Transplant International ISSN 0934-0874

ORIGINAL ARTICLE

Microsurgical hepatic artery reconstruction during living-donor liver transplantation by using head-mounted surgical binocular system

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Keywords
hepatic artery reconstruction, living-donor liver transplantation, microsurgery, surgical telescope.

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Received: 25 April 2007
Revised requested: 29 May 2007
Accepted: 18 June 2007

doi:10.1111/j.1432-2277.2007.00525.x

Summary

We have described our experience with arterial reconstruction during living-donor liver transplantation by using Varioscope® AF3 – a head-mounted surgical binocular system with automatic focusing and continuous zoom magnification from 3.6× to 7.2×. From July 1996 to December 2006, 91 grafts were implanted in 89 living-donor liver transplantation recipients, including two that required retransplantation. For microsurgical reconstruction of the graft hepatic artery, a conventional operating microscope was used in the first 10 transplants and Varioscope, in the subsequent 81. The time required to complete arterial reconstruction while using a conventional operating microscope and Varioscope was 78.6 ± 44.6 min and 35.5 ± 15.5 min, respectively. No arterial complications, including hepatic artery thrombosis, occurred in any of the 89 patients during the observation period. In living-donor liver transplantation, successful hepatic artery reconstruction can be safely carried out using Varioscope.

Introduction

Hepatic artery thrombosis after liver transplantation is a life-threatening event and is associated with high mortality. It has been reported that the incidence of hepatic artery thrombosis varies widely (approximately 2–15%); however, because of recent technical advances, it has generally decreased, even in the case of split liver transplantation or living-donor liver transplantation [1–7]. One of the most important advances in hepatic artery reconstruction is the introduction of microsurgical techniques involving an operating microscope. Generally, a conventional operating microscope comprising a binocular head, counterbalanced pantographic arm, and floor stand is used for microsurgical hepatic artery reconstruction. However, this type of operating microscope has certain drawbacks: it is bulky, requires tilting, and presents difficulties for focusing in the abdominal cavity. As a substitute for this device, we used Varioscope® AF3 (Varioscope; Life Optics®, Vienna, Austria) – a head-mounted surgical binocular system with automatic focusing and continuous zoom magnification from 3.6× to 7.2×. It is operated using a footswitch and can provide a wide field of view at any working distance (300–600 mm) and any magnification (Fig. 1). Here, we describe our experience of hepatic artery reconstruction by using Varioscope in a series of 91 living-donor liver transplantations for 89 adult patients; we have focused on the microsurgeon's perspective.

Patients and methods

Patient population

From July 1996 to December 2006, 91 grafts were implanted in 89 living-donor liver transplantation recipients

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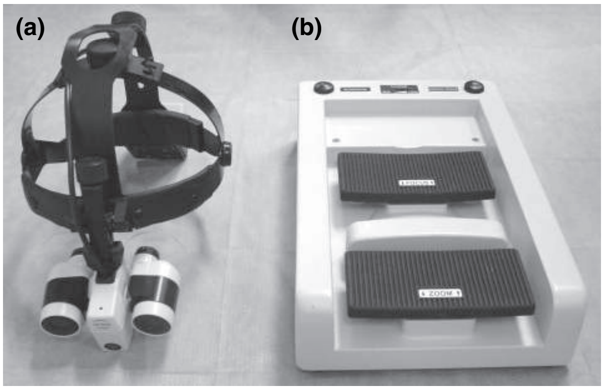

Figure 1 The Varioscope® AF3 is a head-mounted surgical telescope with automatic focusing and continuous zoom magnification from 3.6× to 7.2× that can be operated using a footswitch. This device refocuses if the working distance changes, and the surgeon has almost unlimited mobility without any corresponding loss of sharpness in the obtained three-dimensional images. (a) Head-mounted surgical telescope. (b) Footswitch for focusing and zoom magnification.

comprising 52 men and 37 women whose age ranged from 20 to 69 years (mean age 50). The indications for living-donor liver transplantation included hepatitis virus-related cirrhosis in 52 patients, cholestatic liver disease including primary biliary cirrhosis and autoimmune hepatitis in 14, fulminant hepatitis in 10, retransplantation in two, and others in 13. Of 41 patients with hepatocellular carcinoma, 22 had a history of transcatheter arterial chemoembolization prior to living-donor liver transplantation. The types of liver grafts included those of the right liver lobe (n = 72), left liver lobe (n = 18), and right lateral sector (n = 1).

Surgical technique

Prior to microsurgical hepatic artery reconstruction, the implanted graft was reperfused in the recipients after the portal veins were reconstructed [8]. For microsurgical reconstruction of the graft hepatic artery, a conventional operating microscope was used for the first 10 transplants and Varioscope, for the subsequent 81. The recipient artery was selected according to its patency, extent of intimal damage, and caliber consistency with the graft artery caliber. End-to-end vessel anastomosis was carried out between the recipient and graft hepatic arteries with interrupted 8-0 monofilament nylon sutures. In all 91 implants, we used microvascular double clamp type A-II comprising two bulldog clamps fitted to a sliding bar; it can be used to anastomose vessels of diameters ranging from 0.5 to 5.0 mm without injuring the vessel wall (Fig. 2) [9]. After reconstruction, the intrahepatic arterial signals were verified using color Doppler ultrasonography. Postoperative anticoagulation management was carried out via heparin infusion (the target activated clotting time was 150–200 s for 2 weeks). To determine the adequacy of blood flow and velocity during the first two post-transplant weeks, color flow Doppler ultrasound was performed daily, on alternate days in the third week, and once a week thereafter until discharge.

Results

The details and sizes of the graft/recipient hepatic arteries used for anastomosis are shown in Tables 1 and 2. Double arterial reconstructions were performed in three transplant patients. In one of the right lobe grafts, the

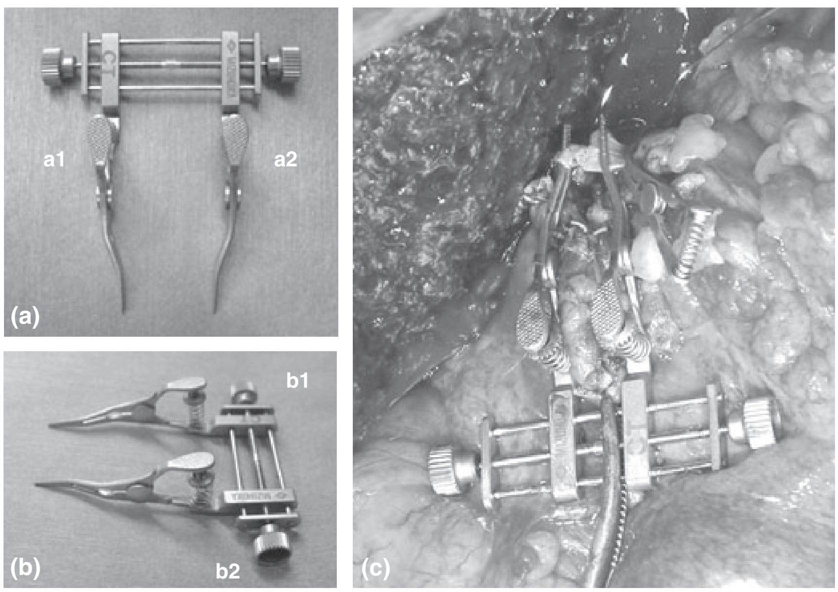

Figure 2 The microvascular double clamp type A-II device comprising 4.2 cm long bulldog clamps and weighing 17 g. By rotating b1 or b2, the distance of the two tips can be freely adjusted from 0 to 25 mm. By rotating a1 and a2, the pressure required to open the tips can be adjusted from approximately 40–250 g. (a) Frontal view. (b) Oblique view. (c) Use of the device during end-to-end anastomosis of the hepatic artery for living-donor liver transplantation with a right lobe.

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Table 1. Details of graft/recipient hepatic arteries anastomosed.

Graft	Recipient	No
Right lobe graft		
RHA	RHA	60
RHA	LHA	7
RHA	CHA	2
RHA	Paramedian branch b of RHA	2
Lateral branch of RHA	Lateral branch of RHA	2
Paramedian branch b of RHA	Paramedian branch of RHA	1
Paramedian branch b of RHA	LHA	1
Left lobe graft		
LHA	LHA	13
LHA	RHA	4
LHA	CHA	1
MHA	RGEA	1
Total		94

RHA, right hepatic artery; CHA, common hepatic artery; LHA, left hepatic artery; RGEA, right gastroepiploic artery; MHA, middle hepatic artery.

Table 2. Diameters of hepatic arteries anastomosed (n = 94).

Diameters	Graft	Recipient
2 mm and less	42 (44.7)	26 (27.7)
2–3 mm	39 (41.9)	48 (51.1)
Over 3 mm	13 (13.8)	20 (21.3)
Mean	2.72 mm	2.92
SD	0.95 mm	0.75

Values indicated in parentheses are percentage.

paramedian and lateral branches of the donor's right hepatic artery were anastomosed to those of the recipient's right hepatic artery, respectively. In another right lobe graft, these branches were anastomosed to the recipient's left and right hepatic arteries, respectively. In one of the left lobe grafts, the left hepatic artery and middle hepatic artery were anastomosed to the recipient's left hepatic artery and right gastroepiploic artery, respectively. Vascular interposition grafts were not used in this series.

Figure 3 shows the chorographical comparison of the time required to complete arterial reconstruction. Overall, the time required for hepatic artery reconstruction by using a conventional operating microscope and Varioscope was 78.6 ± 44.6 min (n = 10) and 35.5 ± 15.5 min (n = 81), respectively. All the anastomoses were patent and yielded a 100% patency rate. Twenty-six patients died postoperatively of multiple organ failure, sepsis, recurrence of hepatic tumor, and chronic rejection. However, arterial complications did not develop even in these 26 patients. In the remaining 63 (74.2%) patients, the hepatic artery anastomoses remained patent during a mean follow-up period of 28.7 ± 19.4 months. Thus, no arterial complications, including hepatic artery thrombosis and hepatic artery stenosis, occurred in any of the 89 patients during the observation period.

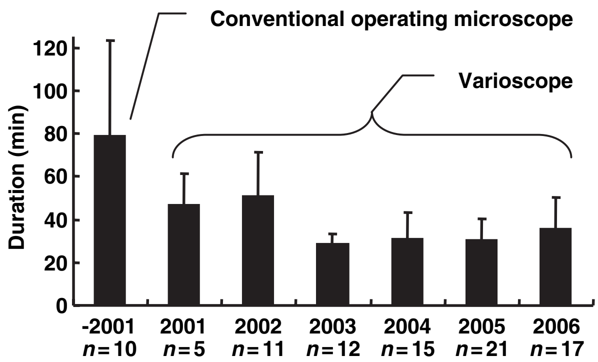

Figure 3 Chorographical comparison of the time required to complete arterial reconstruction. Average values ± SD in each year from 1996 to 2006 are shown.

Discussion

The introduction of microsurgical techniques in living-donor liver transplantation has resolved the problem associated with the high risk of hepatic artery thrombosis, enabled the reconstruction of arteries of different calibers, and reduced the incidence of arterial complications because of the delicate manipulation required in living-donor liver transplantation. The widely used operating microscope, which needs to be covered with a sterile plastic bag and adjusted depending on the operator's position, provides an operating field of view at a certain prefixed angle (usually a vertical view) but does not allow the operating field to be viewed sideways. This takes time and occasionally causes difficulties in the precise observation of the hepatic artery intima that are sequestered by the outer tunica. An additional problem is the movement of the vessels due to ventilation; the upper abdominal organs together with the recipient artery move in accordance with ventilation. During suturing performed with the aid of an operating microscope, it is occasionally difficult to adjust continuously the operative field of view. Therefore, when required, respiration needs to be withheld during suture placement. Because of this inconvenience, high-power surgical loupes are sometimes preferred to operating microscopes. It has been reported that microvascular hepatic artery reconstruction with 4× or 6× loupe magnification can yield results as good as those obtained with an operating microscope [10,11]. We employed the Varioscope – a device that is more sophisticated than surgical loupes; this instrument combines a miniature high-end microscope with a flexible head-

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mounted system. The Varioscope can simply be mounted on the head, thereby saving setup time. It enables the surgeon to easily adapt to the motion of the operative field due to respiration. Temporary termination of artificial respiration to prevent motion of the operative field was not required when the Varioscope was used.

Previously, a liver graft with a fine hepatic artery of diameter <2 mm was regarded as a risk factor for hepatic artery thrombosis. As shown in Table 2, approximately 45% of the graft hepatic arteries and 28% of the recipient hepatic arteries were of diameter ≤2 mm. Our procedure using Varioscope enables the reconstruction of such relatively small arteries. Microvascular double clamp type A-II was used in most transplants in the present series. Both ends of the graft and recipient hepatic arteries were immobilized using the clamps, and the distance between the tips of the two clamps was adjusted such that the ends of the arteries were in contact. After the anterior wall of the hepatic artery had been anastomosed using interrupted sutures, the double clamp was rotated, and the posterior wall was then similarly anastomosed. In two cases wherein the graft hepatic artery was short, we employed the posterior-wall-first anastomotic technique using smaller single-clamp devices. In this technique, microsutures are first placed in the posterior wall of the vessel, and turning over of the microclamp is thereby eliminated; it is known to have significant advantages for such short hepatic artery reconstruction in living-donor liver transplantation [6]. For both anastomotic techniques, Varioscope could provide sufficient magnification at an appropriate working distance. Although vascular interposition grafts for hepatic artery reconstruction were not used in this series, they may be occasionally required when a suitable recipient's artery is not available for reconstruction [12,13]. The utility of the Varioscope in such cases remains to be tested.

In conclusion, we have described our experience with the successful use of Varioscope for arterial reconstruction in living-donor liver transplantation, instead of using a convectional microscope that has positioning and tilting problems.

Authorship

HO and HT performed hepatic artery reconstruction; HO, HT, KI, KI, MS, TI, MO, HT, TI and TA performed recipient transplantation; TI and T.A performed donor hepatectomy; HO analyzed the data and wrote the paper.

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