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ORIGINAL ARTICLE

Ratio of remnant to total liver volume or remnant to body weight: which one is more predictive on donor outcomes?

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Abstract

Backround: Right lobe donations are known to expose the donors to more surgical risks than left lobe donations. In the present study, the effects of remnant volume on donor outcomes after right lobe living donor hepatectomies were investigated.

Methods: The data on 262 consecutive living liver donors who had undergone a right hepatectomy from January 2004 to June 2011 were retrospectively analysed. The influence of the remnant on the outcomes was investigated according to the two different definitions. These were: (i) the ratio of the remnant liver volume to total liver volume (RLV/TLV) and (ii) the remnant liver volume to donor body weight ratio (RLV/BWR). For RLV/TLV, the effects of having a percentage of 30% or below and for RLV/BWR, the effects of values lower than 0.6 on the results were investigated.

Results: Complication and major complication rates were 44.7% and 13.2% for donors with RLV/TLV of ≤30%, and 35.9% and 9.4% for donors with RLV/BWR of < 0.6, respectively. In donors with RLV/TLV of ≤30%, RLV/BWR being below or above 0.6 did not influence the results in terms of liver function tests, complications and hospital stay. The main impact on the outcome was posed by RLV/TLV of ≤30%.

Conclusion: Remnant volume in a right lobe living donor hepatectomy has adverse effects on donor outcomes when RLV/TLV is ≤30% independent from the rate of RLV/BWR with a cut-off point of 0.6.

Keywords

liver transplantation, living donor, remnant, right lobe, donor outcome, body weight

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Introduction

Liver transplantation is a well-established and widely used treatment method for end-stage liver disease. In countries where cadaveric organ supply is problematic, living donor liver transplantation is prioritized. During this process, small-for-size syndrome experienced in left lobe grafts results in more frequent use of right lobe donations.[1] For right lobe donations, donor morbidity is reported to be 0–67% whereas the main drawback is the percentage of donor remnant.[2–8] In most human beings, right lobe volume is 45–80% of the total liver volume; left lobe volume on the other hand is 15–45% of the total volume.[9] In general, remnant liver volume after right hepatectomies is known to be around 20–40%[2,10,11] Together with increasing experience and graft needs, transplant centres are guided towards using donors with smaller remnant volumes, i.e. <30% total liver volume, that qualify as marginal.[2] In previous studies, remnant volume was expressed as the percentage of the remnant volume to the total liver volume. To the best of our knowledge, the present study is the first to evaluate donor morbidity after living donor right lobe donation based on the remnant liver volume to donor body weight ratio.

Whether remnant liver volume (RLV) to donor body weight ratio (BWR) (RLV/BWR) had any impact on outcome of the donors in addition to the widely used RLV to total liver volume (TLV) ratio (RLV/TLV) by the transplant centres was assessed which is generally accepted to be ≥30%.

Patients and methods

From January 2004 to June 2011, 262 consecutive living liver donors who had undergone a right hepatectomy at Florence Nightingale Hospital Organ Transplant Center were included in the study. In the present study, the remnant liver after a right lobe living donor hepatectomy was expressed both as the percentage of total liver volume (RLV/TLV) and as a ratio of donor body weight (RLV/BWR) and the effects of both on donor postoperative outcomes were investigated. Cut-off points were determined by receiver-operating curve (ROC) analysis. For RLV/TLV, 30% and below, and for RLV/BWR the value of under 0.6 were assigned as cut-off points. Donors were studied for age, gender, aspartate transaminase (AST), alanine transaminase (ALT), total bilirubin and international normalized ration (INR) levels, and complications within the first 7 post-operative days.

In order to assess the effects of the copresence of both instances on the results, the donors were divided into four subgroups: A (RLV/TLV $\leq$ 30% and RLV/BWR < 0.6), B (RLV/TLV $\leq$ 30% and RLV/BWR $\geq$ 0.6), C (RLV/TLV > 30% and RLV/BWR < 0.6) and D (RLV/TLV > 30% and RLV/BWR $\geq$ 0.6).

Remnant and total liver volume measurements were performed with multidetector computed tomography (CT). Operative details were published elsewhere.[12] Minor and major complications were categorized according to the modified Clavien's classification.[3] The problems in Clavien 1 and 2, which resolved without invasive interventions, were accepted as minor complications. The problems in Clavien 3 and 4 that required radiological, endoscopic or surgical interventions were accepted as major complications. A post-operative total bilirubin level of >5 mg/dl was accepted as hyperbilirubinemia.

CT protocol and volume calculation

Multidetector computed tomography (MDCT) was performed on a 16-slice CT scanner (Sensation 16; Siemens Medical Solutions, Erlangen, Germany) using a three-phase contrast-enhanced protocol with a 1.0 mm slice thickness. For volumetric assessment, the hepatic venous phase was used with reconstructions of 5 mm thickness. Volumes were calculated using a software package (StereoInvestigator, version 6.0; Microbrightfield, Colchester, VT, USA) that uses a point counting technique based on the Cavalieri principle. Large vessels such as the extrahepatic portal vein in the area of the porta hepatis and the inferior vena cava, as well as larger fissures, and the teres hepatic ligament were excluded from volumetric markings. MDCT measurements were conducted on the middle hepatic vein (MHV) with the marking line passing 5 mm lateral (towards right lobe) to the MHV thereby leaving MHV on the remnant.

Donor evaluation

Individuals between 18–65 years of age who did not have any health problems and who were relatives of the recipients until fourth degree were accepted as donor candidates.

Donor candidates were checked for ABO blood group match, biochemical analyses, a viral hepatitis profile, factor 5 and prothrombin gene mutations. Examinations were carried out by a team consisting of a hepatologist, a transplant surgeon and a psychiatrist. Donor candidates who were found acceptable were evaluated with an abdominal ultrasound. Donor candidates having liver steatosis of more than 10% in radiological evaluation, a body mass index of > 30 and anti-HBc positivity underwent routine liver biopsy. Candidates who were found to be eligible were assessed with volumetric computerized tomography and CT angiography. Bile duct anatomy was assessed with MR cholangiography.

In the first 100 live donor liver transplantations, as the deceased donor option was very limited, and when the recipients did not have any other live donor candidates, individuals with calculated remnant volumes of less than 30% were occasionally accepted for donations. After publishing the results of those data suggesting higher complication rates with remnant volumes < 30%, donors with < 30% remnant volumes were not accepted; however, donors with 30% remnant volumes continue to be accepted.[13] With this limit of 30% in mind, the effects of RLV/BWR with different cut-off points, if any, on the post-operative course and complications in donors in addition to RLV/TLV of 30% were assessed.

Statistical analysis

Values of measured variables were expressed as means $\pm$ standard deviation or as ranges. Categorical variables were expressed as frequencies and percentages. For statistical analysis, continuous parameters in each group were compared using an independent sample *t*-test, and categorical parameters were compared with the chi-square test. ROC curve analysis was used to determine sensitivity and specificity of the values for RLV/TLV, RLV/BWR and hyperbilirubinemia. The differences between continuous variables in subgroups were assessed using the ANOVA test. Tukey's test or Tamhanes's T2 test was used according to the variances of the groups. As group 4 had a much greater sample size compared with the other groups, the Welch statistic was used to assess the differences.

All analyses were performed with SPSS 16.0 for Windows (SPSS, Chicago, IL); a value of $P < 0.05$ was considered significant.

Results

Donor's charasteristic features and post-operative outcome according to the RLV/TLV and RLV/BWR rates are shown in Table 1.

Mean radiological measurement of the grafts and mean actual graft weight were 900 $\pm$ 184 g and 880 $\pm$ 168 g; radiologically measured weight and actual weight of the grafts were significantly correlated ($r = 0.75$, $P = 0.0001$). The mean radiological/actual graft weight was 1019. Radiological/actual graft weight ratios were 1.04 and 0.98 in patients with grafts with MHV ($n = 77$) and without MHV ($n = 184$) ($P = 0.01$).