Transpl Int (2003) 16: 461–464
DOI 10.1007/s00147-002-0480-3

ORIGINAL ARTICLE

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The safety of the donor operation in living-donor liver transplantation: an analysis of 45 donors

Received: 8 October 2001
Revised: 26 April 2002
Accepted: 8 July 2002
Published online: 22 May 2003

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Abstract We retrospectively assessed the safety of the donor operation, based on parameters such as blood loss, blood transfusion, operation time, duration of hospitalization, and complications. Forty-five pediatric and adult recipients underwent living-donor liver transplantation (LDLTx) in Tohoku University Hospital from July 1991 to October 2000. Donor operations were classified into three groups. In the LS group, the graft was the lateral segment ($n=20$); in the LL group, the graft was the left lobe without the middle hepatic vein ($n=16$); and in the LLM group, the graft was the left lobe with the middle hepatic vein ($n=9$). No significant differences were observed among the three groups regarding postoperative liver function or duration of hospitalization. In the LS group, the operation time was shorter and the requirement of autologous blood transfusion was significantly lower than in the other two groups. Most complications following retrieval of the graft were minor. Safety is guaranteed when the left lobe or the left lateral segment is used for LDLTx, but meticulous management of the operation is required to prevent complications.

Keywords Living-donor liver transplantation · Donor operation · Lateral segment · Left lobe

Introduction

At present, living-donor liver transplantation (LDLTx) is performed all over the world including Japan to compensate for the shortage of donor grafts. In Japan, the brain-death law was approved in 1997, and since then, only 13 cadaveric liver transplantations were performed up to August 2001 (personal communication). For this reason, LDLTx is still the most common procedure for end-stage liver disease, especially for children, in Japan. In LDLTx the donor is exposed to the risks inherent in a surgical operation, and might experience a considerable psychological burden [3]. Therefore, the safety of the donor operation must be guaranteed while the viability of the graft is maintained. In our institute we transect the donor liver without using the vascular occlusion technique [4] and inject gabexate mesilate into the portal vein after cannulation to maintain the viability of the graft [2]. We retrospectively reviewed the safety of our donor operations based on parameters such as blood loss, blood transfusion, operation time, duration of hospitalization, and complications. The purpose of this study was to clarify the risks and safety of the donor operation in LDLTx.

Materials and methods

Informed consent was obtained from both donors and recipients. All procedures were reviewed and approved of by the ethical committee of Tohoku University School of Medicine and have therefore been performed in accordance with the ethical standards of the Declaration of Helsinki.

Subjects

Forty-five pediatric and adult recipients underwent liver transplantation from living donors in Tohoku University Hospital from July 1991 to October 2000. The 45 donors were: 23 mothers, 19 fathers, one brother, one son, and one husband. Their mean age, weight, and height were, respectively, 35.1 years, 57.4 kg and 162 cm. None of the donors showed abnormal data in blood tests on pre-operative assessment.

Donor operation

The operation procedure was as follows: laparotomy was carried out via an inverted T-shaped incision. Liver biopsy was performed, and absence of abnormality was ascertained histopathologically. Then we cannulated the portal vein of the meso-colon to infuse gabexate mesilate continuously, to prevent deterioration of the microcirculation of the graft. Intra-operatively, ultrasonography was used to confirm the position of the hepatic veins. Hepatic arteries were isolated, with papaverine hydrochloride used to prevent arterial spasm. Cholangiography was performed to identify the left hepatic duct, which was divided after cholecystectomy. After isolation of the portal vein, the liver parenchyma was transected without interruption to the blood supply. The transection line for lateral segmentectomy was along the falciform ligament, which is the border of segments 3 and 4. The transection line for left lobectomy without the middle hepatic vein was a few millimeters to the left of the middle hepatic vein. The transection line for left lobectomy with the middle hepatic vein was a few millimeters to the right of the middle hepatic vein. After division of the liver parenchyma, we waited for 1 h to allow the graft to recover from the surgical injury and perfused it with lactate Ringer solution from the left portal vein. This was followed by division of the hepatic artery and vein. If disturbance of the circulation in segment 4 or the Spiegel lobe was observed after the retrieval of the graft, we resected the region. Donor operations were classified into three groups as follows: LS group, the graft was the lateral segment ($n=20$); LL group, the graft was the left lobe without the middle hepatic vein ($n=16$); LLM group, the graft was the left lobe with the middle hepatic vein ($n=9$).

Examination items

We evaluated, in donors, blood loss, blood transfusion, operation time, postoperative liver function, complications, and the length of hospitalization.

Statistical analysis

Data are expressed as the mean ± standard deviation (SD). Statistical analysis was by one-way analysis of variance, followed by Scheffe's multiple comparisons procedure. Statistical significance was defined as $P<0.05$. All calculations were made with the Stat View software package (SAS Institute, Cary, N.C., USA).

Results

Age, weight and height of the donors are shown in Table 1. There were no significant differences in weight and height among the three groups, but the average age in the LS group was significantly lower than that of the other two groups. The weight of the graft was significantly higher in the LLM group than in the LS and LL groups. The operation time in the LS group was significantly shorter than that in the other two groups (Table 1).

Blood loss in the LLM group was significantly high, compared with the other two groups. No blood transfusion was required for 13 donors in the LS group and three in the LLM group, while the volume of autologous blood transfused intra-operatively was significantly smaller in the LS group than in the other two groups. Heterologous blood transfusion was required for one donor of the LLM group. Liver function tests performed after the operation showed no significant differences in AST or ALT among the three groups (Table 2).

Postoperative complications occurred in five donors in the LS group, two in the LL group, and three in the LLM group (Table 3). Most postoperative complications were treated without surgical procedure. A donor in the LL group, suffering from sepsis and respiratory distress secondary to an intra-abdominal abscess, was subjected to a drainage operation and was discharged after 64 days of hospitalization. Most of the major complications, such as bile leakage and intra-abdominal abscess, occurred early after we started LDLTx. After donor No 6, we experienced only several minor complications, such as wound infections. All donors returned to their pre-donatory activities within 1 year. There were no donor deaths in our series. There were no significant differences among the three groups with regard to the duration of the hospitalization (Table 3).

Discussion

Singer et al. [6, 7] and Goldman [1] reported that the safety of the donor operation in LDLTx was comparable to that of the living-related kidney or pancreas transplantation. We retrospectively assessed 45 donor operations and found that severe complications had

Table 1 Age, weight, height, graft weight and operation time

Characteristic	LS ($n=20$)	LL ($n=16$)	LLM ($n=9$)
Age (year)	31.1 ± 5.97	36.6 ± 5.45*	41.2 ± 8.61†
Weight (kg)	56.6 ± 7.76	56.9 ± 7.29	60.2 ± 10.1
Height (cm)	164.2 ± 7.37	161.1 ± 8.59	160.8 ± 8.44
Graft weight (g)	228 ± 29.8	270 ± 44.3*	367 ± 55.1†‡
Operation time	7 h 32 min ± 54 min	9 h 23 min ± 1 h 17 min†	9 h 2 min ± 2 h 16 min†

*$P<0.05$ vs. LS
†$P<0.01$ vs. LS
‡$P<0.01$ vs. LL

Table 2 Blood loss, blood transfusion and postoperative liver function

Parameter	LS ($n=20$)	LL ($n=16$)	LLM ($n=9$)
Blood loss (ml)	512 ± 310	743 ± 348	1260 ± 747†‡
Blood transfusion			
Autologous	7/20	16/16	6/9
Milliliters	118 ± 183	501 ± 167†	533 ± 425†
Heterologous	0/20	0/16	1/9 (600 ml)
No transfusion	13/20	0/16	0/9
Postoperative liver function			
AST (IU/l)[a]	294 ± 220	294 ± 183	326 ± 192
ALT (IU/l)[a]	344 ± 183	341 ± 157	445 ± 302

†$P < 0.01$ vs. LS
‡$P < 0.05$ vs. LL
[a]Maximum value after the operation

Table 3 Complications and duration of hospitalization (*DIC* disseminated intravascular coagulation)

Characteristic	LS ($n=20$)	LL ($n=16$)	LLM ($n=9$)
Complications	5/20	2/16	3/9
Biliary fistula	4 (cases 30, 32, 40, 44)	2 (cases 3, 6)	1 (case 4)
Wound infection	1 (case 2)	1 (case 6)	2 (cases 28, 37)
Intra-abdominal abscess	1 (case 2)	1 (case 6)	0
DIC, sepsis	0	1 (case 6)	0
Hospitalization (days)	13.4 ± 4.67	16.6 ± 15.8	15.6 ± 11.9

occurred only in the early period after we started LDLTx at our hospital. In most cases, however, the donors recovered without the need for surgical treatment. The most recent 39 donors developed no major complications. The decrease of donor complications was associated with the improvement of our surgical technique. Especially after donor No 6, we performed an operative cholangiography in all cases, which effectively prevented biliary injuries, decreasing the incidence of major complications. Renz and Roberts [5] reviewed the long-term complications of LDLTx. They reported routine donor hospital stays of under 10 days; average donor blood losses were approximately 400 to 800 ml, and the need for heterologous blood transfusion for the donor was uncommon. Compared with these data, at our institution, donor hospital stays were a little longer and average donor blood losses and the need for heterologous blood transfusion for the donor were similar. Moreover, they reported an overall incidence of complications ranging from 15%–20%. Biliary complications were the most commonly reported source of donor morbidity, with an overall incidence of 5%–10%. In our series, the overall incidence of complications was 22%, and that of biliary complications, 16%.

The risk for donors in LDLTx can be effectively minimized, but it cannot be completely eliminated. Therefore, we should pay close attention to the donor's general condition during and after graftectomy, in addition to preserving the viability of the graft. We continuously injected gabexate mesilate to suppress blood coagulation [4]. After division of the liver parenchyma, we waited for 1 h to allow the graft to recover from the surgical manipulation, however, we have no data on this. Moreover, we retrieved the graft without vascular occlusion, since the viability of the grafts without vascular occlusion has been reported to be better than that of cadaveric grafts [2]. These procedures might contribute to improve liver microcirculation and function after the retrieval of the graft.

In LDLTx, the donor is exposed to the risks inherent in a surgical operation, which may be a considerable psychological burden [3]. Before we carry out the donation procedures, therefore, all donors are assessed by psychiatrists, at our institution.

LDLTx is a promising option to resolve end-stage liver disease. To fulfill the wishes of the donors, thorough consideration and meticulous management during and after the donor operation are required.

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