—Case Reports—

Stenting of Inferior Right Hepatic Vein in a Patient with Budd-Chiari Syndrome: A Case Report

Tetsuya Shimizu, Masato Yoshioka, Junji Ueda, Mampei Kawashima, Toshiyuki Irie, Yoichi Kawano, Akira Matsushita, Nobuhiko Taniai, Yasuhiro Mamada and Hiroshi Yoshida

Department of Gastrointestinal and Hepato-Biliary-Pancreatic Surgery, Nippon Medical School, Tokyo, Japan

A Japanese man in his 20s was referred to our hospital with a two-month history of abdominal fullness and leg edema. Abdominal computed tomography revealing massive ascites and ostial blockage of the main hepatic veins, and angiographic evaluation demonstrating obstruction of the main hepatic veins yielded a diagnosis of Budd-Chiari syndrome (BCS). Diuretic agents were prescribed for the ascites but failed to provide relief. The patient was referred to our department for further evaluation and treatment. Angiography showed ostial obstruction of the main hepatic veins, with most of the portal hepatic flow draining from an inferior right hepatic vein (IRHV) into the inferior vena cava (IVC) thorough an intrahepatic portal venous and venovenous shunt. Access between the main hepatic veins and IVC was impossible, but cannulation between the IRHV and IVC was achieved. Because of the venovenous connection between the main hepatic vein and the IRHV, metallic stents were placed into two IRHVs to decrease congestion in the hepatic venous outflow. After stent placement followed by balloon expansion, the gradient pressure between the hepatic vein and IVC improved remarkably. The ascites and lower leg edema improved postoperatively, and long-term stent patency (6 years) was achieved.

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Key words: Budd-Chiari syndrome, Angioplasty, Stenting

Introduction

Budd-Chiari syndrome (BCS) is a rare disease induced by hepatic venous outflow tract obstruction and characterized by the classic triad of hepatomegaly, ascites, and abdominal pain. Without proper treatment, BCS may progress to portal hypertension, cirrhosis, and liver failure. Herein, we report a case of BCS with ascites and lower leg edema due to obstruction of the main hepatic vein; the patient was treated with endovascular stenting of the inferior right hepatic vein (IRHV) that resulted in long-term patency and improved symptoms.

Case Presentation

A Japanese man in his 20s was referred to our hospital with a two-month history of abdominal fullness and leg edema. The patient reported a medical history of childhood asthma and Graves' disease. Abdominal computed tomography (CT) revealed massive ascites (**Fig. 1a**) and ostial block of all three main hepatic veins (**Fig. 1b**). CT also showed comma-shaped intrahepatic venovenous collateral between the hepatic veins and hypertrophy of the caudate lobe (**Fig. 1c**). CT screening confirmed the absence of abdominal tumors and abscesses. Angiographic evaluation performed at the referring hospital demonstrated dilated porto-venous shunt and complete ostial obstruction of the main hepatic veins. However, because cannulation into a hepatic vein via the inferior vena cava (IVC) could not be performed, additional treatment for hepatic vein stenosis was impossible. Esophagogastroduodenoscopy indicated esophageal varices (LiF1CbRC0) and mild portal hypertensive gastropathy. These findings led to a diagnosis of primary Budd-Chiari syndrome

Correspondence to Tetsuya Shimizu, MD, Department of Gastrointestinal and Hepato-Biliary-Pancreatic Surgery, Nippon Medical School, 1–1–5 Sendagi, Bunkyo-ku, Tokyo 113–8603, Japan
E-mail: tetsuya@nms.ac.jp
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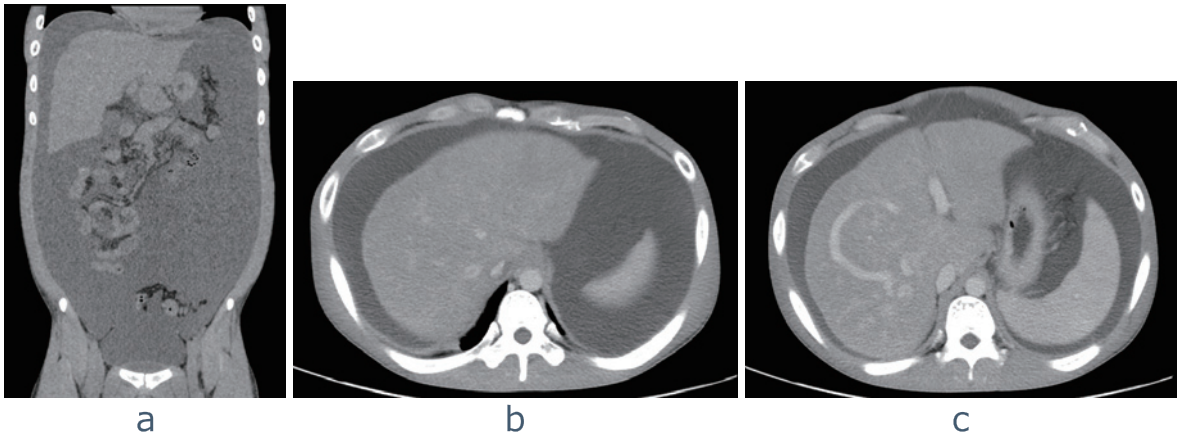

Fig. 1 Abdominal CT demonstrated massive ascites (a), ostial occlusion of all three main hepatic veins (b), and development of a comma-shaped intrahepatic veno-venous shunt (c).

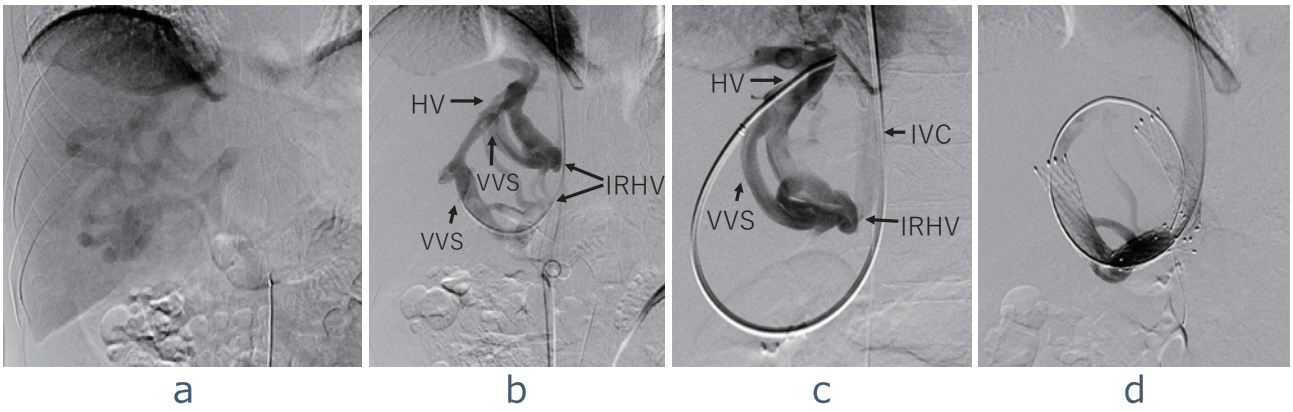

Fig. 2 a. Angiography showed that portal blood flow drained into the hepatic veins via an intrahepatic porto-venous shunt.
b. The main hepatic veins had no direct connection with the IVC, but they were connected with an IRHV through an intrahepatic veno-venous shunt, and liver flow finally drained into the IVC. (HV: hepatic vein, IRHV: inferior right hepatic vein, VVS: veno-venous shunt)
c. Because of obstruction of the main hepatic veins, cannulation of the main hepatic veins with the IVC was impossible. Venography suggested that all liver outflow was maintained by the IRHV via the intrahepatic veno-venous shunt alone. (HV: hepatic vein, IRHV: inferior right hepatic vein, IVC: inferior vena cava, VVS: veno-venous shunt)
d. Metallic stents were placed into each IRHV, and hepatic vein outflow improved.

(BCS). Diuretic agents (flosemide [60 mg/day], spironolactone [75 mg/day]) and a beta-blocker (propranolol hydrochloride [30 mg/day]) were prescribed for the ascites but failed to provide relief. The patient was then referred to our department for further evaluation and treatment.

His general condition was poor because of the massive ascites accompanied by continuous abdominal fullness and loss of appetite. Angioplasty was scheduled, and stents were placed in the stenotic hepatic veins under angiography. To avoid potential complications due to the massive ascites, we did not attempt the percutaneous transhepatic approach. Angiography showed hepatopetal portal blood flow draining into the hepatic veins via an intrahepatic porto-venous shunt (**Fig. 2a**). Furthermore, the main hepatic veins had no direct connection with the IVC, but they were connected to the IRHV through an intrahepatic veno-venous shunt, with liver flow finally draining into the IVC (**Fig. 2b**). Cannulation of two IRHVs was achieved via IVC; however, cannulation of the main hepatic veins to the IVC was impossible because of ostial obstruction of the main hepatic veins. Venography suggested that all liver outflow was maintained by the IRHVs via the intrahepatic veno-venous shunt alone (**Fig. 2c**). Due to a lack of access between the ostial main hepatic veins and the IVC, we decided to place three metallic stents into two patent IRHVs (**Fig. 2 d**). The first, a non-covered stent (E-Luminexx® Vascular Stent, 12 mm × 60 mm, Bard Peripheral Vascular, Tempe, AZ, USA) was inserted into the cranial side, after which,

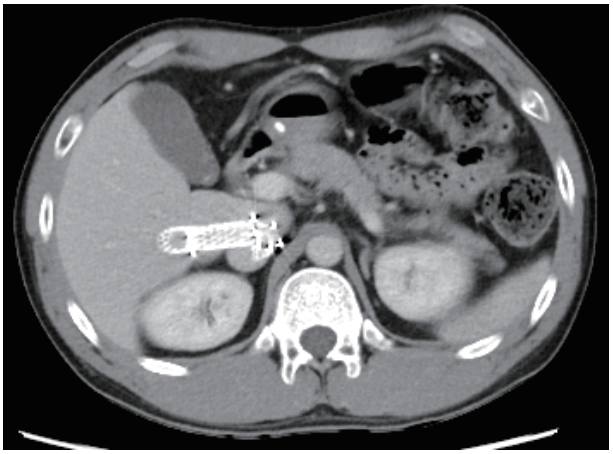

Fig. 3 Follow-up abdominal CT after 6 years of treatment confirmed stent patency and no ascites.

two non-covered stents (E-Luminexx® Vascular Stent, 12 mm × 100 mm and 12 mm × 40 mm) were inserted into the caudal IRHV. Stents were expended using balloon inflation device (Mustang® Balloon Dilatation Catheter, 8 mm × 40 mm). After stent placement and balloon expansion, the pressure gradient between the hepatic vein and the IVC improved remarkably from 24.5 cm H_2O to 3.5 cm H_2O. Thereafter, the patient's general condition remained stable, and he was discharged nine days later. His ascites and lower leg edema resolved postoperatively over the ensuing weeks, and long-term stent patency (6 years) was maintained by anticoagulant therapy with a 5 mg warfarin (**Fig. 3**). Although his initial Laboratory tests revealed mildly elevated bilirubin and thrombocytopenia, most recent laboratory tests revealed normal liver function and platelet count after treatment (**Table 1**).

Table 1 Serum TB, Alb, AST, ALT, γGTP levels and PLT count during the patient's clinical course

	Pre	7 days	6 years
TB (mg/dL)	2.7	1.6	1.4
Alb (g/dL)	4.3	4.5	4.9
AST (U/L)	35	44	23
ALT (U/L)	28	50	22
γGTP (U/L)	169	184	30
PLT (×10⁴/μL)	11.4	16.2	22.7

Discussion

BCS is characterized by obstruction of the hepatic venous outflow tract at any level between the small hepatic veins and the junction of the IVC with the right atrium. Outflow obstruction caused by hepatic veno-occlusive disease or cardiac disorders precludes a diagnosis of BCS[1,2]. The Japanese Ministry of Health and Welfare Research Committee on Aberrant Portal Blood Flow[3] reports an estimated prevalence of BCS in Japan of about 2.4 per million inhabitants, with a mean age at diagnosis of 42 and a female to male ratio of 0.7[3]. However, a recent report on a European cohort indicates a ratio of closer to 1[2].

BCS is classified as primary or secondary according to its etiology, with that of primary BCS being obstruction of the hepatic venous outflow tract by an endoluminal venous lesion (i.e. a thrombus or a web). A definite cause can be determined in most patients, usually abnormal angiogenesis, hypercoagulation, or myeloproliferative neoplasms (MPNs)[2,4], with MPNs reportedly being the most common cause. Approximately 58% of BCS patients with MPNs have a clonal mutation in JAK2 tyrosine kinase (JAK2V617F), which increases the risk of thrombosis[5]. BCS patients are at risk for latent MPNs, so they should be carefully monitored for the subsequent development of overt MPNs. Protein C, Protein S, and antithrombin III (AT III) deficiencies are also reported to be associated with the etiology of BCS[2,6], and such deficiencies have been reported in 31.8%, 18.2%, and 22.7% of BCS patients, respectively[7]. Hyperhomocysteinemia, paroxysmal nocturnal hemoglobinuria, and Behçet's syndrome are also reported to cause primary BCS[8], and because these underlying prothrombotic conditions are observed in at least 75% of patients with primary BCS[4,9], the presence of hypercoagulability should always be considered likely in BCS patients. The etiology of secondary BCS is hepatic venous outflow obstruction caused by a lesion outside the venous system, including tumor invasion into the lumen, and extrinsic compression by a tumor, abscess, cyst or trauma[1,10,11].

BCS has been classified by Sugiura et al.[12] into four types according to the mode of obstruction in the IVC and hepatic veins. According to this classification, type Ia is a relatively thin obstruction of the IVC with at least one patent hepatic vein, while type Ib involves obstruction of all three hepatic veins. Type II is a broad obstruction of the IVC (length of obstruction: from half to several vertebrae) with obstruction of all three hepatic veins; type III is a relatively thin obstruction and narrowing of the IVC with obstruction of all three hepatic veins; and type IV is a hepatic vein obstruction without obstruction of the IVC[12,13]. Asian and Western patients with BCS show different characteristics, with obstruction at the level of the hepatic veins being more common among Asians and incidence comparable between men and women. Among

Westerners, obstruction of the terminal IVC occurs more commonly and is observed more frequently in women[2]. Based on angiographic findings showing only hepatic vein occlusion, our patient's diagnosis was primary BCS with a Sugiura classification of type IV[12].

A step-wise treatment strategy for BCS has been widely adopted in the West[14], yielding an excellent 5-year survival rate of 89%[15]. The major options of step-wise treatment include initial anticoagulation therapy, followed by angioplasty/stenting/thrombolysis, transjugular intrahepatic portosystemic shunting (TIPS), or orthotopic liver transplantation (OLT). All patients receive the initial anticoagulant therapy, and if that fails, the next option is selected according to the treatment strategy. Anticoagulation therapy is very important because, as mentioned above, the etiology of BCS is closely associated with the hypercoagulable state. Angioplasty, stent placement, or TIPS is indicated in the absence of response to the initial therapy. Several reports have confirmed the effectiveness of angioplasty and stent placement in BCS treatment. Zhang et al.[16] reported that in 97 patients with 112 stents (90 IVC stents, 22 hepatic vein stents), 96.7% of the IVC stents and 90.9% of the hepatic vein stents remained patent during 5 years of follow-up. Fisher et al.[17] demonstrated the superiority of angioplasty over shunt surgery in terms of mortality, although no difference in patency rate was observed. Angioplasty or stenting remains a potentially valuable treatment for BCS subtypes with short-length venous stenosis of the hepatic vein or IVC, and because the benefits are potentially significant, investigation of patient suitability for this approach is highly recommended[14]. Generally, shunt surgery is indicated for failure of angioplasty combined with stenting and severe portal hypertension-related complications. TIPS has gradually become prevalent worldwide and has largely replaced surgical shunts in treating patients with BCS[8]. Covered stents can prolong the patency of TIPS[18]. A multi-center study providing long-term data on 133 patients treated with TIPS showed a technical success rate of 93% and a 10-year survival rate 69%[19]. OLT is the final option when TIPS or surgical intervention is ineffective, although a direct surgical approach whereby the occluded hepatic veins are reopened and the occluded IVC is reconstructed has also been reported to be effective. According to Kuniyoshi et al.[20], direct reopening of the occluded hepatic veins is useful in improving hepatic function and decreasing portal pressure, as reflected in the disappearance of esophageal varices.

This step-wise strategy is essentially the ideal one for BCS patients, but the final choice of therapy should always be left to the specialists in charge[18].

Draining the posterior segment of the right lobe directly into the IVC, an IRHV is the most common variant of the hepatic veins[21]. The presence of a thick IRHV is associated with a smaller RHV. Sharma et al.[21] demonstrated that the mean diameter of the RHV was significantly smaller in patients with an IRHV than in patients without one, and that the diameter of the RHV decreased as the number of IRHVs increased. Makuuchi et al.[22] reported that hepatic veins communicate with enlarged IRHVs in BCS patients, suggesting that IRHVs are the main means of drainage of the right lobe of the liver through their communication with the hepatic veins. In BCS patients with main hepatic vein obstruction, IRHVs contribute significantly to drainage from the hepatic flow into the systemic circulation[22–24].

Our patient was diagnosed with primary BCS with a Sugiura classification[12] of type IV on the basis of angiographic findings showing occlusion of the main hepatic vein only. Stent placement into the IRHV was effective in diminishing the patient's ascites and improving his quality of life despite incomplete cannulation into the main hepatic veins. With intrahepatic veno-venous shunt with IRHVs and the main hepatic veins, IRHV stenting improved the patient's general condition.

Endovascular decompression therapy with stenting, angioplasty, and TIPS contributes to significant recovery of hepatic function and portal hypertension-related symptoms, and it is clearly associated with good survival rates in patients with BCS. Such therapeutic intervention to improve hepatic hemodynamics should be strongly encouraged in patients with symptomatic BCS.

Conclusion

We treated a patient with BCS whose symptoms were alleviated by stent placement into an IRHV. In patients with symptomatic BCS, aggressive therapeutic intervention is needed in consideration of the hepatic hemodynamics. IRHV stent placement is a good BCS management option in cases where cannulation of the main hepatic veins is impossible.

Conflict of Interest: The authors declare that they have no conflicts of interest in relation to this report.

References

1. Janssen HL, Garcia-Pagan JC, Elias E, et al. Budd-Chiari syndrome: a review by an expert panel. J Hepatol [Inter-

net]. 2003 Mar;38(3):364–71. Available from: https://www.ncbi.nlm.nih.gov/pubmed/12586305
2. Valla DC. Primary Budd-Chiari syndrome. J Hepatol [Internet]. 2009 Jan;50(1):195–203. Available from: https://www.ncbi.nlm.nih.gov/pubmed/19012988
3. Ohfuji S, Furuichi Y, Akahoshi T, et al. Japanese periodical nationwide epidemiologic survey of aberrant portal hemodynamics. Hepatol Res [Internet]. 2019 Aug;49(8):890–901. Available from: https://www.ncbi.nlm.nih.gov/pubmed/30945395
4. Darwish Murad S, Plessier A, Hernandez-Guerra M, et al. Etiology, management, and outcome of the Budd-Chiari syndrome. Ann Intern Med [Internet]. 2009 Aug;151(3):167–75. Available from: https://www.ncbi.nlm.nih.gov/pubmed/19652186
5. Patel RK, Lea NC, Heneghan MA, et al. Prevalence of the activating JAK2 tyrosine kinase mutation V617F in the Budd-Chiari syndrome. Gastroenterology [Internet]. 2006 Jun;130(7):2031–8. Available from: https://www.ncbi.nlm.nih.gov/pubmed/16762626
6. Valla DC. The diagnosis and management of the Budd-Chiari syndrome: consensus and controversies. Hepatology [Internet]. 2003 Oct;38(4):793–803. Available from: https://www.ncbi.nlm.nih.gov/pubmed/14512865
7. Hirshberg B, Shouval D, Fibach E, Friedman G, Ben-Yehuda D. Flow cytometric analysis of autonomous growth of erythroid precursors in liquid culture detects occult polycythemia vera in the Budd-Chiari syndrome. J Hepatol [Internet]. 2000 Apr;32(4):574–8. Available from: https://www.ncbi.nlm.nih.gov/pubmed/10782905
8. Liu L, Qi XS, Zhao Y, Chen H, Meng XC, Han GH. Budd-Chiari syndrome: current perspectives and controversies. Eur Rev Med Pharmacol Sci [Internet]. 2016 Jul;20(15):3273–81. Available from: https://www.ncbi.nlm.nih.gov/pubmed/27467004
9. Denninger MH, Chait Y, Casadevall N, et al. Cause of portal or hepatic venous thrombosis in adults: the role of multiple concurrent factors. Hepatology [Internet]. 2000 Mar;31(3):587–91. Available from: https://www.ncbi.nlm.nih.gov/pubmed/10706547
10. Kikuchi Y, Yoshida H, Mamada Y, et al. Huge caudate lobe of the liver due to Budd-Chiari syndrome. J Nippon Med Sch [Internet]. 2010 Dec;77(6):328–32. Available from: https://www.ncbi.nlm.nih.gov/pubmed/21206147
11. Shimizu T, Yoshioka M, Kaneya Y, et al. Management of simple hepatic cyst. J Nippon Med Sch [Internet]. 2022 Mar 11;89(1):2–8. Available from: https://www.ncbi.nlm.nih.gov/pubmed/34526451
12. Sugiura M. Current Surgery No. 40. Tokyo: Nakayama; 1970. Etiology and symptoms of the portal system; p. 72–85.
13. Okuda H, Yamagata H, Obata H, et al. Epidemiological and clinical features of Budd-Chiari syndrome in Japan. J Hepatol [Internet]. 1995 Jan;22(1):1–9. Available from: https://www.ncbi.nlm.nih.gov/pubmed/7751574
14. Seijo S, Plessier A, Hoekstra J, et al. Good long-term outcome of Budd-Chiari syndrome with a step-wise management. Hepatology [Internet]. 2013 May;57(5):1962–8. Available from: https://www.ncbi.nlm.nih.gov/pubmed/23389867
15. Plessier A, Sibert A, Consigny Y, et al. Aiming at minimal invasiveness as a therapeutic strategy for Budd-Chiari syndrome. Hepatology [Internet]. 2006 Nov;44(5):1308–16. Available from: https://www.ncbi.nlm.nih.gov/pubmed/17058215
16. Zhang CQ, Fu LN, Xu L, et al. Long-term effect of stent placement in 115 patients with Budd-Chiari syndrome. World J Gastroenterol [Internet]. 2003 Nov;9(11):2587–91. Available from: https://www.ncbi.nlm.nih.gov/pubmed/14606103
17. Fisher NC, McCafferty I, Dolapci M, et al. Managing Budd-Chiari syndrome: a retrospective review of percutaneous hepatic vein angioplasty and surgical shunting. Gut [Internet]. 1999 Apr;44(4):568–74. Available from: https://www.ncbi.nlm.nih.gov/pubmed/10075967
18. Mancuso A. Budd-Chiari syndrome management: Lights and shadows. World J Hepatol [Internet]. 2011 Oct;3(10):262–4. Available from: https://www.ncbi.nlm.nih.gov/pubmed/22059108
19. Garcia-Pagan JC, Heydtmann M, Raffa S, et al. TIPS for Budd-Chiari syndrome: long-term results and prognostics factors in 124 patients. Gastroenterology [Internet]. 2008 Sep;135(3):808–15. Available from: https://www.ncbi.nlm.nih.gov/pubmed/18621047
20. Kuniyoshi Y, Inafuku H, Yamashiro S, et al. Direct reopening of the occluded hepatic veins of Budd-Chiari syndrome: verification of our operative method by the perioperative course of esophageal varices. Gen Thorac Cardiovasc Surg [Internet]. 2018 Jan;66(1):27–32. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28828590
21. Sharma M, Sood D, Singh Chauhan N, Verma N, Kapila P. Inferior right hepatic vein on routine contrast-enhanced CT of the abdomen: prevalence and correlation with right hepatic vein size. Clin Radiol [Internet]. 2019 Sep;74(9):735.e9-14. Available from: https://www.ncbi.nlm.nih.gov/pubmed/31235284
22. Makuuchi M, Hasegawa H, Yamazaki S, Moriyama N, Takayasu K, Okazaki M. Primary Budd-Chiari syndrome: ultrasonic demonstration. Radiology [Internet]. 1984 Sep;152(3):775–9. Available from: https://www.ncbi.nlm.nih.gov/pubmed/6087405
23. Cheng DL, Zhu N, Xu H, et al. Outcomes of endovascular interventional therapy for primary Budd-Chiari syndrome caused by hepatic venous obstruction. Exp Ther Med [Internet]. 2018 Nov;16(5):4141–9. Available from: https://www.ncbi.nlm.nih.gov/pubmed/30402156
24. Miraglia R, Maruzzelli L, Caruso S, de Ville de Goyet J. Hepatic vein stenting in a 7 week/old infant with Budd-Chiari syndrome using an anterograde approach from the inferior accessory hepatic vein. Dig Liver Dis [Internet]. 2018 Nov;50(11):1246. Available from: https://www.ncbi.nlm.nih.gov/pubmed/30030144

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