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Improving hepatic and portal venous flows using tissue expander and Foley catheter in liver transplantation

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Abstract: Background and objective: Vascular reconstruction is important in liver transplantation because its obstruction causes graft failure and eventual loss. Vascular outflow obstruction may be due to graft malposition. We describe our experience with liver allograft repositioning using tissue expander and Foley catheter to improve hepatic and portal venous outflows.
Patients and methods: A total of seven patients who received liver transplantation at our institution developed hepatic and/or portal venous obstruction during final graft positioning detected by Doppler ultrasonography (hepatic vein flow <10 cm/s; portal vein flow <12 cm/s). Chart and operative records of these patients were reviewed. Technique of operation, donor–recipient characteristics, use of tissue expander or Foley catheter to improve venous outflow, complications, and outcome were analyzed.
Results: Hepatic and/or portal venous obstruction were detected after portal reperfusion. We used commercially available tissue expander used in plastic surgery and Foley catheter to reposition the graft. Tissue expanders were used in three recipients (age: 27–46 yr). Foley catheters were used in four recipients (age: 7 months–53 yr). One recipient used both tissue expander and Foley catheter. Expanders were filled with 300–770 mL saline and placed into the right subphrenic space. Foley catheters were filled with 15–75 mL saline. Significant improvements in hepatic and/or portal venous outflow were detected by Doppler ultrasonography post-graft repositioning. Aspiration of expander and Foley catheter contents was started from 6th to 27th postoperative day under sonographic guidance. All expanders and catheters were removed by the 19th–56th postoperative day (mean: 38 d). Complications included chylous ascites (1/7), bile leak (1/7), tube drain infection (2/7), septicemia (2/7). All complications were successfully managed by non-operative interventions. There was no outflow obstruction detected by ultrasonography before and after removal of expanders and catheters. One- and two-year graft and patient survivals were both 100%.
Conclusion: The use of tissue expanders and Foley catheters to improve hepatic and portal venous outflow in malposed liver allografts is a simple and safe method after liver transplantation.

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Key words: allograft malposition – Foley catheter – liver transplantation – tissue expander

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Outflow or inflow obstruction in liver transplantation cause graft dysfunction and eventual graft loss. Partial mechanical hepatic and/or portal outflow obstruction in the allograft in liver transplantation is uncommon but not rare. The incidence of hepatic vein (HV) obstruction varies from 5.3% in a series

of living donor liver transplantation (1) to 12.9% in a series of reduced-size livers (2). It occurs more common in pediatric liver transplant where a small graft may twist around the hepatic venous anastomosis. In adult deceased donor liver transplant where full-size liver is used and there is no disproportion in the size of the abdominal cavity to the graft, this may be an unlikely cause of obstruction. However, free movement of the graft in the abdominal cavity during early postoperative period may cause twisting in either hepatic or portal vessels. This form of obstruction should be recognized early and relieved promptly to prevent complications and graft failure. We have experienced this complication intraoperatively in seven patients undergoing liver transplant. Two of these patients presented with unexplained hypotension after portal reperfusion. In all cases, Doppler ultrasonography, by determining vascular flow patterns and velocities, was able to detect the cause of venous outflow obstruction.

Fixation of the round ligament, placement of bowel loops and use of tissue expanders have been described to stabilize graft position during liver transplantation (3). We have used tissue expander and Foley catheter to improve HV and portal vein (PV) outflows. In this study, we retrospectively reviewed our experience and analyzed the effectivity and safety of this procedure.

Patients and methods

A total of seven patients who received liver transplantation at our institution developed hepatic and/or portal venous outflow obstruction during final graft positioning detected by Doppler ultrasonography. All patients underwent application of tissue expander, Foley catheter, or both to stabilize graft position. The age of the patients ranged from 7 months to 54 yr. Three patients received full-size livers, three patients received left lateral segment grafts, and one patient received a right lobe liver graft. HV outflow obstruction was entertained when HV flow velocity is <10 cm/s and with monophasic waveform is seen on Doppler ultrasound and PV outflow obstruction was entertained when PV flow velocity is <12 cm/s. Tissue expander was used in three recipients. Foley catheter was used in four recipients. One recipient used both tissue expander and Foley catheter (Table 1).

Commercially available croissant-shaped silicone prosthesis (tissue expander used in plastic surgery) was filled with 300–700 mL normal saline. Two-way, and three-way Foley catheters were filled with 15–75 mL normal saline (Table 2). These were placed into the right subphrenic space after completion of vessels and bile duct reconstructions (Fig. 1). The tissue expander port was laid outside of the abdomen. The Foley catheters were brought

Table 1. Patients' clinical profile

No.	Age	Sex	Diagnosis	Procedure/graft	Prosthesis used
1	27 yr	M	Wilson's disease	OLT/full-size	Tissue expander
2	9 months	M	Biliary atresia	LDLT/LLS	Foley catheter
3	8 months	F	Neonatal hepatitis	LDLT/LLS	Foley catheter
4	7 months	F	Biliary atresia	LDLT/LLS	Foley catheter
5	16 yr	F	Wilson's disease	OLT/full-size	Tissue expander
6	54 yr	F	1 Biliary cirrhosis	LDLT/right-lobe	Tissue expander
7	47 yr	M	HBV cirrhosis	OLT/full-size	Tissue expander Foley catheter

HBV, hepatitis B virus; OLT, orthotopic/cadaveric liver transplant; LDLT, living donor liver transplant; LLS, left lateral segment graft.

Table 2. Hepatic vein and portal vein outflow velocities

No.	Outflow velocities before intervention	Intervention	Outflow velocities after intervention
1	HV 7 cm/s monophasic biphasic	TE–770 mL	HV 14 cm/s, biphasic
2	LHV 10 cm/s biphasic LPV 5 cm/s	FC–75 mL	LHV 48 cm/s, biphasic LPV 27 cm/s
3	HV S2 0 cm/s S3 15 cm/s	FC–15 mL	S2 13 cm/s, biphasic S3 57 cm/s, Triphasic
4	PV 0 cm/s	FC–75 mL	PV 13 cm/s
5	HV 8 cm/s	TE–500 mL	HV 35 cm/s, monophasic
6	RHV 20 cm/s, monophasic biphasic RPV 8 cm/s	TE–700 mL	RHV 32 cm/s, biphasic RPV 17 cm/s
7	MHV 6 cm/s, monophasic RHV 15 cm/s, monophasic	TE–300 mL FC–75 mL	MHV 19 cm/s, biphasic RHV 22 cm/s, biphasic

TE, tissue expander; FC, Foley catheter; HV, hepatic vein; PV, portal vein; RHV, right hepatic vein; RPV, right portal vein; MHV, middle hepatic vein.

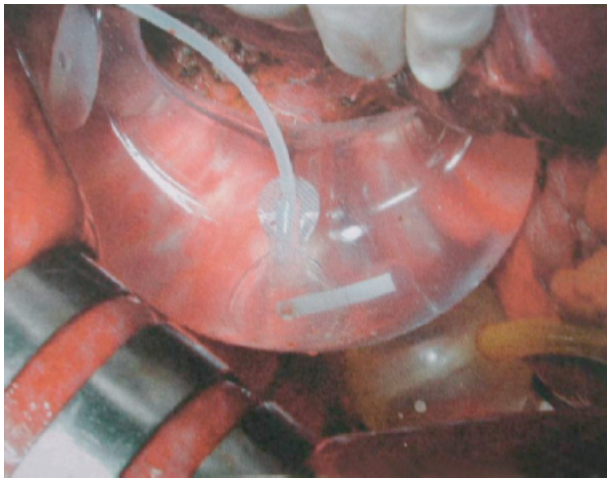

Fig. 1. Tissue expander and Foley catheter.

out through a small opening in the wound. For patients receiving tissue expander, the abdomen was temporarily closed using polytetrafluoroethylene (PTFE/Gor-Tex) graft with a small window for ultrasound studies. The Foley catheters were removed under local anesthesia. The tissue expander was removed with subsequent removal of the PTFE graft and primary abdominal closure under general anesthesia. Hepatic and portal blood flows were monitored before and after removal of prostheses (Fig. 2).

Results

Significant improvements in HV and PV outflows were detected by Doppler ultrasound post-graft repositioning (Table 2). Aspiration of expander and Foley catheter contents was started from 6th to 27th postoperative day under sonographic guidance (Table 3). All expanders and catheters were removed by the 19th–56th postoperative day (mean: 38 d).

Table 3 summarized the complications that developed during use of the prostheses. All complications were successfully managed by non-operative interventions. There was no outflow obstruction detected by ultrasonography before and after removal of the prostheses. One- and two-year graft and patient survivals were 100%.

Discussion

Keys in hepatic and portal venous outflow reconstruction include: (i) size of anastomotic orifice, (ii) length and orientation of vessels, and (iii) position of the graft. Excluding vessel anastomotic techniques, the main factor in intraoperative venous outflow blockade is graft malposition. Several methods of outflow reconstruction have been developed to prevent obstruction. Emond et al. (2) described the triangulation method in reconstruction of HVs in reduced-size livers. Makuuchi developed the technique of triple recipient HV reconstruction with creation of a long venous trunk in living related liver transplant to overcome outflow block (4). Tanaka used middle HV and left HV venoplasty with a right caudal extension in the IVC as innovation in outflow technique in living donor liver transplant (LDLT) (1). Graft septoplasty was developed by Chen in outflow tract reconstruction

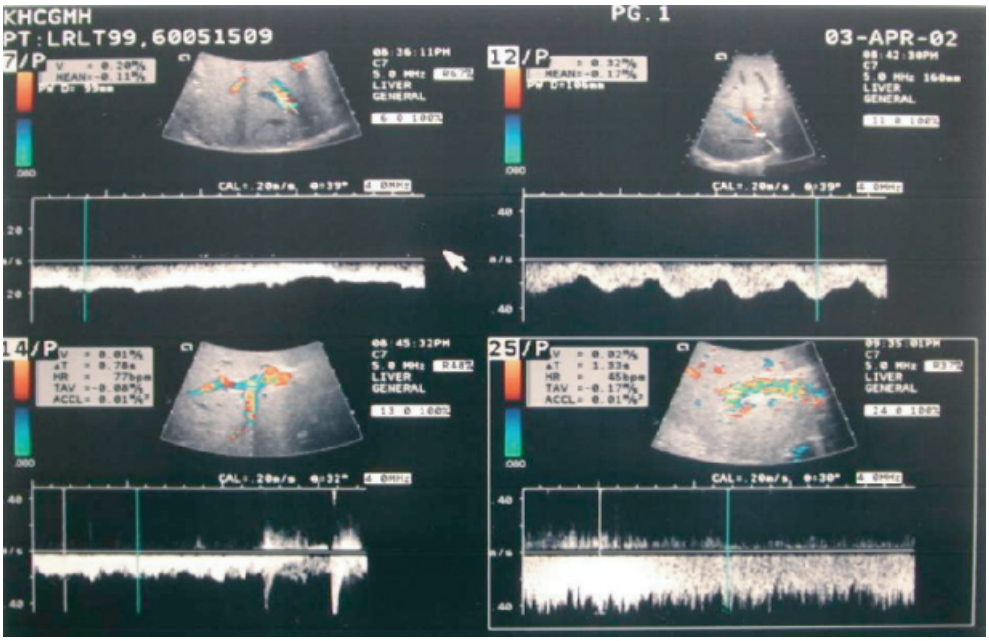

Fig. 2. Use of Doppler ultrasound in detecting obstruction and velocities.

Table 3. Number of days with prostheses; complications

No.	Start of deflation by POD	Date removed by POD	Total days with prosthesis	Complication
1	16	31	15	None
2	40	56	16	None
3	6	19	13	Staph. epidermidis septicemia
4	19	33	14	Chylous ascites, Staph. septicemia
5	27	51	24	Drain infection
6	26	35	9	Bile leak, drain infection
7	21	41	20	Herpes zoster
	35	40	5	

POD, postoperative day.

in LDLT (5). These techniques have become standards in LDLT to ensure adequate outflow. However, despite refinement in surgical techniques, mechanical outflow obstructions from malpositioning of the graft may happen. Oftentimes, it mimics hypovolemia because of decreased venous return. A mild to moderate twist can be tolerated if the hepatic venous anatomoses are wide following the techniques described above.

Intraoperative Doppler ultrasound is used routinely to check vascular flow patterns and velocities. In the HV, a monophasic waveform with peak velocity <10 cm/s indicates inadequate graft drainage. This condition is diagnostic of a primary hepatic outflow problem especially if accompanied by a decrease (peak velocity <12 cm/s) in portal inflow (6–8). Once detected, outflow blockade must be relieved immediately usually by surgical intervention. This can be done by maneuvers as fixation of the round ligament to fix the graft in position, placement of bowel loop to lift the graft, additional side-to-side cavo-cavostomy (3, 9, 10), placement of a Blakemore–Sengstaken tube (11), or use of tissue expander (2, 3).

In these seven patients, we realize that the innovations in hepatic venous anastomoses were not sufficient to prevent outflow obstruction either hepatic or portal. Following Inomata and associates' initial experience with tissue expanders 7 yr ago, we applied tissue expanders to correct outflow obstructions not only in reduced-size livers used in LDLT but expanded its use to full-size livers from cadaveric donation. Further, we innovated the approach by using Foley catheters using the same principle.

Hypotension as a result of hepatic outflow obstruction is temporal hypovelemia. Blind resuscitation with fluids to treat abnormal data from hemodynamic monitoring will not solve the problem. Mechanical obstruction from vessel anastomosis, thrombosis, kinking, and twisting should be managed surgically by meticulous venous anastomosis and/or adjusting the position of the graft (12).

Improvement in venous outflow as shown by prosthesis pre- and post-application Doppler ultrasound results occurred in all patients. Outflow blockade after removal of the prostheses did not occur. It is supposed that the graft is being supported in place by adhesions (3).

All complications were managed by non-operative intervention. The 1- and 2-yr graft and patient survivals were 100%. In conclusion, the use of tissue expander and Foley catheter to improve hepatic and portal venous outflow in malpositioned liver allografts is a simple and safe method during liver transplantation.

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