H-SHAPED PARTIAL SPLENORENAL SHUNTING WITH THE USE OF A REINFORCED GRAFT MADE OF POROUS POLYTETRAFLUOROETHYLENE

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Objective. The study was aimed at improving the immediate and remote results of splenorenal bypass grafting.

Patients and methods. A total of 57 patients presenting with hepatic cirrhosis, portal hypertension, and recurrent haemorrhage from oesophageal varices underwent an H-shaped partial splenorenal shunt procedure using an externally reinforced 1.5–2.0-cm-long synthetic graft with a diameter equalling half of that of the splenic vein in an end-to-side fashion. Assessment of efficacy of shunting was based on intraoperative measurement of venous pressure in the portal system before and after shunting, the findings of Doppler ultrasonography of the linear velocity of blood flow in the portal, splenic, and left renal veins in the early postoperative period, as well as computed tomography, esophagogastroscopy, and assessment of the degree of hepatic encephalopathy in the remote postoperative period.

Results. The findings of intraoperative measurement of venous pressure in the portal vein system before and after shunting demonstrated a statistically significant decrease in (normalization of) portal pressure in all patients after bypass grafting ($p \leqslant 0.05$). There were no severe postoperative complications, in-hospital mortality, nor events of decompensation of hepatic insufficiency. According to the findings of Doppler ultrasonography of the linear velocity of blood flow and control computed tomography after surgery, the splenic vein, left renal vein and the conduit between them remained patent at all terms of postoperative follow up. The findings of control esophagogastroscopy revealed a statistically significant decrease in the degree of oesophageal varices at 3, 6, and 9 months after shunting ($p \leqslant 0.05$). There was no statistically significant difference in the change of the degree of hepatic encephalopathy at 3, 6, and 9 months after shunting ($p=0.853$, $p=0.712$, and $p=0.581$, respectively). At various terms after surgery, nine patients underwent deceased donor liver transplantation, with the splenorenal shunt ligated intraoperatively.

Conclusion. This method of splenorenal shunting makes it possible to decrease the risk of bleeding from oesophageal varices and venous thromboses in vascular anastomoses, as well as complications resulting from using autovenous conduits, to decrease the risk of decomposition of hepatic insufficiency and the frequency of the development of encephalopathy in the postoperative period. Besides, this method makes it possible to easily dismantle the previously created artificial portocaval shunt in the process of liver transplantation.

Key words: *splenorenal shunting, porous polytetra fluoroethylene, graft patency, portal hypertension.*

INTRODUCTION

According to the data of the World Health Organization, the global prevalence of liver diseases remains high [1]. Liver cirrhosis is an increasing cause of morbidity and mortality in more developed countries, being the 14th most common cause of death in adults worldwide but the fourth in central Europe [1, 2].

The only radical method of treatment of end-stages of irreversible hepatic diseases is liver transplantation, however, this operation is available for a limited number of patients due to scarcity of donor organs [3, 4].

Liver cirrhosis leads to elevated pressure in the vessels of the portal system (portal hypertension), splenomegaly with subsequent gastro-oesophageal varices and the development of haemorrhage therefrom [5].

Bleeding from varicose veins of the upper portions of the gastrointestinal tract is the most dangerous complication of hepatocirrhosis, with frequent relapses and high mortality rates of up to 30–60% in primary haemorrhage and 60–70% in recurrent ones [6]. It is also the leading cause of death in patients being on waiting lists of donor organs [3].

The median survival in patients after the first episode of bleeding from varicose veins amounts to approximately 19 months [7].

Portosystemic shunting is an efficient method of prevention of the development of haemorrhage, decreasing the frequency of recurrent haemorrhage

in portal hypertension and prolonging the lifespan of patients who are on the donor organ waiting list [2, 8].

Portosystemic shunting should be used in the maximal number of patients presenting with portal hypertension and recurrent haemorrhage from oesophageal varices (OV) and placed on the donor liver transplant waiting list [5].

Currently, there exist various methods of eliminating portal hypertension in cirrhosis: a side-to-side splenorenal anastomosis, portocaval shunting, formation of an end-to-side splenorenal anastomosis with complete ligation of the splenic vein, formation of an H-shaped splenorenal shunt using the internal jugular vein, transjugular intrahepatic portosystemic shunt (TIPS), etc. [2, 5].

However, the question concerning the choice of the method of shunting is currently disputable. Disadvantages of shunting operations include high frequency of shunt thrombosis, the appearance and progression of hepatic encephalopathy, difficulty of dismantling the shunt during subsequent transplantation of the donor liver, reduction of the portal blood flow, as well as technical complexity of the procedure [2, 5, 9]. The most common complications that develop after TIPS are occlusion or stenosis of the stent (18–78%) and hepatic encephalopathy. The events of new onset encephalopathy or worsening of previous encephalopathy appear to account for 10–44% of cases after TIPS [3, 5].

This determines the current importance of working out new surgical techniques of portosystemic shunting in patients with liver cirrhosis and oesophageal varices on the background of the portal hypertension syndrome.

PATIENTS AND METHODS

A total of 57 patients presenting with liver cirrhosis and oesophageal varices on the background of the portal hypertension syndrome underwent H-shaped partial splenorenal shunting with an externally reinforced polytetrafluoroethylene synthetic conduit. This method of splenorenal shunting was granted RF patent 2017122189, 2017.06.23.

The indications for the operation included recurrent bleeding from oesophageal varices and a high risk of grade III–IV haemorrhage from OV, whereas decompensated cirrhosis (Child-Pugh class B and C), tense ascites, manifest hepatic encephalopathy (grade III–IV), previously endured splenectomy, and thrombosis of the mesentericoportal system veins were considered contraindications to performing splenorenal shunting.

The procedure of the operation was as follows. The midline laparotomy was performed, making an incision up to 12 cm long in the patients with a body mass index (BMI) below 30 and not longer than 15–18 cm in those with a BMI above 30. We carried out intraoperative examination during which we specified the presence of liver cirrhosis, degree of portal hypertension, as well as the number and diameter of venous collaterals. After dissection of the peritoneum in the area of the ligament of Treitz we gained an access to the inferior vena cava, left renal vein, and splenic vein, which were exposed and taken onto the holders. Vascular clamps were used to push aside the left renal vein along a portion of about 3.5 cm. Then, by means of an uninterrupted suture with a monofilament thread, into the appropriate-diameter aperture formed on the superior wall of the pushed aside portion of the left renal vein we sewed the distal end of an externally reinforced synthetic graft manufactured by the Closed Joint-Stock Company "Research and Production Complex "Ecoflon" (Russia), having a diameter equal to half

Fig. 1. Final view after surgery (scheme): 1 – portal vein; 2 – pancreas; 3 – splenic vein; 4 – reinforced synthetic graft; 5 – left renal vein; 6 – inferior vena cava; 7 – tributaries of the superior mesenteric vein

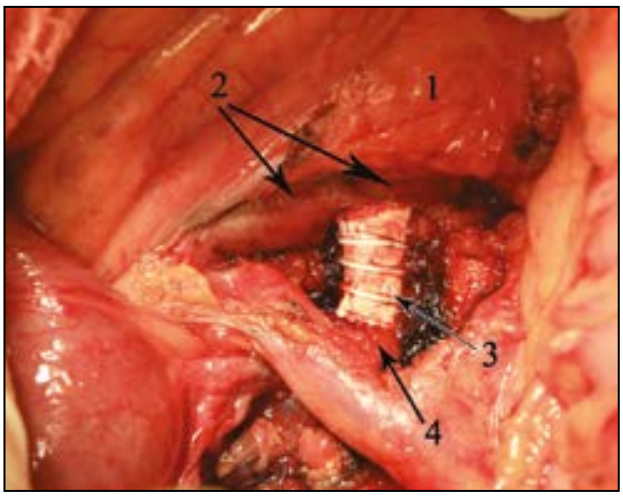

Fig. 2. Intraoperative photo: 1 – pancreas; 2 – splenic vein; 3 – reinforced synthetic graft; 4 – left renal vein

of that of the splenic vein (6–8 mm) and measuring 1.5–2.0 cm in length. After that, the splenic vein was pushed aside with the help of vascular clamps and the proximal end of the synthetic graft was sewn into the appropriate-diameter aperture formed on the inferior wall of the pushed aside portion of the splenic vein with an uninterrupted suture using a monofilament thread (Fig. 1, 2). This was followed by re-establishing blood flow. No special anticoagulant therapy was performed.

With the help of the resuscitation monitor SIEMENS SC 9000 (Germany) we directly in an invasive manner measured intraoperative venous pressure in the portal system before and after shunting. The parameters of venous pressure before and after shunting were compared by means of the Mann–Whitney test. The critical level of significance in testing the statistical hypotheses was regarded as $\leqslant 0.05$. The obtained findings were statistically processed using the software package Statistica 6.0.

Patency of the synthetic conduits and efficacy of shunting in the early postoperative period were assessed by means of Doppler ultrasonography of the linear blood flow velocity in the portal, splenic, and left renal veins.

The degree of severity of hepatic encephalopathy was evaluated according to the Conn-modified West Haven classification (1994).

In the remote terms after surgery, efficacy of shunting was assessed by computed tomography and gastroscopy. The grade of oesophageal varices was determined according to the classification of K.-J. Paquet (1983).

RESULTS

The findings of intraoperative measurement of venous pressure in the portal vein system before and after shunting demonstrated a statistically significant decrease in (normalization of) portal pressure in all patients after bypass grafting ($p \leqslant 0.05$). The data are shown in Fig. 3.

According to the findings of Doppler ultrasonography of the linear velocity of blood flow and control computed tomography in the examined group of patients, the splenic, left renal veins and the graft between them remained patent at all terms of follow up, with neither haemodynamically significant stenoses nor thromboses of the porous-polytetrafluoroethylene synthetic conduits observed at any term of follow up. The obtained results are shown in Fig. 4.

The findings of control gastroscopy revealed a statistically significant decrease in the grade of oesophageal varices at 3, 6, and 9 months after shunting ($p \leqslant 0.05$). The statistics is diagrammatically presented in Fig. 5.

There were no severe postoperative complications, in-hospital mortality, nor long-term events of decompensated hepatic insufficiency.

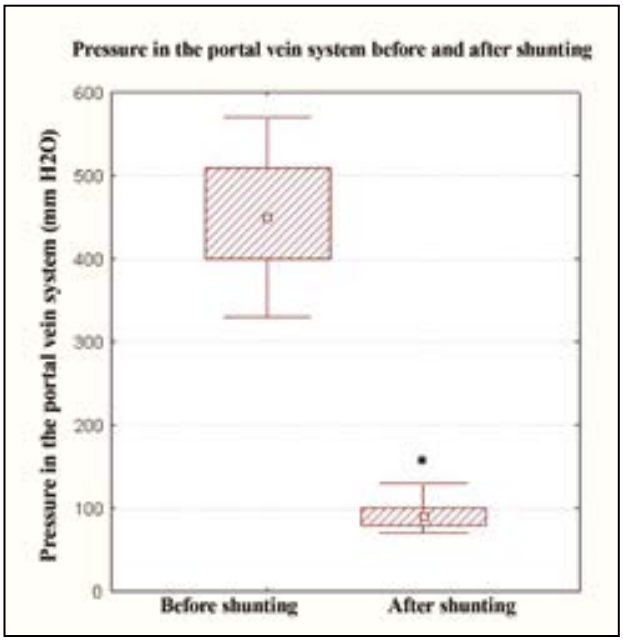

Fig. 3. Results of intraoperative assessment of venous pressure in the system of the portal vein before and after shunting. Note: * – statistically significant difference

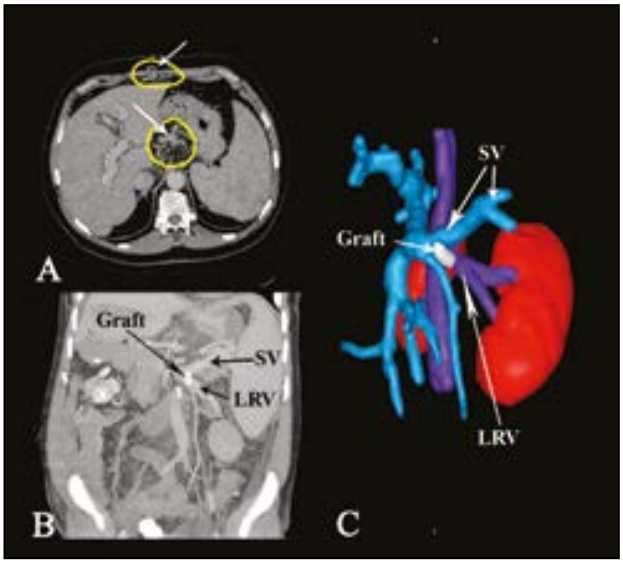

Fig. 4. A – preoperative computer tomogram prior to shunting. The arrows indicate pronounced venous collaterals of the anterior abdominal wall and lesser omentum; B – control computer tomogram at 9 months postoperatively. The splenic, left renal veins and conduit are patent, with a decrease of venous collaterals observed; C – three-dimensional vascular reconstruction of the computer tomogram after shunting. Note: SV – splenic vein; LRV – left renal vein

During several months after the operation, all patients underwent repeated examinations, with no relapsing haemorrhage, signs of decompensated hepatic insufficiency, nor progressing encephalopathy revealed. There was no statistically significant difference in the change of the degree of encephalopathy at 3, 6, and 9 months after shunting ($p=0.853$, $p=0.712$, and $p=0.581$, respectively). The obtained results are shown in Fig. 6.

At various terms postoperatively, nine patients were subjected to cadaveric liver transplantation, with the splenorenal shunt ligated during surgery.

DISCUSSION

The portosystemic shunt procedure is performed in order to decrease pressure in the portal vein, thus preventing the risk for the development of haemorrhage from oesophageal varices, as well as to maintain total hepatic and portal blood flow. Besides, a decrease of pressure in the portal system following portosystemic shunting makes it possible to stabilize the events of hypersplenism and in some instances attain regression thereof [1, 5, 9].

Currently, there exist several methods of eliminating portal hypertension in patients with liver cirrhosis [2, 5].

Formation of a side-to-side splenorenal anastomosis may in the remote period be complicated by anastomotic thrombosis due to a commissural process [2]. The use of a reinforced synthetic graft appears to completely solve this problem, preventing compression of the graft at the expense of commissural process and deformation of thin-walled veins. Besides, the findings of experimental and clinical studies demonstrated high patency of polytetrafluoroethylene grafts in the venous position [10, 11].

The use of an autovenous conduit from the internal jugular vein significantly increases the duration and traumatic nature of the intervention, as well as the amount of intraoperative blood loss, requiring the widening of the operational access and obligatory reconstruction of the internal jugular vein [8]. This problem is solved by using a ready-made synthetic conduit of an appropriate diameter and length.

Ligation of the splenic vein leads to at least a 2-fold reduction in the portal blood flow, thus inducing the development of ischaemia of the hepatic parenchyma, hepatocellular insufficiency, and high incidence of hepatic encephalopathy [2]. The use of a graft with a diameter equalling half of that of the splenic vein contributes to partial outflow of blood from the portal vein system, ensuring, on the one hand, appropriate blood supply of the liver and on the other hand preventing the development of hepatic encephalopathy.

Besides, mobilization of the splenic vein from the pancreas increases the risk for the development of postoperative haemorrhage and the frequency of acute postoperative pancreatitis resulting from impaired blood supply of the pancreas, which may lead to severe complications up to a lethal outcome [7]. The proposed technique of splenorenal shunting prevents the above-mentioned complications.

An important aspect is a possibility of restoring the physiological portal circulation after liver transplantation. This method makes it possible to easily dismantle the artificial portocaval shunt during liver transplantation.

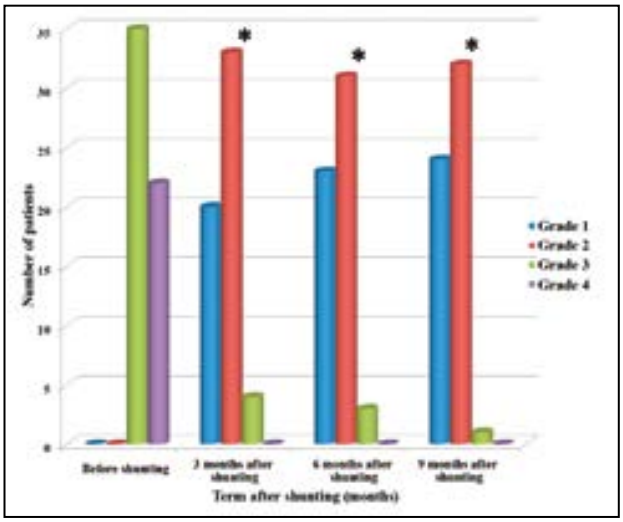

Fig. 5. Grades of oesophageal varices (OV) before and at various terms after shunting, demonstrating a statistically significant decrease in the OV grade at all terms after shunting (p≤0.05). Note: * – statistically significant difference

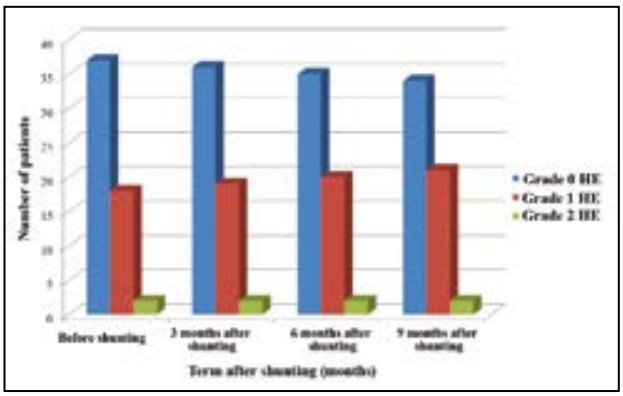

Fig. 6. Grades of hepatic encephalopathy (according to the Conn-modified West Haven classification) before and after shunting at various postoperative terms

CONCLUSION

Hence, the obtained findings suggest that the proposed method of splenorenal shunting decreased the risk for the development of life-threatening complications of hepatocirrhosis, postoperative complications and makes it possible to easily remove the shunt during the subsequent liver transplantation. This may substantially increase operability and long-term survival of patients with liver cirrhosis and the portal hypertension syndrome, improve both immediate and remote results of surgical treatment, as well as prolong the life of patients who are on the donor organ waiting list with a perspective of subsequent adequate restoration of the physiological blood flow in the system of the portal vein following liver transplantation, with the synthetic conduit ligated during surgery.

Conflict of interest: none declared.

ЛИТЕРАТУРА/REFERENCES

1. ***Tsochatzis E.A., Bosch J., Burroughs A.K.*** Liver cirrhosis. Lancet. 2014; 383: 9930: 1749–1761. doi: 10.1016/S0140–6736(14)60121–5.
2. ***Nazyrov F.G., Devyatov A.V., Babadzhanov A.Kh., Mardonov L.L.*** Analysis of quality of life of patients suffering from liver cirrhosis with portal hypertension after portosystemic shunting. Journal of Experimental and Clinical Surgery. 2012; 5: 3: 509–516 (in Russian).
3. ***Meirelles Júnior R.F., Salvalaggio P., Rezende M.B., et al.*** Liver transplantation: history, outcomes and perspectives. Einstein (Sao Paulo). 2015; 13: 1: 149–152. doi: 10.1590/S1679–45082015RW3164
4. ***Voskanyan S.E., Artemiev A.I., Sushkov A.I., et al.*** Peculiarities of vascular reconstruction and outcomes of 220 adult-to-adult right lobe living donor liver transplantation. Almanac of Clinical Medicine. 2018; 46: 6: 598–608. doi: 10.18786/2072–0505-2018–46-6–598-608 (in Russian).
5. ***Kibrit J., Khan R., Jung B.H., Koppe S***. Clinical Assessment and Management of Portal Hypertension. Semin. Intervent. Radiol. 2018; 35: 3: 153–159. doi: 10.1055/s-0038–1660793.
6. ***Stanley A.J., Laine L.*** Management of acute upper gastrointestinal bleeding. BMJ. 2019; 364: l536. doi: 10.1136/bmj.l536.
7. ***Ray G.*** Long-term outcome of endoscopic variceal band ligation of esophageal varices in patients with chronic liver disease. Indian. J. Gastroenterol. 2019; 38: 1: 69–76. doi: 10.1007/s12664–019-00938–7.
8. ***Sharma N., Bajpai M., Kumar A., et al.*** Portal hypertension: A critical appraisal of shunt procedures with emphasis on distal splenorenal shunt in children. J. Indian. Assoc. Pediatr. Surg. 2014; 19: 2: 80–84. doi: 10.4103/0971–9261.129599.
9. ***Zagainov V.E., Lotov A.N., Gorokhov G.G., et al.*** Concomitant lesion of the common hepatic duct and right hepatic artery. Annals of Surgical Hepatology. 2012; 1: 1: 110–115 (in Russian).
10. ***Voskanyan S.E., Shabalin M.V., Volkov A.V., Kolyshev I.Yu.*** Peculiarities of vitalization of grafts made of porous polytetrafluoroethylene in reconstruction of major veins (an experimental study). Angiology and Vascular Surgery. 2017; 23: 4: 123–127 (in Russian).
11. ***Voskanyan S.E., Artemiev A.I., Naydenov E.V., et al.*** Results of using PTFE conduits in reconstruction of abdominal-cavity major veins in locally advanced pancreatic cancer. Saratov Journal of Medical Scientific Research. 2015; 11: 4: 668–672 (in Russian).

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