



Use of discarded liver in living-donor liver transplantation

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Introduction

Liver transplantation is the most effective method to save the lives of patients with acute liver failure and end-stage liver disease; however, the shortage of donor livers restricts its application and is primarily associated with the increase in mortality of patients waiting for liver transplantation. Li *et al.*'s study of 15 consecutive cases showed that partial grafts with benign lesions are safe for liver transplantation (1). A study by Li *et al.* showed that this method was safe and feasible for children and lean individuals (2). Some studies have explored the use of discarded partial livers in open hepatectomy for benign liver tumors, such as hemangiomas, as donor livers for living liver transplantation and can alleviate the shortage of donor livers to a certain extent (3).

With the gradual expansion of indications for laparoscopic hepatectomy and significant improvement in surgical safety and accuracy, laparoscopic live donor hepatectomy is considered as safe as open live donor hepatectomy and has obvious advantages in reducing intraoperative blood loss and the incidence of complications and shortening hospital stay (4,5). In particular, it is potentially beneficial to liver donors because aesthetics is unaffected at the incision site, postoperative pain is reduced, and postoperative quality of life is improved (6). Based on the ample clinical experience in laparoscopic hepatectomy and liver transplantation at our institution, we propose, for the first time, the use of partial livers discarded

after laparoscopic hepatectomy for living-donor liver transplantation (LHLD-LT) with the aim of improving safety and quality of life for donors while expanding limited liver sources.

The key advantages

Most laparoscopic surgeries for benign liver tumors only require the removal of the tumor along the tumor envelope without additional removal of the surrounding normal liver tissue. When the tumor is located deep in the liver, such as the caudate lobe, or compresses important hepatic duct structures, it is often necessary to resect part of the normal liver tissue above the tumor or even a part of the normal liver area supplied by the compressed duct structure to better expose and completely resect the tumor during surgery. This part of the normal liver tissue, called the discarded partial liver, which is produced in a normal medical process, does not cause medical harm to the donor, and the surgical process does not increase the scope of liver resection or medical costs and risks. Using discarded livers as donor livers not only provides an alternative source of liver transplantation for children and young adult recipients and broadens the limited source of donor livers but can also play an important role in sequential liver transplantation in adults. Patients with benign liver tumors can not only receive treatment through surgery but also save other lives as organ donors, which is a great charity worthy of advocacy.

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Clinical principles

LHLD-LT follows eight principles: (I) patients with benign liver tumors with clear surgical indications, including hepatic hemangioma, focal nodular hyperplasia, hepatocellular adenoma, hepatitis pseudotumor, and hepatic angiomyolipoma, can be selected as completely voluntary donors. (II) The donors must be aged 4–60 years with a body mass index ≤ 26 kg/m² and have good general condition, psychological status, and can tolerate general anesthesia and laparoscopic hepatectomy. (III) Donors must not have significant abnormal liver function, transaminase ≤ 3 times normal value, total bilirubin ≤ 2 times normal value, no fibrosis, and mild fatty liver (degree of vesicular steatosis $\leq 10\%$). The texture of the liver should be smooth and soft, with full and uniform perfusion. The estimated cold ischemia time should be ≤ 8 h. (IV) Three-dimensional visualization technology can be applied to the segmentation, labeling, volume measurement, and quantitative evaluation of the spatial stereoscopic relationship of the liver, tumor, bile duct, and blood vessels (hepatic artery, portal vein, and hepatic vein), based on the results of multi-phase dynamic-enhanced liver magnetic resonance imaging and computed tomography. The remaining liver volume of the donor should be $\geq 40\%$ of its standard liver volume. (V) Intraoperative pathological examination should confirm that the tumor was benign and discarding the liver was safe for the donor and feasible. (VI) In accordance with the technical requirements and procedures for laparoscopic living-donor liver resection, complete and smooth resection of benign liver tumors should be ensured, and the inflow and outflow of the liver should be preserved as completely as possible to facilitate subsequent liver transplantation. (VII) Reasonable allocation of the donor liver according to its volume and the volume or body mass ratio of the recipient can effectively reduce the incidence of postoperative small liver syndrome. The ratio of donor liver mass to recipient body mass should be $\geq 0.8\%$. (VIII) In sequential liver transplantation, only part of the donor liver is removed, and the portal vein branch of the retained liver is partially lapped, thus it rapidly enlarges the donor liver. The discarded liver meets the requirements of donor liver for this type of transplantation and can be used as a graft for sequential liver transplantation in normal adults.

The limitation

At present, there are no reports on LHLD-LT and there

is a lack of corresponding implementation standards and norms for donor selection, transplantation indications, preoperative surgical evaluation and planning, technical points, and operational procedures (7). The core principle is to ensure the legitimacy of the donor liver, including the voluntary nature of the donation, without external pressure and economic temptation. Second, the matching of donor liver and recipient and recipient indications should meet the ethical requirements and norms of organ transplantation management. Finally, it is necessary to ensure that the donor liver actually comes from the discarded liver of normal medical behavior, without disguised organ trading behavior, and the surgical process does not increase the scope of liver resection or medical costs and risks to the donor to ensure the safety and necessity of the surgery and fundamental interests of the donor and recipient. Further ethical discussions and approvals are required to address these issues.

Conclusions

A discarded liver is a special type of marginal donor liver with a potentially wide range of sources, especially in children, young adult recipients, and normal adults with sequential liver transplantation. The establishment of legal policy and a supervision mechanism in line with ethical requirements, strict screening of donors, and strengthening the training and qualification of doctors for laparoscopic donor liver extraction are expected to standardize this technology to improve the limited pool of liver sources for transplantation, save more patient lives, and turn discarded livers into a gift of life. Further high-level, evidence-based studies are required to verify the safety and efficacy of this technology.

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Footnote

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