

## The Reconstruction of Hepatic Arteries Using Extra-Anatomical Free Autografts in Living Donor Liver Transplantation

Shigehito Miyagi\*, Kenji Shimizu, Koji Miyazawa, Yuta Kakizaki, Atsushi Fujio, Yasuyuki Hara, Chikashi Nakanishi, Hitoshi Goto, Takashi Kamei, Naoki Kawagishi, Noriaki Ohuchi, and Susumu Satomi

Division of Transplantation, Tohoku University, Japan

\*Corresponding author: Shigehito Miyagi, Division of Transplantation, Upper Digestive and Vascular Surgery, Tohoku University, 1-1 Seiryomachi, Aoba-ku, Sendai 980-8574, Japan, Tel No: +81-22-717-7214; Fax No: +81-22-717-7217; E-mail: [msmsmiyagi@yahoo.co.jp](mailto:msmsmiyagi@yahoo.co.jp)

Received date: December, 31 2015; Accepted date: February, 19 2016; Published date: February, 26 2016

Copyright: © 2016 Miyagi S et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

### Abstract

**Objectives:** In living-donor liver transplantation (LDLT), microsurgical reconstruction of a hepatic artery is essential but requires challenging techniques, because graft arteries are short and usable vessel grafts are limited. Furthermore, hepatic artery thrombosis can be a lethal complication. Extra-anatomical jump graft reconstruction using free grafts is reported to have a high reocclusion rate. However, this technique is necessary when there is no other option. We report 4 cases of LDLT that required extra-anatomical reconstruction technique using free autografting from the aorta to the hepatic artery. In this technique, we used the systemic administration of gabexate mesilate that is the strong serine protease inhibitor.

**Methods:** From 1991 to 2015, we performed 164 LDLTs. We retrospectively investigated 4 cases of extra-anatomical reconstruction of the hepatic artery using free autografting from the aorta to the hepatic artery.

**Results:** Two cases initially underwent anatomical reconstruction, but the arteries occluded early, because of the dissection of recipient's artery. There was no arterial graft, so we performed extra-anatomical reconstruction by using free autografting from the aorta to the hepatic artery. In the other two cases, the recipient arteries could not be used. Therefore, we initially performed extra-anatomical reconstruction by using radial artery free autografting as jump grafts from the aorta to the hepatic artery. In all cases, we used the systemic administration of gabexate mesilate, and could rescue all cases.

**Conclusion:** We experienced and were able to salvage 4 cases that required free autografts. When there is no other means of reconstructing arteries, it is necessary to perform this procedure, depending on the condition of the intima of the recipient artery.

**Keywords:** Extra-anatomical reconstruction; Free autograft; Microsurgery; LDLT

### Abbreviations:

Aspartate Transaminase (AST); Alanine Transaminase (ALT)

### Introduction

Microsurgical reconstruction of a hepatic artery is essential but requires challenging techniques in living-donor liver transplantation (LDLT), because the recipient artery is located deep in the abdominal cavity, and the operating field is limited [1, 2]. Compared with cadaveric donor liver transplantation, LDLT is difficult owing to the short hepatic artery, severe intimal damage, and limited usable vessel grafts. Furthermore, hepatic artery thrombosis (HAT) can be a lethal complication. To avoid these difficulties, we used the back-wall support suture technique with double needle sutures, which reportedly has a protective effect on the intima [3, 4]. However, in LDLT, there may be cases in which it is difficult to reconstruct the arteries, such as with dissection of the recipient common hepatic artery or median arcuate ligament syndrome (MALS), even using this technique.

On the other hand, extra-anatomical jump graft reconstruction using free grafts is reported to have a high reocclusion rate [5]. However, when recipient hepatic arteries cannot be used as inflow arteries, and there is no other option, it is necessary to perform such grafts [5]. In LDLT, in particular, usable vessel grafts are limited, so it is necessary to perform this procedure by using free autografts. We recently experienced 4 cases of LDLT that required extra-anatomical jump graft reconstruction using free autografts from the aorta to the hepatic artery. In this technique, we used the systemic administration of gabexate mesilate that is the strong serine protease inhibitor. It was often effective on treatments of disseminated intravascular coagulation (DIC) and preservation of the intima. We were able to salvage 4 cases, which we report here.

### Patients and Methods

Informed consent was obtained from both the recipient's parents and the donors. All procedures were reviewed and approved by the Ethics Committee of the Tohoku University School of Medicine and were performed in accordance with the ethical standards of the Declaration of Helsinki.

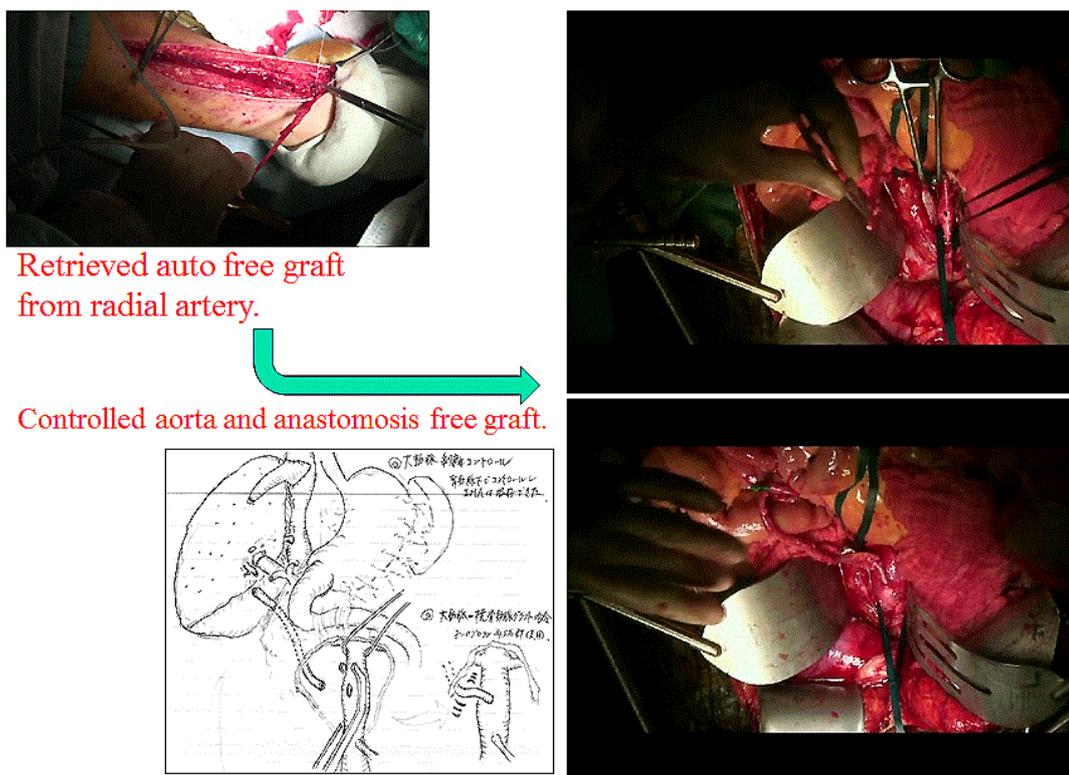
From 1991 to 2015, we performed 164 LDLTs (pediatric:adult = 92:72, left lobe: right lobe = 97:67). We report the cases of 4 patients

requiring extra-anatomical reconstruction of the hepatic artery using free autografts from the aorta to the hepatic artery; we investigated these cases retrospectively.

Briefly, we first controlled the abdominal aorta at the level of the infrarenal arteries. If the wall of the abdominal aorta was usable, we were able to perform the procedure. The lumbar arteries were ligated for safety. The radial artery autograft was retrieved from the forearm (over 15 cm). We perforated the wall of the aorta, and performed an anastomosis of the free graft to the aorta using a microsurgical interrupted suture technique.

Then we confirmed that blood inflow was sufficient. After that, we performed an anastomosis of the free graft to the hepatic artery using a microsurgical interrupted suture technique (Figure 1). Each stitch was placed from the inner side of the arterial wall to the outer side with double needle sutures to protect the intima of arteries. Then we used the systemic administration of gabexate mesilate that is the strong serine protease inhibitor at full dose (40mg/kg/day) at least 10 days after operation to protect the intima [6]. We think this technique is also gentle for intima of arteries.

## Extra-anatomical jumping graft reconstruction of hepatic artery



**Figure 1:** Operation of extra-anatomical jumping graft reconstruction of hepatic artery.

We monitored for HAT using ultrasonography every 8 hours, daily for 14 days after transplantation [7]. We examined the pulsatile index (peak systolic - end diastolic/mean velocities), resistive index (peak systolic - end diastolic/peak systolic velocities), and acceleration time. In the third week, we reduced the frequency of ultrasonography to once per day, and eventually discontinued it as a routine diagnostic procedure. We defined HAT as the absence of hepatic arterial flow on ultrasonography and worsening laboratory results, such as aspartate transaminase (AST) and alanine transaminase (ALT) levels.

### Results

The first case was a 10-month-old female with biliary atresia (failed Kasai procedure) (Table 1). We initially performed anatomical reconstruction, but the recipient artery had intimal dissection, and occluded early. We performed reconstruction immediately, but two days later the dissection had spread to the common hepatic artery. The

common hepatic arteries cannot be used as inflow arteries and the usable vessel grafts are limited, so there was no other option. Then, we performed extra-anatomical reconstruction by using a saphenous vein free autograft as a jump graft from the aorta to the hepatic artery. After that, the blood flow was decreased, but anticoagulant therapy was effective. Fortunately, we could rescue the case.

Age	Sex	Disease	Liver graft	Donor Age	Reason	Graft Survival
0	F	BA	Left lateral liver	24	dissection of CHA	Function
47	F	HCV	Right liver	47	dissection of CHA	Function
50	M	NASH	Right liver	45	dissection of CHA	Function

45	M	PSC	Right liver	43	MALS	Function
*MALS: median arcuate ligament syndrome						

**Table 1:** The Results of 4 cases.

The second case was a 47-year-old female with liver cirrhosis (hepatitis C) (Table 1). We initially performed anatomical reconstruction, but the recipient hepatic artery also had dissection, and occluded 13 days after transplantation. The hepatic arteries cannot be used as inflow arteries. Therefore, we performed extra-anatomical reconstruction by using a radial artery free autograft as a jump graft from the aorta to the hepatic artery. We thought that the artery autograft might be better than the vein autograft for the reconstruction of the artery. Fortunately, we were able to reconstruct the hepatic artery, and the blood flow in the arterial graft did not decrease by the time of discharge.

The third case was a 50-year-old man with nonalcoholic steatohepatitis (NASH) (Table 1). We were aware of difficulty with the recipient artery before the operation. The recipient common hepatic artery had dissection, so we initially performed extra-anatomical reconstruction by using a radial artery free autograft from the aorta to the hepatic artery.

The fourth case was a 45-year-old man with primary sclerosing cholangitis (PSC) (Table 1). We also were aware of difficulty with the recipient artery before the operation. The recipient celiac artery had a stricture because of MALS. Therefore, we initially performed extra-anatomical reconstruction by using a radial artery free autograft from the aorta to the hepatic artery. We were able to reconstruct the arteries in all cases.

## Discussion

Compared with cadaveric donor liver transplantation, LDLT is difficult due to the short hepatic artery, severe intimal damage, and limited usable vessel grafts. In these difficult LDLT cases, we often struggled to reconstruct the arteries. Extra-anatomical jump graft reconstruction using free grafts is said to have a high reocclusion rate, but when recipient common hepatic arteries cannot be used as inflow arteries, and there is no other vessel grafts, it is necessary to perform such grafts [5]. Then we used the systemic administration of gabexate mesilate to protect the intima. As a result, we were able to reconstruct the arteries in all cases, and the blood flow in the arterial grafts did not decrease by the time of discharge. Thus, we felt that it was necessary to carry out this procedure before the recipient and graft intimal condition became irreparable. Our results suggest that the procedure seems to be safe for microvascular reconstruction in liver transplantation.

We used the back-wall support suture technique with double needle sutures, which is known to have a protective effect on the intima [3], because the key to preventing HAT is to protect the endothelial cells. It is known that healthy endothelial cells prevent thrombosis in the intravascular lumen. Even when the reconstruction method is extra-anatomical, the result is the same with jump graft reconstruction. We also thought that an artery autograft might be better than a vein autograft for the reconstruction of the artery, because the vein graft gradually thickens under arterial pressure. This is the reason we performed extra-anatomical jump graft reconstruction using radial

artery free autografting. The number of cases in our study was small, and further investigation is necessary in the future.

Gabexate mesilate is one of the strongest serine protease inhibitor. Previously we reported about gabexate mesilate and risk factors of HAT [5, 6]. Then we recognized that those serine protease inhibitors have the cytoprotective effects of the endothelial cells. In Japan gabexate mesilate is sometimes used on the treatment of disseminated intravascular coagulation (DIC), and in some cases it is more effective rather than heparin. So, in these cases we used gabexate mesilate on this extra-anatomical reconstruction.

We investigated HAT using daily ultrasonography for 2 weeks after the operation. However, after the third week, we performed only non-routine ultrasonography a few times a week, because it has been reported that HAT often occurred 6 to 10 days after surgery [4, 7]. We also think that monitoring for HAT is not so important from the third week forward. We had two patients in whom arterial flow could not be confirmed on ultrasonography for a few days, but recovered afterwards. However, laboratory results remained within acceptable limits in these cases, and we perceived no problem. Especially in these cases, it is not advisable to depend only on ultrasonography. There may also have been several patients, in whom small collateral arteries reduced the main arterial flow, causing further difficulty in confirming flow. This is the reason we defined HAT when both hepatic artery flow was not seen by ultrasonography and laboratory data worsened.

In these cases, we firstly used venous grafts because we were not able to think auto arterial grafts. But after that, we knew the cardiovascular surgeons' technique using the auto arterial grafts. Actually there were some cases of vascular patients that the artery grafts really had better patency than vein grafts. Now, we thought that arterial grafts are better than venous grafts because arteries have tolerance for blood pressure and are hard to thicken.

In conclusion, we experienced 4 cases that required extra-anatomical jump graft reconstruction using free autografts in conjunction with gabexate mesilate, which we were able to save. Our jump graft reconstruction technique allows for safe intimal adaptation, because we use healthy arteries and our stitches are carried from inside to outside. Gabexate mesilate has a side effect of hemorrhage, so there were a few cases of contraindication such as bleeding cases. But when there is no other means of arterial reconstruction, it is necessary to perform this procedure as soon as possible, depending on the intimal condition of the recipient artery.

## References

1. Shirouzu Y, Kasahara M, Morioka D, Sakamoto S, Taira K, et al. (2006) Vascular reconstruction and complications in living donor liver transplantation in infants weighing less than 6 kilograms: the Kyoto experience. *Liver Transpl* 12: 1224-1232.
2. Kim BW, Won JH, Lee BM, Ko BH, Wang HJ, et al. (2006) Intraarterial thrombolytic treatment for hepatic artery thrombosis immediately after living donor liver transplantation. *Transplant Proc* 38: 3128-3131.
3. Miyagi S, Enomoto T, Sekiguchi S, Kawagishi N, Sato A, et al. (2008) Microsurgical back wall support suture technique with double needle sutures on hepatic artery reconstruction in living-donor liver transplantation. *Transplant Proc* 40: 2521-2522.
4. Miyagi S, Kawagishi N, Nakanishi W, Fujio A, Miyazawa K, et al. (2013) Risk factors for hepatic artery thrombosis after microsurgical vascular reconstruction in liver transplantation. *Transplant Proc*. 45: 1994-1996.
5. Uchiyama H, Shirabe K, Taketomi A, Soejima Y, Ninomiya M, et al. (2010) Extra-anatomical hepatic artery reconstruction in living donor

- 
- liver transplantation: can this procedure save hepatic grafts? *Liver Transpl.* 16: 1054-1061.
6. Luh SP, Tsai CC, Shau WY, Chen JS, Kuo SH, et al. (1999) Effects of gabexate mesilate (FOY) on ischemia-reperfusion induced acute lung injury in dogs. *J Surg Res.* 87: 152-163.
7. Kaneko J, Sugawara Y, Akamatsu N, Kishi Y, Niiya, et al. (2004) Prediction of hepatic artery thrombosis by protocol Doppler ultrasonography in pediatric living donor liver transplantation. *Abdom Imaging* 29: 603-605.