Partial Splenectomy and Use of Splenic Vein as an Autograft for Meso-Rex Bypass: A Clinical Observational Study

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEFG 1 **Zhang Wei**
ABD 1 **Shao Guang Rui**
AC 2 **Zhang Yuan**
BCD 3 **Li Dian Guo**
BDF 3 **Liu Qian**
ADFG 4 **Liu Shu Wei**

1 Department of Radiology, Second Hospital of Shandong University, Jinan, Shandong, P.R. China
2 Department of Evidence-Based Medicine, Second Hospital of Shandong University, Jinan, Shandong, P.R. China
3 Department of Pediatric Surgery, Second Hospital of Shandong University, Jinan, Shandong, P.R. China
4 Department of Anatomy, Medical College of Shandong University, Jinan, Shandong, P.R. China

Corresponding Author: Liu Shu Wei, e-mail: sdeyzw@163.com

Background: Meso-Rex bypass (MRB) surgery is being increasingly used to treat chronic prehepatic portal hypertension secondary to extrahepatic portal vein thrombosis (EPVT) and cavernous transformation (EPVCT) in children. Rather than using the internal jugular vein (IJV, the traditional venous graft), we used an autogenous splenic vein segment graft for MRB.

Material/Methods: We examined 25 children with extrahepatic portal hypertension and a history of recurrent upper gastrointestinal (GI) variceal bleeding despite previous endoscopic sclerotherapy. All patients had melena, splenomegaly, hypersplenism, or some combination thereof. Left portal vein (LPV) patency was verified in 22 patients using intraoperative direct portography through the umbilical vein. Partial splenectomy was performed to enable the harvest of the splenic vein trunk, which was anastomosed between the superior mesenteric vein (SMV) and the left portal vein (LPV). All patients were followed for 12–48 months (mean=25.6 months) and no patients were lost to follow-up.

Results: Preoperative Doppler ultrasound (US) imaging indicated that 18/25 patients had adequate intrahepatic portal veins for shunting, with no blood flow in the LPVs of 7 patients. LPV patency in 22/25 patients was verified using intraoperative direct portography, with successful MRB. Shunting was converted into a portosystemic shunt in the remaining 3/25 patients with thrombosed LPVs. A Doppler US evaluation of the vein conduit revealed excellent postoperative flow. The patients' mean hemoglobin, platelet, and white blood cell counts increased significantly, and in all cases the endoscopic status obviously improved after shunting. Occlusion or narrowing occurred in 2/22 patients after discharge. At 12 months (for 1 patient) and 24 months (for 1 patient), the shunt was converted into a portosystemic shunt. The cumulative graft patency rate was 91% (20/22).

Conclusions: Partial splenectomy and splenic vein autografting in MRB surgery can successfully resolve prehepatic portal hypertension and hypersplenism in children.

MeSH Keywords: **Autografts • Child • Hypertension, Portal • Splenic Vein**

Full-text PDF: http://www.medscimonit.com/abstract/index/idArt/892482

📄 2681   🖥 3   📊 5   📖 34

Background

Chronic portal hypertension is frequently observed in children secondary to extrahepatic portal vein obstruction (EHPVO). It is most commonly caused by extrahepatic portal vein thrombosis (EPVT) and cavernous transformation (EPVCT). Furthermore, it is associated with acute gastrointestinal (GI) hemorrhage from the esophageal and gastric varices, which can be temporarily treated using sclerotherapy or variceal banding [1]. A porto-systemic distal splenorenal shunt (Warren procedure) is usually indicated for patients who present with recurrent variceal bleeding (despite endoscopic sclerotherapy), severe hypersplenism, or both. Recently, the meso-Rex bypass procedure (MRB) procedure, in which the portal vein blood is redirected into the intrahepatic left portal venous circulation, has become the definitive treatment for pediatric patients with extrahepatic portal hypertension [2–7]. The internal jugular vein (IJV) is the typical venous autograft used in MRB, showing satisfactory long-term patency and a significantly reduced rate of clinical complications [8–11]. Alternative graft vessels have included the inferior mesenteric vein, the autologous great saphenous vein, the splenic vein, the recanalized umbilical remnant, and the left gastric vein [1,5,12–15]. In the present study, we successfully used a segment of the splenic vein trunk via a partial splenectomy to bridge the superior mesenteric vein (SMV) and the left portal vein (LPV) within the Rex recessus (Figure 1).

Material and Methods

The ethics board at the Second Hospital of Shandong University approved this study and all patients' guardians provided written informed consent. Twenty-five children without previous splenectomy (16 boys and 9 girls) aged from 4.5 years to 13 years (median, 8.3 years) with symptomatic extrahepatic portal hypertension were referred to our unit for surgical treatment between March 2009 and March 2013. All pediatric patients had a history of upper GI bleeding, melena, splenomegaly, severe hypersplenism, or some combination thereof. We performed a preoperative Doppler ultrasound (US) evaluation in all patients. The patients' demographics, characteristics, and perioperative data are shown in Table 1. LPV patency was verified with intraoperative direct portography through the recanalized umbilical remnant. All patients' splenic veins were measured preoperatively via Doppler US and a complete blood count and upper GI endoscopy were performed preoperatively and postoperatively. Esophageal varices were graded at endoscopy as grade 3 (large), grade 2 (medium), grade 1 (small), or grade 0 (cherry-red spots) according to Triger's classifications (Table 2) [16].

Partial splenectomy was performed to enable the harvest of the splenic vein trunk, which was subsequently anastomosed between the SMV and LPV. Anticoagulant therapy was routinely
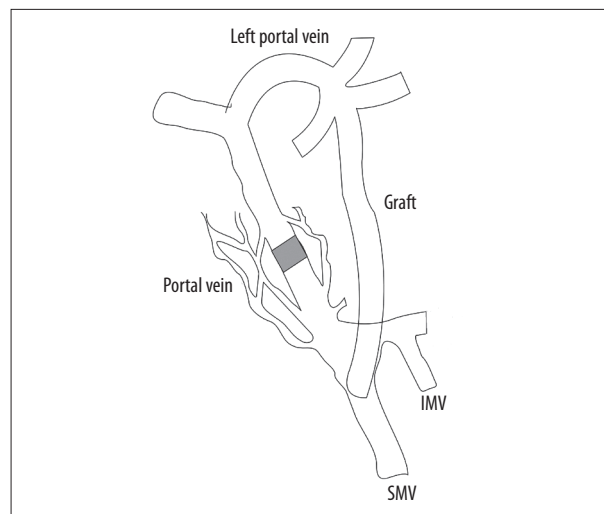

Figure 1. An autogenous splenic vein is used as a graft to bridge the umbilical portion of the LPV and the SMV with the transection of the splenic vein trunk in meso-Rex bypass.

administered to all patients postoperatively as follows: during the first 3 postoperative days, an intravenous heparin infusion (100 IU/kg/d) was administered, followed by oral dipyridamole (14 mg/kg/d) and acetyl salicylic acid (7 mg/kg/d) for 6 months. All patients with a meso-Rex shunt were followed postoperatively using Doppler US, and certain patients were followed using low-dose computed tomographic angiography (CTA). All patients were closely followed after discharge from the hospital.

Operative technique

The biopsy of the hepatic tissue was performed preoperatively. The same surgery was conducted in all patients without cirrhosis on histopathology. The peritoneum was incised, and the obliterated umbilical vein remnant in the round ligament was carefully divided. The umbilical vein was catheterized, and direct portography revealed the patency of the branches of the intrahepatic portal veins (Figure 2). The liver bridge between segments III and IV was divided, and the round ligament was followed into the Rex recessus to expose the LPV. The termination of the portal vein was carefully isolated and vascular control was established as previously described [8]. After exposing the spleen and sparing the short gastric vessels, we transected the splenic vein trunk via partial splenectomy, which was treated with heparin salt. The edges were trimmed for use as a conduit. End-to-end anastomosis was performed first between the graft and the junction of the round ligament and the LPV. Next, an end-to-side anastomosis was performed to the SMV using 7-0 continuous Prolene sutures. At unclamping, hepatopetal flow was observed immediately. Negative pressure wound therapy (NPWT) was used to prevent

Table 1. Patient characteristics.

Patient	Age (years)	Sex	Weight (kg)	Clinical symptom	Follow-up (months)	MRB (yes/no)	Days in the hospital
1	13.0	M	40.2	HT, M, S, J	12	Y	10
2	10.2	M	35.7	HT, M, S, HS, J	12	Y	12
3	9.4	F	28.4	HT, M, S	24	Y	15
4	8.8	M	26.6	HT, M, S, J	24	Y	11
5	7.2	M	25.0	HT, M, S	24	Y	12
6	6.0	M	23.8	HT, M, S, HS	36	Y	14
7	4.5	M	20.0	HT, M, S, HS, J	36	Y	17
8	11.3	F	35.0	HT, M, S	24	Y	19
9	5.8	F	20.6	HT, M, S, J	12	Y	20
10	10.1	M	30.4	HT, M, S, HS, J	12	Y	16
11	9.4	M	27.6	HT, M, HS, S	36	Y	17
12	8.2	M	26.5	HT, M, HS	48	Y	18
13	7.6	M	23.0	HT, M, S, J	48	Y	16
14	6.5	F	21.3	HT, M, S, HS	24	Y	14
15	5.5	M	20.5	HT, M, S, HS, J	36	Y	14
16	9.7	F	28.0	HT, M, S, HS	24	Y	18
17	11.0	F	32.0	HT, M, S, J	24	Y	17
18	12.5	M	37.4	HT, M, S, HS, J	24	Y	13
19	9.4	M	28.0	HT, M, S	24	Y	14
20	8.2	F	24.5	HT, M, S, J	24	Y	15
21	7.2	F	23.5	HT, M, S, HS	24	Y	15
22	6.0	M	22.5	HT, M, S, HS	12	Y	13
23*	4.8	M	20.6	HT, M, S, HS, J		N	
24*	10.5	M	34.0	HT, M, S, HS		N	
25*	5.8	F	25.6	HT, M, S, HS, J		N	
Mean	**8.3**		**27.2**		**25.6**		**15.0**
Standard-deviation	**2.4**		**5.4**		**10.7**		**2.6**

HT – hematemesis; M – melena; S – splenomegaly; HS – hypersplenism; J – jaundice; MRB – Meso-Rex bypass.

surgical site infections and promote healing processes after surgery in our series [17,18].

Doppler US was performed upon completion of the anastomoses, and the portal pressure gradient was measured intraoperatively before and after bypass. Postoperative Doppler US examination was performed on day 7, at 1, 3, 6, and 12 months postoperatively, and each year thereafter. This technique was used to assess the shunt patency at the SMV anastomosis, the shunt, the LPV anastomosis, and the shunt flow velocity. GI endoscopy was performed at 6 and 12 months, then each year thereafter. Routine blood and biochemical parameters were also evaluated at day 7, at 1, 3, 6, and 12 months, and each year thereafter.

Table 2. Endoscopic grades of the esophageal varices.

No.	Pre-bypass	Post-bypass
1	III	I–II
2	III	I–II
3	III	0–I
4	II–III	I–II
5	II–III	I
6	III	I–II
7	III	I
8	III	I–II
9	III	0–I
10	II–III	0
11	III	I–II
12	III	I–II
13	III	0–I
14	III	I–II
15	II–III	I
16	II–III	I–II
17	III	0–I
18	III	I
19	III	I
20	II–III	0–I

Statistical analysis

The results are expressed as the mean ± standard deviation and the data were analyzed using Student's t-tests to determine the differences between the preoperative and postoperative periods. All statistical analyses were performed using SPSS 13.0 (SPSS Inc., Chicago, IL, USA), and a *P*-value of <0.05 was considered as statistically significant.

Results

Doppler US revealed thrombosis or cavernous transformation of the portal vein in all patients. The preoperative Doppler imaging results indicated that 18 patients had adequate intrahepatic portal veins for shunting, with no blood flow found in the LPV of 7 patients. LPV patency was verified using intraoperative direct portography in 22 patients with successful MRB using the autogenous splenic vein (Figure 3). The remaining 3 patients had a thrombosed LPV, which was verified using direct
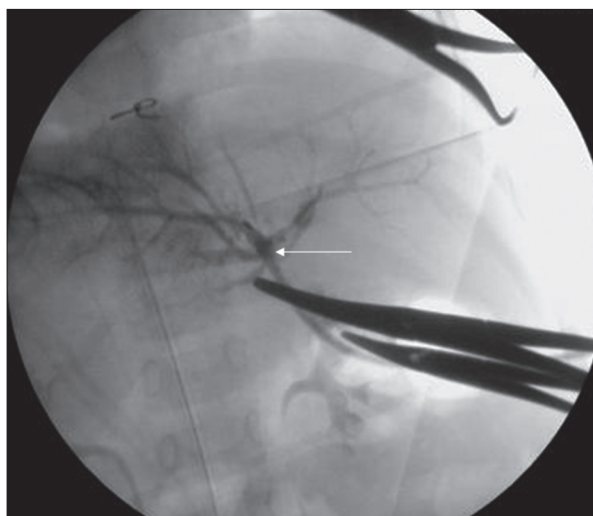

Figure 2. Intrahepatic angiography in a 12-year-old boy before shunting through the recanalized umbilical vein (the white arrow indicates the patency of the LPV).
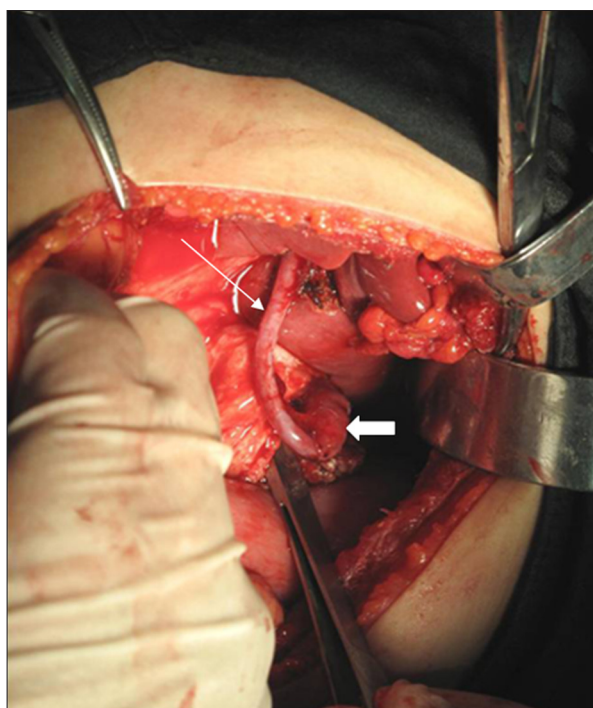

Figure 3. The thin white arrow indicates the autogenous splenic vein graft between the umbilical portion of the LPV and the SMV (thick white arrow) after mesoportal shunting of the same patient shown in Figure 2.

portography and were converted to a portosystemic shunt. The preoperative Doppler US failed to confirm the patency of the intrahepatic LPV in 3 of 25 patients (12%).

Regarding the 22 MRB patients, the average hospital stay was 15 days (range=10–20 days), the median length of the harvested

Table 3. Comparison of pre-shunt and post-shunt clinical variables.

Variables	Pre-shunt	Post-shunt	t	P
Mean hemoglobin (10^9 g/L)	86.2±20.6	126.2±28.1	8.236	0.000
Mean leukocyte count (10^9/L)	5.9±1.7	8.9±2.4	7.423	0.018
Platelet count (10^9/L)	63.5±13.6	160.2±28.1	15.488	0.000
Umbilical part of LPV blood flow rate (cm/s)	16.5±3.4	37.8±7.6	8.874	0.000
Intraoperative portal pressure (cm H_2O)	34.5±6.2	17.5±4.3	11.265	0.000

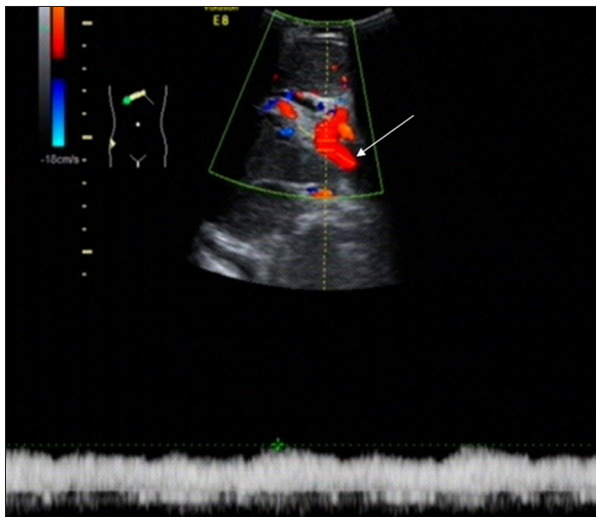The data are presented as the mean ±standard deviation.

Figure 4. Doppler US showing excellent intrahepatic portal flow through the bypass (white arrow) after mesoportal shunting in the same patient shown in Figure 2.

splenic vein was 7.5 cm (range=6.0–9.0 cm), and the median diameter of the graft vein was 0.76 cm (range=0.65–0.85 cm). The portal pressure gradient was measured intraoperatively, and it decreased from 34.5±6.2 cm H_2O before bypass to 17.5±4.3 cm H_2O after bypass ($P<0.01$, Table 3). Doppler US evaluation of the vessels following anastomoses revealed excellent flow, and postoperative recovery was rapid in 22 patients. GI variceal bleeding recurred in 3 patients 1 week postoperatively. Anticoagulant therapy was discontinued, and GI bleeding was treated successfully via endoscopic sclerotherapy. We followed the patients who underwent MRB for 12–48 months postoperatively.

Long-term patency was achieved in 20 patients as confirmed by postoperative upper GI endoscopy. Endoscopic status improved significantly in all patients. Residual varices were single, small-, or medium-sized, and pressure decreased (Table 2). At 12 months postoperatively, the median blood flow through the mid-graft was 29.3 cm/s (25.6±8.2 cm/s) according to Doppler US evaluation (Figure 4). Although the LPV and its
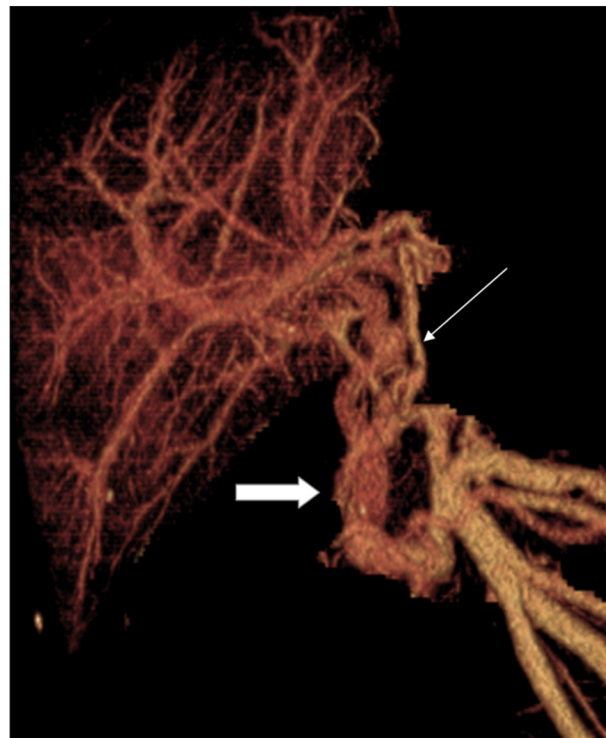

Figure 5. CTA coronal image showing the splenic graft after the meso-Rex bypass. The splenic graft (thin white arrow) after meso-Rex bypass was much smaller in diameter compared with the expanding cavernous portal vein (thick white arrow). The images are of the same patient shown in Figure 2.

intrahepatic branches were hypoplastic during the preoperative Doppler US evaluation, the mean blood flow velocity of the umbilical portion increased from 16.5±3.4 cm/s preoperatively to 37.8±7.6 cm/s postoperatively ($P<0.05$). During the follow-up period, mean hemoglobin increased from 86.2±20.6×10^9 g/L to 126.2±28.1×10^9 g/L ($P < 0.01$) after shunting. In addition, mean leukocyte and platelet counts increased dramatically from 5.9±1.7 to 8.9±2.4×10^9/L ($P<0.01$) and from 63.5±13.6 to 160.2±28.1×10^9/L ($P<0.01$), respectively (Table 3). Some patients ($n=16$) underwent follow-up with low-dose computed

tomography, which revealed that the graft vein had sufficient flow to the liver following MRB (Figure 5). Occlusion or narrowing occurred in 2 patients at 12 and 24 months (median=18 months); these patients then received surgical revision to their portosystemic shunts. The cumulative graft patency in our study was 91% (20/22).

Discussion

Ville de Goyet et al. originally reported use of MRB to treat portal vein thrombosis after liver transplantation, and it has also been used to reconstitute portal venous flow to the liver in these patients [6,7]. This technique is the treatment of choice for pediatric patients with extrahepatic portal hypertension caused by EPVT or EPVCT. By restoring normal portal venous circulation, MRB not only effectively relieves the symptoms of extrahepatic portal hypertension in children, but also shows metabolic benefits over portosystemic shunting [19]. The IJV is the autologous graft traditional used in the standard MRBs, and it has been associated with excellent results for the past 2 decades. However, many reports have mentioned problems secondary to the thrombosis of the IJV, or its removal for various purposes, including use as a graft for all kinds of clinical resections. In addition, procuring the internal jugular vein is hazardous for patients who have congenital diseases such as hydrocephalus, malformation of the skull, Chiari malformation, and abnormalities of the venous return [8]. For example, Fuchs et al. reported on 1 patient with negative results regarding harvesting the IJV, leading to pseudotumor cerebri [20].

Alternative graft veins include the coronary vein, the inferior mesenteric vein, the saphenous vein, and the splenic veins [1,5,12,14,15]. The shunt also can be achieved through the interposition of a conduit using the recanalized umbilical vein, or even an artificial graft [13,21]. Chen et al. introduced the technique of using the proximal splenic vein in a left intrahepatic portal bypass ("Spleno-Rex bypass") 20 years ago [22]. This procedure involved a splenectomy and the complete mobilization of the splenic vein. Chiu et al. previously described the complete mobilization procedure of the splenic vein for use as a conduit for draining the portal vein into the Rex recessus [1]. Specifically, this technique was performed in a patient who had previously undergone a splenectomy at another hospital and, consequently, did not receive a spleen preservation procedure. Another report addressed the idea of preserving the spleen while using the splenic vein as an inflow; in that study, the authors used a jugular vein as a conduit interposed between the splenic vein and the Rex recessus [23].

Splenectomies were not typically proposed because the absence of the spleen could lead to overwhelming infection from encapsulated bacteria [24]. Schumacher reported that splenectomy

could lead to impaired immunoreaction in children [25]. Horton et al. found that the delayed clearance of bacteria was caused by the reduced blood flow in rats; when the blood supply was maintained, even small volumes of splenic tissue resulted in normal immunologic responses [26].

The current technique applied in our series with partial splenectomy using the splenic vein as a conduit should be considered a valuable modification of the conventional Rex shunt. It would be valuable in reduction of portal hypertension and hypersplenism in pediatric patients. During the follow-up period, the patients' mean hemoglobin, leukocyte, and platelet counts clearly increased. Only single residual varices or small- and medium-sized residual varices were observed in patients during the follow-up period (Table 2). No bleeding recurrence was noted among the patients, except for the GI variceal bleeding that recurred in 3 patients during the first postoperative week. The mean flow in the umbilical portion of the LPV increased from 16.5±3.4 cm/s before bypass to 37.8±7.6 cm/s (P<0.01) after bypass. A preoperative Doppler US evaluation did not indicate blood flow in the LPVs of 7 patients. Direct portography revealed that the intrahepatic portal veins were appropriate for shunting in 4 of these patients, although the vessels were hypoplastic. We believe that small LPVs result in poor visualization of blood flow and that direct portography through the umbilical vein is the criterion standard for assessing the size and patency of the Rex recessus and LPV. Furthermore, the thrombosed Rex recessus and the LPV of 3 patients with a suspected history of neonatal umbilical catheterization were unsuitable for use after direct inspection [27] and thus underwent a portosystemic shunting procedure.

Previous studies have described the long-term follow-up results of mesoportal bypass operations [9,10,15,27,28]. In most studies, MRB was performed using IJV grafts. Superina et al. reported an approximate 91% patency rate among patients undergoing classic Rex shunt operation during a follow-up period of 1–7 years [9]. Sharif et al. showed an overall mesoportal patency rate of 92% in a series of 30 children after a median follow-up period of 8 years [10], and Chin et al. showed an overall mesoportal patency rate of 84% in a series of 62 children [28]. Alberti et al. found that 53 of 57 (93%) patients were alive at the final follow-up assessment with controlled bleeding, and 27 of 33 (82%) had a patent conduit [27]. Recently, Luoto et al. showed an overall mesoportal patency rate of 81% in a series of 21 children who received saphenous vein grafting [15]. Because 2 of our patients with permanent shunt occlusion were converted to portosystemic shunts, our overall success rate was 91% (20/22) with a follow-up period of 12–48 months (mean=25.6 months). This result matched those of some series [9,10], but showed a slightly higher rate than other series [15,27,28]. The use of a non-absorbable suture with a relatively narrow vein might have resulted in the stricture of anastomosis observed

in 2 patients in our series over 2 years. As such, we propose that such bypasses should be performed using absorbable sutures to preserve the potential for the growth of the anastomosis to match the growth of the child.

Using a splenic vein graft, the SMV and LPV were bridged directly, thereby avoiding the twisting or kinking of the graft in the transposition of the splenic vein, which can decelerate blood flow, which might be a risk factor associated with graft thrombosis. The complete mobilization of the splenic vein with partial splenectomy for use as a graft was successful in our patients. The procedure is less invasive than the procurement of another autologous vein conduit. It simplifies management and should be considered whenever possible. Splenomegaly is the most common clinical symptom of prehepatic portal hypertension, thus improvement would be expected after MRB in pediatric patients. Sharif et al. reported that although the spleen size decreased after MRB surgery in all patients, the normalization of spleen size was seen only in 30% of patients with median 8-year followup, and secondary increase of spleen size was observed in 5 children [10]. Therefore, a partial splenectomy is necessary to avoid splenic venous stasis and left-sided portal hypertension. This management had positive effects on the problems associated with portal hypertension, including bleeding and hypersplenism, and was an optimal treatment providing further refinement of the surgical approach for patients with recurrent, symptomatic, prehepatic portal hypertension. However, this event might bring recurrent episodes of gastrointestinal bleeding. The resection of the splenic vein might lead to short gastric and gastroepiploic varices revealed at long-term follow-up assessments, because the venous drainage of the remaining spleen can only occur through short gastric vessels [29–31]. Miura et al. reported that perigastric varices was found in 7 of 10 patients after

spleen preservation with splenic vein ligation for more than 52 months, and variceal bleeding was observed in 1 patient [32]. The flow velocity through the graft increased 2- to 3-fold those seen intraoperatively during follow-up in our series; in parallel, the graft clearly grew in diameter, but the diameter of the splenic vein graft was still inferior to that of a jugular vein in the same child. This difference might limit blood flow because the diameter of the splenic vein is inferior to that of the portal vein in the child and is certainly smaller than that of an adult portal vein, risking inadequate blood flow over time. Some experts believe that the IJV remains the best graft for MRB, because it was close to the diameter of a normal portal vein trunk, which allowed adequate flow through the bypass [7,8,10,33]. Third, not all patients have a patent splenic vein. Orloff et al. mentioned that, according their experience with the Portal-Systemic Shunt, the splenic vein was not viable in 33% of patients [34]. Therefore, the proposed innovation is not applicable in all children, in which case an alternative vein graft is required and can obtain similar results.

Conclusions

Partial splenectomy and native splenic vein graft used in MRB is a feasible and valuable alternative for children with prehepatic portal hypertension. Because of the small sample size and short follow-up duration in this study, further studies on use of this surgery are needed.

Statement

The authors declare no potential conflicts of interest with respect to the current research, authorship, or publication of this article.

References:

1. Chiu B, Pillai SB, Sandler AD et al: Experience with alternate sources of venous inflow in the meso-Rex bypass operation: the coronary and splenic veins. J Pediatr Surg, 2007; 42(7): 1199–202

2. Ates O, Hakguder G, Olguner M et al: Mesenterico left portal bypass for variceal bleeding owing to extrahepatic portal hypertension caused by portal vein thrombosis. J Pediatr Surg, 2006; 41(7): 1259–63

3. Bambini DA, Superina R, Almond PS et al: Experience with the Rex shunt (mesenterico-left portal bypass) in children with extrahepatic portal hypertension. J Pediatr Surg, 2000; 35(1): 13–18

4. Chin AC, Thow F, Superina RA: Previous portal hypertension surgery negatively affects results of mesenteric to left portal vein bypass. J Pediatr Surg, 2008; 43(1): 114–19

5. Query JA, Sandler AD, Sharp WJ: Use of autogenous saphenous vein as a conduit for mesenterico-left portal vein bypass. J Pediatr Surg, 2007; 42(6): 1137–40

6. de Ville de Goyet J, Clapuyt P, Otte JB: Extrahilar mesenterico-left portal shunt to relieve extrahepatic portal hypertension after partial liver transplant. Transplantation,1992; 53(1): 231–32

7. de Ville de Goyet J, Gibbs P, Clapuyt P et al: Original extrahilar approach for hepatic portal revascularization and relief of extrahepatic portal hypertension related to late portal vein thrombosis after pediatric liver transplantation. Long term results. Transplantation, 1996; 62(1): 71–75

8. di Francesco F, Grimaldi C, de Ville de Goyet J: Meso-Rex bypass – a procedure to cure prehepatic portal hypertension: the insight and the inside. J Am Coll Surg, 2014; 218(2): e23–36

9. Superina R, Bambini DA, Lokar J et al: Correction of extrahepatic portal vein thrombosis by the mesenteric to left portal vein bypass. Ann Surg, 2006; 243(4): 515–21

10. Sharif K, Mckiernan P, deGoyet JD: Mesoportal bypass for extrahepatic portal vein obstruction in children: close to a cure for most. J Pediatr Surg, 2010; 45(1): 272–76

11. Dasgupta R, Roberts E, Superina RA et al: Effectiveness of Rex shunt in the treatment of portal hypertension. J Pediatr Surg, 2006; 41(1): 108–12

12. Chardot C, Darani A, Dubois R et al: Modified technique of meso-Rex shunt in case of insufficient length of the jugular vein graft. J Pediatr Surg, 2009; 44(11): e9–e12

13. Facciuto ME, Rodriguez-Davalos MI, Singh MK et al: Recanalized umbilical vein conduit for meso-Rex bypass in extrahepatic portal vein obstruction. Surgery, 2009; 145(4): 406–10

14. Ates O, Hakguder G, Olguner M et al: Extrahepatic portal hypertension treated by anastomosing inferior mesenteric vein to left portal vein at Rex recessus. J Pediatr Surg, 2003; 38(10): E10–11

15. Luoto T, Pakarinen M, Mattila I et al: Mesoportal bypass using a constructed saphenous vein graft for extrahepatic portal vein obstruction – technique, feasibility, and outcomes. J Pediatr Surg, 2012; 47(4): 688–93

16. Triger DR: Extrahepatic portal venous obstruction. Gut, 1987; 28: 1193–97

17. Wang X, Zhang Y, Han C: Topical negative pressure improves autograft take by altering nutrient diffusion: A hypothesis. Med Sci Monit, 2014; 20: 61–63

18. Dohmen PM: Letter to the Editor regarding: Negative pressure wound therapy. Med SciMonit, 2014; 20: 681–82

19. Timothy B, Lisa A, Joseph C: Advantages of the Meso-Rex Bypass Compared with Portosystemic Shunts in the Management of Extrahepatic Portal Vein Obstruction in Children. J Am Coll Surg, 2013; 216(1): 83–89

20. Fuchs J, Warmann S, Kardorff R et al: Mesenterico-left portal vein bypass in children with congenital extrahepatic portal vein thrombosis: a unique curative approach. J Pediatr Gastroenterol Nutr, 2003; 36(2): 213–16

21. Yamamoto S, Sato Y, Oya H et al: Splenic-intrahepatic left portal shunt in an adult patient with extrahepatic portal vein obstruction without recurrence after pancreaticoduodenectomy. J Hepatobiliary Pancreat Surg, 2009; 16(1): 86–89

22. Chen VT, Wei J, Liu YC: A new procedure for management of extrahepatic portal obstruction. Proximal splenic-left intrahepatic portal shunt. Arch Surg, 1992; 127(11): 1358–360

23. Salzedas-Netto AA, Duarte AA, linheres M et al: Variation of the Rex shunt for treating concurrent obstruction of the portal and superior mesenteric veins. J Ped Surg, 2011; 46(10): 2018–20

24. Balfanz JR, Nesbit ME Jr, Jarvis C et al: Overwhelming sepsis following splenectomy for trauma. J Pediatr, 1976; 88(3): 458–60

25. Schumacher MJ: Serum immunoglobulin and transferrin levels after childhood splenectomy. Arch Dis Child, 1970; 45(239): 114–17

26. Horton J, Ogden ME, Williams S et al: The importance of Splenic blood flow in clearing pneumococcal orgnanisms. Ann Surg, 1982; 195(2): 172–76

27. Alberti D, Colusso M, Cheli M et al: Results of a Stepwise Approach to Extrahepatic Portal Vein Obstruction in Children. J Pediatr Gastroenterol Nutr, 2013; 57(5): 619–26

28. Chin AC, Thow F, Superina RA: Previous portal hypertension surgery negatively affects results of mesenteric to left portal vein bypass. J Pediatr Surg, 2008; 43(1): 114–19

29. Warshaw AL: Distal pancreatectomy with preservation of the spleen. J Hepatobiliary Pancreat Sci, 2010; 17(6): 808–12

30. Warshaw AL: Conservation of the Spleen With Distal Pancreatectomy. Arch Surg, 1988;123(5): 550–53

31. Choi SK, Kang CM, Kim JY et al: Laparoscopic extended (subtotal) distal pancreatectomy with resection of both splenic artery and vein. Surgical Endoscopy, 2013; 27(4): 1412–13

32. Miura F, Takada T, Asano T et al: Gastric varices occurring after middle-segment pancreatectomy preserving spleen with division of splenic artery and vein. Surgery, 2004; 135(6): 696–97

33. Bhat R, Lautz TB, Superina RA et al: Perioperative strategies and thrombophilia in children with extrahepatic portal vein obstruction undergoing the meso-Rex bypass. J Gastrointest Surg, 2013; 17(5): 949–55

34. Orloff MJ, Orloff Ms, Girard B et al: Bleeding Esophagogastric Varices from Extrahepatic Portal Hypertension: 40 Years' Experience with Portal-Systemic Shunt. J Am Coll Surg, 2002; 194(6): 717–30