

Transdiaphragmatic cavoatrial anastomosis during orthotopic liver transplantation in a patient with chronic Budd-Chiari syndrome and thrombosis of inferior vena cava proximal to the right atrium - case report and review of literature

Vladislav Braşoveanu^{1,2}, Emil Matei¹, Mihnea Ioan Ionescu¹, Bogdan Rădulescu³, Speranţa Iacob⁴, Nicolae Bacalbaşa¹, Mugur Grasu⁵, Radu Dumitru⁵, Dana Tomescu⁶, Irinel Popescu¹

Corresponding author:

Assistant Professor Vladislav Braşoveanu, 1 "Dan Setlacec" Center of General Surgery and Liver Transplantation Fundeni Clinical Institute, Bucharest, Romania
E-mail: brasoveanuvlad@yahoo.com

¹"Dan Setlacec" Center of General Surgery and Liver Transplantation Fundeni Clinical Institute, Bucharest, Romania

²Faculty of Medicine, "Titu Maiorescu" University, Bucharest, Romania

³"CC Iliescu" Emergency Center of Cardiovascular Diseases, Bucharest, Romania

⁴Clinic of Gastroenterology, Fundeni Clinical Institute, Bucharest, Romania

⁵Center of Imagistics and Interventional Radiology, Fundeni Clinical Institute, Bucharest, Romania

⁶Center of Anesthesiology and Intensive Care, Fundeni Clinical Institute, Bucharest, Romania

ABSTRACT

Introduction: Budd-Chiari syndrome associated with inferior vena cava (IVC) thrombosis extended to the right atrium is a rare condition, which requires liver transplantation with different techniques of caval reconstruction. The procedure is technically demanding, especially if it is performed solely transdiaphragmatically.

Case presentation: An orthotopic liver transplantation (OLT) was performed in April 2014 in a 24-year old male patient with Budd-Chiari syndrome due to idiopathic thrombophilia and complete thrombosis of the retrohepatic IVC, up to its intrapericardic portion. Due to the impossibility of performing a cavo-caval anastomosis, a transdiaphragmatic anastomosis between the recipient right atrium and the donor superior cuff of the IVC was performed, without sternotomy.

Results: Postoperative course was uneventful except for persistent ascites, which was successfully managed with diuretics. The patient was discharged after 34 days; 9 months postoperatively he has optimal liver function and has returned to normal life

Conclusion: A transdiaphragmatic cavo-atrial anastomosis represents a feasible option in the setting of OLT, when the recipient IVC cannot be used due to extensive thrombosis, especially if it is performed by a multidisciplinary operative team.

Key words: orthotopic liver transplantation, transdiaphragmatic cavoatrial anastomosis, Budd-Chiari syndrome, inferior vena cava obstruction

INTRODUCTION

Budd-Chiari syndrome (BCS) is provoked by hepatic venous outflow obstruction due to various underlying diseases (1,2). Two forms of BCS have been described: primary, occurring in Asia, caused by internal membranes in the lumina of the inferior vena cava (IVC) and the hepatic veins, and secondary, mainly found in Europe and North America, mostly caused by myeloproliferative diseases. The location of the obstructive thrombus tends to be in the hepatic veins (HV) in Western patients, whereas in Asian patients, both the HV and the IVC are occluded more frequently (3). Patients with either acute (4) or chronic Budd-Chiari syndrome (BCS) benefit from a vast range of therapeutic approaches: surgical portocaval shunts (5), angioplasty or transjugular intrahepatic portosystemic shunt (TIPS) (6,7,8), and liver transplantation (OLT), be it a whole liver graft (9-11) or a living donor liver transplantation (12). The therapeutic sequence should include OLT only after the other, less invasive options have been applied. On the other hand, liver transplantation should be considered when any of the following occur in the patient: hepatic encephalopathy, decompensated liver function or liver malignancy. So far, the best possibility of therapeutic approach is OLT, with optimal results (10). Herein, we report the case of a patient with Budd-Chiari syndrome, with complete thrombosis of the IVC proximal to the right atrium, who was transplanted when the liver function decompensated to such extent

that the ascites and the poor synthetic capability of the liver were uncontrollable through medical treatment, thus mandating a swift and viable therapeutic option.

CASE PRESENTATION

The 24-year old patient was referred to our center for chronic Budd-Chiari syndrome; contrast-enhanced computed tomography revealed complete thrombosis of the retrohepatic inferior vena cava extending to the hepatic veins (*figure 1*) and to the intrapericardic portion of the IVC (*figure 2*), but no veno-occlusive disease.

The etiology of the thrombophilia was deemed as idiopathic, as the tests for Factor V Leiden, deficit of AT III, protein C and protein S were all negative. Considering the extent of the thrombotic process and the fact that the IVC had a radiologic aspect of complete fibrosis, any attempt to reduce the portal hypertension by a TIPS procedure or the hypertension in the caval system using balloon angioplasty +/- stent placement was considered both dangerous and ineffective for the patient. The patient was administered per os warfarin and the renal dysfunction (albeit with relatively low creatinin due to the fact that the patient had a reduced body mass index) and the refractory ascites were managed with diuretics. As the status of the patient gradually deteriorated, with severe hypoproteinemia, uncontrollable ascites and progressive liver decompensation, a decision was taken to transplant the patient.



Figure 1 - (a) Pretransplant aspect: Complete thrombosis of the IVC, both in the supra- and infrahepatic segments; the IVC is transformed into a fibrous chord. (b) Compensatory enlargement of azygos (fat arrow) and hemiazygos (slim arrow) veins



Figure 2 - Extensive thrombotic involvement of the IVC, in the suprahepatic segment with visualization of a small thrombus at the level of the right atrium (arrow)

Operative technique

Due to the extension of the thrombotic process inside the intrapericardic portion of the IVC (*figure 2*), the inferior vena cava of the donor, together with a small cuff of the donor right atrium, was harvested en bloc with the liver graft. The outflow anastomoses of the OLT consisted in an end-to-end anastomosis between the inferior portion of the donor IVC and the suprarenal IVC of the recipient. The superior end of the donor IVC was anastomosed to the right atrium. No sternotomy was performed, the latter anastomosis was performed in a transdiaphragmatic manner by a mixed team (cardiac surgeon and the liver transplantation team). A circular incision was performed in the diaphragm, at a radius of about 1 cm around the IVC, thus achieving optimal exposure. After incising the pericardium, a clamp was positioned on the intrapericardic portion of the IVC, after which the anastomosis was performed, with 2 running sutures of Prolene 4-0.

Despite the important collateral venous circulation, no venovenous bypass was used, and the intraoperative echoDoppler examination showed a satisfactory liver outflow and the patient presented an optimal haemodynamic function. The portal, arterial and biliary anastomoses were subsequently completed in a standard manner. The length of the procedure was 319 minutes; the duration of the cold ischemia time was

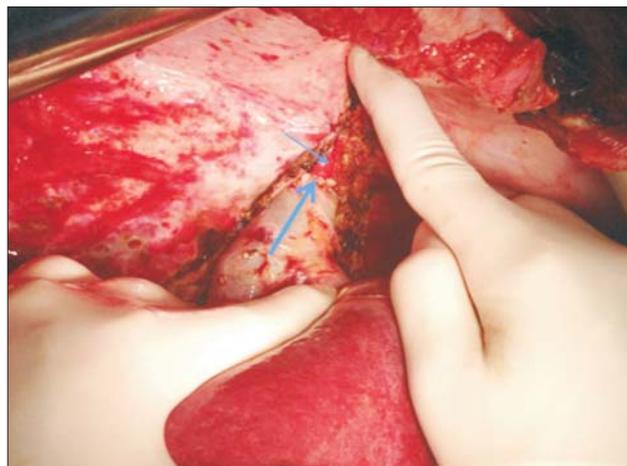


Figure 3 - Cavoatrial anastomosis (fat arrow); Right atrium (slim arrow)

322 minutes and the warm ischemia time was 118 minutes; the transfusion requirement was approximately 1500 ml; the volume of blood loss was c. 500 ml.

Postoperatively, the liver graft function was within normal limits, with patent anastomoses. (*figure 3*) The patient presented 4-6 L of ascitis per day, which was successfully managed by repletive treatment (albumin) and diuretics; the patient presented a low-flow of the hepatic arterial anastomosis on the routine echo-Doppler check, which was corrected with a short-term Ilomedin therapy. The postoperative cardiologic evaluation noted perfect cardiac function. The prophylaxis of the rebound of the thrombotic process was achieved by administering fractionated Heparin (Clexane 1 mg/ kg of body mass/ day s.c.); after the patients was discharged, a target international normalized ratio (INR) of 2:3 was maintained with per os coumarin anticoagulants (Sintrom). At follow-up, 9 months postoperatively, the patient has normal liver graft function, with no signs of thrombosis (*figure 4*) and has returned to normal life.

DISCUSSION

BCS is a clinical condition determined by a wide variety of diseases: polycythemia vera, oral contraceptives, paroxysmal nocturnal hemoglobinuria, trauma, systemic lupus eritematosus, Crohn's disease, myeloproliferative disorders, immune thrombocytopenic purpura, AT III deficiency, protein C deficiency, factor V Leiden, anti-phospholipid syndrome, pregnancy or post-partum (13). In the largest series of patients transplanted for BCS published so far, the etiology remained undetermined in 29% of the cases (10). 1-year and 3-year spontaneous mortality in BCS patients is 70% and 90%, respectively (14). Recently, a multi-step

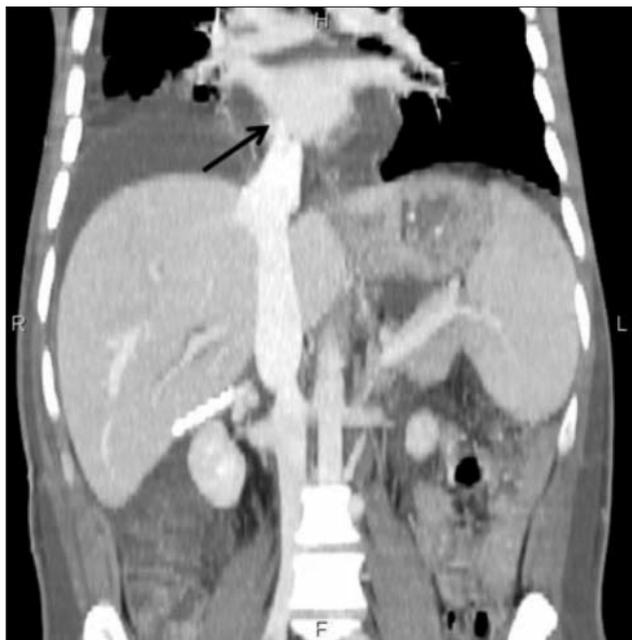


Figure 4 - Postoperative aspect of the cavoatrial anastomosis (arrow)

strategy was imagined, applied to BCS patients that were stratified according to the extent of the thrombosis and the degree of liver dysfunction: first line treatment consists in anticoagulation and diuretics; second-line consists in balloon angioplasty, catheter-thrombolysis and stent placement for short-segment thrombosis; TIPS as a third tier option; the fourth step, in case the symptoms and the thrombotic process have not been controlled with the previous steps, is OLT (15).

An issue of paramount importance in the management of BCS with IVC thrombosis is the sequence of applying interventional radiologic techniques as opposed to OLT. A study on a large cohort of patients (23352) showed that the trend of the surgical therapeutic approach in BCS is decreasing, while interventional radiology is employed on an increasingly larger scale (16). Mortality has been proven to increase in patients whose transplantation procedure was performed shortly after a TIPS procedure (2 weeks) or a portosystemic shunt (1 month) (10).

Recent studies have shown promising results in BCS patients treated with IVC placement and balloon angioplasty (17). Wang et al. proved that decreasing IVC hypertension by radiologic interventional means as a first step also alleviates portal hypertension in a subset of patients with important collateral venous circulation (18); however, this was possible in patients with short segmental obstruction of the IVC. A longer extent of the thrombosis would not only seriously increase the risk of pulmonary embolism, but would also render any

attempt of recanalization by interventional means futile; therefore, conservative management before the OLT was the strategy of choice in our case. The choice between minimally invasive procedures as opposed to surgery in BCS with obstruction of IVC seems to also depend on whether the condition is caused by membranous obstruction, as is the case in Asian patients in which interventional radiology is applied to increasing numbers of patients with improving results, or by myeloproliferative diseases, in the case of Western patients. In the latter group of patients the benefits of the above named minimally invasive procedures are less evident, and TIPS is the procedure of choice; the consequent next step if the TIPS does not improve the condition is OLT (19,20,21).

Apart from liver transplantation, mesoatrial (MAS) or meso-superior caval shunts have been proven successful in increasing survival in patients with acute or chronic BCS. Meso-cavo-atrial shunts (MCAS) using ePTFE-covered Gore-Tex artificial vascular grafts showed further improved results in terms of 5-year survival and graft patency, while concomitantly improving clinical symptoms and decreasing complications, compared to meso-atrial shunts (22). However, both MAS and MCAS have been performed in relatively small series of patients, albeit with good results (23, 24). A promising approach consists in mesoatrial shunt combined with side-to-side portacaval shunt (SSPCS) (25), yet, in our case, a MCAS would simply not work, due to the inferior extent of the thrombus on the IVC. A superior mesenteric vein-caval-right atrium Y shunt, as described by Zhang et al. (26) was taken in consideration for solving the IVC hypertension and the portal hypertension, yet, since the patient had been listed for OLT with an already damaged liver function, it was considered that supplementary pretransplant surgery would be detrimental in terms of added risk of surgical complications.

OLT for BCS was first performed in 1974 (27); in BCS patients it has the advantage of completely solving the thrombotic process, with satisfactory 10-year survival (68%) (10). A cavoatrial anastomosis should be taken in consideration during OLT in patients with a thrombotic process of the IVC extending from the renal veins to the right atrium (2, 28).

The most important pitfall of the OLT for BCS is the recurrent thrombosis of the IVC (29). Thrombotic recurrence is mainly associated with either poor coagulative status posttransplantation or a stenotic suprahepatic IVC. Resecting the entire donor IVC superior to the renal veins, en bloc with a small portion of the recipient right atrium (RA), with a subsequent cavoatrial anasto-

mosis, precludes a posttransplant stenosis, thus decreasing the risk of recurrent thrombosis.

One of the available procedures for BCS is LDLT. Although the experience with this procedure is relatively limited in comparison with OLT, important progress has been made in order to overcome the difficulties associated with the venous outflow reconstruction. Unless a thrombectomy of the IVC can be properly performed (30), the recipient fibrotic retrohepatic IVC also has to be resected, consequently requiring reconstruction with a vascular graft (autologous (31), cryopreserved (32), or a synthetic Dacron one (33).

A novel procedure reported by Mancuso et al. (34) consists in solving the thrombotic obstruction of the IVC near to the atrium by resecting the affected segment and replacing it with a caval homograft.

Due to the fact that BCS with IVC obstruction has a relatively low incidence, most studies regarding the efficacy of various therapeutic approaches are retrospective (15), therefore the issue of the optimal treatment in an individual patient should remain open to discussion.

In conclusion, orthotopic liver transplantation is the best therapeutic option available for patients with decompensated liver function due to Budd-Chiari syndrome. Various technical modifications to the standard OLT procedure can be successfully applied in order to overcome pathological challenges, such as the extensive thrombotic process, in our particular case.

REFERENCES

- Orloff MJ, Daily PO, Orloff SL, Girard B, Orloff MS. A 27-year experience with surgical treatment of Budd-Chiari syndrome. *Ann Surg.* 2000 Sep; 232(3):340-52.
- Menon KV, Shah V, Kamath PS. The Budd-Chiari syndrome. *N Engl J Med.* 2004 Feb 5;350(6):578-85. Comment in *The Budd-Chiari syndrome. [N Engl J Med.* 2004] *The Budd-Chiari syndrome. [N Engl J Med.* 2004]
- Hoekstra J, Guimaries AH, Leebeek FW, Darwish Murad S, Maffiet JJ, Plessier A, et al. Impaired fibrinolysis as a risk factor for Budd-Chiari syndrome. *Blood.* 2010 Jan 14;115(2):388-95. doi: 10.1182/blood-2009-03-211557. Epub 2009 Nov 18.
- Tucker O, Battula N, Kane P, Karani J, Heaton N, Muesan P. Liver transplantation with caval thrombectomy and cavoatrial shunt in acute Budd-Chiari syndrome. *Liver Transpl.* 2007 Apr;13(4):624-5.
- Darwish Murad S, Valla DC, de Groen PC, Zeitoun G, Hopmans JA, Haagsma EB, et al. Determinants of survival and the effect of portosystemic shunting in patients with Budd-Chiari syndrome. *Hepatology.* 2004 Feb; 39(2):500-8.
- Molmenti EP, Segev DL, Arepally A, Hong J, Thuluvath PJ, Rai R, et al. The utility of TIPS in the management of Budd-Chiari syndrome. *Ann Surg.* 2005 Jun;241(6):978-81; discussion 982-3.
- Eapen CE, Velissaris D, Heydtmann M, Gunson B, Olliff S, Elias E. Favourable medium term outcome following hepatic vein recanalisation and/or transjugular intrahepatic portosystemic shunt for Budd Chiari syndrome. *Gut.* 2006 Jun;55(6):878-84. Epub 2005 Sep 20.
- Neumann AB, Andersen SD, Nielsen DT, Holland-Fischer P, Vilstrup H, Gronbeak H, et al. Treatment of Budd-Chiari syndrome with a focus on transjugular intrahepatic portosystemic shunt. *World J Hepatol.* 2013 Jan 27;5(1):38-42. doi: 10.4254/wjh.v5.i1.38.
- Segev DL, Nguyen GC, Locke JE, Simpkins CE, Montgomery RA, Maley WR, et al. Twenty years of liver transplantation for Budd-Chiari syndrome: a national registry analysis. *Liver Transpl.* 2007 Sep;13(9):1285-94.
- Mentha G, Giostra E, Majno PE, Bechstein WO, Neuhaus P, O'Grady J, et al. Liver transplantation for Budd-Chiari syndrome: a European study on 248 patients from 51 centres. *J Hepatol.* 2006 Mar;44(3):520-8. Epub 2005 Dec 27.
- Yamada T, Tanaka K, Ogura Y, Ko S, Nakajima Y, Takada Y, et al. Surgical techniques and long-term outcomes of living donor liver transplantation for Budd-Chiari syndrome. *Am J Transplant.* 2006 Oct;6(10):2463-9. Epub 2006 Aug 25.
- Choi GS, Park JB, Jung GO, Chun JM, Kim JM, Moon JI, et al. Living donor liver transplantation in Budd-Chiari syndrome: a single-center experience. *Transplant Proc.* 2010 Apr;42(3):839-42. doi: 10.1016/j.transproceed.2010.02.045.
- Mackiewicz A, Kotulski M, Zieniewicz K, Krawczyk M. Results of liver transplantation in the treatment of Budd-Chiari syndrome. *Ann Transplant.* 2012 Jan-Mar;17(1):5-10.
- Wang ZG, Zhang FJ, Yi MQ, Qiang LX. Evolution of management for Budd-Chiari syndrome: a team's view from 2564 patients. *ANZ J Surg.* 2005 Jan-Feb;75(1-2):55-63.
- Seijo S, Plessier A, Hoekstra J, Dell'era A, Mandair D, Rifai K, et al. Good long-term outcome of Budd-Chiari syndrome with a step-wise management. *Hepatology.* 2013 May;57(5):1962-8. doi: 10.1002/hep.26306.
- Qi XS, Ren WR, Fan DM, Han GH. Selection of treatment modalities for Budd-Chiari Syndrome in China: a preliminary survey of published literature. *World J Gastroenterol.* 2014 Aug 14;20(30):10628-36. doi: 10.3748/wjg.v20.i30.10628.
- Wang R, Meng Q, Qu L, Wu X, Sun N, Jin X. Treatment of Budd-Chiari syndrome with inferior vena cava thrombosis. *Exp Ther Med.* 2013 Apr; 5(4):1254-1258. Epub 2013 Feb 18.
- Sun YL, Fu Y, Zhou L, Ma XX, Wang ZW, Wu Y. Staged management of Budd-Chiari syndrome caused by co-obstruction of the inferior vena cava and main hepatic veins. *Hepatobiliary Pancreat Dis Int.* 2013 Jun;12(3): 278-85.
- Darwish Murad S, Plessier A, Hernandez-Guerra M, Fabris F, Eapen CE, Bahr MJ, et al. Etiology, management, and outcome of the Budd-Chiari syndrome. *Ann Intern Med.* 2009 Aug 4;151(3):167-75.
- Cheng D, Xu H, Lu ZJ, Hua R, Qiu H, Du H, et al. Clinical features and etiology of Budd-Chiari syndrome in Chinese patients: a single-center study. *J Gastroenterol Hepatol.* 2013 Jun;28(6):1061-7. doi: 10.1111/jgh.12140.
- Plessier A, Sibert A, Consigny Y, Hakime A, Zappa M, Denninger MH, et al. Aiming at minimal invasiveness as a therapeutic strategy for Budd-Chiari syndrome. *Hepatology.* 2006 Nov;44(5):1308-16.
- Chen H, Zhang F, Ye Y, Cheng Y, Chen Y. Long-term follow-up study and comparison of meso-atrial shunts and meso-cavo-atrial shunts for treatment of combined Budd-Chiari syndrome. *J Surg Res.* 2011 Jun 1;168(1):162-6. doi: 10.1016/j.jss.2009.07.024. Epub 2009 Aug 15.
- Emre A, Kalayci G, Ozden I, Bilge O, Acarli K, Kaymakoglu S, et al. Mesoatrial shunt in Budd-Chiari syndrome. *Am J Surg.* 2000 Apr;179(4):304-8.
- Behera A, Menakuru SR, Thingnam S, Kaman L, Bhasin DK, Kochher R, et al. Treatment of Budd-Chiari syndrome with inferior vena caval occlusion by mesoatrial shunt. *Eur J Surg.* 2002;168(6):355-9.
- Orloff MJ, Isenberg JI, Wheeler HO, Daily PO, Girard B. Budd-Chiari syndrome revisited: 38 years' experience with surgical portal decompression. *J Gastrointest Surg.* 2012 Feb;16(2):286-300; discussion 300. doi: 10.1007/s11605-011-1738-9. Epub 2011 Nov 8.
- Zhang Y, Zhao H, Yan D, Xue H, Lau WYJ. Superior mesenteric vein-caval-right atrium Y shunt for treatment of Budd-Chiari syndrome with obstruction to the inferior vena cava and the hepatic veins - a study of 62 patients. *J Surg Res.* 2011 Jul;169(1):e93-9. doi: 10.1016/j.jss.2011.02.030. Epub 2011 Mar 21.
- Putnam CW, Porter KA, Weil R 3rd, Reid HA, Starzl TE. Liver transplantation

- of Budd-Chiari syndrome. *JAMA*. 1976 Sep 6;236(10):1142-3.
28. Remiszewski P, Zieniewicz K, Krawczyk M, "Early results of orthotopic liver transplantations using the technique of inferior vena cava anastomosis. *Transplant Proc*. 2006 Jan-Feb;38(1):237-9.
 29. Chen ZY, Yan LN, Zeng Y, Wen TF, Li B, Zhao JC, et al. Transdiaphragmatic exposure for direct atrioatrial anastomosis in liver transplantation. *Chin Med J (Engl)*. 2010 Dec;123(24):3515-8.
 30. Soyama A, Eguchi S, Yanaga K, Takatsuki M, Hidaka M, Kanematsu T. Living donor liver transplantation with extensive caval thrombectomy for acute-on chronic Budd-Chiari syndrome. *Surg Today*. 2011 Jul;41(7):1026-8. doi: 10.1007/s00595-010-4376-z. Epub 2011 Jul 12.
 31. Shimoda M, Marubashi S, Dono K, Miyamoto A, Takeda Y, Nagano H, et al. Utilization of autologous vein graft for replacement of the inferior vena cava in living-donor liver transplantation for obliterative hepatocavopathy. *Transpl Int*. 2007 Sep;20(9):804-7. Epub 2007 Jul 9.
 32. Yan L, Li B, Zeng Y, Wen T, Zhao J, Wang W, et al. Living donor liver transplantation for Budd-Chiari syndrome using cryopreserved vena cava graft in retrohepatic vena cava reconstruction. *Liver Transpl*. 2006 Jun;12(6):1017-9.
 33. Lee SG, Hwang S, Kim KH, Ahn CS, Moon DB, Ha TY, et al. Toward 300 liver transplants a year. *Surg Today*. 2009;39(5):367-73. doi: 10.1007/s00595-008-3917-1. Epub 2009 Apr 30.
 34. Mancuso A, Martinelli L, De Carlis L, Rampoldi AG, Magenta G, Cannata A, et al. A caval homograft for Budd-Chiari syndrome due to inferior vena cava obstruction. *World J Hepatol*. 2013 May 27;5(5):292-5. doi: 10.4254/wjh.v5.i5.292.