Clinical Case Report

Management of hepatic vein occlusive disease after liver transplantation
A case report with literature review

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Abstract

Rationale: Hepatic vein occlusive disease (HVOD) is a rare complication after liver transplantation, which is characterized by nonthrombotic, fibrous obliteration of the small centrilobular hepatic veins by connective tissue and centrilobular necrosis in zone 3 of the acini. HVOD after solid organ transplantation has been reported; recently, most of these reports with limited cases have documented that acute cell rejection and immunosuppressive agents are the major causative factors. HVOD is relatively a rare complication of liver transplantation with the incidence of approximately 2%.

Patient concerns: A 59-year-old male patient with alcoholic liver cirrhosis underwent liver transplantation in our center. He suffered ascites, renal impairment 3 months after the surgery while liver enzymes were in normal range.

Diagnoses: Imagining and pathology showed no evidence of rejection or vessels complications. HVOD was diagnosed with pathology biopsy.

Interventions: Tacrolimus was withdrawn and the progression of HVOD was reversed.

Outcomes: Now, this patient has been followed up for 6 months after discharge with normal liver graft function.

Lessons: The use of tacrolimus in patients after liver transplantation may cause HVOD. Patients with jaundice, body weight gain, and refractory ascites should be strongly suspected of tacrolimus related HVOD.

Abbreviations: ACR = acute cell rejection, ALT = alanine aminotransferase, AMR = antibody-mediated rejection, AST = aspartate aminotransferase, CT = computed tomography, CTP rating = Child–Turcotte–Pugh rating, CYP = cytochrome P450, DBCD = organ donation after brain death followed by cardiac death, HCT = hematopoietic stem cell transplantation, HVOD = hepatic vein occlusive disease, IVC = inferior vena cava, LT = liver transplantation, POD = postoperation day, TBil = total bilirubin.

Keywords: alcoholic liver cirrhosis, complication, HVOD, liver transplantation, tacrolimus

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1. Introduction

Hepatic vein occlusive disease (HVOD) is a rare complication after liver transplantation, with complicated pathogenesis and poor prognosis.[1] HVOD pathophysiology is associated with endothelial cell damage triggered by cytotoxic chemotherapy. The clinical syndrome of HVOD is characterized by painful hepatomegaly, fluid avidity, increased weight gain, and jaundice.[2] The pathological characteristics of HVOD are non-thrombotic, fibrous obliteration of the small centrilobular hepatic veins by connective tissue and centrilobular necrosis in zone 3 of the acini.[3] The first case of HVOD was described in Jamaicans who had consumed large amounts of bush tea containing pyrrolizidine alkaloids.[4] HVOD is always induced by high-dose chemotherapy and stem cell transplantation.[5–9] Some published papers reported that the occurrence of HVOD is associated with the use of toxic traditional Chinese medicine sedum aizoon.[10–12] This disease is also reported in recipients of solid organ transplantation. Incidence and severity of HVOD are associated with differences in conditioning regimens, type of graft (allogeneic vs autologous), and patient characteristics. In those studies, acute cell rejection (ACR) is the major causative factor.[13–20] The immunosuppression agents are also thought to play a fatal role.[21–26] Azathioprine and tacrolimus have been implicated as predisposing factors of HVOD.[27–29] In this article, we report 1 case of HVOD after liver transplantation, which may
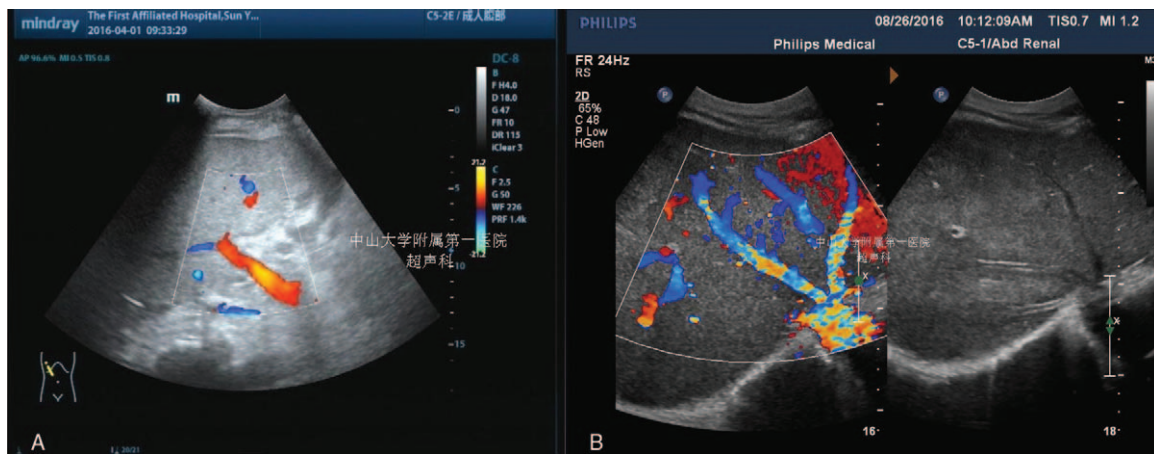
Figure 1. A 59-year-old male underwent liver transplantation. Hepatic hemodynamics at POD 11 were normal. (A) The large vessels in liver were unobstructed. (B) The blood flow returned to normal at POD 160.

be induced by tacrolimus. Our treatment strategy has successfully ameliorated the symptoms and the patient recovered well.

2. Case report

The study was approved by the Institutional Review Board for the Protection of Human Subjects of The First Affiliated Hospital of Sun Yat-Sen University and adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from the patient.

A 59-year-old male with alcoholic liver cirrhosis underwent liver transplantation in our center 9 months ago. The patient had poor liver function preoperation with the Child–Turcotte–Pugh (CTP) rating of B. The donor was a China Category III (organ donation after brain death followed by cardiac death, DBCD) donor. He was a 27-year-old male suffered traumatic brain injury in a car accident and met the brain-heart double death criteria of the first affiliated hospital, Sun Yet-Sen University. Organ donation and transplant in our center was performed strictly according to the guidelines of the 1975 Helsinki Declaration and the principles of the Declaration of Istanbul. Written informed consent was obtained from the donor's family. The liver function of the donor was stable with detection indicators of alanine aminotransferase (ALT) 46 U/L, aspartate aminotransferase (AST) 74 U/L, and total bilirubin (TBil) 18.4 μmol/L. The cold ischemic time and anhepatic phase were 325 and 56 minutes, respectively. The patient condition after operation was stable in general. The serum TBil reached a peak of 48.3 μmol/L at postoperation day 1 (POD) and progressively dropped to normal range during the next few days. The levels of ALT and AST peaked on day 1 separately after liver transplantation, and then recovered continuously. Then, they decreased sharply and then maintained the normal level at POD 14. The patient's coagulation function was basically good. The patient was followed by routine fluid replacement strategy and monitoring of Doppler ultrasonography every day. The Doppler ultrasonography at POD 11 of hepatic vein, portal vein, and inferior vena cava revealed no vascular abnormalities (Fig. 1). He received a dose of 20 mg basiliximab (Simulect; Novartis Pharma AG, Basel, Switzerland) intraoperatively and the fourth day postoperation. Immunosuppressive strategy was tacrolimus (2.5 mg, every 12 hours) combined with mycophenolate mofetil (0.75 g, every 12 hours) during the early period postoperatively; blood

concentration of tacrolimus was monitored and maintained at a range of 8 to 12 mg/L. No obvious rejection occurred in the patient.

The patient recovered well and was discharged at POD 15. He received a routine followed up with a weekly to monthly interval according to our liver transplant recipient's follow-up protocol. He complained of abdominal distention at 2 months after the operation and was admitted to hospital for a detailed evaluation. Physical examination showed abdominal distention without edema of low extremity. Laboratory blood biochemistry examination showed that the serum creatinine was 159 μmol/L without peripheral edema. The serum TBil was 36.2 umol/L. The ALT was 58 U/L and AST was 56 U/L. Repeat Doppler ultrasonography suggested the blood flow was unobstructed. With consideration of the results of Doppler ultrasonography and no edema developed, we excluded the possibility of inferior vena cava stenosis. The blood concentration of Tacrolimus was 16.70 μg/L. Therefore, we considered that ascites and renal impairment were caused by toxicity of tacrolimus. To relieve symptoms, the patient was given symptomatic treatment of albumin infusion and diuretic. To stop the further impairment to kidneys and supply sufficient immunosuppressive strength, we reduced the dosage of tacrolimus to 1 mg (every 12 hours) and add sirolimus (1 mg, per day). The blood concentration of Tacrolimus declined to 6.00 μg/L with the patient's ascites reduced and renal function improved. His symptoms were relieved, and he was discharged at POD 91.

The patient was reviewed at POD 106 for the same complaint as previous. His symptoms did not improve with conservative treatment. The serum TBil was 24.4 μmol/L. The ALT was 16 U/L and AST was 23 U/L. Doppler ultrasonography revealed enlargement of liver, which might be caused by liver congestion. However, the large vessels in liver were unobstructed. Abdominal computed tomography (CT) scan at POD108 showed the absence of blood flow in hepatic vein and their branches (Fig. 2). Combined with the results of Doppler ultrasonography, we speculated the onset of HVOD. And, subsequent liver biopsy confirmed the diagnosis of HVOD (Fig. 3). Histologic result showed sinusoidal congestion and fibrosis of centrilobular veins. The postoperative pathology results showed that acute and chronic rejection did not occur (Fig. 3). At the same time, the pathology results of donor can also exclude the possibilities of HVOD in the donor liver before the operation. Therefore, we
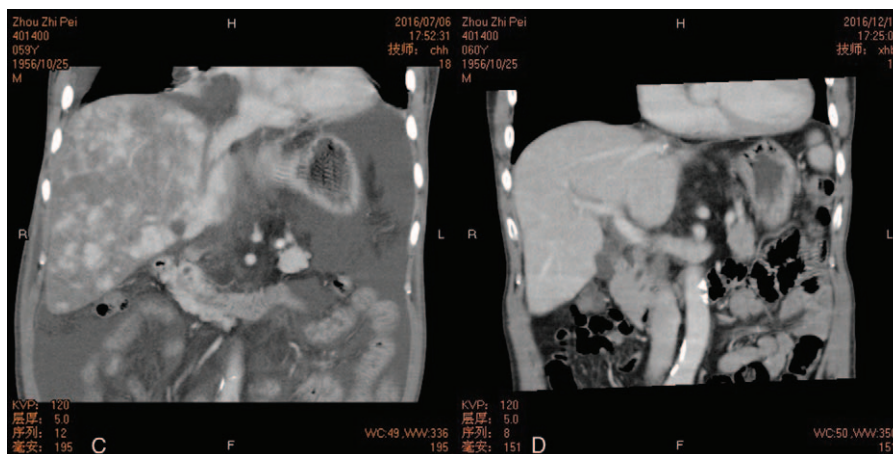
Figure 2. The CT results of this patient. (A) The uneven reduction of hepatic density and there is no blood flow in hepatic vein and their branches. We withdrew tacrolimus after confirming the diagnosis of HVOD and the development of HVOD was reversed rapidly. (B) The redevelopment of hepatic vein.

suspected that the occurrence of this complication is associated with tacrolimus. We then withdrew tacrolimus and switched our immunosuppressive strategy to a combination of cyclosporine A (75 mg, per day) with mycophenolate mofetil (0.75 g, every 12 hours) and sirolimus (1 mg, per day). The blood concentration of Cyclosporine A was monitored and gradually tapered to a dose of 50 mg/day. The blood concentration of Cyclosporine A was 64.90 μg/L at POD131. Doppler ultrasonography at POD 160 showed that the blood flow of inferior vena cava returned to normal (Fig. 1). The CT scan of the patient's latest review showed that the blood flow of hepatic veins and their branches returned to normal after the treatment (Fig. 2). The adjustment to our immunosuppressive strategy reversed the progression of HVOD. Clinical characteristics during the disease course are summarized in Table 1.

3. Discussion

HVOD describes a sinusoidal endothelial cell injury leading to hepatic sinusoids dimensional occlusion of the disease. This disease is a common complication of hematopoietic stem cell transplantation (HCT).[30–34] Seattle Criteria and Baltimore Criteria are widely used for HVOD after HCT.[35,36] Body weight gain (≥2%), ascites, hepatomegaly, and jaundice (bilirubin ≥2 mg/dL) are recognized as diagnostic clues. It is recommended

that the diagnosis of VOD be based primarily on established clinical criteria. Liver biopsy is reserved for patients in whom the diagnosis of VOD sinusoidal obstruction syndrome (SOS) is unclear and there is a need to exclude other diagnoses.[2] The early injury is characterized by endothelial damage to sinusoidal and small hepatic vein endothelium. And the late injury consists of fibrous obliteration of small hepatic veins.[37]

In recent years, some cases of HVOD after solid organ transplantation have been reported. HVOD is relatively a rare complication of liver transplantation and the histologic incidence is approximately 2%.[14,15] Most studies suggest that ACR is the main pathogenic factor of HVOD after LT. Takamura et al[13] reported 2 cases and found that ACR and perhaps atypical antibody-mediated rejection (AMR) would be associated with the onset of VOD/SOS. Sebagh et al[14] identified 19 HVOD of 1023 patients transplanted over a 9-year period and demonstrated that ACR is the main factor of HVOD after LT. Sanei et al[17] reported 15 cases of HVOD after LT and suggested that ACR resulted in HVOD. However, with the development of the immunosuppressive agents, rejection related HVOD after LT decreased fast recently.[38]

Immunosuppressive agents may also play an important role. HVOD after liver transplantations was first reported as complications of azathioprine hepatotoxicity by Sterneck et al in 1991.[25] Sebagh et al[15] analyzed 31 cases of HVOD after LT
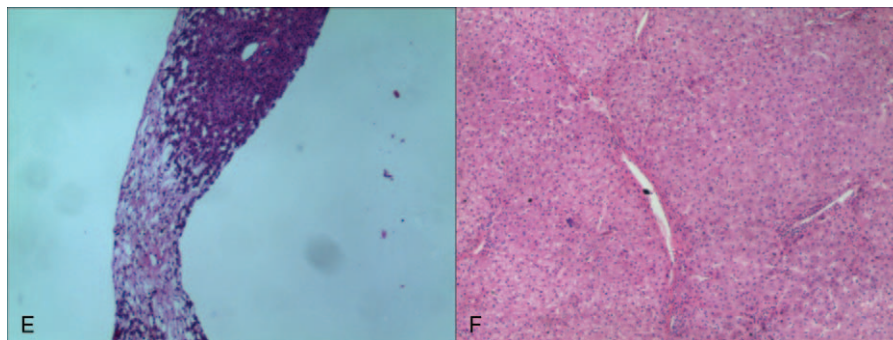

Figure 3. The histologic results of this patient. (A) The central venous sinusoidal expansion around the regional congestion and atrophy or dissolved of liver cells. That can confirm the diagnosis of HVOD. (B) The normal structure of donor liver under the microscope after operation. The graft liver did not have HVOD before liver transplantation.

Table 1

Clinical characteristics during disease course.

Days after LT	15	66	90	106	131	160
Clinical course	Discharge after LT	Admission for ascites	Discharge	Diagnosis of HVOD	Resolution	Review
ALT, U/L	19	58	26	16	9	20
AST, U/L	17	56	18	23	12	15
TB, μmol/L	17.2	36.2	23	24.4	25	24.1
TAC, ng/mL	11.3	16.7	6	7.7	–	–
CSA, ng/mL	–	–	–	–	64.9	93.9
Crea, μmol/L	67	159	169	181	132	119
ALB, g/L	42.4	34.7	33.9	31.7	39.3	35.2
Wt, kg	62.5	68	60	67	58	60
Immunosuppressive strategy	Tacrolimus (2.5 mg, every 12 h) + mycophenolate mofetil (0.75 g, every 12 h)		Tacrolimus (1 mg every 12 h) + sirolimus (1 mg, per day).		Cyclosporine A (75 mg, per day) + mycophenolate mofetil (0.75 g, every 12 h) + sirolimus (1 mg, per day).	

ALB = albumin, ALT = alanine aminotransferase, Crea = creatinine, CSA = cyclosporine A, LT = liver transplantation, PT = prothrombin time, TAC = tacrolimus, TB = total bilirubin, Wt = body weight.

and found that 16 of them are associated with ACR, while the others may be caused by immunosuppressive agents. However, few reports of tacrolimus-related cases are available. According to published literatures, 3 literatures reported patients complicated HVOD after organ transplantation, which have proved to be triggered by tacrolimus.[21,22,39]

In some cases, patients without ACR can also rule out the factors of immunosuppressive agents. Bat-Erdene et al[40] demonstrated that graft liver infection and IVC stenosis can lead to the most important cause of HVOD. The underlying causes of HVOD are a complex pathologic entity with multifactorial etiology. Tacrolimus is mainly metabolized by the cytochrome P450 (CYP) 3A subfamily in liver microsomes. The level of CYP in zone 3 of the liver acinus is the highest, while zone 3 is also the most affected by HVOD.[24] Published literatures about HVOD after solid organ transplantation are summarized in Table 2.

Our present case reported a 59-year-old male with alcoholic liver cirrhosis underwent liver transplantation in our center. The patient had symptoms of ascites and renal dysfunction 2 months after operation. We gave symptomatic treatment and decreased the dosage of tacrolimus to reduce its damage to the kidney.

However, the symptoms were not relieved and the patient was reviewed 1 month later. An ultrasound-guided percutaneous liver biopsy was performed. The histologic result showed sinusoidal congestion and fibrosis of centrilobular veins. At the same time, rejection was excluded. The progression of HVOD was reversed after discontinuing tacrolimus. Hence, we considered tacrolimus as the main predisposing factor for onset of HVOD in our case.

In conclusion, we described a HVOD patient after LT. The pathological result can confirm the diagnosis of HVOD and exclude the possibility of cell rejection. Tacrolimus might be a possible causative agent in our case. Discontinuation of tacrolimus reversed the development of HVOD. In future liver transplant patients, we should pay close attention to the use of tacrolimus. Once we discover clinical symptoms, including jaundice, body weight gain, and refractory ascites, it is necessary to consider if tarcrolimus-related HVOD is developed.

Author contributions

Table 2

A brief summary of published literatures about HVOD after solid organ transplantation.

Ref.	Year	Number of cases	Transplant site	Causative factor
Shen et al[21]	2015	1	Liver	Tacrolimus
Wang et al[39]	2013	1	Pancreas	Tacrolimus
Shah et al[22]	2006	1	Lung	Tacrolimus
Takamura et al[13]	2014	2	Liver	ACR/AMR
Yamada et al[19]	2012	1	Liver	ACR
Sanei et al[17]	2011	15	Liver	ACR
Sebagh et al[15]	2011	1	Liver	ACR
Kitajima et al[38]	2010	2	Liver	ACR
Izaki et al[18]	2004	1	Liver	ACR
Nakazawa et al[20]	2003	1	Liver	ACR
Sebagh et al[14]	1999	19	Liver	ACR
Sterneck et al[25]	1991	2	Liver	Azathioprine
Liano et al[28]	1989	5	Kidney	Azathioprine
Katzka et al[26]	1986	3	Kidney	Azathioprine
Read et al[29]	1986	4	Kidney	Azathioprine
Eisenhauer et al[27]	1984	1	Kidney	Azathioprine
Bat-Erdene et al[40]	2016	1	Liver	Graft liver infection/ IVC stenosis

ACR = acute cell rejection, AMR = acute antibody-mediated rejection, IVC = inferior vena cava.

patient samples. Bing Liao supplied the biopsy results and provided suggestions from the angle of pathology. Shunjun Fu and Yi Ma: critical revision of the article for important intellectual contents. Linwei Wu and Xiaoshun He: the conception of the study, acquisition of data, drafting of the article, and critical revision of the article for important intellectual contents. All listed authors participated meaningfully in the study and they have witnessed and approved of the final manuscript.

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References

[1] Senzolo M, Germani G, Cholongitas E, et al. Veno occlusive disease: update on clinical management. World J Gastroenterol 2007;13: 3918–24.

[2] Dignan FL, Wynn RF, Hadzic N, et al. BCSH/BSBMT guideline: diagnosis and management of veno-occlusive disease (sinusoidal obstruction syndrome) following haematopoietic stem cell transplantation. Br J Haematol 2013;163:444–57.

[3] Wadleigh M, Ho V, Momtaz P, et al. Hepatic veno-occlusive disease: pathogenesis, diagnosis and treatment. Curr Opin Hematol 2003;10: 451–62.

[4] Stuart KL, Bras G. Veno-occlusive disease of the liver. Q J Med 1957;26:291–315.

[5] Shulman HM, Gooley T, Dudley MD, et al. Utility of transvenous liver biopsies and wedged hepatic venous pressure measurements in sixty marrow transplant recipients. Transplantation 1995;59:1015–22.

[6] Robinson O, Want E, Coen M, et al. Hirmi Valley liver disease: a disease associated with exposure to pyrrolizidine alkaloids and DDT. J Hepatol 2014;60:96–102.

[7] Zhang L, Wang Y, Huang H. Defibrotide for the prevention of hepatic veno-occlusive disease after hematopoietic stem cell transplantation: a systematic review. Clin Transplant 2012;26:511–9.

[8] Mahgerefteh SY, Sosna J, Bogot N, et al. Radiologic imaging and intervention for gastrointestinal and hepatic complications of hemato-poietic stem cell transplantation. Radiology 2011;258:660–71.

[9] Azar N, Valla D, Abdelsamad I, et al. Liver dysfunction in allogeneic bone marrow transplantation recipients. Transplantation 1996;62:56–61.

[10] Shao H, Chen HZ, Zhu JS, et al. Computed tomography findings of hepatic veno-occlusive disease caused by Sedum aizoon with histopath-ological correlation. Braz J Med Biol Res 2015;48:1145–50.

[11] Lin G, Wang JY, Li N, et al. Hepatic sinusoidal obstruction syndrome associated with consumption of Gynura segetum. J Hepatol 2011;54: 666–73.

[12] Wu GL, Yu GY, Chen J. Clinical analysis of hepatic veno-occlusive disease induced by Sedum aizoon. Zhongguo Zhong Yao Za Zhi 2008;33:2402–4.

[13] Takamura H, Nakanuma S, Hayashi H, et al. Severe veno-occlusive disease/sinusoidal obstruction syndrome after deceased-donor and living-donor liver transplantation. Transplant Proc 2014;46:3523–35.

[14] Sebagh M, Debette M, Samuel D, et al. Silent" presentation of veno-occlusive disease after liver transplantation as part of the process of cellular rejection with endothelial predilection. Hepatology 1999;30: 1144–50.

[15] Sebagh M, Azoulay D, Roche B, et al. Significance of isolated hepatic veno-occlusive disease/sinusoidal obstruction syndrome after liver transplantation. Liver Transplant 2011;17:798–808.

[16] Carreras E. Veno-occlusive disease of the liver after hemopoietic cell transplantation. Eur J Haematol 2000;64:281–91.

[17] Sanei MH, Schiano TD, Sempoux C, et al. Acute cellular rejection resulting in sinusoidal obstruction syndrome and ascites postliver transplantation. Transplantation 2011;92:1152–8.

[18] Izaki T, Inomata Y, Asonuma K, et al. Early graft failure due to a veno-occlusive disease after a pediatric living donor liver transplantation. Pediatr Transplant 2004;8:301–4.

[19] Yamada N, Urahashi T, Ihara Y, et al. Veno-occlusive disease/sinusoidal obstruction syndrome associated with potential antibody-mediated rejection after pediatric living donor liver transplantation: a case report. Transplant Proc 2012;44:810–3.

[20] Nakazawa Y, Chisuwa H, Mita A, et al. Life-threatening veno-occlusive disease after living-related liver transplantation. Transplantation 2003; 75:727–30.

[21] Shen T, Feng XW, Geng L, et al. Reversible sinusoidal obstruction syndrome associated with tacrolimus following liver transplantation. World J Gastroenterol 2015;21:6422–6.

[22] Shah S, Budev M, Blazey H, et al. Hepatic veno-occlusive disease due to tacrolimus in a single-lung transplant patient. Eur Respir J 2006;27: 1066–8.

[23] Deleve LD, Wang X, Kuhlenkamp JF, et al. Toxicity of azathioprine and monocrotaline in murine sinusoidal endothelial cells and hepatocytes: the role of glutathione and relevance to hepatic venooclusive disease. Hepatology 1996;23:589–99.

[24] Marubbio AT, Danielson B. Hepatic veno-occlusive disease in a renal transplant patient receiving azathioprine. Gastroenterology 1975;69: 739–43.

[25] Sterneck M, Wiesner R, Ascher N, et al. Azathioprine hepatotoxicity after liver transplantation. Hepatology 1991;14:806–10.

[26] Katzka DA, Saul SH, Jorkasky D, et al. Azathioprine and hepatic venocclusive disease in renal transplant patients. Gastroenterology 1986;90:446–54.

[27] Eisenhauer T, Hartmann H, Rumpf KW, et al. Favourable outcome of hepatic veno-occlusive disease in a renal transplant patient receiving azathioprine, treated by portacaval shunt. Report of a case and review of the literature. Digestion 1984;30:185–90.

[28] Liaño F, Moreno A, Matesanz R, et al. Veno-occlusive hepatic disease of the liver in renal transplantation: is azathioprine the cause? Nephron 1989;51:509–16.

[29] Read AE, Wiesner RH, Labrecque DR, et al. Hepatic veno-occlusive disease associated with renal transplantation and azathioprine therapy. Ann Intern Med 1986;104:651–5.

[30] Carreras E, Grañena A, Navasa M, et al. Transjugular liver biopsy in BMT. Bone Marrow Transplant 1993;11:21–6.

[31] Zeng L, An L, Fang T, et al. A murine model of hepatic veno-occlusive disease induced by allogeneic hematopoietic stem cell transplantation. Cell Biochem Biophys 2013;67:939–48.

[32] Robitaille N, Lacroix J, Alexandrov L, et al. Excess of veno-occlusive disease in a randomized clinical trial on a higher trigger for red blood cell transfusion after bone marrow transplantation: a Canadian Blood and Marrow Transplant Group Trial. Biol Blood Marrow Transplant 2013; 19:468–73.

[33] Carreras E, Bertz H, Arcese W, et al. Incidence and outcome of hepatic veno-occlusive disease after blood or marrow transplantation: a prospective cohort study of the European Group for Blood and Marrow Transplantation. European Group for Blood and Marrow Transplantation Chronic Leukemia Working Party. Blood 1998;92:3599–604.

[34] Corbacioglu S, Cesaro S, Faraci M, et al. Defibrotide for prophylaxis of hepatic veno-occlusive disease in paediatric haemopoietic stem-cell transplantation: an open-label, phase 3, randomised controlled trial. Lancet 2012;379:1301–9.

[35] Mcdonald GB, Sharma P, Matthews DE, et al. Venocclusive disease of the liver after bone marrow transplantation: diagnosis, incidence, and predisposing factors. Hepatology 1984;4:116–22.

[36] Jones RJ, Lee KS, Beschorner WE, et al. Venoocclusive disease of the liver following bone marrow transplantation. Transplantation 1987;44: 778–83.

[37] Shulman HM, Gown AM, Nugent DJ. Hepatic veno-occlusive disease after bone marrow transplantation. Immunohistochemical identification of the material within occluded central venules. Am J Pathol 1987; 127:549–58.

[38] Kitajima K, Vaillant JC, Charlotte F, et al. Intractable ascites without mechanical vascular obstruction after orthotopic liver transplantation: etiology and clinical outcome of sinusoidal obstruction syndrome. Clin Transplant 2010;24:139–48.

[39] Wang SE, Shyr YM, Lee RC. Hepatic veno-occlusive disease related to tacrolimus after pancreas transplantation. J Chin Med Assoc 2013; 76:358–60.

[40] Batsaikhan BE, Sergelen O, Erdene S, et al. Inferior vena cava stenosis-induced sinusoidal obstructive syndrome after living donor liver transplantation. Korean J Hepatobiliary Pancreat Surg 2016;20:133–6.