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# Anesthetic risks for donors in living-related liver transplantation: analysis of 30 cases

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**Abstract** Liver transplantation involving living-related donors has been adopted in many centers as a way of relieving organ shortage. This study reviewed the anesthetic considerations for donor operations at our institution in relation to intraoperative blood transfusion, complications, and postoperative liver function test results. From January 1990 to May 2001, 30 living-related liver transplantations were performed at Başkent University Hospital, Ankara. The donor data used for analysis were retrospectively obtained through chart review, anesthesia records, and the computerized hospital database. Left lobectomy was performed in 19 cases, and left lateral segmentectomy in 11 cases. Intraoperatively, the average volume of intravenous fluids used was 6431 ± 468 ml, and the average amount of blood transfused was 2.1 ± 0.4 units. The mean postoperative hospital stay was 11.5 ± 1.3 days. The only intraoperative complication observed in these 30 donors was severe bleeding during retrohepatic vena cava dissection in one of the cases. The postoperative complications related to anesthesia were one case each of shoulder pain, neuropraxia, and compartment syndrome. The levels of total and direct bilirubin, aspartate aminotransferase, and alanine aminotransferase peaked within the first 2 postoperative days (2.19 ± 0.36 mg/dl, 1.02 ± 0.18 mg/dl, 245.7 ± 26.6 U/l, 313.5 ± 51.9 U/l, respectively). In all 30 donors, these levels had normalized by 1 month after surgery. Maximal efforts must be applied in the anesthetic approach to minimize donor complications in living-related liver transplantation; however, this will not completely eliminate some risks to the donor.

**Keywords** Living-related liver transplantation · Donor surgery · Anesthesia

## Introduction

Although liver transplantation has been established as the definitive therapy for patients with end-stage liver disease, access to cadaveric donor organs continues to be a major problem for those on waiting lists [1, 2]. This problem is especially severe in developing countries. Living-related liver transplantation is one of the novel approaches that have been developed to alleviate the imbalance between supply and demand in transplantation [3, 4, 5]. However, the potential risks to donors need to be considered, and meticulous perioperative care is required to avoid complications. In this study, we reviewed the anesthetic considerations for our donor cases of living-related liver transplantation with respect to intraoperative blood transfusions, complications, and postoperative liver function test results.

## Patients, methods, and results

From January 1990 to May 2001, 30 living-related liver transplantations were performed at Başkent University Hospital, Ankara. After approval by the hospital Ethical Committee, donor data were obtained through chart review, anesthesia records, and the computerized hospital database. All data were collected by the same anesthesia resident (Ç.E.). The characteristics of the donors are shown in Table 1. Their age ranged from 18 to 56 years (mean: 36.4 ± 1.9 years). All donor candidates were thoroughly investigated to evaluate function of all organ systems. The donors were screened by laboratory testing with complete blood count, liver and renal biochemistry panels, and viral serology. All donors received psychological counseling before the operation. The blood type of each donor was either matched or compatible with that of the corresponding recipient. Ultrasonography, computed tomography (CT), and celiac angiography were also routinely performed. CT volumetry was not done for the first 12 donors, but was performed in the other 18 cases. The distribution of donors in their relation to the recipients was: 13 parents, 8 siblings, 3 spouses, 1 daughter, 1 grandfather, and 4 second-degree relatives.

All donors received oral diazepam (10 mg) and famotidine (40 mg) as pre-medication. In the operating room, we secured intravenous (IV) access with large-bore central (7- or 8-F) and peripheral (14- or 16-G) catheters in all cases. Monitoring included ECG, heart rate, invasive arterial and central venous pressure, pulse oxymetry, and core temperature. Anesthesia was induced with thiopental (5–7 mg/kg), fentanyl (2–5 μg/kg), and vecuronium (0.1 mg/kg) and was maintained with isoflurane and 50% $N_2O/O_2$ mixture in all cases. Intravenous fluid therapy was initiated with routine infusion of 500 ml of colloid solution (hydroxyethyl starch or gelatine) followed by a crystalloid solution. Maintenance of intraoperative fluid and blood transfusions was provided according to observation of hemodynamic status and measurement of coagulation profile. The duration of donor surgery ranged from 8 to 17 h (mean: 11.5 ± 0.4 h). All donors underwent left hepatic resection, with left lobectomy in 19 cases and left lateral segmentectomy in 11 cases.

Ten donors (33.3%) required no blood transfusion. The average amount of whole blood transfusion in all donors was 2.1 ± 0.4 units (range: 0–12 units) and in those with the requirement of blood transfusion 3.2 ± 0.6 units. Only one patient required fresh frozen plasma transfusion. Major blood transfusion was performed in only one donor who received 12 units of whole blood and 2 units of fresh frozen plasma transfusion. Two donors with preoperative anemia required 5 units of whole blood transfusion. Autologous blood transfusion was not performed in any of the cases.

**Table 1** Donor characteristics ($n = 30$)

| | |
|---|---|
| Age (years) | 36.4 ± 1.9 |
| Weight (kg) | 69.7 ± 2.6 |
| Gender | |
| Male | 14 (46.7%) |
| Female | 16 (53.3%) |
| Medical history | |
| Unremarkable[a] | 16 (53.3%) |
| Non-abdominal surgery | 11 (36.7%) |
| Anemia | 2 (6.7%) |
| Peptic ulcer | 1 (3.3%) |
| Relationship with recipient | |
| Parent | 13 (43.3%) |
| Sibling | 8 (26.7%) |
| Spouse | 3 (10%) |
| Grandparent | 1 (3.3%) |
| Child | 1 (3.3%) |
| Second-degree relative | 4 (13.3%) |

[a]Physical examination and biochemical investigation of all organ system functions were normal

Intraoperatively, the average volume of all intravenous fluids used was 6431 ± 468 ml. Apart from the donor with the intraoperative bleeding complication, hypotension was not a problem in any of the cases. The other 29 donors did not have any hypotensive episode and did not require inotropic and/or vasopressor support at any time during surgery. It appears that the blood transfusion requirement was greater in the cases of left lobectomy than in lateral segmentectomy (2.7 ± 0.6 units vs 1.2 ± 0.5 units, respectively), although the difference was not statistically significant. The volume of fluids administered intraoperatively in the two types of procedures was significantly different (7444 ± 610 ml in lobectomy vs 4772 ± 377 ml in lateral segmentectomy, $P = 0.002$). Intraoperative normothermia was maintained by means of external heating (Bair Hugger). Core temperatures below 35°C were not allowed in any of the donors. All donors were extubated in the operating room. They were transferred and closely monitored for 24 h in the intensive care unit. Postoperative analgesia was provided by patient-controlled analgesia (PCA), using intravenous morphine sulphate or meperidine. Epidural catheters were not used for postoperative pain control.

There were no complications during the evaluation period before surgery. Intraoperatively, one donor developed severe bleeding from the retrohepatic vena cava at the end of the splitting procedure. This required massive blood transfusion (12 units of whole blood, plus 2 units of fresh frozen plasma) and both vasopressor and inotropic support. He did not have any hemodynamic or coagulation problems during the rest of the operation. The postoperative course was uneventful, and the donor was discharged on postoperative day 7 without any sequelae. Three donors had postoperative complications related to the intraoperative period, including one case each of shoulder pain, neuropraxia, and compartment syndrome. The complaint of shoulder pain was expressed early after surgery. It was not associated with biliary leakage or bleeding, which could cause referred pain from the diaphragm. There was no additional neurological symptom, and the pain resolved spontaneously within 1 week. Another donor had numbness and motor weakness in her right heel and subsequently developed foot drop. These symptoms resolved spontaneously within 2 months, and there were no long-term sequelae. The most serious complication we encountered was compartment syndrome in the right leg of a female donor. This was related to the pressure applied by surgical instruments during the long operation. Fasciotomy was performed on postoperative day 3, and the donor was discharged on day 10 with no neurological sequelae [6]. None of the donors developed stress-related gastrointestinal symptoms, and there were no infectious, coagulopathic, or hemodynamic complications. Biliary leakage was encountered in two cases which were treated with percutaneous drainage. There was no donor mortality.

The mean postoperative hospital stay was 11.5 ± 1.3 days (range: 4–36 days). The duration was more than 7 days for 20 of the donors. The donors with shoulder pain and neuropraxia were among this group. The hospital stay was prolonged more than 10 days in 13 cases, amongst which were the donors with intraoperative bleeding and postoperative compartment syndrome.

Data on the postoperative serum levels of total and direct bilirubin, alanine aminotransferase (ALT), and aspartate aminotransferase (AST) are shown in Fig. 1. Peak levels of AST and total bilirubin were reached on postoperative day 1 (245.7 ± 26.6 U/l and 2.19 ± 0.36 mg/dl, respectively), and peak ALT and direct bilirubin levels were observed on postoperative day 2 (313.5 ± 51.9 U/l and 1.02 ± 0.18 mg/dl, respectively). All values decreased during the first week after surgery, but were still above normal at the time of discharge. By the end of the first postoperative month, the levels were all within the normal range. Analysis

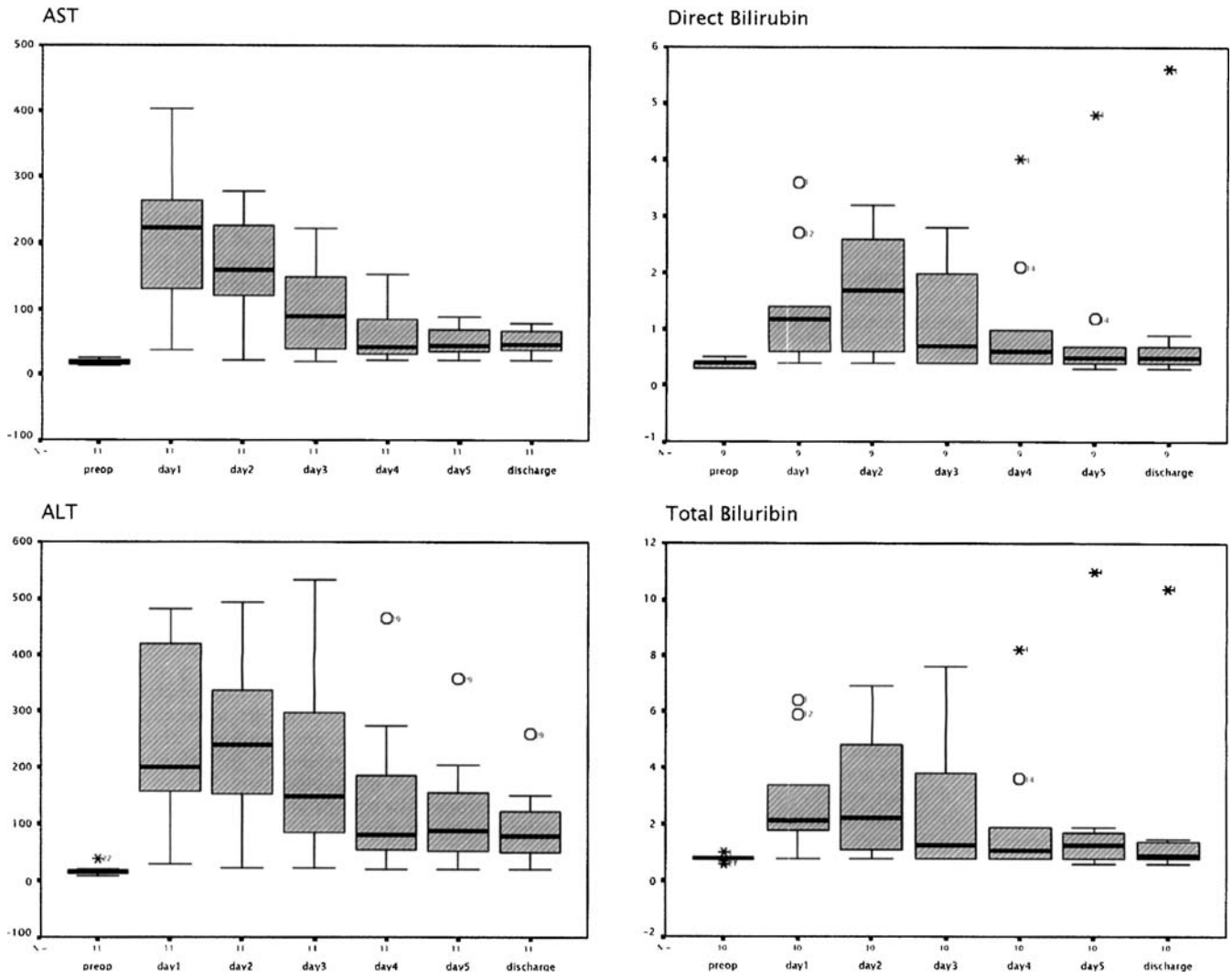


**Fig. 1** Serial changes in serum levels of AST and ALT (in U/l) as well as total bilirubin and direct bilirubin (in mg/dl)

of bilirubin and enzyme findings according to surgical technique showed that the levels and serial patterns were similar in the lobectomy and lateral segmentectomy cases ($P > 0.05$). Spot measurements were also performed for other parameters evaluating the status of liver function and coagulation, but they were not recorded on a daily basis.

All data are expressed as mean ± SEM. Statistical analysis was performed using the program SPSS 10.0 for Windows. The Student's *t*-test was used to compare samples between groups, and we used the Friedman and Wilcoxon tests to analyze measurements of liver function tests over time. *P*-values of less than 0.05 were considered statistically significant.

## Discussion

This report focuses on the anesthetic aspects of living-related liver transplantation in terms of blood requirements, complications, and liver function test results in 30 healthy adult donors. Living-related liver transplantation is an alternative treatment that offers many advantages to recipients. The operation is done on an elective basis and can thus be carefully planned. The recipient is in better health since the timing of surgery is not dependent on cadaveric organ availability. Also, the anxiety of being on a long waiting list is avoided. Compared to results with cadaveric liver transplantation, graft outcome with live donors has been shown to be superior [2, 7].

In contrast to the situation for recipients, there are still considerable reservations about subjecting a donor to major surgery. The main issues connected with this procedure are the surgical risks and psychological stress to which donors are exposed [8, 9]. Moreover, the definitive rates of morbidity and mortality have not yet been determined. Also, there are very few data on the perioperative complications and long-term outcome of living-related liver donors. The reasons for this are that no national registry follows these individuals and that

the numbers reported in most series are too small to allow strong conclusions concerning the risks involved with the procedure [7]. In light of this, it is important that all complications regarding the donor procedure be fairly documented.

The risks to the donor include such associated with invasive testing before surgery and the surgical procedure itself. The donor's operative morbidity has been reported to be very low (10–15%, depending on the extent of resection), with biliary leakage, wound infection, and gastroduodenal ulceration being the most frequent complications [10]. The most important potential danger during donor hepatectomy is bleeding, which can be serious in the deeper plane of transection near the middle hepatic vein [11]. Major bleeding is associated with a decrease in blood flow and ischemic injury to the liver and other organs. One of the donors in our series developed serious intraoperative bleeding, which we managed by aggressive treatment with blood transfusion and pharmacological resuscitation.

Another risk to the donor is bile duct injury resulting in biliary stricture or leakage [11]. We encountered two cases of biliary leakage (6.67%) in the early postoperative period. Neither of these was related to anesthetic management, and no anesthetic intervention was required.

A further potential issue is viral infection due to transfusion of exogenous blood or blood products. Many centers routinely collect autologous blood preoperatively in order to avoid transfusion complications [12]. Currently, autologous blood collection is not part of our routine protocol, but the authors are strongly advocating to implement this to better protect donors. Fortunately, we did not observe any serological conversion postoperatively in terms of viral infection.

Studies have reported various findings on the relationship between type of donor hepatectomy and intraoperative transfusion requirements, biliary complications, and postoperative liver function test results [2, 7, 13]; however, we did not investigate the connection with type of donor hepatectomy in this study. Singer at al. [14] demonstrated that donor risks and benefits are comparable to those in accepted procedures for transplantation with living donors, such as kidney or pancreas transplantation. Grewal et al. [7] presented their results with 100 living liver donors, defining major complications as those that required surgical intervention. They listed a total of 34 complications, including 20 minor and 14 major ones. Similarly, Yamaoka et al. [8] reported a 15% incidence of postoperative complications, and Sterneck et al. [9] reported a 20% incidence of major complications, including one death from pulmonary embolism. In the total series, two donors died (mortality rate $<0.2\%$), both due to thromboembolic complications [10]. The only minor complication related to anesthesia encountered in our 30 donors was shoulder pain (3.3%). It was possibly due to extensive retraction in order to provide good surgical exposure or overstretching of the arm during surgery, and it resolved spontaneously within a week. Apart from this case, one intraoperative complication of massive bleeding and the two other postoperative problems of neuropraxia and compartment syndrome resulted in a total of three major complications (10%) related to the intraoperative period in our series. This constitutes an overall rate of 13.3% for anesthesia-related complications. All three postoperative problems (shoulder pain, foot drop, and compartment syndrome) were thought to be due to malpositioning of the donor's body during long surgery. Proper positioning is the obligation of all members of the surgical team, including anesthesiologists. Every effort must be made to minimize, if not completely eliminate, this type of risk. The donor should be carefully positioned and prepared on the operating table in order to avoid sores at pressure points. Also, it is important to check regularly for external mechanical pressure from instruments during the lengthy surgery and to make intermittent positional changes as needed. None of the complications in our donors was associated with long-term neurological sequelae.

The duration of hospital stay was longer in our donor cases than that reported in the literature [15, 16]. However, most of the donors volunteered to stay longer than required in order to care for their recipient, especially the pediatric cases. This increased the mean hospitalization time.

The rate of anesthetic complications found in this study is comparable to that documented in the literature as surgical complications [10]. Addition of two biliary leakage cases to the four major anesthesia-related complications encountered in this study results in an overall morbidity of 16.7% in our series. Although anesthetic care and perioperative complications have been presented in some reports, the incidence of anesthesia-related complications in living-related liver transplantation has not yet been well documented. Beebe et al. [15] presented the anesthetic records of 12 donors, and perioperative anesthetic care was uneventful in all of them. Choudhry et al. [16] discussed postoperative complications in 22 donors. They encountered four minor complications in three of the donors (18.1%).

Many series have documented a trend towards increased liver enzymes after donor surgery in living-related liver transplantation and have noted similar times to peak levels [2, 10, 17, 18]. As we observed, the levels peak in the first few postoperative days and return to normal within weeks.

Living-related liver transplantation is a very important treatment modality for end–stage liver disease, especially in countries where programs are hindered by severe cadaveric donor organ shortage. Based on our experience, we encourage the use of this technique and

look ahead to further surgical and technological improvements. Our findings emphasize the importance of perioperative anesthetic care for living liver donors. Thorough consideration and meticulous anesthetic management are required to minimize complications that are independent of surgical technique. Careful attention will increase success in these operations, and maximal efforts must be made with regard to all aspects of the anesthetic approach; however, this will not completely eliminate some risks to the donor.

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