipient and 5 (8.3%) donors had no biological relationship to the recipient. Before these 5 unrelated donors underwent hepatectomy, the ethics committee obtained consent for donation. Fifteen (25%) donors underwent left hepatectomy (segments 2–4) and 45 (75%) underwent left-lateral segment resection (segments 2–3). The mean follow-up period was 30 ± 7.1 (range, 2–58) months. Donors' demographic and surgical data are summarized in Table 1.

Sixteen postoperative complications occurred in 12/60 donors who underwent left lobe hepatectomy and were evaluated using a modified 5-tier Clavien classification system (Table 2). Briefly, the morbidity rate was 20%: 9 (56.2%) postoperative complications were minor (Grade I, $n = 7$ [46.6%]; Grade II, $n = 2$ [13.4%]) and 7 (43.7%) complications were major (Grade IIIa, $n = 4$ [26.6%];

Table 1. Demographical and Surgical Data of the Donors are Summarized

Characteristics	No. (%)/Mean ± SD
No. of donors	60
Age	31.7 ± 8.8
Gender	
Men	30 (50%)
Women	30 (50%)
Type of donor	
Related	55 (91.6%)
Unrelated	5 (8.3%)
Blood type	
0 Rh (+/−)	32 (53.3%)
A Rh (+/−)	15 (25%)
B Rh (+/−)	12 (20%)
AB (+)	1 (1.6%)
BMI	24.9 ± 3.5
Type of Surgical Procedure	
Left hepatectomy	15 (25%)
Left letaral hepatectomy	45 (75%)
Operation time	340.51 ± 68.2
Graft Weight	328.11 ± 123.0
Blood transfusion	0
Reoperation	1 (1.66%)
Intensive care unit stay (d)	1.2 ± 0.4 (1–3)
Duration of hospitalization (d)	8.21 ± 7.4 (2–31)
Follow-up time (mo)	30 ± 7.1

Table 2. Postoperative Complications of the Donor Based on Clavien's Modified 5-Tier Classification

Postoperative Complications	Grade I	Grade II	Grade IIIa	Grade IIIb	No.
Abdominal wound problems					
Superficial wound infection and abscess	4				4
Abdominal wound dehiscence/hernia				1	1
Bilary					
Bile leak/biloma	2		3	1	6
Biliary stricture				1	1
Others					
Hypotension	1				1
Hypoalbuminemia		2			2
Small-for-size			1		1
Coronary ischemia					
Total	7 (43.7%)	2 (12.5%)	4 (25%)	3 (18.8)	16

Grade IIIb, $n = 3$ [13.3%]). No Grade IV or V complication was observed.

The 9 minor postoperative complications and 7 major complications each occurred in 6 (10%) donors. The most frequently observed postoperative complication was biliary ($n = 7$ [11.6%]; Table 2). Postoperative complications were observed in 6/15 (40%) donors who underwent left hepatectomy (segments 2–4) and 6/45 (13.3%) who underwent left lateral segmentectomy (segments 2–3; $P = .056$). Biliary complications were observed in 4 donors who underwent left hepatectomy and in 3 who underwent left lateral segmentectomy. The overall and biliary complication rates did not differ significantly between the 2 surgical procedures ($P = .056$ and $P = .058$, respectively; Table 3). No donor mortality occurred during the follow-up period.

Grade I ($n = 7$) and Grade II ($n = 3$) complications were treated conservatively with medication. Grade IIIa complications ($n = 4$) were treated by various procedures in 3 donors with biliary leakage or biloma. One patient underwent endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic sphincterotomy (ES), and an external drainage catheter was placed after aspiration in conjunction with USG. ERCP was used to place a nasobiliary catheter in 1 donor and an internal stent in another. Five of 6 donors with biliary tract problems were treated by follow-up or surgical intervention ($n = 2$). One patient with small-for-size syndrome was treated with medical therapy and 2 sessions with a molecular adsorbent recirculating system (MARS). This patient later exhibited extended jaundice and acid retrograde and was discharged from the hospital in a healed condition.

Table 3. Complications of Left Lobe Hepatectomy and Left Lateral Segmentectomy Based on Clavien's Modified 5-Tier Classification

Grade	Left Lobe Heptatectomy (Segment 2–4) n = 15	Left Lateral Segmentectomy (Segment 2–3) n = 45
Grade I		
Superficial wound infection and abscess	3	1
Bile leak/biloma	1	1
Grade II		
Hypoalbuminemia	1	1
Hypotension		1
Grade III a		
Bile leak/biloma	2	1
Small for size		
Grade III		
Abdominal wound dehiscence/hernia	1	
Bile leak/biloma		1
Biliary strictures	1	
No. of complications	9	7
No. of complicated donors	6 (40%)	6 (13.3%)

Grade IIIb complications ($n = 3$) comprised 1 case each of incisional hernia, benign biliary stricture, and biliary leakage/bilioma. The incisional hernia and benign biliary stricture occurred in the same patient, who was treated using herniorrhaphy and hepaticojejunostomy with mesh. The donor with biliary leakage/bilioma underwent surgical intervention. Bile leakage was observed on the cut surface of the liver, which was sutured, and a T-tube catheter was placed into the choledoch. Treatments for complications are summarized in Table 4 No preoperative or postoperative bleeding complication requiring transfusion occurred in any donor.

DISCUSSION

The number of patients requiring LT has been increasing for the last 20 years, but the number of donated organs has not increased correspondingly. Thus, waiting lists for cadaveric LT are long.[11] LDLT, which expands the graft pool and reduces waiting times for LT, is the accepted therapeutic approach for end-stage liver disease (hepatopathy), and the popularity of this approach continues to increase.[11,12] In Turkey, 75% of organ transplantations are from living donors and 25% are from cadavers;[9] LDLT comprises 78% of organ transplantations performed in our clinic.

The transplantation of a liver graft from an adult donor to an infant or young-adult recipient through left-lobe or left-lateral segmentectomy is accepted worldwide. Left-lobe donor hepatectomy for LDLT, which does not benefit the

Table 4. Treatment of Complications

Type of Complications/No.	Treatment
Grade I	
Superficial wound infection and abscess (n = 4)	Conservative
Grade II	
Hypoalbuminemia (n = 2)	Conservative
Hypotension (n = 1)	Conservative
Grade IIIa	
Bile leak/biloma	ERCP/EST ERCP/nasobiliary drain ERCP/internal drainage
Biliary strictures	Percutaneous drainage catheter by USG
Small-for-size	MARS
Grade III	
Abdominal wound dehiscence/ hernia	Herniorrhaphy with mesh
Bile leak/biloma	Reoperation
Biliary strictures	Hepaticojejunostomy

completely healthy donor, has been performed safely and with low complication rates in clinics with experienced surgeons, but it carries low risks of morbidity and mortality.[3,6] Hepatectomies in living donors are highly complex procedures, and complications may occur despite the safety of the procedure. The majority of complications after donor hepatectomy develop during the postoperative period. Many studies have specified the types and incidence of complications developing after donor hepatectomy for LDLT. A systematic review reported a 16.1% (range, 0–100%) rate of donor morbidity following right- or left-lobe donor hepatectomy.[7] Bile leakage, biliary stricture, and other biliary complications have been reported most frequently (6.2% of cases), followed by infections (5.8%), especially of the wound site. Hashikura et al[7] observed similar donor morbidity rates following right-lobe (9.4%) and left-lobe (8.7%) hepatectomies for LDLT in a multicentric study including data from 3565 donors and 35 centers. However, that study did not include Grade I complications, resulting in lower than expected total complication rates.

In the present study, the rate of major (≥Grade III) postoperative complications, according to the modified 5-tier Clavien classification, was 11.6%. Hashikura et al[7] reported a morbidity rate of 8.7% for Grade I–IV complications following left hepatectomy. Although we used preoperative MRCP and cholangiography and carefully performed hilar dissection, the most frequently encountered complication in this study was biliary (11.6%), followed by infection (6.6%).

Differences in morbidity rates can be ascribed to differences in the type of donor hepatectomy for LDLT, and full agreement about complication classification and rates has not been reached. In 2004, Dindo et al[10] reported that the use of the modified 5-tier Clavien classification partially resolved this problem. In our center, we identified 16 complications in 12/60 (20%) donors after left-lobe donor hepatectomy: 9 (56.2%) were minor (Grade I–II) and 7 (43.7%) were major (Grade III–V) complications.

After hepatectomy for LDLT, the functional remnant volume of living donor liver must be 30%–40% of the total liver volume. When the remnant volume is lower, small-for-size syndrome, characterized by hyperbilirubinemia, extended international normalized ratio, and acid in the abdomen, is observed. Some donors have been reported to require LT because of hepatic failure after LDLT. Major risk factors for hepatic failure in living donors after hepatectomy are excessive hepatectomy, steatosis, and ischemic congestion injury due to hepatectomy failure.[13,14] Five donors (2 from the United States, 2 from Europe, and 2 from Japan) required LT due to the rare complication of hepatic failure after left hepatectomy for LDLT. One of these donors healed after LT, but the other 4 died.[15] In the present study, small for size syndrome was observed in 1 (7.6%) donor after left-lobe donor hepatectomy. Small for size syndrome has been reported in up to 70% hepatectomy with steatosis and/or undergoing right-lobe living-donor hepatectomy in donor,[16] but this complication is not expected to develop after 30%–50% left-lobe donor hepatectomy procedures in the donor. In 1 of our patients who underwent left lateral segmentectomy, hepatic failure was considered to occur after short-term functional failure of the remnant liver volume due to hepatosteatosis. The small for size syndrome regressed in this patient after two MARS sessions, and the patient was discharged from the hospital in a healed condition.

Renz et al[17] reported that complication rates were higher in centers in which LT was performed only rarely and in donors who underwent right hepatectomy, who had smaller remnant liver volumes than donors who underwent left hepatectomy. In a study conducted previously in our clinic, the complication rate was higher in donors who underwent left hepatectomy than in those who underwent right hepatectomy or left-lateral hepatectomy.[18] In the present study, postoperative complications occurred in 40% of donors who underwent left hepatectomy and in 13.3% of 45 patients who underwent left lateral segmentectomy, but this difference was not statistically meaningful. The higher complication rate in donors who underwent left hepatectomy in our center may be because this procedure is performed in our clinic only infrequently.

Donor deaths following hepatectomy have been reported. Totter et al[5] reported the deaths of 19 donors worldwide in 2006. The most significant case was the death of a 29-year-old woman who underwent left-lobe hepatectomy due to pulmonary embolism 48 hours postoperatively. The most common reasons for donor death are sepsis, liver failure, myocardial ischemia, cerebral hemorrhage, pulmonary embolism, and peptic ulcer complications.[5] A multicentric study reported a 0.2% donor mortality rate following left lobe hepatectomy.[8] One case of donor liver failure (Grade IIIa complication) has been observed at our center, but no donor mortality has occurred to-date.

LDLT is a safe procedure for donors and an effective therapeutic approach for patients with end-stage liver disease. Left-lobe donor hepatectomy for LDLT, which does not benefit the completely healthy donor, can be performed safely with low complication rates, but carries the risk of morbidity. Low morbidity rates following living-donor hepatectomy can be expected when surgical and clinical monitoring and follow-up are adequate and the surgeon has gained increased experience.

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