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Assessment of Graft Selection Criteria in Living-Donor Liver Transplantation: The Jikei Experience

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In living-donor liver transplantation, graft selection is especially important for the safety of the live donor and an acceptable outcome for the recipient. The essential medical requirements for living liver donation at Jikei University Hospital are as follows: an adult aged 65 years or younger, in good general condition, with partial liver volume of more than 35% of the standard liver volume (SLV) for the recipient, and without severe liver steatosis. Based on our criteria, we performed 13 living-donor liver transplantations between 2007 and 2013, including 1 retransplantation. Three cases were outside our standard donor criteria, including age (18 and 66 years) and 33% graft volume (GV) to SLV ratio for the recipient on preoperative volumetry using computed tomography. In 2 cases, the actual GV to SLV ratio at transplantation was less than 35%. Median postoperative hospital stay was 11 days for the donors, and 29 days for the recipients. All donors returned to their preoperative status, and all recipients were discharged in good condition. Our medical requirements for living liver donation seem to be acceptable because of the good outcome.

Key words: Living-donor liver transplantation – Graft selection – Prognosis

Because of difficulty with cadaveric organ donation, living-donor liver transplantation in Japan has evolved to be an effective therapeutic option for end-stage liver disease. In living-donor liver transplantation, graft selection is especially important for the safety of the live donor and an acceptable outcome for the recipient.[1] For this study, we retrospectively assessed our graft selection criteria.

Patients and Methods

The essential medical requirements for living liver donation are as follows: an adult aged 65 years or younger, in good general condition, with partial liver volume of more than 35% of the standard liver volume (SLV) for the recipient on preoperative volumetry using computed tomography (CT), and

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Table 1 Recipient characteristics and clinical variables

Case	Age (years)	Sex	Diagnosis	Type of graft	GV to SLV ratio on CT	Actual GV to SLV ratio	Postoperative hospital stay (days)	Complications and notes
1	62	M	LC-C	Left + Caudate	44.8	43.1	19	
2	61	M	LC-NBNC	Right	58.3	56.6	32	Hepatic vein stenosis
3	47	M	LC-C	Right	46.2	47.5	29	HAT Died due to FCH 35 months after LDLT
4	46	F	PBC	Left + Caudate	49.5	41.0	22	
5	12	F	BA, PVT	Left + Caudate	47.4	40.6	33	Reoperation due to PVT on POD5
6	45	F	PBC	Left + Caudate	33.3	42.7	15	
7	47	F	PBC	Left + Caudate	51.0	37.5	19	
8	43	M	PSC	Left + Caudate	38.1	27.8	24	
9	46	M	PBC	Right	57.9	66.5	46	Chylous ascites
10	45	M	PSC	Right	47.5	53.9	53	Late-onset biliary stenosis Retransplant due to recurrence of PSC
11	57	F	PBC	Left + Caudate	35.4	35.8	55	Bile leakage
12	51	F	PBC	Left + Caudate	39.0	32.4	23	
13	60	F	PBC	Left + Caudate	46.0	45.7	36	

BA, biliary atresia; CT, computed tomography; FCH, fibrosing cholestatic hepatitis; GV, graft volume; HAT, hepatic artery thrombosis; LC-C, liver cirrhosis due to hepatitis C virus; LC-NBNC, liver cirrhosis without hepatitis B or C virus infection; LDLT, living-donor liver transplantation; PBC, primary biliary cirrhosis; PSC, primary sclerosing cholangitis; PVT, portal vein thrombosis; SLV, standard liver volume.

without severe liver steatosis. In brief, according to these prerequisites and medical requirements for living liver donation, we performed 13 living-donor liver transplantations between January 2007 and June 2013 at Jikei University Hospital, including 1 retransplantation for graft failure resulting from a recurrence of primary sclerosing cholangitis. Tacrolimus and steroids were used for initial immunosuppression. For assessment of graft regeneration after transplantation, posttransplant graft volume on postoperative day (POD) 5 was measured using CT.

Statistical Analysis

Spearman's rank correlation coefficient was used for analysis of the relationship between the graft volume (GV) at POD5 to the GV at transplant ratio and the GV to SLV ratio at transplant. *P* values were considered statistically significant when the associated probability was less than 0.05.

Results

Tables 1 and 2 list recipient and live donor characteristics and clinical variables, respectively. Two cases were outside our criteria, including an 18-year-old daughter, a 66-year-old uncle, and 33% of the GV to SLV ratio for the recipient on preoperative volumetry using CT. The extended left lobe graft with the caudate lobe was used in 8 cases; while in the other 4, the right lobe graft without the middle hepatic vein was used. The recipients included 2 with type C cirrhosis, 1 with non-B non-C cirrhosis, 1 with biliary atresia, 6 with primary biliary cirrhosis, and 2 (including 1 retransplantation) with primary sclerosing cholangitis. In 2 cases, the actual GV to SLV ratios at transplantation were less than 35% (28% and 32%, respectively). On assessment of posttransplant graft regeneration, GV at POD5 to GV at transplant ratio was significantly correlated with GV to SLV ratio at transplant by Spearman's rank correlation coefficient (Fig. 1; $P = 0.029$, $r = -0.604$). Graft regeneration was greater in grafts with lower GV to SLV ratio at transplant. Postoperative graft function was good regardless of the GV to SLV ratio at transplantation. Median postoperative hospital stay was 11 days (range, 8–26 days) for the donors, and 29 days (range, 15–55 days) for the recipients. All donors returned to their preoperative status, and all recipients were discharged in good condition. One patient died of graft failure by recurrent hepatitis C at 35 months after transplantation. One patient underwent retransplantation for

Table 2 Donor characteristics and clinical variables

Case	Age (years)	Sex	Relationship	Postoperative hospital stay (days)	Complications
1	32	M	Son	13	
2	55	M	Brother	13	
3	43	F	Spouse	12	Hemorrhage
4	45	M	Spouse	9	Late-onset bile leakage
5	39	F	Mother	13	
6	50	M	Brother	10	
7	18	F	Daughter	12	
8	66	M	Uncle	11	
9	43	F	Sister	10	
10	43	F	Spouse	8	
11	26	M	Son	10	
12	20	F	Daughter	26	Bile leakage
13	52	M	Spouse	8	

graft failure resulting from recurrence of primary sclerosing cholangitis at 30 months after the first transplantation and was able to return to work.

Discussion

Because the causes of graft dysfunction or graft loss are multifactorial, including the recipient status, portal hypertension, blood loss during operation, donor age, graft steatosis, and postoperative complications,[2] recent reports have described no evidence of inferior outcomes with small-size grafts versus large-size grafts.[3] Therefore, development and assessment of graft selection criteria, such as lower limits of predicted GV, in each case of transplant are in urgent need.[1] Sometimes, actual GV at transplantation differs from predicted GV determined using CT before the operation. The causes of these situations include acute radiocontrast injection and liver dehydration of donor revealed on enhanced CT.[4] The safety margin for the difference between actual GV and predicted GV should be considered for determining the lower limits of predicted GV. In 2 cases in this series, actual GV to SLV ratios at transplantation were less than 35%, but postoperative graft function was good regardless of the GV to SLV ratio at transplantation.

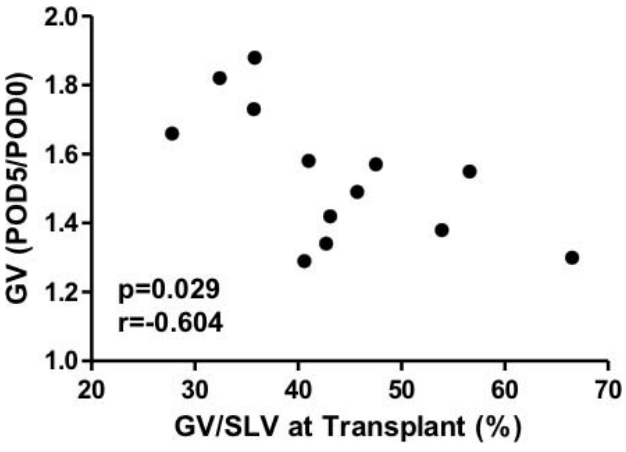

Fig. 1 On assessment of posttransplant graft regeneration, GV at POD5 to GV at transplant ratio was significantly greater in grafts with lower GV to SLV at transplant by Spearman's rank correlation coefficient ($P = 0.029$, $r = -0.604$).

In Western single-center experience, technical aspects[5–8] and graft volume evaluation[9] for successful living-donor right lobe donation, intraoperative Doppler ultrasonography of reconstructed liver vessels for avoiding early vascular complication,[10] and assessment of donors' remnant liver regeneration after right lobe donation[11] have been reported. Moreover, splenic artery embolization has been described as a therapeutic application for small-for-size syndrome.[12] The model for end-stage liver disease–Na score and preoperative serum platelet counts as risk factors of early graft dysfunction,[13] and importance of avoidance of hepatitis C virus–infected living-donor liver donation have also been described.[14]

In conclusion, our medical requirements for living liver donation seem to be acceptable, because of the good outcome. Further assessment of the technique of living-donor liver donation, adequate graft volume for pretransplant, each recipient's condition, and recipients' risks of early graft dysfunction may help to improve the outcome of living-donor liver transplantation for patients with end-stage liver disease.

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