A Successful Urgent Liver Retransplant From a Donor With a Left Ventricular Assist Device

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Abstract

Organ shortage is one of the major limitations in the field of liver transplantation, which has led to the consideration of extended criteria donors as a way to expand the donor pool. The use of extended criteria donors in cases of high Model for End-Stage Liver Disease scores or urgent recipients could be complicated by increased postoperative mortality. Donors on left ventricular assist devices could be considered extended criteria donors because of the mechanical circulatory support itself and the potential of chronic liver damage due to right ventricular failure, but experiences in the literature are limited. Here, we report the first case of an urgent liver retransplant procured from a left ventricular assist device donor.

Key words: *Bridge to transplant, Chronic liver disease, Extended criteria donor, Liver transplant, Mechanical circulatory support*

Introduction

Organ shortage is a major limitation in the field of liver transplantation. A growing demand for livers has led to the consideration of extended criteria donors as a way to expand the donor pool.[1] Extended criteria donors are routinely used for recipients with higher Model for End-Stage Liver Disease (MELD) scores, who cannot further delay intervention, although some reports have stated that use of extended criteria donors can result in an increase in postoperative mortality and complications.[2,3] The use of left ventricular assist devices (LVAD) as a bridge to transplant has become a common modality to treat patients with end-stage heart failure.[4] Unfortunately, patients on such devices are at increased risk for cerebrovascular accidents and may become potential organ donors while on the heart transplant wait list.[5] A donor on LVAD could be considered an extended criteria donor because right ventricular failure rates can vary between 5% and 44%, leading to potential chronic liver damage (fibrotic or cirrhotic disease) due to vein obstruction, even if cardiac cirrhosis represents a rare condition (1.2% of cases).[6] Here, we report the first case of an urgent liver retransplant procured from an LVAD donor.

Case Report

The recipient was a 63-year-old female patient with multiple unresectable neuroendocrine liver metastases. At the time of her first liver transplant, we had performed a piggy-back technique, an end-to-end portal anastomosis, and an end-to lateral arterial anastomosis between the celiac donor trunk and the recipient hepatic-mesenteric trunk. We also performed an end-to end bile duct anastomosis. The post-transplant course was complicated by progressive liver failure. On the basis of biochemical parameters, hepatic encephalopathy, hemodynamic disorders, and liver congestion, an emergency request for liver retransplant was sent.

The donor was a 47-year-old woman mechanically supported by an LVAD system implanted for refractory heart failure caused by an end-stage dilated idiopathic cardiomyopathy who was on the wait list

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**Vincenzo Buscemi and Giuliana Checchini contributed equally to this study.*

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for heart transplant. After 3 years on LVAD, the patient developed an irreversible severe hemorrhagic stroke and was pronounced brain dead and considered for organ donation. Authorization for organ donation was obtained from the donor's family. The biochemical parameters of liver function were at normal, reference levels, with 25 U/L aspartate aminotransferase, 12 U/L alanine aminotransferase, 24 U/L gamma-glutamyltranspeptidase, 72 U/L alkaline phosphatase, 2.1 mg/dL total bilirubin, 0.43 mg/dL direct bilirubin, and 2.5 international normalized ratio.

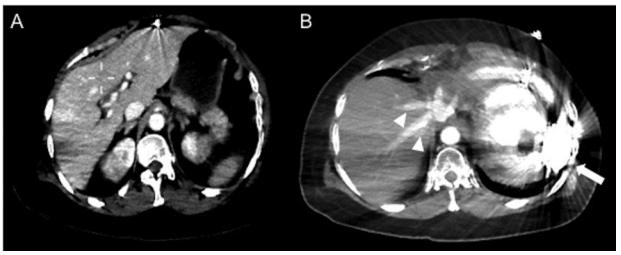
An abdominal ultrasonography and CT scan showed a normal liver morphology (Figure 1). Echocardiography showed normal right ventricular function. To avoid clotting formations, LVAD was systemically heparinized (10 000 U), with infusion of a low dosage of vasoactive drugs (norepinephrine of 0.05 μg/kg/min) and maintenance of positive fluid balance to guarantee a proper LVAD running with sufficient peripheral perfusion.

Organ procurement was performed without stopping the LVAD system. The patient had a previous sternotomy, and the left upper quadrant was occupied by the LVAD and dense fibrous tissue. A xyphoid-to-pubis midline incision was performed with a right subcostal extension, preserving the LVAD driveline tract (Figure 2). Macroscopically, the liver presented a normal consistency, with sharp margins and a smooth surface, and was considered suitable for transplant (Figure 3). On the basis of routine practice in our center, given the excellent gross aspect, no liver biopsy was obtained.

A sternotomy was performed by the heart surgeon to improve exposure of abdominal organs and to gain access to the supradiaphragmatic cava vein. Systemic heparinization was reinforced (5000 U), the abdominal aorta was cross-clamped, the LVAD was stopped by removal of both energy sources, the infrarenal distal aorta was directly cannulated, and cold solution was infused through the aortic cannula. The cava vein was transected to vent the cold solution. Portal vein solution flushing was accomplished by cannulating the inferior mesenteric vein, and then the liver and kidneys were procured.

We again performed a piggy-back technique, an end-to-end portal anastomosis (demolishing the previous anastomosis), an arterial anastomosis between the celiac donor trunk and supraceliac aorta using an interposition iliac arterial graft (the previous arterial anastomosis was not suitable for a new anastomosis), and an end-to-end bile duct

Figure 1. Donor Computed Tomography Scan



(A) Liver aspect at scan. **(B)** A particular of liver hepatic veins (arrowheads) and left ventricular assist device site (arrow).

Figure 2. Left Ventricular Assist Device Drive Lines on Chest Radiography

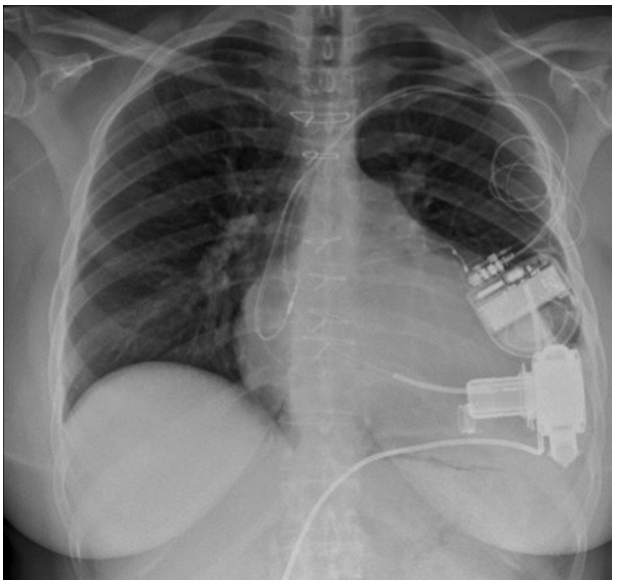
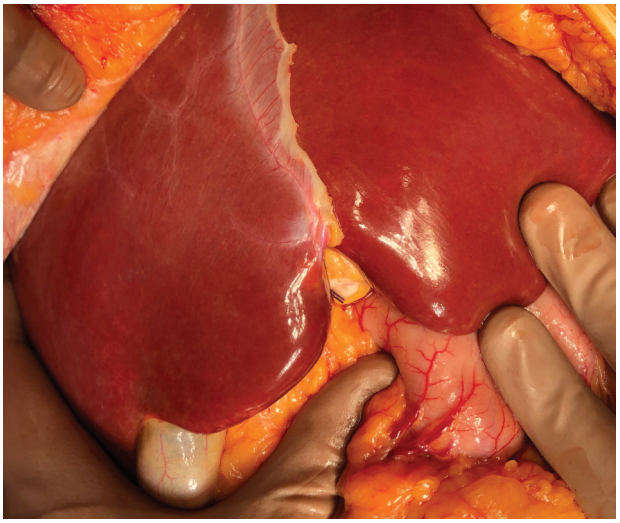


Figure 3. Liver Aspect at Time of Laparotomy



anastomosis with T-tube placement. The patient's course after retransplant was uneventful, with progressive normalization of biochemical parameters and without infections, acute rejection, or any complication. Alanine aminotransferase, bilirubin, and international normalized ratio peaks were, respectively, 753 U/L, 7 mg/dL, and 2.15. Inotrope agents were dismissed during the first day posttransplant, and diuresis was regular without pharmacological support.

The patient was extubated and discharged from the intensive care unit on posttransplant day 5 and posttransplant day 9, respectively. The immunosuppression regimen was based on tacrolimus, mycophenolate, and steroid. Bile production progressively increased to 500 to 600 mL/day, and a T-tube cholangiography showed a normal biliary tree without any leakage. The patient was discharged on day 39 posttransplant because of prolonged rest to bed syndrome, requiring musculoskeletal physiotherapy. The patient maintained good graft function over a total follow-up of 6 months.

Discussion

This article reports a successful emergency liver retransplant from a donor with a previous LVAD system placed as a bridge to treatment for heart transplant. The LVAD donor was considered an extended criteria donor because LVAD could result in right ventricular failure and progressive liver failure, whose severity could increase over time, although cardiac cirrhosis is a rare condition.[7] A prolonged venous congestion, usually subclinical and characterized by cholestasis, could induce liver atrophy with or without centrilobular hepatic necrosis.[8] This condition may progress in deposition of sinusoidal collage evolving to a fibrotic and cirrhotic stage with a typical microscopical aspect.

To the best of our knowledge, only a few cases of LVAD donors have been reported in the current literature.[9] Rayhill and colleagues reported a successful case of organ procurement in a donor after cardiac death who had LVAD implantation for idiopathic dilated cardiomyopathy. Once death was declared based on circulatory criteria, LVAD was stopped in the operating room and systemic cold perfusion was performed, waiting for an additional 5 minutes for local Institute of Medicine guidelines and technical time to gain infrarenal distal aorta access. Liver biopsy showed sinusoidal dilatation, 10% to 15% macrovascular fat, and no significant inflammation, and the recipient's posttransplant course was uneventful.[10]

Two successful similar cases have been recently reported, with no stop of LVAD before organ procurement.[11,12] Recently, Kamei and colleagues reported a case of an LVAD donor with unexpected congestive liver fibrosis. The LVAD was implanted for hypertrophic cardiomyopathy as a bridge to heart transplant. During follow-up for cardiac disease, laboratory tests showed a slightly elevated bilirubin (although it remained under 2.0 mg/dL). An abdominal CT scan 8 months prior to the donor surgery showed dilatated hepatic veins, without signs of liver fibrosis. Aspartate aminotransferase and alanine aminotransferase levels were normal at the time of liver donation, but bilirubin level was 4.5 mg/dL (reference range of 0.3-1.2 mg/dL). The liver was shown to be slightly reduced in size, and multiple macronodular lesions were detected. Liver biopsy showed a mild microvesicular steatosis (<10%) with lymphoid filtration and advanced fibrosis (stage F3 to F4), and the organ was considered not suitable for transplant.[13]

Our recipient was in a critical status; nevertheless, we attempted to use an organ from a donor on LVAD in the absence of other available organs; both the intraoperative and postoperative courses were uneventful. Biochemical and radiological preoperative examinations, such as optimal macroscopically liver aspect, encouraged the organ procurement, and no liver biopsy was performed due to absence of hepatic congestion. Technical aspects were not so different compared with standard organ procurement, but special attention was required to preserve LVAD drive lines and thoracic access.

According to the limited experience available, LVAD donors can be considered for liver transplant, especially in the absence of cholestasis on biochemical preoperative examinations, regular cardiological course, and normal liver morphology on CT scan or ultrasonography. Repeated echocardiography could provide additional information regarding right ventricular function and indirectly of possible chronic liver damage.[14] Elastography might help with liver donor selection, although this procedure is not considered a standard radiological test.[15]

Conclusions

A donor with mechanical circulatory support system such as LVAD can be considered as a potential liver donor, in relation to hepatic organ shortages. Preoperative biochemical-radiological tests and cardiological history could play significant roles in donor selection and liver suitability. Considering the technical aspects, the surgical field is reduced because of a circulatory support system, and special attention is needed to preserve the drive lines of LVAD during thoracotomy and laparotomy.

References

1. Busuttil RW, Tanaka K. The utility of marginal donors in liver transplantation. *Liver Transpl.* 2003;9(7):651-663. doi:10.1053/jlts.2003.50105
2. Maluf DG, Edwards EB, Kauffman HM. Utilization of extended donor criteria liver allograft: Is the elevated risk of failure independent of the model for end-stage liver disease score of the recipient? *Transplantation.* 2006;82(12):1653-1657. doi:10.1097/01.tp.0000250571.41361.21
3. Weismuller TJ, Negm A, Becker T, et al. The introduction of MELD-based organ allocation impacts 3-month survival after liver transplantation by influencing pretransplant patient characteristics. *Transpl Int.* 2009;22(10):970-978. doi:10.1111/j.1432-2277.2009.00915.x
4. Suarez-Pierre A, Zhou X, Fraser CD, 3rd, et al. Survival and functional status after bridge-to-transplant with a left ventricular assist device. *ASAIO J.* 2019;65(7):661-667. doi:10.1097/MAT.0000000000000874
5. Goldstein DJ, Oz MC, Rose EA. Implantable left ventricular assist devices. *N Engl J Med.* 1998;339(21):1522-1533. doi:10.1056/NEJM199811193392107
6. Lampert BC, Teuteberg JJ. Right ventricular failure after left ventricular assist devices. *J Heart Lung Transplant.* 2015;34(9):1123-1130. doi:10.1016/j.healun.2015.06.015
7. Myers RP CR, Sayegh R, Moreau R, Degott C, Lebrec D, et al. Cardiac hepatopathy: clinical, hemodynamic, and histologic characteristics and correlations. *Hepatology* 37(2):393-400.
8. Poelzl G, Ess M, Mussner-Seeber C, Pachinger O, Frick M, Ulmer H. Liver dysfunction in chronic heart failure: prevalence, characteristics and prognostic significance. *Eur J Clin Invest.* 2012;42(2):153-163. doi:10.1111/j.1365-2362.2011.02573.x
9. De Carlis R, Buscemi V, Checchini G, et al. Liver transplantation from brain-dead donors on mechanical circulatory support: a systematic review of the literature. *Transpl Int.* 2021;34(1):5-15. doi:10.1111/tri.13766
10. Rayhill SC, Martinez-Mier G, Katz DA, Kanchustambam SR, Wu YM. Successful non-heart-beating donor organ retrieval in a patient with a left ventricular assist device. *Am J Transplant.* 2004;4(1):144-146. doi:10.1046/j.1600-6143.2003.00280.x
11. Munawar K, Rajagopalan N, Grigorian A, Dennis D, Guglin M. Successful liver transplantation from a donor with a continuous-flow left ventricular assist device for 9 months. *Transplant Proc.* 2017;49(10):2406-2408. doi:10.1016/j.transproceed.2017.09.039
12. Martinez-Lopez de Arroyabe B, Peressutti R, de Carlis L, Muzzi R, Ranucci M, Livi U. Ventricular assist devices: from bridge to transplantation to bridge to organ donation. *J Cardiothorac Vasc Anesth.* 2015;29(3):738-740. doi:10.1053/j.jvca.2014.01.011
13. Kamei H, Komagome M, Kurata N, et al. Brain death organ donor supported by a left ventricular assist device showing unexpected congestive liver fibrosis: A case report. *Int J Surg Case Rep.* 2018;47:57-60. doi:10.1016/j.ijscr.2018.04.026
14. El Hadi H, Di Vincenzo A, Vettor R, Rossato M. Relationship between heart disease and liver disease: a two-way street. *Cells.* 2020;9(3):567. doi:10.3390/cells9030567
15. European Association for Study of Liver, Asociacion Latinoamericana para el Estudio del H. EASL-ALEH Clinical Practice Guidelines: Non-invasive tests for evaluation of liver disease severity and prognosis. *J Hepatol.* 2015;63(1):237-264. doi:10.1016/j.jhep.2015.04.006