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Robotic-assisted living donor-initiated domino liver transplantation: a window of opportunity for transplant oncology

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Dear Editors,

The TransMet randomized trial established liver transplantation (LT) as a curative treatment option for carefully selected patients with unresectable colorectal liver metastases (CRLM), demonstrating superior 5-year overall survival compared with chemotherapy alone [1]. Despite these encouraging results, timely access to transplantation remains a major limitation. In deceased-donor programs, the narrow oncological window requires rapid access to grafts, often through allocation priority, which can challenge the equity of organ allocation systems and result in a substantial number of eligible patients untransplanted because of disease progression while waiting.

We report a case of living donor–initiated domino liver transplantation chain that addressed a pediatric metabolic indication and an adult oncologic indication simultaneously. The novelty of this approach lies in linking living donor liver transplantation for maple syrup urine disease (MSUD) with the subsequent use of the explanted liver for a selected oncologic recipient, rather than using the robotic technique itself. This strategy illustrates a potential means of optimizing graft utilization without additional use of the deceased-donor pool (Figure 1A).

A 10-year-old child (33 kg) with MSUD underwent living donor liver transplantation using a left liver graft (segments II–IV with the middle hepatic vein; 380 g) donated by the child's 36-year-old mother. Donor evaluation included CT volumetry and Primovist-enhanced biliary MRI. Robotic donor hepatectomy was performed according to a standardized technique with Pfannenstiel graft extraction [2]. The procedure was uneventful; donor warm ischemia time was 5 min, and the pediatric graft-to-recipient weight ratio (GRWR) was 1.15%. Apart from transient small-for-size syndrome manifested by moderate ascites, the postoperative recovery period was uneventful. Leucine concentrations normalized rapidly, and the graft remained fully functional at 6 months.

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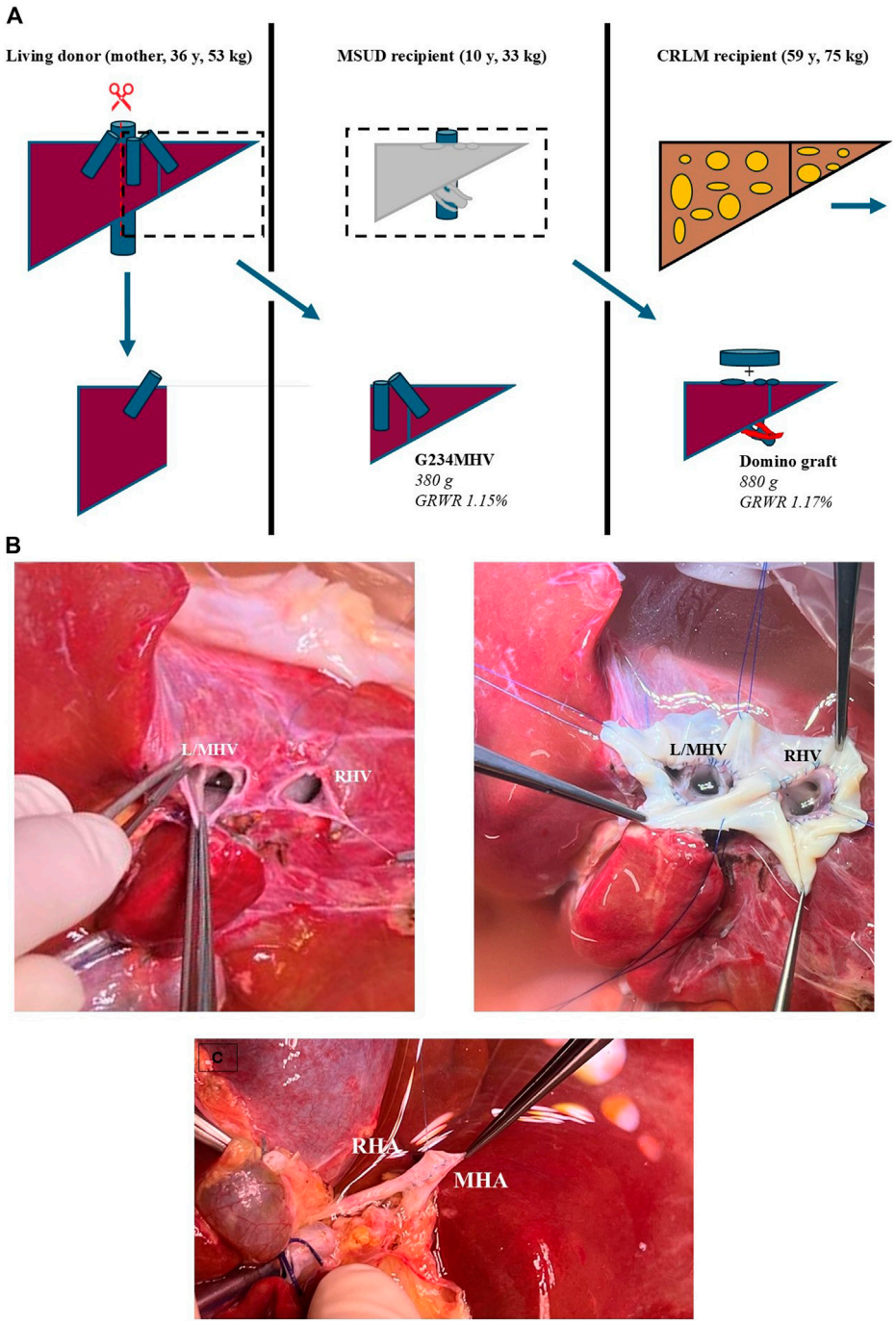


FIGURE 1
(A) Domino transplantation chain. *Graft to Recipient Weight Ratio (GRWR).* **(B,C)** Vascular reconstruction. **(B)** Hepatic venous reconstruction using a cadaveric iliac vein graft. *Middle hepatic vein (MHV), left hepatic vein (LHV), and right hepatic vein (RHV).* **(C)** Arterial reconstruction after unification of the right hepatic artery (RHA) and middle hepatic artery (MHA).

The explanted MSUD liver, structurally normal despite its metabolic defect, had been designated as a domino graft following standard institutional assessment. Warm ischemia time was less than 5 min. The graft was transplanted into a 59-year-old woman (75 kg) with unresectable CRLM that fulfilled TransMet eligibility criteria. Of note, the patient had right-sided colon adenocarcinoma with synchronous, unresectable, bilobar liver metastases (15 lesions), including an infiltrative lesion that involved the right anterior sectoral pedicle. Following resection of the primary tumor, she received two lines of chemotherapy: FOLFOX plus bevacizumab, followed by FOLFIRI plus

Abbreviations: BCKD, branched-chain α-ketoacid dehydrogenase; CRLM, colorectal liver metastases; GRWR, graft-to-recipient weight ratio; LT, liver transplantation; MSUD, maple syrup urine disease.

bevacizumab. The disease remained stable according to RECIST criteria, with no evidence of extrahepatic disease. Tumor markers remained within the normal range following normalization.

Explantation preserved the native vena cava, together with adequate portal and arterial length, to facilitate pediatric implantation. The bile duct was intentionally left with the domino graft because the pediatric recipient required a hepaticojejunostomy. The domino graft weighed approximately 880 g (GRWR 1.17%).

Implantation required specific vascular reconstruction because the graft lacked a retrohepatic vena cava. Hepatic venous outflow was reconstructed using suprahepatic venoplasty with a cadaveric iliac vein graft according to modified domino techniques [3] (Figure 1B). Arterial reconstruction consisted of unifying the right and middle hepatic arteries to allow a single arterial anastomosis (Figure 1C). Implantation was completed using a piggyback technique with duct-to-duct biliary reconstruction. Cold ischemia time reached 240 min owing to *ex situ* vascular reconstruction and transfer between the pediatric and adult transplant centers. A reperfusion biopsy demonstrated preserved liver architecture without fibrosis or ischemia-reperfusion injury. Early graft function was excellent, with rapid normalization of coagulation parameters and declining transaminases. A hepatic artery stenosis diagnosed 1 month later was successfully treated with percutaneous angioplasty. At 6 months, graft function remained normal, without evidence of tumor recurrence.

This case illustrates several important concepts. First, a living donor–initiated domino sequence can simultaneously benefit two recipients with completely different indications. This approach may offer a complementary pathway for selected patients with unresectable colorectal liver metastases, particularly when timely transplantation is clinically desirable [4]. By linking a planned living donor procedure to the subsequent use of the explanted liver as a domino graft, this strategy may improve graft utilization without additional use of deceased-donor organs. However, the potential of this strategy to reduce waiting times, avoid chemotherapy interruptions, or improve access to transplantation remains speculative and cannot be established from this single case. In the TransMet trial, nearly one-fifth of patients randomized to transplantation ultimately did not undergo liver transplantation, mainly because of disease progression [1].

Second, MSUD livers are ideal domino grafts because their metabolic defect is effectively compensated for by extrahepatic branched-chain α-ketoacid dehydrogenase activity, which is predominantly located in skeletal muscle. Consequently, recipients without MSUD maintain normal amino acid homeostasis despite receiving an MSUD liver, while benefiting from an otherwise structurally normal graft [5, 6].

Third, several technical aspects deserve emphasis. Robotic donor hepatectomy minimizes donor morbidity while allowing meticulous vascular and biliary dissection, thereby supporting the broader implementation of living donor programs [7, 8]. In the present case, its role was to support graft procurement within the living donor–initiated domino strategy; however, this single case does not establish a specific advantage of the robotic approach for domino transplantation itself. The GRWR of 1.17% was appropriate because the recipient had neither portal hypertension nor cirrhosis, limiting the risk of small-for-size syndrome. Nevertheless, domino implantation requires advanced vascular expertise because the retrohepatic vena cava is absent. The reconstruction principles described by Lerut et al. remain particularly valuable in this context [3]. Importantly, donor safety must always be the priority during graft procurement, even if this necessitates more complex vascular reconstruction before implantation. Finally, although the cold ischemia time reached 240 min, the histological examination showed no evidence of ischemia-reperfusion injury. Hypothermic oxygenated machine perfusion may further optimize these procedures when prolonged *ex situ* reconstruction or national graft sharing is required [9].

Ethically, domino graft allocation within living donor chains must be integrated into national regulatory frameworks [10]. In the present case, the oncologic recipient fulfilled the eligibility criteria for the TransMet trial for unresectable colorectal liver metastases. Informed consent was obtained from both the donor family and the oncologic recipient, who was fully informed of the metabolic origin of the graft and the specific surgical reconstruction required. The allocation of the domino graft should be considered in the context of the recipient's oncological eligibility, the suitability of the graft, and the applicable allocation and consent procedures. Further clarification of regulatory and allocation pathways will be necessary before this strategy can be generalized to other transplant settings.

In conclusion, this case illustrates the feasibility of a living donor–initiated domino liver transplantation strategy combining pediatric transplantation for MSUD with the subsequent use of the domino graft for a selected oncologic indication. Although this approach may offer an additional option for graft utilization, its impact on access to transplantation and its broader applicability cannot be established from a single case with limited follow-up. Further experience and longer-term outcome data are needed to clarify its role in clinical practice.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by local ethics committee CSEHCL_21_202. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the minor(s)' legal guardian/next of kin for the publication of any potentially identifiable images or data included in this article.

Author contributions

RK drafted the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

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