**ORIGINAL ARTICLE**

# Immediate Redo Hepatic Artery Reconstruction in Living Donor Liver Transplantation

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## ABSTRACT

**Background:**In living donor liver transplant, vascular complications by compromising the blood flow to the graft can have significant and sometimes might lead to life-threatening consequences for the patient.
**Aim:** To evaluate the practice of immediate redo hepatic artery reconstruction in living donor liver transplant.
**Methods:** Across sectional study (June 2003-August 2015) included recipients with hepatic artery complication who underwent living donor liver transplantation at Chang Gung Memorial Hospital, Kaohsiung, Taiwan. Intraoperative complications necessitating immediate redo reconstruction of hepatic arterywere recorded. Vascular patency was evaluated by intraoperative and postoperative Doppler Ultrasonography. Immediate redo reconstruction was carried out when either arterial wall problem or low flow or RI less than 0.55. Late redo reconstruction (> 24 hours) was carried out to patients developed HAT postoperatively. The data was analyzed by SPSS version 21. P value less than 0.05 was regarded as significant.
**Results:** A59 recipients developed hepatic artery complication,and underwent redo reconstruction with incidence of 6.6%. Immediate redo reconstruction was performed in 86.4%, and 13.6% underwent late redo reconstruction (>24 hours). Minimal discrepancy was encountered in 71.2%, and there was significant correlation between discrepancy and RI, (p=0.048). RI <0.55 was seen in 25.4%. There was significant difference in the outcome between the groups of patient managed by early versus late HA redo reconstruction, (p=0.031).
**Conclusion:** Preliminary results show that immediate redo HA reconstruction preserving blood flow, maintaining perfusion and preventing post-transplant graft loss.
**Keywords:**Hepatic artery (HA),complications,reconstruction; redo reconstruction,resistive index

## INTRODUCTION

In liver transplant hepatic arterial complications may lead to graft ischemia and necrosis[1].Therefore, the early detection and treatment of vascular complications are essential to reduce the associated morbidity and mortality[2]. Because of the small hepatic arteries diameter, arterial reconstruction has a major technical problem [3], and challenging issue especially in living donor liver transplantation (LDLT)[4].Microsurgical HA reconstruction is known to be superior to the conventional method in reconstructing the HA in living donor liver transplantation (LDLT)[5].

Doppler ultrasonography (US) is the established method for initial screening of vascular abnormalities after liver transplantation. Doppler waveforms of the postanastomotic hepatic artery are indirect indicators of anastomosis patency[6].

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The hepatic artery is a low-resistance vessel with a pulsatile waveform because the liver requires continuous blood flow. After transplantation, normal hepatic arterial RI ranges from 0.55 to 0.8[7], however, in the immediate postoperative period, some patients have an elevated RI that returns to a normal waveform within a few days.[7-9] High hepatic arterial resistance (RI >0.8) may be seen in cold ischemia posttransplantation and any stage of transplant rejection. Low hepatic arterial resistance (RI<0.55) is usually associated with proximal arterial narrowing, which in case of liver transplant may mean a stenosis in the hepatic artery anastomosis and concomitant reduced flow[7].

In this study, we intended to explore our experience in early redo hepatic reconstruction in prevention of graft loss in LDLT.

## PATIENTS AND METHODS

All consecutive recipients who had undergone living donor liver transplantation (LDLT), and necessitate hepatic artery redo reconstruction at the center of Liver transplant, Kaohsiung Chang Gung Memorial Hospital, Kaohsiung, Taiwan, during the period from

26 June 2003 to 27 August 2015, were enrolled into this cross sectional study. Approval was obtained from ethics committee and institutional review board, whereas, the requirement for informed consent was waived. Microsurgical hepatic artery reconstruction was performed after venous reconstruction by the samemicrosurgeon. Diameter of donor and recipients reconstructed arteries was measured by caliper prior to reconstruction and documented, as well as the patency and vessel wall status, such as intimal dissection, and fragility.

Single arterial anastomoses were performed in an end-to-end fashion using Prolene 8-0 or nylon 9-0.Paired microvascular clips are applied to both donor and recipient arteries before anastomosis to obtain a flat and bloodless vision field. Reconstruction performed by posterior interrupted and anterior continuous running and interrupted closure technique adopted in our center for biliary and hepatic artery reconstruction.

Intraoperative complications necessitating immediate redo reconstruction; anastomotic disruption, twisting, intimal dissection (ID), hepatic artery injury and acute hepatic artery thrombosis all were recorded.

The ID was classified as mild, moderate, or severe according to the gross appearance of the ID under the operating microscope during HA reconstruction. Mild ID was defined as ID that was less than one-quarter of the circumference of the HA. Moderate ID was defined as ID that had reached one-half of the circumference of the HA. Severe ID was defined as ID that involved more than one-half of the circumference of the HA or the entire vessel wall.

All patients were evaluated by Doppler Ultrasonography intra and postoperatively according to protocol. Ultrasonography was performed with a commercially available Color Doppler Scanner Hitachi Aloka'sProsound Alpha 7, Model 2013.

Color Doppler sonography was used to identify inflow and outflow vessels and to provide spectral analysis. The radiologist scrubbed in the usual sterile surgical manner. A senior attending radiologist was present during the procedure. The transducer was clothed in a plastic cover, which was then placed in a sterile sleeve. The examination was performed from the patient's right side. The transducer was placed directly over the extra hepatic inferior vena cava, hepatic artery, and portal veins.

The following Doppler characteristics of reconstructed hepatic artery were documented are; hepatic artery maximum flow (Vmax = m/sec) and hepatic artery RI (Resistive Index) that was automatically calculated. Hepatic artery RI ranges from 0.55 to 0.80 were considered normal.

Immediate Redo reconstruction was carried out in all cases with arterial twisting, wall injuries (traction, thermal, mechanical), intimal injury, and intimal dissection (ID), or when poor flow or RI less than 0.55 as in acute hepatic artery thrombosis (HAT) obtained and confirmed by Doppler Ultrasonography. Late redo reconstruction (> 24 hours) was carried out in patients who developed HAT postoperatively.

The collected data was managed statistically using SPSS computer package for windows version 21. Numerical data was expressed as means ± standard deviation. Categorical data was expressed as percentages and means and compared between groups using $\chi^2$ test and Fischer's exact test. P value less than 0.05 was regarded as statistically significant.

## RESULTS

During the study period 900 LDLT was performed and redo reconstruction of HA was carried out in 59 patients with the incidence of 6.6%. There were 43(72.9%) males, and 16(27.1%) females. Male to female ratio was 2.7:1. Their mean age was 47.5±17.7 years (Range 7 months - 65 years). Immediate HA redo reconstruction was performed in 51(86.4%), and in 8(13.6%) underwent late HA redo reconstruction.

The graft HA was anastomosed to the recipient LHA in 22(37.3%) cases, and 19(32.2%) graft arteries were anastomosed to the RHA, 8(13.6%) to GEA, 4(6.8%) to the Proper hepatic artery (PHA), 2(3.4%) to the MHA, 2(3.4%) to the LGA, 1(1.7%) to the GDA, and 1(1.7%) to A4 artery.

Table 1: Descriptive Statistics of study group (n=59)

| | ***Range*** | | ***Mean/ Years*** | ***Std. Deviation (SD)/ yrs*** |
|---|---|---|---|---|
| | ***Min.*** | ***Max.*** | | |
| Age | 7 months | 65 Years | 47.47 | 17.69 |
| Donor HA diameter/ mm | 1.00 | 3.00 | 2.24 | 0.48 |
| Recipient A. diameter/ mm | 1.20 | 4.00 | 2.48 | 0.64 |
| Velocity (Vmax m/sec.) | 0.00 | 1.16 | 0.45 | 0.24 |
| Resistive Index (RI) | 0.00 | 0.91 | 0.61 | 0.21 |

The mean diameter of the graft artery was 2.34±0.48 mm and the mean recipient artery diameter was 2.48±0.64mm. Minimal discrepancy was encountered in 42(71.2%), and there was significant correlation between discrepancy and RI (p=0.048).

The intraoperative mean maximum velocity (Vmax) of the HA was 0.45±0.24 m/sec (range, 0 to 1.16), and mean RI was 0.61±0.21 (Range 0.0 to 0.91) (Table 1). RI <0.55 was seen in 15(25.4%) patients (Fig. 1). Immediate redo was carried in 13 out of 15 patients with IR<0.55 and the reminder 2 patients required re LDLT.There was significant difference in the outcome between the groups of patient managed by early versus late HA redo reconstruction (p=0.031).

Fig. 1: Resistive Index (RI) among the study group (n=59)

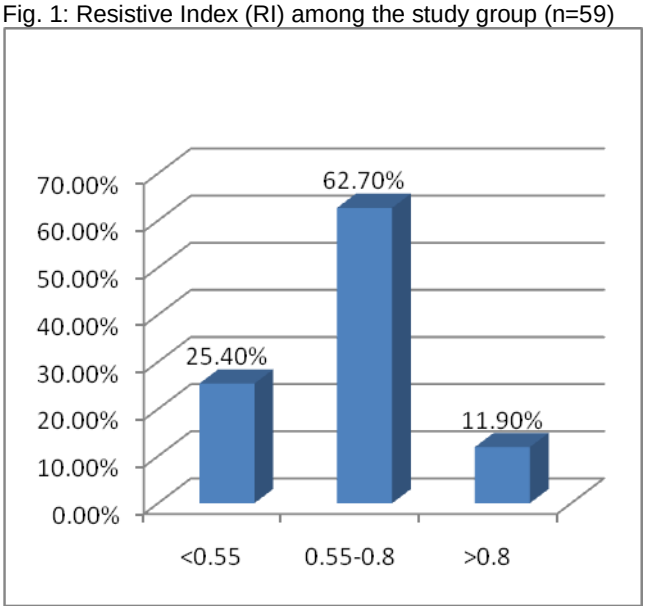


Table 2: Complications encountered necessitate redo reconstruction (n=59)

| Complication | Frequency | %age |
|---|---|---|
| HAT Acute(intraoperative) | 28 | 47.5 |
| Late (After 24 hours) | 4 | 6.8 |
| Low flow | 16 | 27.1 |
| Disruption/Injury | 7 | 11.9 |
| Twist | 2 | 3.4 |
| Thin fragile | 2 | 3.4 |

Intraoperative Ultrasonographic echogenic material representing thrombus demonstrating acute HAT was seen in 28 (47.5%) of total examinations sample, and redo reconstruction done by mean of trimming back and re-anastomosis or using other artery as a replacement in 17 (28.8%) and 11 (18.7%) cases respectively. However, lack or poor flow due to spasm within the intrahepatic arterial branches was also documented by color flow Doppler sonography and spectral analysis in 16 (27.1%), and redo reconstruction done by either trimming back and re-anastomosis or using other artery as a replacement in 9 (15.2%) and 7 (11.9%) cases respectively. These findings were confirmed by operative exploration prior to surgical revision of the anastomosis in all cases, other complications managed by HA redo reconstruction were summarized in Table 2.

In the current series 18 (30.5%) of the patients had an intimal dissection of the hepatic artery after in a varying degrees. In the cases in which ID was encountered, 16.9% had mild ID that trimmed back and re-anastomosed and the remainder 13.6% had severe ID that necessitate replacement anastomosis.

In all cases after redo HA reconstruction a repeat ultrasonography showed restoration of flow within all of the intrahepatic arterial branches, except in two cases that necessitate retransplantation.

## DISCUSSION

Arterial problems are the most common vascular complications after LT [10], thus, hepatic artery reconstruction is one of the most important processes in LDLT.An adequate blood flow is directly related to graft survival and prevention of postoperative complications in living donor liver transplantation[11].

Graft hepatic arteries are usually reconstructed with a recipient HA branch in LDLT. Occasionally, the recipient HAs are unsuitable for reconstruction, potentially because of scarring from a previous operation, hardening by preoperative transarterial embolization for hepatocellular carcinoma, intraoperative arterial dissection, or a size discrepancy between the graft and recipient HAs. In these cases, an alternative source for arterial inflow is necessary other than HAs; this is termed an extra-anatomical HA reconstruction[12,13].

The incidence of HA complication after reconstruction in LDLT is generally ranges between2 to 25%[10,14,15,16].Many factors have been described as the cause of these vascular complications such as technical problems in anastomosis (injury, intimal dissection), problems in allograft anatomy which may result in vascular kinking, and differences in the size of donor's and recipient's vessels[10,17,18].These complications include artery thrombosis (HAT), hepatic artery stenosis (HAS), hepatic artery kinks (HAK), torsion and tension[10,15,19].From those, HAT is most common complication encountered in most series[16].This is in concordance with the results obtained from the current study.

HAS and HAT can lead to allograft ischemia, which carries a high mortality and morbidity rate. These complications are usuallydiagnosed by intraoperative Doppler Ultrasound[6-9,10].The early detection of these is critical to treat them promptly and to reduce the liver damage[16].

Vascular complications can be treated by several approaches: revascularization, retransplantation, and medical management (anticoagulation)[15,20,21]. The choice depends on timing, onset of the vascular

complication, severity of symptoms, and severity of graft injury. So currently, emergency revascularization by surgical re-anastomosis is tried first[15,20,22], but if irreversible graft damage happens, then retransplantation would be the only option[15].In the current study, among the group with HA complications; immediate HA redo reconstruction was performed in 86.4% in term of trimming back and reanostomosis or using alternative artery, and in 13.6% underwent HA redo reconstruction after 24 hours because of late development of complications. Repeat ultrasonographyin all these patients demonstrated the restoration of flow, except in two cases into whichretransplantation was performed.

In conclusion, thecurrent series reviewed the immediate redoreconstruction of hepatic arterial to prevent possible complications that may arise in a previously reconstructed hepatic artery.Microsurgery is the most reliable procedure adopted in our center for hepatic artery reconstruction, especially in LDLT.Immediate surgical intervention is required for acute vascular complications, so, microsurgeons ought to be prepared for unexpected situations during surgery.Rearterialization as early as possible before irreversible biliary and liver parenchyma damage can avoid re-transplant. High level of suspicion and aggressive utilization of intraoperative Doppler Ultrasonography can lead to early diagnosis of low HA blood flow to prevent salvage of the allograft.

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