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Outcomes and Safety of Living Donor Hepatectomy for Liver Transplantation: A Single-Center Experience

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Abstract

Background and Objectives: Donor hepatectomy for living related liver transplantation (LRLT) has been using widely worldwide, particularly in countries that face a shortage of deceased donors. In this study, the outcomes and safety of donor hepatectomy were aimed to be examined.

Methods: Total of 69 donor hepatectomies have been performed between 2006 and 2020. All data were collected retrospectively from hospital charts. Donor evaluation starts with whole blood tests, viral load, blood group analysis. Later, all donors evaluated by the transplantation surgery, gastroenterology, pulmonary, cardiologic and psychiatric teams.

Results: Of the 69 living liver donors, 28 (41%) were female, 41 (59%) were male, 39 (57%) for pediatric and 30 (43%) for adult recipient, respectively. The mean age of the donor was 35 ± 10.5 years (range, 21-60). Among the donors, 25 (36%) donors underwent to right lobectomy without middle hepatic vein, 28 (41%) left lobectomy and in 16 (23%) left lateral (LL) lobectomy. Totally 8 (12%) surgical complications were seen (n=6 early, n=2 late complication) in median 100 months (range 44-205) follow-up period.

Conclusion: Our study demonstrates favorable outcomes and safety profiles of donor hepatectomy for LRLT at our center. The meticulous evaluation process, comprehensive surgical planning, and multidisciplinary approach contribute to the success of the procedure.

Keywords: Complication, Donor hepatectomy, Liver transplant, Outcome

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1. Introduction

Living donor hepatectomy has become a widely practiced procedure across the globe for liver transplantation (LRLT), particularly in countries that face a shortage of deceased donors. While cadaveric donations

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↑*Question* *What are the outcomes and safety profiles of living donor hepatectomy for liver transplantation in regions facing a shortage of deceased donors?*

Findings *Our single-center study demonstrated that out of 69 living donors, the majority experienced a safe recovery with only 12% developing surgical complications. Early complications included bleeding and bile leaks, all of which resolved without invasive interventions. No vascular or Clavien Grade II-IV complications were noted. Left lobectomy was the most common procedure performed, and 88% of donors remained complication-free during a median follow-up period of 100 months.*

→*Meaning* *This study emphasizes the importance of comprehensive preoperative evaluation and meticulous surgical technique to minimize complications and improve donor safety. Living donor hepatectomy remains a viable and safe option for liver transplantation, particularly in regions with a limited supply of deceased donors. Establishing donor selection criteria, ensuring adequate remnant liver volume, and utilizing a multidisciplinary team approach are crucial to successful outcomes in living donor liver transplantation.*

remain the primary source for organ procurement in Western countries, living donors are the main source in Asian countries (1).

The advent of solid organ transplantation in Turkey can be traced back to 1975 when the first successful living-related kidney transplant took place. Spearheaded by Prof. Dr. Haberal, this groundbreaking achievement paved the way for significant developments in the field. Recognizing the significance of organ transplantation, the Turkish Parliament passed a specialized law in 1979. Subsequent clinical and laboratory investigations led to another milestone in 1988 with the country's inaugural liver transplant, once again led by Prof. Dr. Haberal. Building upon these achievements, the medical team accomplished the first successful partial living-donor liver transplant in children on March 15, 1990. Shortly thereafter, on April 24, 1990, Prof. Dr. Haberal and colleagues performed Turkey's first liver transplant in a child using a left lateral segment from a living donor (2). After this date, a significant and rapid momentum was gained in LRLT in Türkiye.

After five decades of experience, liver transplantation has become a highly successful treatment for end-stage hepatic disease, with short-term survival rates ranging from 85% to 90% and long-term survival rates around 75% (2-4). In recent years, short-term survival after transplantation has become less of a metric for success and more of an expected outcome (4). Donor hepatectomy for LRLT has gained widespread acceptance and is now widely practiced around the world. This study aimed to assess the outcomes of living donor hepatectomy procedures conducted at our center.

2. Material and Methods

A total of 69 donor hepatectomies have been performed at Gazi University Organ Transplantation Center between 2006 and 2020. All data were retrospectively gathered from hospital records. Primary selection criteria for LRLT donors included voluntary and informed consent recognition of the potential risks of donor mortality or residual disability, and meeting the following acceptance criteria: (1) relationship within the fourth degree of relativity or a spouse to the recipient (married > 2 years; If the donor/recipient cannot prove the relativeness, or any doubted that does not fulfil the criteria, they have been sent to City Ethical Committee) and (2) absence of medical disorders that could affect postoperatively or history of a malignant disease.

Donor evaluation begins with whole blood tests, viral load assessment, and blood group analysis. Subsequently, all donors are assessed by the gastroenterology, transplantation surgery, pulmonary, cardiology, and psychiatric teams. Then, magnetic resonance cholangiopancreaticography (MRCP) is performed with 3D celiac computed tomography (CT) angiography to assess the anatomy of the hepatic vasculature and biliary tree. If MRCP is inconclusive, intraoperative cholangiography was conducted. In each case, our institutional transplantation committee was the final judge of whether a living donor candidate's approval. All donors' hepatectomies were performed by same group of transplantation surgeons in the same unit.

The demographics (age and gender), the relationship between the recipient and donor, the donor's body mass index (BMI), the type of donor hepatectomy performed (right lobectomy, left lobectomy or left lateral lobectomy), the liver volume, graft-recipient body weight ratio, intraoperative blood transfusion, length of hospital stay, follow-up period, the surgical complications were categorized using the Clavien-Dindo Classification System for adverse outcomes in general surgery and solid organ transplantation (5), and the management of complications were recorded. We classified short-term complications as those occurring within 4 weeks post-operation, medium-term complications as those occurring between 4 weeks and 3 months, and long-term complications as those occurring after 3 months.

All procedures involved in this study were conducted in compliance with the ethical guidelines set forth by the relevant institutional and national research committees, as well as in accordance with the principles outlined in the 1964 Helsinki Declaration and its later amendments, or other comparable ethical guidelines. The study received approval from the Local Ethical Committee of Gazi University Faculty of Medicine (approval number: 09.06.2023-534).

Statistical analysis was conducted using SPSS software (version 20). Results are presented as means ± standard deviation (SD) or as median values with ranges. Descriptive statistics were used to analyze the relevant variables.

3. Results

Of the 69 living liver donors, 28 (41%) were female, 41 (59%) were male, 39 (57%) for pediatric and 30 (43%) for adult recipient, respectively. Among 69, there were first degree 38 (55%), second degree 27 (39%), third degree 2 (3%) and fourth degree 2 (3%) were identified. The mean age of the donor was found 35 ± 10.5 years (range 21-60). The donor's mean BMI was 28 ± 1.5 kg/m^2 (median 28). Among the donors, 25 (36%) donors underwent to right lobectomy without middle hepatic vein, 28 (41%) left lobectomy and in 16 (23%) left lateral (LL) lobectomy. The median future remnant liver volume for right hepatectomy was 39% (range 29.5-51), for the right lobe graft-recipient body weight ratio 1.2% (range 0.8-2.5), for LL lobe graftrecipient body weight ratio 2% (range 1-3.5), mean intraoperative blood transfusion 2 ± 1.9 U (0-13) respectively. The median duration of the postoperative stay for donors 9 days (range 6-28) (Table 1).

Totally 8 (12%) surgical complications were seen (n=6 early, n=2 late complication) in median 100 months (range 44-205) follow-up period (Table 2). The median follow-up periods for R, L, and LL lobectomy were 96 months (range 44–188), 99 months (range 45–167), and 101 months (range 72–205), respectively. An early surgical complication, specifically bleeding, occurred in only one patient (1%). This patient was immediately re-explored. Bleeding was originating from left gastric artery (LGA) stump (LL lobe's artery was originating from LGA). After uneventful early postoperative follow-up, he was discharged on postoperative day 7. Cholangitis occurred in two donors (3%) on the 3rd and 5th postoperative days (5)

Table 1. Living donor hepatectomy demographics and characteristics

Donor Characteristics	
Gender	
Female	28 (41%)
Male	41 (59%)
Relationship degree	
First	38 (55%)
Second	27 (39%)
Third	2 (3%)
Fourth	2 (3%)
Mean age (year)	35 ± 10.9 (range 21-60)
Median - Mean BMI* (kg/m^2)	28 - 28 ± 1.5 (range 23-32.5)
Median GRBWR** (%, R†)	1.2 (0.8-2.5)
Median GRBWR (%, LL‡)	2 (1-3.5)
Type of lobectomy	
Right lobectomy (without MHV#)	25 (36%)
Right lobectomy (with MHV)	0 (0%)
Left lobectomy	28 (41%)
Left lateral	16 (23%)
Mean future remnant liver volume (%) for R†	39.8 ±10% (median 39%)
Median hospital stay (day)	9 (range 6-28)
Mean intraoperative blood transfusion (unit)	2 ± 1.9 (range 0-13)

*BMI: Body mass index, #MHV: Middle hepatic vein, **GRBWR: Graft-recipient body weight ratio, †R: right lobe, ‡LL: left lateral lob

(Table 2). Both donors were treated with antibiotics and discharged without complications on postoperative day 14 and 13, respectively.

Bile leak was observed in three patients (4%) after donor hepatectomy on postoperative day 5, 7, and 10, respectively. All three donors had right lobe donor hepatectomy. Magnetic Resonance Cholangiography was performed to all patients after surgery to provide detailed images of the bile ducts and to determine the precise location of bile leak. And found that all three leaks coming from cutsurface of the remnant liver. None of them have required any surgical, endoscopic or radiologic interventional approach; all have resolved spontaneously.

As late surgical complication two incisional hernias were detected on postoperative month 14 and 25, respectively. Eighty-eight percent of the donors are complication free, and also we have not seen any vascular, Clavien Grade II or IV complications after donor hepatectomy surgery in this study.

4. Discussion

Experienced centers performing LRLT have developed algorithms that consider various crucial factors, including the donor's age, BMI, vascular anatomy, biliary structure, graft selection, postoperative care, adequate future remnant liver volume, precise surgical technique, and the expertise of both the center and surgeons, all aimed at minimizing complications and managing complex cases effectively. However, there is no consensus on how these parameters specifically influence the occurrence of complications.

Table 2. Postoperative complications

Total complications	8 (12%)
Early postoperative complications	6 (9%)
Clavien Grade I	
Cholangitis	2 (3%)
Bile Leak	3 (4%)
Clavien Grade II	
Bleeding	1 (2%)
Late postoperative complications	2 (3%)
Incisional hernia	2 (3%)

The results of this study demonstrate the successful outcomes and safety of donor hepatectomy for LRLT at our center. We performed a total of 69 donor hepatectomies between 2006-2019, with a majority of male donors (41 out of 69) and a mean age of 35 years. The evaluation process involved comprehensive assessments by various medical specialties to ensure the suitability of the donors.

In order to prioritize donor safety, it is imperative to ensure that the future remnant liver volume exceeds the standard liver volume (35%) in the context of right lobe-based living donor liver transplantation (6). Regarding the type of hepatectomy performed, we observed that left lobectomy (28 cases) was the most common procedure, followed by right lobectomy (25 cases) and left lateral (LL) lobectomy (16 cases) due to nearly half of the cases were pediatric recipient. The mean liver volume for right hepatectomy was 39.8%, and the median graft-recipient body weight ratio for the right lobe was 1.2%. These parameters indicate that appropriate graft size matching was achieved to ensure optimal outcomes for the recipients.

Studies have consistently reported that when the future remnant liver volume is less than 35% of the total liver volume, it exerts a substantial influence on the restoration of liver functions and the length of stay in both the hospital and the intensive care unit (6-8). In terms of surgical outcomes, the overall duration of the donors' hospital stay was relatively short, with a median of 9 days. We encountered only one case of early surgical complication, specifically bleeding originating from the LGA stump. This complication was promptly identified and managed through re-exploration, highlighting the importance of careful surgical technique and vigilance during the procedure. In a multicenter study involving 246 cases, prolonged operative time, intraoperative hypotension, vascular abnormalities, and intraoperative blood loss have been

identified as multivariable risk factors for postoperative donor complications (9).

The cut surface of the liver, where the liver parenchyma has been divided, is a potential site for bile leakage up to 15.3% (10, 11). Biliary complications have been a significant concern for both donors and recipients. Identifying a bile leak early is crucial as it can be associated with significant morbidity and can prolong the donor's recovery. Prompt intervention, such as drainage of the bile collection and possibly endoscopic or surgical interventions, may be necessary to address the leak and prevent further complications.

Bile leaks can lead to complications such as abdominal pain, infection, biliary peritonitis, or bilioma formation (a localized collection of bile). In our study group we only saw in one patient with bilioma. This and other two patients have had drain that functioning well, thus did not required for percutaneous drainage. All patients' events resolved within 3 months without any problem. In this study, biliary complications were the third most common type of donor morbidity, occurring in approximately 4.5% of cases, which is consistent with the existing literature.

Reports indicate that the incidence of major complications ranges from 2% to 32% across different series (9). In a recent review, it was reported that donor morbidity in living donor liver transplantation ranged from 10% to 78.3% (8). Postoperative complications (12%) were relatively rare in our study. Cholangitis, an infection of the bile ducts, occurred in two donors (%3) at postoperative day 3 and day 5, respectively. These cases were successfully treated with antibiotics, and the donors were discharged without any further issues. Notably, no vascular complications were observed in our cohort, indicating the effectiveness of our surgical approach in preserving vascular integrity.

After donor hepatectomy, incisional hernia development has been reported with a rate of over 5% (7, 12). In our series, this rate was 3% with 2 patients. There is a significantly higher

incidence of incisional hernia in patients who underwent a reversed T incision during partial hepatectomy (13). So we modified our donor hepatectomy incision to either right or left subcostal incision extending to xiphoid (thorough midline) depending on whether it was right or left/LL lobectomy in order able to decrease incision area and for cosmetic reasons (Figure 1). After this modification we have not observed any incisional hernia. It is important to recognize that, various factors, including intraoperative hypotension, excessive blood transfusions, preoperative nutrition, wound infection and conditions leading to increased intraabdominal pressure play a significant role in the postoperative healing process (8-11). These factors should not be disregarded when evaluating the outcomes following the surgical procedure.

The results of this study align with previous research and add to the increasing body of evidence supporting the safety profile and efficacy of LRLT using donor hepatectomy. The high success rate of the LRLT, with one-year survival rates of 85-90% and long-term survival rates around 75%, emphasizes the importance of LRLT in addressing the shortage of deceased donors, especially in countries like ours (2-4). It is advocated that living donor liver transplantation should only be performed in established centers with appropriate medical expertise and sufficient institutional resources. To reduce complications and ensure an adequate functional graft, careful donor evaluation is essential (14).



Figure 1. Modified donor hepatectomy incision (for right lob resection)

However, it is important to recognize the limitations of our study. First, the retrospective natüre of data collection may introduce inherent biases and incomplete documentation. Additionally, the relatively small sample size and single-center experience limit the generalizability of our findings. Future studies with larger cohorts and multicenter collaborations are warranted to further validate our results and assess long-term outcomes.

5. Conclusion

Our study demonstrates favorable outcomes and safety profiles of donor hepatectomy for LRLT at our center. The meticulous evaluation process, comprehensive surgical planning, and multidisciplinary approach contribute to the success of the procedure. These findings support the continued utilization of LRLT as a viable treatment for patients with end-stage liver disease, particularly in regions facing a shortage of deceased donors.

Ethical Statement

This study was approved by the Local Ethical Committee of Gazi University Faculty of Medicine (approval No. 09.06.2023-534) and was conducted in accordance with the Declaration of Helsinki.

Authors' Contributions

RK: Conceptualization and methodology, conducting the study, drafting the article, approval of the final version of the manuscript, HS: Conceptualization and methodology, data collection, data analysis and interpretation, drafting the article, approval of the final version of the manuscript, SS, ÖEG, KA, HÖ, KM, MC and EI: Data collection, data

analysis and interpretation, approval of the final version of the manuscript, BD: Data collection, data analysis and interpretation, drafting the article, revising and final approval of the manuscript, AD: Conceptualization and methodology, data analysis and interpretation, drafting the article, revising and final approval of the manuscript.

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Conflict of Interests

The authors declare that they have no competing interests.

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