

# Incidence and treatment of hepatic artery complications after orthotopic liver transplantation

Ji-Chun Zhao, Shi-Chun Lu, Lu-Nan Yan, Bo Li, Tian-Fu Wen, Yong Zeng, Nan-Sheng Cheng, Jing Wang, Yan Luo, Yu-Lan Pen

**Ji-Chun Zhao, Shi-Chun Lu, Lu-Nan Yan, Bo Li, Tian-Fu Wen, Yong Zeng, Nan-Sheng Cheng, Jing Wang,** Department of General Surgery, West China Hospital, Sichuan University, Chengdu 610041, Sichuan Province, China

**Yan Luo, Yu-Lan Pen,** Department of Ultrasound Diagnosis, West China Hospital, Sichuan University, Chengdu 610041, Sichuan Province, China

**Correspondence to:** Dr. Ji-Chun Zhao, Department of General Surgery, West China Hospital, Sichuan University, Chengdu 610041, Sichuan Province, China. jichunzhao@hotmail.com

**Telephone:** +86-28-85422474

**Received:** 2003-03-19 **Accepted:** 2003-04-24

## Abstract

**AIM:** To investigate the incidence and treatment of hepatic artery complications after orthotopic liver transplantation.

**METHODS:** From February 1999 to May 2002, orthotopic liver transplantations (OLT) were performed in 72 patients with end-stage liver diseases with an average age of  $40.2 \pm 13.6$  years (ranged from 11 to 68 years), 56 were males and 16 females. The preoperative evaluation for the 72 patients was performed using duplexsonography, abdominal CT scan, and angiography of the hepatic artery. All donor grafts were perfused and preserved in University of Wisconsin solution at  $4^{\circ}\text{C}$ . OLT was performed with standard techniques with or without a veno-venous bypass. Reconstructions of hepatic artery were performed between the branch patches of gastroduodenal/hepatic or splenic/common hepatic artery confluence of the donors and recipients, and an end-to-end anastomosis between other arterial vessels of the donors and recipients was done. Arterial anastomosis was performed with interrupted 7-0/8-0 monofilament polypropylene suture under  $3.5 \times$  loupe magnification. Diagnosis of the complications of hepatic artery after OLT was based on the clinical presentations, ultrasound findings and arterial angiography. All patients were followed up regularly for duplex ultrasound scan after discharge.

**RESULTS:** The overall incidence of arterial complications in 72 patients after OLTs was 1.4 % (1/72). One 3 cm pseudoaneurysm at the side of anastomotic site of hepatic artery was found by urgent arteriogram due to hemoperitoneum secondary to bile leakage after OLT. Subsequently the pseudoaneurysm was successfully embolized and the blood flow toward the donor liver in hepatic artery remained. The overall postoperative 30-day mortality rate was 8.33 %. The one-year survival rate was 83.72 % in 50 patients with benign diseases and was 71.43 % in 22 patients with malignant diseases following OLT. No death associated with complications of hepatic artery occurred.

**CONCLUSION:** Careful preoperative evaluations and intraoperative microsurgical technique for hepatic artery reconstructions are the keys in prevention of hepatic artery complications after OLT.

Zhao JC, Lu SC, Yan LN, Li B, Wen TF, Zeng Y, Cheng NS, Wang J, Luo Y, Pen YL. Incidence and treatment of hepatic artery complications after orthotopic liver transplantation. *World J Gastroenterol* 2003; 9(12): 2853-2855

<http://www.wjgnet.com/1007-9327/9/2853.asp>

## INTRODUCTION

Vascular complications after orthotopic liver transplantation (OLT) ranges from 2 % to 25 % in most publications<sup>[1,2]</sup>. The most frequent complications involve the hepatic artery (2 % to 12 % in adults)<sup>[3-5]</sup>, in which the hepatic artery thrombosis (HAT) is most common<sup>[6,7]</sup>. The complications of hepatic artery are usually associated with technical, hemodynamic, immunological and infectious factors<sup>[2,8,9]</sup>, which may result in biliary tract complications or sepsis<sup>[10,11]</sup>, and even a retransplantation may be required<sup>[12,13]</sup>. In the present study, we report the incidence and treatment of hepatic artery complications in 72 patients with end-stage liver diseases after OLT from February 1999 to May 2002.

## MATERIALS AND METHODS

### Patients

From February 1999 to May 2002, OLTs were performed in 72 patients with an average age of  $40.2 \pm 13.6$  years (range 11 to 68 years, and 56 males, 16 females). Indications for OLT included post-inflammatory liver cirrhosis complicated with hepatitis B and liver function failure (34 cases), primary hepatocellular carcinoma (19 cases), end-stage liver hydatid cyst disease complicated with liver function failure (4 cases), Caroli's disease (3 cases), cholestatic liver cirrhosis complicated with hepatolithiasis (2 cases), polycystic liver disease complicated with liver function failure (2 cases), primary sclerosing cholangitis (2 cases), Budd-Chiari syndrome complicated with liver function failure (2 cases), cholangiocarcinoma (2 cases), alcoholic cirrhosis (one case) and secondary hepatic malignancy (gallbladder cancer) (one case).

### Methods

The preoperative evaluation for the 72 patients was performed using duplexsonography, abdominal CT scan, and angiography of the hepatic artery. All donor grafts were perfused and preserved in University of Wisconsin solution at  $4^{\circ}\text{C}$ . OLT was performed with standard techniques and a veno-venous bypass was used in 61 patients, and no veno-venous bypass was used in 5 patients. Retro-hepatic vena cava was resected in 66 patients, and an end-end interposition of donor vena cava together with donor liver was performed. Hepatectomy was performed according to the classical technique with preservation of retrohepatic vena cava (piggy back) in the remaining 6 patients. Reconstruction of the portal vein was performed by an end-to-end veno-venous anastomosis. The reconstruction of hepatic artery was variable and dependent on hepatic artery anatomy of the donors and recipients. Arterial anastomosis was performed between the branch patches of gastroduodenal/hepatic or splenic/common hepatic artery

confluence of the donors and recipients in 22 out of the 72 cases. End-to-end anastomosis was done between the proper hepatic artery of the donors and recipients in 18 out of the 72 cases, and the remaining anastomosis was performed between the proper hepatic artery of the donors and the right hepatic artery or the common hepatic artery of the recipients respectively in 6 and 5 out of the 72 cases. Anastomoses were performed between the proper hepatic artery of the donors and the splenic artery, between the left gastric artery and the left hepatic artery of the recipients in one case each, and between the splenic artery of the donors and the proper hepatic artery, the common hepatic artery or the left hepatic artery of the recipients in 6, 4 and one case respectively, between the common hepatic artery of the donors and the proper hepatic artery or the left hepatic artery of the recipients in 3 and one case respectively, and between the coeliac trunk of the donors and the common hepatic artery of the recipients in 3 cases. Arterial reconstruction was performed by microsurgical techniques with interrupted 7-0/8-0 monofilament polypropylene suture under 3.5 x loupe magnification, interposition grafting with same donor's part of common hepatic conduit was used selectively in one case with end-to-end anastomosis between the proper hepatic arteries of the donors and recipients when anastomotic thrombosis was suspected before closure of the abdominal incision<sup>[14,15]</sup>. Diagnosis of complications of hepatic artery after OLTs was based on the clinical presentations, ultrasound findings and arteriography of hepatic artery. The hepatic artery was detected with routine duplex sonography intraoperatively after completion of hepatic artery reconstruction and daily in the first week after OLTs<sup>[16,17]</sup>. When the patients had elevated hepatic enzymes, cholestasis, bile leakage and high fever in the absence of acute rejection and drug toxicity, spiral CT scan or angiography of hepatic artery should be considered. No anticoagulable pharmacotherapy to maintain arterial patency was used intraoperatively and postoperatively in this group, but laboratory examination of coagulation state should be done regularly. All the patients received immunosuppressive therapy including cyclosporine or FK506 regimens and were followed up from 3 to 34 months. Hepatic artery of liver transplant patients was detected regularly by duplex ultrasound scan three or six months after discharge.

### Statistical methods

The Kaplan-Meier method was used to calculate survival rate, and statistical calculations for mean values and standard deviations were performed using the SPSS software package.

## RESULTS

The overall incidence of arterial complications in the 72 patients after OLTs was 1.4 % (1/72) and no HAT and hepatic artery stenosis were found after OLTs. A 3 cm anastomotic pseudoaneurysm of hepatic artery was found in 1 case by urgent arteriogram due to hemoperitoneum secondary to bile leakage about one month after OLT. The pseudoaneurysm at the side of anastomotic site of hepatic artery was successfully embolized, and blood flow toward the donor liver in hepatic artery remained. This patient was fully recovered and discharged one month later when bile leakage was stopped. The patient was doing well 1 year after OLT. The overall postoperative 30-day mortality rate was 8.33 % (6 deaths in 72 patients). The one-year survival rate was 83.72 % in 50 patients with benign diseases and was 71.43 % in 22 patients with malignant diseases after OLTs. No death occurred due to complications of hepatic artery.

## DISCUSSION

Vascular reconstructions are critical to a successful outcome

in orthotopic liver transplantation (OLT), complications associated with hepatic artery reconstructions are one of the major causes of graft loss and mortality after OLT. Hepatic artery complications after OLT include HAT, hepatic artery stenosis, hepatic artery pseudoaneurysm (HAP) and hepatic artery fistula. The early complications of hepatic artery were usually caused by technical problems<sup>[11-13]</sup>. The late complications of hepatic artery were usually associated with hypercoagulable state, over transfusion of platelets and fresh-frozen plasma during the surgery, severe rejection and bile leakage<sup>[11,18,19]</sup>. The hepatic artery is relatively small (3 to 6 mm in diameter in adults) during the vascular reconstructions of OLT with a very fragile intima that requires highly careful atraumatic manipulating technique during the reconstruction of hepatic artery. The anatomical variations<sup>[20-22]</sup>, diameter and length of hepatic artery, and injury to vessels including prolonged clamping of hepatic artery, kinking of a long artery, and hematoma of artery wall from improper flushing after clamping during operation, and the quality of recipient vessels and mismatch between donor and recipient arterial vessels should be carefully considered and managed preoperatively and intraoperatively<sup>[2,15]</sup>. The incidence of arterial complications after OLTs varied between 2 % and 25 % among the liver transplant patients<sup>[2]</sup>, HAT was most common<sup>[6,7]</sup>, and caused irreversible graft damage and often required immediate revascularization of hepatic artery, even retransplantation of the liver<sup>[12,13]</sup>. HAP occurred in less than 1 % patients after OLT<sup>[23,24]</sup>. The incidence of hepatic artery complications was low in this group. The technique of microsurgical hepatic artery reconstruction contributed greatly to the reduction of incidence of HAT and hepatic stenosis<sup>[6,15,25]</sup>. Current HAT rate reported after hepatic arterial reconstruction was 1.44 % via the branch patch technique using the hepatic-gastroduodenal bifurcation and interrupted suture of 7/0 monofilament polypropylene suture<sup>[6,20]</sup>. We found a single case of hepatic artery pseudoaneurysm whose opening was at the side of anastomotic site of hepatic artery as the complication following OLT and the pseudoaneurysm was embolized successfully. The reported incidence of pseudoaneurysm of hepatic artery was low, but this complication could be devastating with a high mortality rate due to massive bleeding that often required immediate revascularization<sup>[26,27]</sup>, and even retransplantation<sup>[12,13]</sup>. Extrahepatic pseudoaneurysms of hepatic artery were associated with local infection, bile leakage while intrahepatic pseudoaneurysms were caused by liver punctures<sup>[2,5]</sup>. The most frequent presentations of hepatic artery pseudoaneurysm were hemorrhages including gastrointestinal hemorrhage, hemoperitoneum and hemobilia<sup>[5,19]</sup>, which often occurred within the first two months after liver transplantation, and might lead to death due to massive bleeding or loss of the donor graft<sup>[5,28,29]</sup>. Although ultrasound and CT scanning were useful in the diagnosis of hepatic artery pseudoaneurysms<sup>[30-32]</sup>, arteriography was more accurate<sup>[10,33]</sup>, and might demonstrate clearly an anastomotic pseudoaneurysm of the hepatic artery with bleeding into peritoneum cavity or bile tract<sup>[23,29,33]</sup>. The treatment for hepatic artery pseudoaneurysm remains a challenging problem. The current treatment options include ligation or embolization, excision and immediate revascularization of hepatic arterial pseudoaneurysm with or without a donor iliac artery or autogenous saphenous vein, and retransplantation. However, ligation resulted in an extremely high morbidity and mortality<sup>[12,26,34,35]</sup>, especially at the early stage after liver transplantation. The excision and immediate revascularization of hepatic arterial pseudoaneurysm appeared to be the best choice<sup>[26,27]</sup>. At the time of revascularization, bile leakage should be also repaired<sup>[26]</sup>, and the donor iliac artery or autogenous saphenous vein was often used for arterial revascularization<sup>[34,35]</sup>. If an adequate donor

iliac artery or autogenous saphenous vein was not available, an autogenous radial artery could be used<sup>[36]</sup>. Embolization therapy of hepatic artery pseudoaneurysm after OLT was seldom reported. In our study, pseudoaneurysm at the side of the anastomotic site of hepatic artery was embolized successfully and the patency of the hepatic artery toward the donor liver remained, which salvaged the donor liver as well as the recipient by the mini-invasive percutaneous endovascular techniques. This case provides a good example of safe and effective approach in the management of pseudoaneurysm of hepatic artery, but more experience is expected.

## REFERENCES

- Turroni VS**, Alvira LG, Jimenez M, Lucena JL, Ardaiz J. Incidence and results of arterial complications in liver transplantation: experience in a series of 400 transplants. *Transplant Proc* 2002; **34**: 292-293
- Settmacher U**, Stange B, Haase R, Heise M, Steinmuller T, Bechstein WO, Neuhaus P. Arterial complications after liver transplantation. *Transpl Int* 2000; **13**: 372-378
- Sanchez-Bueno F**, Robles R, Acosta F, Ramirez P, Lujan J, Munitiz V, Rios A, Parrilla P. Hepatic artery complications in a series of 300 orthotopic liver transplants. *Transplant Proc* 2000; **32**: 2669-2670
- Stange B**, Settmacher U, Glanemann M, Nussler NC, Bechstein WO, Neuhaus P. Hepatic artery thrombosis after orthotopic liver transplantation. *Transplant Proc* 2001; **33**: 1408-1409
- Almogy G**, Bloom A, Verstandig A, Eid A. Hepatic artery pseudoaneurysm after liver transplantation. A result of transhepatic biliary drainage for primary sclerosing cholangitis. *Transpl Int* 2002; **15**: 53-55
- Proposito D**, Loinaz Seguro C, Garcia Garcia I, Jimenez C, Gonzalez Pinto I, Gomez Sanz R, De La Cruz J, Moreno Gonzalez E. Assessment of risk factors in the incidence of hepatic artery thrombosis in a consecutive series of 687 liver transplantations. *Ann Ital Chir* 2001; **72**: 187-205
- Abou Ella KA**, Al Sebayel MI, Ramirez CB, Rabea HM. Hepatic artery thrombosis after orthotopic liver transplantation. *Saudi Med J* 2001; **22**: 211-214
- Abou El-Ella K**, Al Sebayel M, Ramirez C, Hussien R. Outcome and risk factors of hepatic artery thrombosis after orthotopic liver transplantation in adults. *Transplant Proc* 2001; **33**: 2712-2713
- Pastacaldi S**, Teixeira R, Montalto P, Rolles K, Burroughs AK. Hepatic artery thrombosis after orthotopic liver transplantation: a review of nonsurgical causes. *Liver Transpl* 2001; **7**: 75-81
- Cavallari A**, Nardo B, Catena F, Montalti R, Cavallari G, Bellusci R, Golfieri R, Rossi C. Mini-invasive treatment of arterial and biliary complications after orthotopic liver transplantation. *Transplant Proc* 2001; **33**: 2001
- Leonardi LS**, Boin IF, Neto FC, de Oliveira GR, Leonardi MI. Biliary reconstructions in 150 orthotopic liver transplantations: an experience with three techniques. *Transplant Proc* 2002; **34**: 1211-1215
- Dudek K**, Nyckowski P, Zieniewicz K, Michalowicz B, Pawlak J, Malkowski P, Krawczyk M. Liver retransplantation: indications and results. *Transplant Proc* 2002; **34**: 638-639
- Bramhall SR**, Minford E, Gunson B, Buckels JA. Liver transplantation in the UK. *World J Gastroenterol* 2001; **7**: 602-611
- Zhao JC**, Lu SC, Huang FG, Yan LN, Li B, Jin LR, Wen TF, Wang J, Luo Y, Peng YL, Yuan ZX. Reconstruction of hepatic artery in orthotopic liver transplantation. *Zhongguo Xiandai Shoushuxue Zazhi* 2001; **5**: 24-26
- Zhao JC**, Huang FG, Lu SC, Yan LN, Li B, Jin LR, Wen TF, Wang J, Luo Y, Peng YL. Reconstructions of hepatic artery in orthotopic liver transplantation. *Zhonghua Qiguan Yizhi Zazhi* 2002; **23**: 37-39
- Lin M**, Crawford M, Fisher J, Hitos K, Verran D. Hepatic artery thrombosis and intraoperative hepatic artery flow rates in adult orthotopic liver transplantation. *ANZ J Surg* 2002; **72**: 798-800
- De Candia A**, Como G, Tedeschi L, Zanardi R, Vergendo M, Rositani P, Bazzocchi M. Color doppler sonography of hepatic artery reconstruction in liver transplantation. *J Clin Ultrasound* 2002; **30**: 12-17
- Bhattacharjya S**, Gunson BK, Mirza DF, Mayer DA, Buckels JA, McMaster P, Neuberger JM. Delayed hepatic artery thrombosis in adult orthotopic liver transplantation—a 12-year experience. *Transplantation* 2001; **71**: 1592-1596
- Hidalgo E**, Cantarell C, Charco R, Murio E, Lazaro JL, Bilbao I, Margarit C. Risk factors for late hepatic artery thrombosis in adult liver transplantation. *Transplant Proc* 1999; **31**: 2416-2417
- Proposito D**, Loinaz Seguro C, Garcia Garcia I, Jimenez C, Gonzales Pinto I, Gomez Sanz R, Moreno Gonzalez E. Role of anatomic variations and methods of hepatic artery reconstruction in the incidence of thrombosis following liver transplantation. *Ann Ital Chir* 2001; **72**: 303-314
- Gruttadauria S**, Foglieni CS, Doria C, Luca A, Lauro A, Marino IR. The hepatic artery in liver transplantation and surgery: vascular anomalies in 701 cases. *Clin Transplant* 2001; **15**: 359-363
- Jones RM, Hardy KJ**. The hepatic artery: a reminder of surgical anatomy. *J R Coll Surg Edinb* 2001; **46**: 168-170
- Marshall MM**, Mulesan P, Srinivasan P, Kane PA, Rela M, Heaton ND, Karani JB, Sidhu PS. Hepatic artery pseudoaneurysms following liver transplantation: incidence, presenting features and management. *Clin Radiol* 2001; **56**: 579-587
- Stange B**, Settmacher U, Glanemann M, Nuessler NC, Bechstein WO, Neuhaus P. Aneurysms of the hepatic artery after liver transplantation. *Transplant Proc* 2000; **32**: 533-534
- Egawa H**, Asonuma K, Sakamoto Y, Iwasaki M, Kim I, Tanaka K. Surgical techniques for vascular reconstruction of the portal vein and hepatic artery in living-donor liver transplantation. *Nippon Geka Gakkai Zasshi* 2001; **102**: 798-804
- Bonham CA**, Kapur S, Geller D, Fung JJ, Pinna A. Excision and immediate revascularization for hepatic artery pseudoaneurysm following liver transplantation. *Transplant Proc* 1999; **31**: 443
- Sellers MT**, Haustein SV, McGuire BM, Jones C, Bynon JS, Diethelm AG, Eckhoff DE. Use of preserved vascular homografts in liver transplantation: hepatic artery aneurysms and other complications. *Am J Transplant* 2002; **2**: 471-475
- Busenius-Kammerer M**, Ott R, Wutke R, Grunewald M, Hohenberger W, Reck T. Pseudoaneurysm of the hepatic artery—a rare complication after orthotopic liver transplantation. *Chirurg* 2001; **72**: 78-81
- Glehen O**, Feugier P, Ducerf C, Chevalier JM, Baulieux J. Hepatic artery aneurysms. *Ann Chir* 2001; **126**: 26-33
- Garcia-Criado A**, Gilabert R, Nicolau C, Real I, Arguis P, Bianchi L, Vilana R, Salmeron JM, Garcia-Valdecasas JC, Bru C. Early detection of hepatic artery thrombosis after liver transplantation by Doppler ultrasonography: prognostic implications. *J Ultrasound Med* 2001; **20**: 51-58
- Quiroga S**, Sebastia MC, Margarit C, Castells L, Boye R, Alvarez-Castells A. Complications of orthotopic liver transplantation: spectrum of findings with helical CT. *Radiographics* 2001; **21**: 1085-1102
- Katyal S**, Oliver JH 3rd, Buck DG, Federle MP. Detection of vascular complications after liver transplantation: early experience in multislice CT angiography with volume rendering. *Am J Roentgenol* 2000; **175**: 1735-1739
- Cavallari A**, Vivarelli M, Bellusci R, Jovine E, Mazziotti A, Rossi C. Treatment of vascular complications following liver transplantation: multidisciplinary approach. *Hepatogastroenterology* 2001; **48**: 179-183
- Zamboni F**, Franchello A, Ricchiuti A, Fop F, Rizzetto M, Salizzoni M. Use of arterial conduit as an alternative technique in arterial revascularization during orthotopic liver transplantation. *Dig Liver Dis* 2002; **34**: 122-126
- Meyer C**, Riehm S, Perrot F, Cag M, Nizand G, Audet M, Veillon F, Jaeck D, Wolf P. Donor iliac artery used for arterial reconstruction in liver transplantation. *Transplant Proc* 2000; **32**: 2791
- Rogers J**, Chavin KD, Kratz JM, Mohamed HK, Lin A, Baillie GM, Shafizadeh SF, Baliga PK. Use of autologous radial artery for revascularization of hepatic artery thrombosis after orthotopic liver transplantation: case report and review of indications and options for urgent hepatic artery reconstruction. *Liver Transpl* 2001; **7**: 913-917