Circumferential Fence With the Use of Polyethylene Terephthalate (Dacron) Vascular Graft for All-in-One Hepatic Venous Reconstruction in Right-Lobe Living-Donor Liver Transplantation

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ABSTRACT

Integration of hepatic vein tributaries with a diameter ≥5 mm into the drainage system in right-lobe living-donor liver transplantation (LDLT) is of vital importance for graft function. Recently, the most commonly emphasized hepatic venous reconstruction model is the all-in-one reconstruction model. In the final stage of this model that aims to form a common large opening, allogeneic vascular grafts are almost always used to construct a circumferential fence. To date, no other study has reported the use of polyethylene terephthalate (Dacron) vascular graft as a circumferential fence in LDLT. We aimed to present the 1st 4 cases of circumferential fences created with Dacron vascular graft. Four right-lobe grafts weighing 522–1,040 g were used. A polytetrafluoroethylene vascular graft was used for the integration of segment 5 vein and segment 8 vein into the drainage model, whereas a Dacron graft was used to creating a circumferential fence. The patency of hepatic outflow evaluated with the use of multi-detector computerized tomography at postoperative day 7. Venous outflow obstruction was not detected in any cases. This study suggested that owing to its flexible structure the polyethylene terephthalate vascular graft can be an alternative to allogeneic vascular grafts in forming circumferential fence.

SINCE the first successful liver transplantation performed by Starzl et al in 1967, liver transplantation has become the standard therapy for many liver disorders, mainly chronic liver disease [1,2]. Although organ requirement in the majority of liver transplantations in Western countries is met by cadaveric donors, it is mainly dependent on living donors in many Asian countries, including Turkey [2,3]. During the 1st years of LDLT, the left lobe of the liver was used as graft in the majority of adult cases to ensure donor safety. However, certain complications in recipients of left-lobe graft, such as small-for-size due to low graft weight, have paved the way for the use of right-lobe graft in LDLT [2,4,5]. The main problem with the use of a right lobe graft is that the right lobe possesses a unique complex venous anatomy [4,6]. Therefore, venous drainage of the right lobe is one of the most significant issues that must be overcome. To drain the right-lobe graft in a nonproblematic manner, middle hepatic vein (MHV), segment V (V5), segment VIII (V8), and major short hepatic veins (SHVs) should be integrated into the drainage system with the use of allogeneic and synthetic vascular graft materials [7,8]. Although many techniques have recently been defined for hepatic venous reconstruction, the most commonly emphasized technique is the all-in-one venous reconstruction model. In the final stage of this model that aims to form a common large opening, allogeneic vascular grafts are almost always used to construct a circumferential fence. To date, no other study has reported the use of polyethylene terephthalate (Dacron) vascular graft as a circumferential fence in LDLT. We aimed here to present the 1st 4 cases of circumferential fence formation with the use of Dacron vascular graft.

MATERIALS AND METHODS

From January 2014 to December 2014, a total of 184 living-donor hepatectomies, consisting of 143 right lobe, 24 left lobe, 12 left lobe lateral segment, and 4 not known, were performed for LDLT at Inonu University Liver Transplantation Institute. After donor hepatectomy, the obtained liver graft was placed in a container full of ice cubes on the

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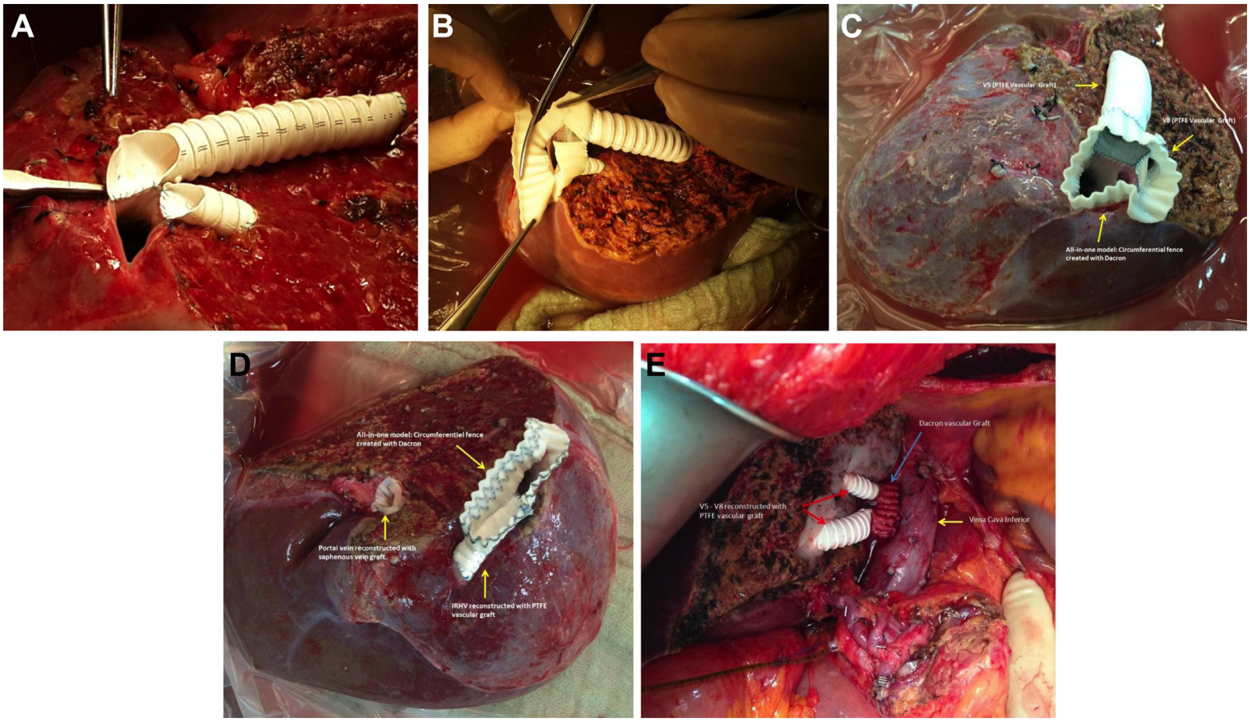

Fig 1. Technical details of the all-in-one hepatic venous reconstruction model. (**A**) First, section V, section VIII, and IRHV are extended to the right hepatic vein with the use of expanded polytetrafluoroethylene vascular grafts. (**B**–**D**) Circumferential fence was created with the use of Dacron vascular graft. (**E**) Anastomosis created between Dacron graft and recipient inferior vena cava with the use of a running suture.

back table. First, the portal vein was perfused with RL and subsequently HTK preservation solutions at +4°C until a clear fluid is drained from hepatic vein orifices. All back-table reconstruction procedures were performed by the same senior surgeon (S.Y.), who has extensive experience in LDLT. Although the all-in-one venous reconstruction model was used in 124 right-lobe grafts, other venous reconstruction models were used in 19 right-lobe grafts. The technique of all-in-one venous reconstruction model was as follows. After procurement of the right-lobe graft, the hepatic vein orifices were carefully put forth. The artificial vascular grafts used for venous extension were 6, 8, or 10 mm internal diameter ringed-walled expanded polytetrafluoroethylene (ePTFE). The V5, V8, and (in 1 case) SHVs were anastomosed to the proximal end of 2 ePTFE vascular grafts end-to-end fashion with the use of 6/0 polypropylene sutures (Fig 1A). Two ePTFE vascular grafts were separately extended to the right hepatic vein orifice of the graft (Fig 1A). A venoplasty was performed to fashion a single and wide outflow orifice. Then a Dacron vascular graft was cut open longitudinally and sutured around joined vessels as a circumferential fence (Fig 1B–D). Finally, an anastomosis was established between the liver graft in which a circumferential fence was created with Dacron and the recipient inferior vena cava (IVC; Fig 1E). The 4 patients in whom a Dacron vascular graft was used were prospectively followed. The vascular structures were imaged postoperatively with the use of Doppler ultrasonography for the 1st 3 days and dynamic computerized tomography on the 7th day.

RESULTS

There were 3 male and 1 female patients, with an overall mean age of 54.3 ± 11.7 years (range, 41–72 y). The Model for End-Stage Liver Disease scores ranged from 10 to 12 and Child scores ranged from 5 to 9. All patients underwent right-lobe liver graft implantation. The grafts weighed 522–1,040 grams and their graft-recipient weight ratios were 0.74–1.0. The indication for liver transplantation were as follows: hepatitis B virus (HBV) + hepatocellular carcinoma ($n = 2$), HBV ($n = 1$), and hepatitis C virus ($n = 1$). The mean follow-up period was 4.75 ± 0.4 months (range, 4–5 mo) for all patients and we not observed any complication including hepatic venous outflow obstruction. Detailed demographic and clinical data of the 4 patients are summarized in Table 1.

DISCUSSION

LDLT has been a viable alternative to deceased-donor liver transplantation (DDLT) in countries with limited cadaveric donor pool [2,3]. Viewed from the vascular structure, the most striking differences between LDLT and DDLT are the hepatic venous reconstruction techniques [3,9]. In DDLT the postoperative drainage issues in liver grafts have been minimized by virtue of the advance of the wide-mouthed cavocavostomy techniques (conventional, piggyback, modified piggyback) [5]. In contrast, severe congestion may ensue in some segments of the implanted graft, especially the ones drained by MHV and its tributaries, in LDLT of a right-lobe graft having a complex venous drainage system. To overcome this issue, construction models integrating all hepatic vein branches with a

Table 1. Demographic and Clinical Characteristics of 4 Recipients With Graft Reconstructed With the Use of Dacron

Parameter	Case 1	Case 2	Case 3	Case 4
Patient ID	MSU	AE	MY	NO
Age (y)	72	47	41	57
Sex	M	M	M	F
MELD	11	10	12	11
Child	9	5	8	7
BMI (kg/m^2)	28.1	25.1	33.6	32.0
Underlying cause	HBV+HCC	HBV+HCC	HBV	HCV
Graft weight (g)	695	522	1040	670
GRWR	0.80	0.74	1.0	0.86

Abbreviations: MELD, Model for End-Stage Liver Disease; BMI, body mass index; GRWR, graft-recipient weight ratio.

diameter ≥5 mm into the drainage system have been developed [3,4,9,10].

It is of vital importance to integrate both the veins draining the right anterior sector (V5, V8, and MHV) and major SHVs contributing to the drainage of the right posterior sector into the venous system for optimal drainage of the right-lobe graft [2–4,10,11]. Studies have shown that congestion of V5 and V8 may develop as a result of insufficient drainage of the right anterior sector, and this may progress to early graft dysfunction and even liver failure and small-for-size syndrome [3–5,10]. Therefore, either separate anastomoses should be established between the hepatic venous branches draining the right-lobe graft (right hepatic vein, MHV, V5, V8, SHVs) and IVC or all venous orifices of hepatic vein tributaries should be turned into a common orifice and anastomosed to the IVC with the use of the all-in-one technique [3,4,6]. Separate anastomoses formed by using allogeneic or synthetic vascular grafts cause both a prolonged warm ischemia time and multiple small-orifice anastomoses on the IVC [3,4,6]. Moreover, it is well known that small-orifice anastomoses are occluded early after surgery. To overcome these obstacles, wide-mouthed hepatic venous reconstruction models have been developed in centers with high LDLT volume.

No consensus has been reached yet for the proper naming of the models. A search in the Pubmed database reveals that the most commonly used terms for hepatic venous reconstruction models in LDLT include quilt venoplasty, unification quilt venoplasty, fence conduit venoplasty, conventional unification venoplasty, funneling unification venoplasty, simplified unification funneling venoplasty, large clustered venoplasty, patch graft venoplasty, common large opening, and all-in-one [1–16]. In our opinion, this terminology should be reviewed. Whatever their names are, all of these reconstruction models aim at both preventing congestion in liver graft and minimizing the postoperative venous outflow obstruction risk. We use the all-in-one venous reconstruction model for almost all right-lobe grafts. With the use of this model, we have minimized some complications, such as congestion-associated graft dysfunction and postoperative venous outflow obstruction. Among 1,011 LDLT cases that completed up to April 2014, only 3.46% developed postoperative venous outflow obstruction (unpublished data), a figure that is even lower than the lowest rate reported in the literature (3.9%) [9].

The graft materials most commonly used for hepatic venous reconstruction are the allogeneic (homologous or autologous) and synthetic (artificial, prosthetic) vascular grafts [1,2]. Peritoneal patch has been successfully used for reconstruction in cases with limited graft access [3,8,11]. The most commonly used homologous vascular grafts are saphenous vein, iliac vein, iliac artery, IVC, and aortic artery grafts obtained from cadaveric donors [1,2]. The most commonly used autologous vascular grafts are left portal vein, paraumbilical vein, and saphenous vein [1,2,4]. The homologous vascular graft requirement is met by saphenous veins obtained at varices surgery, or various vascular grafts obtained from cadaveric donors. Synthetic vascular grafts are mostly used when other materials are unavailable or allogeneic vascular grafts suitable for the reconstructed vein's size can not be found. PTFE is the most commonly used synthetic vascular graft for vascular reconstruction in liver transplantation. We frequently use PTFE graft for the reconstruction of hepatic vein tributaries. During the 1st years of our experience we preferred PTFE graft when we had no access to allogeneic vascular grafts. We have recently begun to use PTFE grafts more commonly after the publication of the reports suggesting high patency rates with PTFE and our results (unpublished) paralleling those data [11]. One other important reason for using PTFE graft is its availability.

Dacron is the most commonly used synthetic vascular graft after PTFE. It is used in many vascular reconstruction procedure, including renal transplantation. Despite its flexible structure and easy manipulability, however, Dacron could not replace PTFE graft in liver transplantation, and a limited number of case reports about Dacron graft use have been published so far [13–16]. This is mainly because Dacron graft has larger pores and therefore an increased infection risk compared with PTFE. Moreover, immunosuppression after liver transplantation and a relatively higher biliary leakage rate have caused surgeons to avoid using Dacron [11,13,14]. Recently, rifampicin-soaked Dacron with a lower infectious risk has been introduced into clinical practice [13]. Dacron was used for retrohepatic vena cava replacement in almost all of the case reports about its use in liver transplantation. Thus, a Dacron graft has not been used to date in any stage of the reconstruction of hepatic venous tributaries of the right lobe except for Dr Tokat's work on hepatic venous reconstruction models in LDLT (unpublished data) [7].

Our experience of Dacron use in LDLT consists of the 4 patients presented in the present manuscript. We, however, experienced no technical difficulty in forming a circumferential fence with the use of Dacron. In our opinion, Dacron vascular graft can be used efficiently in all stages of hepatic venous reconstruction, particularly in the all-in-one model. No sign of graft infection was observed in the postoperative follow-up of any patient.

In conclusion, allogeneic graft supply may sometimes be problematic for centers with a high LDLT volume.

Considering the ease of use and ergonomic structure of Dacron graft, it can be suggested to be a good alternative to allogeneic vascular grafts in the formation of a circumferential fence.

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