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ORIGINAL ARTICLE

HEPATIC ARTERY RECONSTRUCTION IN LIVING DONOR LIVER TRANSPLANTATION; MICROSURGICAL APPROACH

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Abstract

Aim: Hepatic artery (HA) reconstruction is one of the crucial steps during the process of living donor liver transplantation (LDLT). The incidence of hepatic artery thrombosis has been reduced over the last few years by the introduction of microsurgical approach under high resolution microscope or loupe. In this study we investigate the incidence of hepatic artery thrombosis after introducing the microsurgical approach at our Liver Unit.

Methods: We report our experience in 25 cases of HA reconstruction in LDLT using graft-artery-unclamp and posterior-wall-first technique. HA reconstructions were done by specialized microsurgical surgeon.

Results: In our series there was no report of any case with HA thrombosis. The risk factors for failed procedures appeared to be reduced by participation of specialized microsurgical surgeon comparing to the results in the published data.

Conclusion: HA reconstruction without clamping the graft artery is a feasible and simplified technique. It should be done by specialized microsurgical surgeons this could be mastered by transplant surgeons in the future with plenty of microsurgical training.

Keywords: Living donor, liver transplantation, Microsurgery; Anastomosis, Hepatic artery.

INTRODUCTION

Hepatic artery (HA) reconstruction is one of the corner stone steps for living donor liver transplantation (LDLT).[1-4] Arterial complications, including thrombosis, stenosis and aneurysm formation, are life-threatening in LDLT by causing irreversible biliary damage and graft failure.[5] Due to the HA small vascular diameter, its arterial reconstruction was a major technical problem in LDLT until the introduction of microvascular anastomosis under high resolution surgical microscope or loupe.[6,7] The incidence of arterial thrombosis has been reduced dramatically from 25% without microscope[6] to 0%-3.8% with microscope.[8-10]

Nevertheless, the technical failure of the reconstruction usually leads to permenant biliary damage and retransplantation or even death.[11,12] The procedure is complicated by anatomical variation, vascular consistency.[13] It is essential to set up a specialised team and method to avoid technical failure as far as possible.

We report our experience in 25 cases of HA reconstruction in LDLT. We set up our technique of HA reconstruction without clamping the donor's artery, which were carried out by specialized microsurgical surgeon.

PATIENTS AND METHODS

Donors and Recipients: Between October 2008 – October 2010, 25 LDLTs were performed at Liver Unit, Al Zahraa University Hospital. Ethical committee approval was obtained for this work. Both patient and donor had signed a consent form.

All the cases were operated by the same surgical team and HA reconstructions were done by the same specialized microsurgical surgeon. 24 recipients were adult right lobe graft without middle hepatic vein and one recipient had left liver graft. Recipients have follow up at the outpatient clinic with HA assessment until April 2011. 23 recipients are males and two are females. The average age of the recipients was 46.2 years (range 29 - 59 years). The underlying liver pathology for the recipients was: hepatitis C virus (HCV) related cirrhosis (n=24) and one patient had primary sclerosing cholangitis. Out of the 24 HCV related cirrhotic recipient 10 had hepatocellular carcinoma (HCC). (Table 1)

Estimated graft volume to recipient body weight ratio was assessed by CT-based graft volume to recipient body weight (Toshiba Aquilion 64 CT Scanner, Japan). Graft weight to recipient body weight ratio was not to be lower than 0.8%. The remaining donor liver volume should be more than 30%-35%. CT angiography was performed to evaluate the anatomy of the donor's HA (Fig. 1).[14,15]

Surgical Technique: Hepatic arterial reconstruction was performed under the optical field of continuous zoom magnification (8x) with an operating microscope (Zeiss; OPMI PICO, Germany).

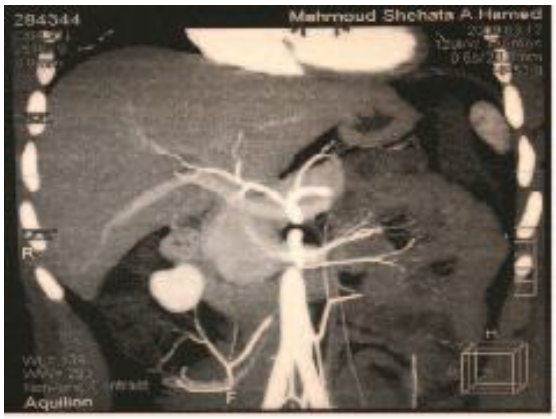

Fig 1. CT arterioghraphy as preoperative assessment for the hepatic artery in living donor (transplant procedure No. 5).

The recipient's operation was 60 min preceded by donor's operation, in which a careful inspection of hepatic volume, hilar structures and venous outflow. Thereafter, both donor and recipient's procedures would proceed simultaneously by two surgical teams. Usually the completion of the graft harvesting and recipient hepatectomy could reach perfect timing which leads to shortening the time of graft ischemia (cold ischemia time). We start reconstruction of the HA after completion of the hepatic vein and portal vein anastomsis. The reconstruction of HA was completed by specialized microsurgical surgeon. We selected the most appropriate branches of recipient's HA according to the following guidelines: the HA quality, the amount of outflow, matching of diameters, and reciprocal stump location.[6] A single microvascular clamp was placed on the recipient arterial stump after good arterial flow was confirmed. The donor's artery was remained free

Table 1. Recipient data who underwent LDLT between October 2008 – October 2010 (n=25).

Recipient Data	Maximum	Minimum	Average
Age (years)	55	29	45
Body weight (Kg)	92	61	77
Graft weight (gm)	1100	700	912
Operative time (h)	11	6	8
Cold ischemia time (m)	90	45	53
Warm ischemia time (m)	70	35	47
ICU stay (days)	14	5	8
Hospital stay (days)	42	20	24
Follow up (months)	30	6	16

(**Kg**) Kilo grams, (**gm**) grams, (**h**) hours, (**m**) minute.

without clamping as the main target of this work is to keep the donor hepatic artery stump unclamped (illustration 1A), and a back flow would be found from the portal inflow graft. The back flow was continuously washed by using a syringe with heparanized saline and a fine sucker. The donor and recipient arteries were anastomosed in an end-to-end manner with interrupted sutures using 8-0 monofilament polypropylene sutures (illustration 1). The anastomosis was started with a central stitch on the posterior wall, with the knot tied on the outside (illustration 1B).[6] The sutures were advanced by either side adjacent to the previous suture (illustration 1C), until the entire suture of the posterior wall was completed (illustration 1D). The stitching for the anterior wall was performed in the similar manner, however, going through each vessel wall consecutively (illustration 1E).

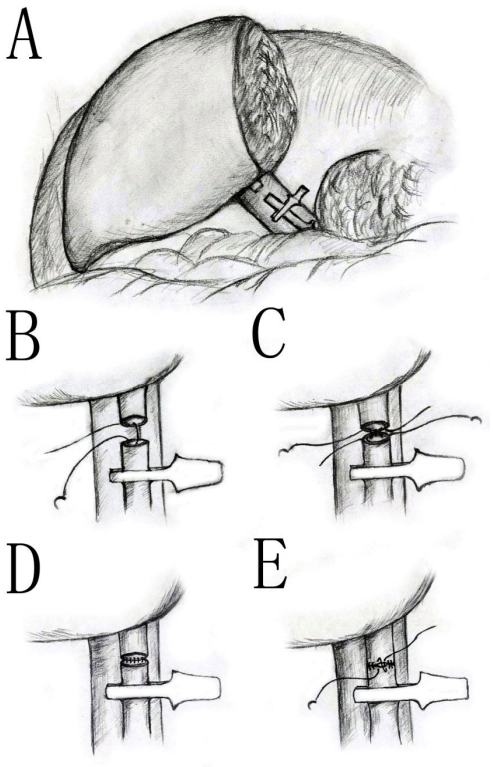

Illustration 1. Microsurgical technique for hepatic artery reconstruction in living donor liver transplant.

The two penultimate stitch ends were left untied so that the last stitch could be inserted accurately. When there was a discrepancy in diameter of the arteries, the discrepancy was gradually taken up with individual stitching. In this technique we did not use any haemostatic material like surgicell as it might perform a heamatoma later on and jeopardized the follow in the HA. However, additional stitches were performed when there were apparent interspaces between each stitch causing a leak. Frequent heparinized saline (25 U/mL) was irrigated throughout the procedure to allow clear visualization of the vascular wall, thereby the persistent backflow from the donor arterial end did not affect the reconstruction.

Doppler ultrasonography (DUS) (Esaote My Lab50 X Vision, Italy) to assess the velocity of the hepatic artery flow and resistance index (RI), was performed immediately after the completion of the arterial reconstruction. DUS assessment was repeated after biliary reconstruction and before abdominal closure to inspect the patency of the anastomosis. Intensive monitoring by DUS was done twice a day for the first post-transplant week. Post-transplant HA assessment continues on daily basis for the next two weeks (Fig. 2). In long term assessment CT arteriography might be used to assess the anastomotic site if there a suspicion of stenosis (Figs. 3a,b).

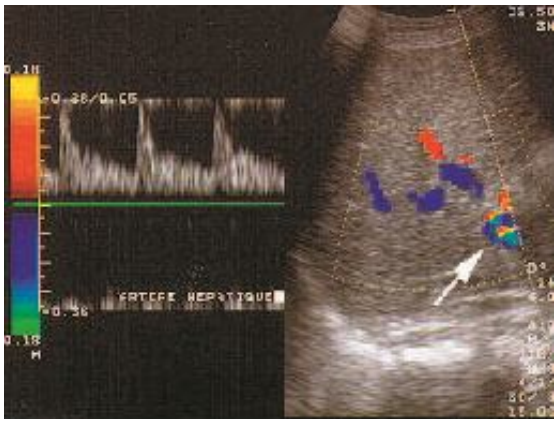

Fig 2. DUS assessment of the intrahepatic part of hepatic artery post LDLT (recipient) (transplant procedure No. 11).

Fig 3a. CT arteriography in LDLT (recipient) showed normal patency of the anastomotic site (arrow). (Transplant procedure No. 7).

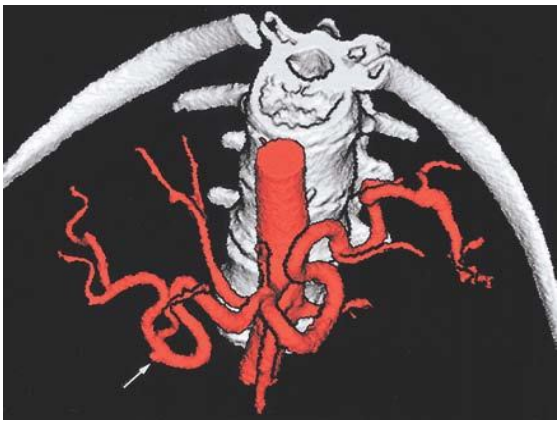

Fig 3b. CT arteriography (recipient), reconstructive image (shaded surface display) showed normal hepatic graft arterial supply and normal anastomotic site (antro-superior view) (arrow) (transplant procedure No. 7).

RESULTS

Anatomical Data: The anatomy of the donor HA was identified according to the Takatsuki et al. classification based on the orifices of the HA.[9] All liver grafts had a single orifice (n=25), of them, single orifice without aberrant artery (n=23) and single orifice with aberrant artery (n=2).

Clinical Outcome: The graft HA was anastomosed to the recipient RHA in 17 cases. Three graft arteries were anastomosed with LHA, one with middle hepatic artery (MHA), 4 with common hepatic artery. The mean diameter of the graft artery was 2.4±0.8 mm (range, 1-4 mm), similar to previous reports.[16-18] The intraoperative maximum velocity of the HA was 43.3±16.1 cm/s and resistance index was 0.64±0.12 by Doppler ultrasound. We followed these recipients for average period of 16 months (range 30-6 months).

Complications: In our series there was no report of hepatic artery thrombosis. However, during the HA artery reconstruction we reported arterial angulation (n=2) and corrected during the procedure. There was also one recipient right hepatic artery with intimal dissection which required re-anastomosis during the operation. This dissection was in the recipient right hepatic artery as this recipient was diagnosed pre transplant with HCC in segment VII. This recipient underwent Targeted Arterial Chemoembolisation through the right hepatic artery using a microcatheter which might cause injury of arterial intima. During the period of follow up we reported one case with arterial stricture after 9 months (Fig. 4) and it did not require any surgical intervention.

Fig 4. CT arteriography (oblique view) showed liver graft artery stenosis (recipient) at the anastomotic site (white dote). (Transplant procedure No. 2).

DISCUSSION

In LDLT microvascular reconstruction of the HA is extremely challenging because of the narrow caliber, suboptimal visualization, donor-recipient discrepancy and intimal dissection.[19,20] Several techniques had been attempted at aim to improve the success rate.[21-23]

As reported by many transplant centers,[24,25] paired microvascular clips are applied to both donor and recipient's arteries before suture, which start from the anterior wall then to the posterior by turnover. The paired clamping could provide a flat and bloodless vision; however, it has some disadvantages. The arterial stumps in the liver graft are usually short in length, and vulnerable in consistence, clamping would exacerbate the situation of intimal dissection.[26,27] Turnover of the paired clips for reestablishing the posterior wall might lacerate the intima.[23] When there is a branch arising from the RHA to segment IV, the RHA has to be disconnected distal to the branch. In such circumstance, the arterial orifice is considerably close to the graft parenchyma, and there is no space for placing a clamp at the graft side.[22]

We completed all the hepatic arterial reconstruction after portal reperfusion, leaving the graft artery unclamped.[28] We found there would be small amount of back flow from the graft artery by intrahepatic communication with the portal system, but it was slow and negligible during the procedure.[29] Keeping the best distance, depth and direction of the two arterial ends was the key step for subsequent suture, even more important than suture itself. It was achieved by adjusting the recipient's hepatoduodenal ligament by an experienced left hand from the assistant. Particularly for the first 3 stitches, stable and flexible control of the recipient artery was the base for a promising reconstruction. Intensive training for this procedure under the surgical microscope would help to master the technique.

Hepatectomy of the recipient's liver in LDLT requires elaborative dissection of the portal structure in a close-to-hilum fashion, to ensure sufficient length and appropriate arterial caliber for reconstruction. Sharp dissection instead of electronic coagulation adjacent to the vessel is recommended. All HA branches were disconnected as close as possible to the hepatic hilum in order to keep sufficient length and appropriate size for arterial anastomosis. This calls for transplant surgeons who have an intimate knowledge of microsurgical arterial reconstruction to avoid traumatic manipulation to the recipient's artery.

Surgeons would take more concern to the HA during liver resection if they have detailed insight into the procedure of HA reconstruction thereafter.

In conclusion, by these 25 cases of experience and lessons, we found that hepatic artery reconstruction without clamping the graft artery is a feasible and simplified technique. In this technique we did not need to turn over the anastomosis to place stitches in the posterior wall like the usual microsurgical approach. In grafts with short arterial stump, the procedure went easily as there is no need to clamp this stump comparing to the ordinary microsurgical technique.

We believe that HA reconstruction in living donor liver transplant without clamping the graft artery could be mastered by transplant surgeons with plenty of microsurgical training.

REFERENCES

1. Turrión 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;34:292–93.

2. Uchiyama H, Hashimoto K, Hiroshige S, Harada N, Soejima Y, Nishizaki T, et al. Hepatic artery reconstruction in living-donor liver transplantation: a review of its techniques and complications. Surgery. 2002;131:S200–S204.

3. Wei WI, Lam LK, Ng RW, Liu CL, Lo CM, Fan ST, Wong J. Microvascular reconstruction of the hepatic artery in live donor liver transplantation: experience across a decade. Arch Surg. 2004;139:304–07.

4. Sheiner PA, Varma CV, Guarrera JV, Cooper J, Garatti M, Emre S, Guy SR, Schwartz ME, Miller CM. Selective revascularization of hepatic artery thromboses after liver transplantation improves patient and graft survival. Transplantation. 1997;64:1295–99.

5. Broelsch CE, Frilling A, Testa G, Cicinnati V, Nadalin S, Paul A, et al. Early and late complications in the recipient of an adult living donor liver. Liver Transpl. 2003;9:S50–S53.

6. Yi Yang, Lu-Nan Yan, Ji-Chun Zhao, Yu-Kui Ma, Bin Huang, et al. Microsurgical reconstruction of hepatic artery in A-A LDLT: 124 consecutive cases without HAT. World J Gastroenterol. 2010;16:2682–88.

7. Mori K, Nagata I, Yamagata S, Sasaki H, Nishizawa F, Takada Y, et al. The introduction of microvascular surgery to hepatic artery reconstruction in living-donor liver transplantation--its surgical advantages compared with conventional procedures. Transplantation. 1992;54:263–68.

8. Broelsch CE, Whitington PF, Emond JC, Heffron TG, Thistlethwaite JR, Stevens L, et al. Liver transplantation in children from living related donors. Surgical techniques and results. Ann Surg. 1991;214:428.

9. Takatsuki M, Chiang YC, Lin TS, Wang CC, Concejero A, Lin CC, et al. Anatomical and technical aspects of hepatic artery reconstruction in living donor liver transplantation. Surgery 2006;140:824-29.

10. Goldstein MJ, Salame E, Kapur S, Kinkhabwala M, LaPointe-Rudow D, Harren NPP, et al. Analysis of failure in living donor liver transplantation: differential outcomes in children and adults. World J Surg. 2003;27:356.

11. Matsuda H, Yagi T, Sadamori H, Matsukawa H, Shinoura S, Murata H, et al. Complications of arterial reconstruction in living donor liver transplantation: a single-center experience. Surg. Today. 2006;36:245–51.

12. Pomposelli JJ, Verbesey JE, Simpson MA, Morin DS, Gordon FD, Lewis WD, Jenkins RL, Pomfret EA. Hepatic artery thrombosis after live donor adult liver transplantation (LDALT) using right lobe grafts. Transplantation. 2006;82:705–6.

13. Ikegami T, Hashikura Y, Nakazawa Y, Urata K, Mita A, Ohno Y, et al. Risk factors contributing to hepatic artery thrombosis following living-donor liver transplantation. J Hepatobiliary Pancreat Surg. 2006;13:105–9.

14. Byun JH, Kim TK, Lee SS, Lee JK, Ha HK, Kim AY, et al. Evaluation of the hepatic artery in potential donors for living donor liver transplantation by computed tomography angiography using multidetector-row computed tomography: comparison of volume rendering and maximum intensity projection techniques. J Comput. Assist Tomogr. 2003;27:125.

15. Sahani D, Mehta A, Blake M, Prasad S, Harris G, Saini S. Preoperative hepatic vascular evaluation with CT and MR angiography: implications for surgery. Radiographics. 2004;24:1367.

16. Okazaki M, Asato H, Takushima A, Nakatsuka T, Sarukawa S, Inoue K, et al. Hepatic artery reconstruction with double-needle microsuture in living-donor liver transplantation. Liver Transpl. 2006;12:46.

17. Haberal M, Sevmis S, Karakayali H, Moray G, Yilmaz U, Ozcay F, et al. A novel technique for hepatic arterial reconstruction in living-donor liver transplant. Exp. Clin. Transplant. 2007;5:585.

18. Someda H, Moriyasu F, Fujimoto M, Hamato N, Nabeshima M, Nishikawa K, Okuma M, Tanaka K, Ozawa K. Vascular complications in living related liver transplantation detected with intraoperative and postoperative Doppler US.J Hepatol. 1995;22:623–32.

19. Luo Y, Fan YT, Lu Q, Li B, Wen TF, Zhang ZW. CEUS: a new imaging approach for postoperative vascular complications after right-lobe LDLT. World J Gastroenterol. 2009;15:3670–75.

20. Inomoto T, Nishizawa F, Sasaki H, Terajima H, Shirakata Y, Miyamoto S, Nagata I, Fujimoto M, Moriyasu F, Tanaka K, et al. Experiences of 120 microsurgical reconstructions of hepatic artery in living related liver transplantation. Surgery. 1996;119:20–6.

21. Ikegami T, Nishizaki T, Uchiyama H, Hashimoto K, Yanaga K, Sugimachi K. Doubly-armed short sutures are useful for microsurgical hepatic artery reconstruction in living-related liver transplantation. Hepatogastroenterology. 2000;47:1103–4.

22. Miyagi S, Enomoto Y, Sekiguchi S, Kawagishi N, Sato A, Fujimori K, Satomi S. Microsurgical back wall support suture technique with double needle sutures on hepatic artery reconstruction in living donor liver transplantation. Transplant Proc. 2008;40:2521–2.

23. Alper M, Gundogan H, Tokat C, Ozek C. Microsurgical reconstruction of hepatic artery during living donor liver transplantation. Microsurgery. 2005;25:378–83; discussion 383-4.

24. Hwang S, Lee SG, Lee YJ, Sung KB, Park KM, Kim KH, et al. Lessons learned from 1,000 living donor liver transplantations in a single center: how to make living donations safe. Liver Transpl. 2006;12:920–7.

25. Coelho GR, Leitao AS Jr, Cavalcante FP, Brasil IR, Cesar-Borges G, Costa PE, et al. Continuous versus interrupted suture for hepatic artery anastomosis in liver transplantation: differences in the incidence of hepatic artery thrombosis. Transplant Proc. 2008;40:3545–7.

26. Katz E, Fukuzawa K, Schwartz M, Mor E, Miller C. The splenic artery as the inflow in arterial revascularization of the liver graft in clinical liver transplantation. Transplantation. 1992;53:1373–4.

27. Ikegami T, Kawasaki S, Hashikura Y, Miwa S, Kubota T, Mita A, et al. An alternative method of arterial reconstruction after hepatic arterial thrombosis following living-related liver transplantation. Transplantation. 2000;69:1953–5.

28. Kalayoglu M, Belzer FO. A new technique for arterialization of the hepatic graft. Surg. Gynecol Obstet. 1987;164:564–7.

29. Ahn CS, Lee SG, Hwang S, Moon DB, Ha TY, Lee YJ, et al. Anatomic variation of the right hepatic artery and its reconstruction for living donor liver transplantation using right lobe graft. Transplant Proc. 2005;37:1067–9.