



Emergent hybrid-dual-graft liver transplantation: a life-saving strategy for a patient with inadequate living donor graft during the COVID-19 pandemic

Yongsheng Xiao^{1,2}, Xiaowu Huang^{1,2,3}, Yinghong Shi^{1,2}, Zheng Wang^{1,2}, Xiaoying Wang^{1,2}, Yifeng He^{1,2}, Ting Wang⁴, Jian Sun^{1,2}, Kang Song^{1,2}, Zhenbin Ding^{1,2}, Yinghao Shen^{1,2}, Yuanfei Peng^{1,2}, Zaozhao Shen^{1,2}, Lei Yu^{1,2}, Kai Zhu^{1,2}, Hui Li^{1,2}, Di Zhou⁵, Changhong Miao⁵, Yuan Ji⁶, Liuxiao Yang⁴, Yingyong Hou⁶, Xudong Qu⁷, Jia Fan^{1,2,3}, Jian Zhou^{1,2,3}

¹Department of Liver Surgery and Transplantation, Liver Cancer Institute, Zhongshan Hospital, Fudan University, Shanghai, China; ²Key Laboratory of Carcinogenesis and Cancer Invasion (Fudan University), Ministry of Education, Shanghai, China; ³Shanghai Key Laboratory of Organ Transplantation, Shanghai, China; ⁴Department of Intensive Care Unit, Zhongshan Hospital, Fudan University, Shanghai, China; ⁵Department of Anesthesiology, Zhongshan Hospital, Fudan University, Shanghai, China; ⁶Department of Pathology, Zhongshan Hospital, Fudan University, Shanghai, China; ⁷Department of Interventional Radiotherapy, Zhongshan Hospital, Fudan University, Shanghai, China

Correspondence to: Jian Zhou. Department of Liver Surgery and Transplantation, Liver Cancer Institute, Zhongshan Hospital, Fudan University, Shanghai 200032, China; Key Laboratory of Carcinogenesis and Cancer Invasion (Fudan University), Ministry of Education, Shanghai 200032, China; Shanghai Key Laboratory of Organ Transplantation, Shanghai 200032, China. Email: zhou.jian@zs-hospital.sh.cn.

Submitted Jul 31, 2022. Accepted for publication Sep 16, 2022.

doi: 10.21037/hbsn-22-335

View this article at: <https://dx.doi.org/10.21037/hbsn-22-335>

Introduction

Liver transplantation (LT) benefits patients with decompensated liver cirrhosis, acute liver failure, or hepatocellular carcinoma. The greatest challenge in LT is the insufficient number of donors for the growing number of transplantation candidates. Various surgical strategies have been adopted to overcome the increasing donor-recipient disparity, including sequential/“domino” transplantation, split LT, use of marginal livers, and living donor LT (LDLT). To ensure the safety of donors and recipients, dual-graft LT may be considered (1). Herein, we describe the first successful hybrid-dual-graft LT in an obese patient requiring urgent LT, which involved transplantation of an otherwise-wasted resected liver lobe from a patient with a benign hepatic tumor and an inadequate-size living donor graft from the recipient's father.

Case presentation

Donor and recipient descriptions

A morbidly obese 28-year-old male [125 kg; body mass index (BMI), 39.5 kg/m²] presented to Zhongshan Hospital with acute portal hypertension-related gastrointestinal

hemorrhage (blood loss, 2,900 mL). He had severe hepatitis B-related cirrhosis and hepatocellular carcinoma (2.8 cm in diameter) and was on the LT waiting list in the China Organ Transplant Response System (blood group, A+). Given his critical clinical condition, emergent LDLT was indicated.

The recipient's 54-year-old 75-kg father (BMI, 23.7 kg/m²) had blood group A which is the same blood group as the patient and agreed to donate the right lobe of his liver. Computed tomography (CT) volumetry showed a calculated right lobe volume of 686 mL without middle hepatic vein (MHV) and 747 mL with MHV. The predicted graft-to-recipient weight ratio (GRWR) was 0.55% without MHV and 0.60% with MHV. It is widely accepted that to avoid small-for-size syndrome, the GRWR should be >0.80% (2). Therefore, additional liver volume was required. However, it was impractical to find another living donor for the traditional dual-graft LT given the emergent situation, especially since a coronavirus disease 2019 (COVID-19) outbreak was occurring in Shanghai at that time (March 2022).

Fortunately, a 43-year-old female with a large hepatic tumor in the caudate lobe suspicious for hepatic adenoma had blood group A (*Figure 1A-1D*). She planned to

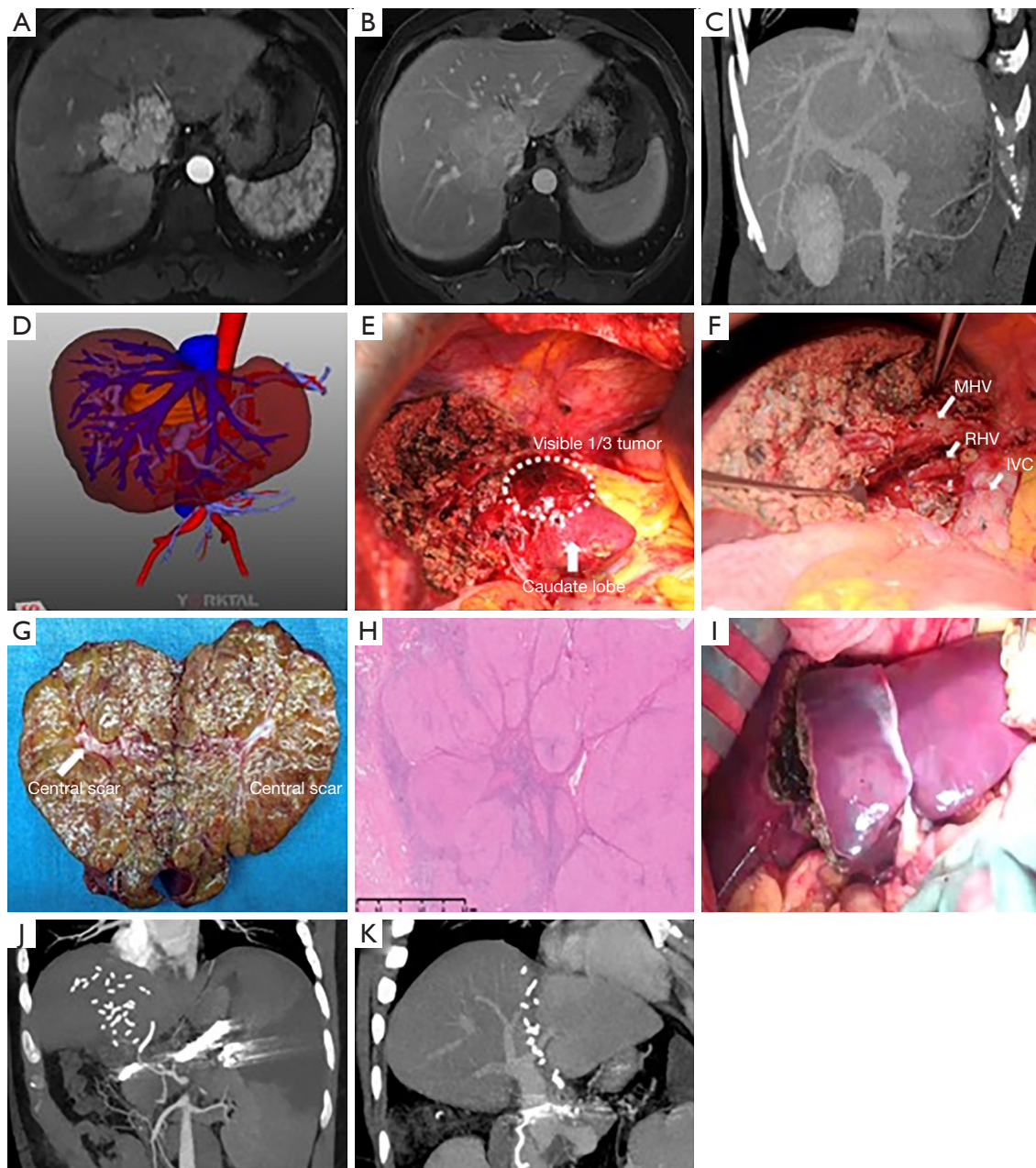


Figure 1 Imaging & pathological characteristics of the hepatic tumor from the female patient and images of dual grafts implantation. The tumor of the female patient was located in the caudate lobe, MRI presented arterial phase enhancement (A) and portal venous phase washout (B). Coronal imaging showed the tumor was located between the left and right branches of portal vein and also among the left, middle and right hepatic veins (C). Three-dimensional reconstructed image was more intuitive to show the location of the tumor (D). Only after left hemihepatectomy, circa one third of tumor (outlined by dashed lines) in the caudate lobe was visible (E). After complete resection of the caudate lobe tumor, the MHV, RHV and IVC were clearly exposed (F). The diameter of the resected tumor is 7.0 cm, and the central scar (white arrow) was visible on the section (G). Tumor pathological diagnosis of resected liver lesions revealed FNH. Hepatocellular nodules of different sizes were separated by fibrous septa (hematoxylin and eosin staining, $\times 1.25$) (H). Dual grafts were orthotopically implanted at the recipient's corresponding liver fossa (I), respectively, and on PTD 66, CT hepatic angiography findings showed hepatic artery (J) and portal vein (K) were patent. MHV, middle hepatic vein; RHV, right hepatic vein; IVC, inferior vena cava; MRI, magnetic resonance imaging; FNH, focal nodular hyperplasia; PTD, post-transplantation day; CT, computed tomography.

undergo left hemihepatectomy and caudate lobectomy and volunteered to donate her resected left lobe, which would be otherwise wasted. On CT volumetry, the calculated volume of her left lobe was 432 mL, resulting in a predicted GRWR for the recipient of 0.35%. Thus, the total predicted GRWR of the dual-grafts from the father and this woman was 0.90% (0.55% + 0.35%).

Hybrid-dual-graft LT

Liver donations were approved by our hospital ethics committee. The two grafts were procured consecutively. First, the female patient underwent left hemihepatectomy without pedicle clamping (*Figure 1E*) and then caudate lobectomy for tumor resection (*Figure 1F*). Intraoperative rapid pathology analysis confirmed the presence of focal nodular hyperplasia (FNH) (*Figure 1G,1H*). Next, the right lobe liver graft from the father was retrieved by transecting the liver on the right side of the MHV. Cryopreserved iliac artery was used to reconstruct the segment V hepatic vein outflow tract of right liver graft in back table. The right lobe graft (570 g) was orthotopically implanted into the recipient's right liver fossa, followed by implantation of the female patient's left lobe graft (370 g) without FNH (*Figure 1I*). The total dual liver graft weight was 940 g (570 g + 370 g), with a true GRWR of 0.75%. For the right lobe graft, right hepatic vein (RHV), right branch of portal vein, were anastomosed to the recipient's RHV, right branch of portal vein, respectively. After right lobe graft reperfusion, reconstructed segment V hepatic vein was anastomosed to the side wall of inferior vena cava (IVC). For the left lobe graft, left hepatic vein (LHV) and recipient's common trunk of the left and middle hepatic veins, left branch of portal vein and left branch of recipient's portal vein were anastomosed, respectively. After blood reperfusion of the left lobe graft, we started to anastomose hepatic artery and bile duct. Right hepatic artery (RHA), left hepatic artery (LHA), right hepatic duct (RHD) and left hepatic duct (LHD) of the 2 grafts were anastomosed with RHA, LHA, RHD and LHD of the recipient, respectively. Intraoperative color Doppler ultrasound suggested that the blood flow of dual grafts was normal.

Perioperative complications and follow-up

Both donors tolerated the operation without complications and recovered uneventfully. They were discharged with normal liver function tests. On post-transplantation day (PTD) 4, the recipient's LHA was not clearly displayed on

routine bedside ultrasound, and subsequent arteriography confirmed irregular stenosis of the LHA lumen; early thrombosis was diagnosed. A rapamycin-coated stent was implanted, and the splenic and gastroduodenal arteries were embolized with coils to alleviate arterial steal syndrome. Continuous transcatheter arterial thrombolysis with urokinase was performed, resulting in a patent LHA. The patient recovered well and was discharged with good liver function on PTD 37. CT hepatic angiography showed a normal LHA without stenosis (*Figure 1J,1K*), and liver function was normal on PTD 66.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). This study was approved by the Medical Ethics Committee of Zhongshan Hospital, Fudan University (approval No. B2022-138). Written informed consent was obtained from the patients for publication of this article and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

Since dual-graft LT was first described in 2001, more than 400 cases have been reported (1,3,4). Nevertheless, in an urgent situation, as in our obese patient with impending life-threatening hemorrhage, and/or in the presence of an unanticipated societal event, such as COVID-19-associated quarantine, it is nearly impossible to find two compatible donors within an acceptable timeframe. Hence, our newly proposed hybrid-dual-graft LT using otherwise-wasted resected liver to substitute for a second living donor can be a life-saving strategy.

Successful adult-to-adult LT was reported in 2013 using an otherwise-discarded partial liver allograft from a patient with cavernous hemangioma (5). In 2015, our team successfully performed pediatric LT with a graft from an adult with large FNH in the caudate lobe, who donated her otherwise-wasted resected left liver lobe (*Figure S1*). Our previous experience and the literature prompted us to perform the first successful hybrid-dual-graft LT using an otherwise-wasted resected liver lobe and a living donor liver graft in the current obese patient requiring emergent LT (*Figure S2*). In the future, the surgical technique for this procedure would be considered in large-volume, experienced centers as a viable option for emergent LT in patients with fulminant liver failure or for LDLT with a small-for-size graft.

Acknowledgments

Funding: This study was jointly supported by the National Natural Science Foundation of China (Nos. 82150004, 81830102), and Shanghai Municipal Key Clinical Specialty.

Footnote

Provenance and Peer Review: This article was a standard submission to the journal. The article has undergone external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://hbsn.amegroups.com/article/view/10.21037/hbsn-22-335/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). This study was approved by the Medical Ethics Committee of Zhongshan Hospital, Fudan University (approval No. B2022-138). Written informed consent was obtained from the patients for publication of this article and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Cite this article as: Xiao Y, Huang X, Shi Y, Wang Z, Wang X, He Y, Wang T, Sun J, Song K, Ding Z, Shen Y, Peng Y, Shen Z, Yu L, Zhu K, Li H, Zhou D, Miao C, Ji Y, Yang L, Hou Y, Qu X, Fan J, Zhou J. Emergent hybrid-dual-graft liver transplantation: a life-saving strategy for a patient with inadequate living donor graft during the COVID-19 pandemic. *HepatoBiliary Surg Nutr* 2022;11(5):785-788. doi: 10.21037/hbsn-22-335

Open Access Statement: This is an Open Access article distributed in accordance with the Creative Commons Attribution-NonCommercial-NoDerivs 4.0 International License (CC BY-NC-ND 4.0), which permits the non-commercial replication and distribution of the article with the strict proviso that no changes or edits are made and the original work is properly cited (including links to both the formal publication through the relevant DOI and the license). See: <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

References

1. Lee S, Hwang S, Park K, et al. An adult-to-adult living donor liver transplant using dual left lobe grafts. *Surgery* 2001;129:647-50.
2. Kiuchi T, Kasahara M, Uryuhara K, et al. Impact of graft size mismatching on graft prognosis in liver transplantation from living donors. *Transplantation* 1999;67:321-7.
3. Song GW, Lee SG, Moon DB, et al. Dual-graft Adult Living Donor Liver Transplantation: An Innovative Surgical Procedure for Live Liver Donor Pool Expansion. *Ann Surg* 2017;266:10-8.
4. Chen Z, Yan L, Li B, et al. Successful adult-to-adult living donor liver transplantation combined with a cadaveric split left lateral segment. *Liver Transpl* 2006;12:1557-9.
5. Sun B, Mu X, Wang X. Successful adult-to-adult liver transplantation of an otherwise discarded partial liver allograft with a cavernous hemangioma: new strategy for expanding liver donor pool. *Transpl Int* 2013;26:e79-80.

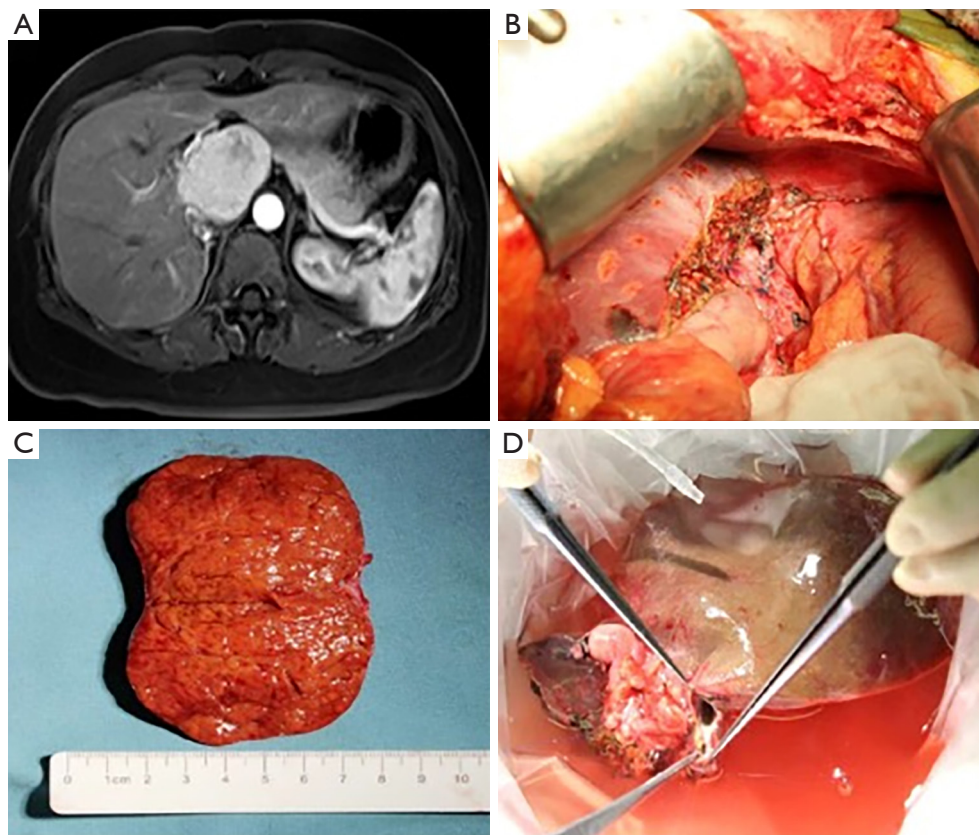


Figure S1 A pediatric LT with an otherwise-wasted resected liver lobe from an adult patient with big FNH in the caudate lobe in 2015. MRI presented arterial phase enhancement tumor in the caudate lobe from the female patient (A) and then she underwent the planned left hemihepatectomy and caudate lobectomy in 2015 (B). A resected tumor pathology was confirmed to be FNH (C). The perfusion and preservation of the otherwise-wasted resected left lobe from the female patient with cold UW solution (D). LT, liver transplantation; FNH, focal nodular hyperplasia; MRI, magnetic resonance imaging; UW solution, the University of Wisconsin solution.



Figure S2 Emergent hybrid-dual-graft liver transplantation: a life-saving strategy for a patient with inadequate living donor graft during the COVID-19 pandemic. COVID-19, coronavirus disease 2019.