

# Hepatic Artery Reconstruction in Living Donor Liver Transplant Experience at King Hussein Medical Center

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## ABSTRACT

**Objective:** Living donor liver transplantation is being increasingly carried out successfully in adults and children in many centers around the world. This multi tasked surgery is carried out by several teams of surgeons. The aim of this study is to present the results of hepatic artery reconstruction carried out by the Plastic and Reconstructive surgeons in the liver transplant surgery team at King Hussein Medical Center (KHMC).

**Methods:** From June 2004 to October 2012 seventy five living donor liver transplant surgeries were carried out at KHMC for seventy four patients (one redo). There were 56 males and 18 females, with a mean age of 42 years (age range, 2-62 years). The mean body weight of these patients was 67.03 kg (range, 13-100kg). The hepatic artery in all patients was reconstructed using a classical end to end anastomosis using an 8/0 or 9/0 nylon suture under microscopic magnification by the same team of microsurgeons. We present our experience and show complications related to hepatic artery reconstruction.

**Results:** The mean diameter of the graft's hepatic artery was 1.8 mm (Range 1.1-2.4mm), and the mean diameter of the recipient artery was 2.3mm (Range 1.3-3.2mm). Three of the recipients (4%) experienced early hepatic arterial thrombosis (HAT). In 16 occasions (21%) we had to redo the anastomosis of the hepatic artery due to inadequate flow.

**Conclusion:** There is a learning curve during the progress of our program in living donor liver transplants (LDLT). The results have significantly improved with better selection of the recipients, technical refinements, and improvement in perioperative care.

**Key words:** Hepatic Artery, Reconstruction, HAT, LDLT.

**JRMS September 2014; 21(4): 61-65 / DOI: 10.12816/0005530**

## Introduction

Living donor liver transplantation (LDLT) is being increasingly carried out successfully in adults and children in many centers around the

world since the 1990's.<sup>(1,2)</sup> It offers hope to patients with end-stage liver disease where the waiting-time mortality is high with noncadaveric organs available.<sup>(3)</sup> This multi tasked surgery is carried out by several teams of surgeons. Hepatic

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Manuscript received April 29, 2013. Accepted August 15, 2013

artery (HA) reconstruction is one of the most important steps for LDLT, since arterial complications are life-threatening leading to graft failure and patient demise if retransplant is not done.<sup>(4,5)</sup> This procedure is technically demanding due to the fact that the diameters of the arteries are very small, and in many cases will be diseased by atherosclerosis and occasional intimal dissection. This dictated the introduction of microsurgical techniques under high magnification using specialized high resolution surgical microscopes.<sup>(6,7)</sup> Moreover there are many other challenges to this procedure, such as the constant movement of the field due to breathing, short graft vessels and working at depth.<sup>(8)</sup>

## Methods

From June 2004 to October 2012 seventy five living donor liver transplant surgeries were carried out at KHMC for seventy four patients (one redo) for end stage liver disease resulting from various conditions as shown in Table I. There were 56 males and 18 females, with a mean age of 42 years (age range, 2-62 years) (Table II). The mean body weight of these patients was 67.03 kg (range, 13-100kg). The grafts harvested varied according to the recipient body weight (at least 10 grams of graft per kilogram of body weight). There were sixty five right lobes, seven left lobes and two left lateral lobes (Table III).

### *Surgical technique*

The hepatic artery in all patients was reconstructed by the same team of Plastic and Reconstructive microsurgeons using a classical end to end anastomosis using an 8/0 or 9/0 nylon suture under continuous zoom microscopic magnification of approximately 12X. After applying Acland microvascular clamps to both vessels the back wall-first microsurgical anastomosis technique was employed in all cases. In all cases we used interrupted sutures for both walls. Before suturing, clamps were released temporarily to confirm adequate arterial outflow from the recipient arterial end.

Immediately after reconstructing the hepatic artery, flow was assessed by an experienced radiologist using a Color Doppler Ultrasonography (CDU), this was done intra-

**Table I:** Indications for transplant

Indication	No.	%
Cryptogenic liver cirrhosis	16	21.6
Viral hepatitis B	15	20.3
Autoimmune hepatitis	9	12.2
Hepatocellular carcinoma	1	1.4
Viral hepatitis C	9	12.2
Primary sclerosing cholangitis	4	5.4
Progressive familial intrahepatic cholestasis	2	2.7
Others	18	24.3
Total	74	100

**Table II:** Demographic data for recipients

		No.	%
Age	<4 Yrs.	2	2.7
	4-17 Yrs.	12	16.2
	18-60 Yrs.	58	78.4
	> 60 Yrs.	2	2.7
Gender	Male	56	77.0
	Female	18	23.0

**Table III:** Lobes harvested from donors.

Lobe	No.	%
Right	68	90.7
Left	5	6.60
Left Lateral	2	2.70
Total	75	100

operatively with direct contact between the probe and the surface of the graft (Fig. 1). Then the resistive index (RI) of the flow was recorded, if the RI was outside the normal range of 0.5-0.9 indicating abnormal perfusion then the anastomosis had to be revised.

## Results

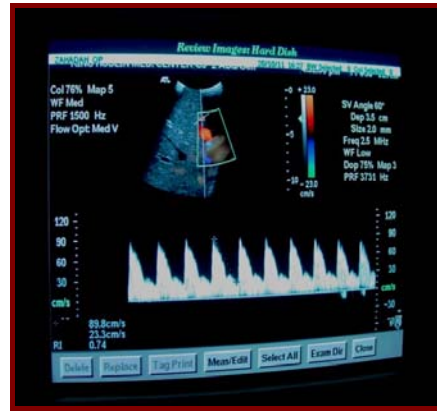
The mean diameter of the graft's hepatic artery was 1.8 mm (Range 1.1-2.4mm), and the mean diameter of the recipient artery was 2.3mm (Range 1.3-3.2mm).

The recipient hepatic artery and its branches were used for arterial anastomosis in all cases except two, where the splenic artery was used (Table IV). In those two cases the spleen was left alone since it had adequate collateral circulation. The mean time required for an arterial reconstruction was 48.2 minutes (Range 29-66min). The mean Resistive index (RI) measured just after the completion of the final anastomosis was 0.63 (Range 0.54-0.82).

In 16 occasions (21%) we had to redo the anastomosis of the hepatic artery due to inadequate flow.



**Fig. 1A**



**Fig. 1B**

**Fig. 1:** Immediate intra-operative assessment of anastomotic flow by color Doppler Ultrasonography (CDU). **Fig. 1A** shows the actual procedure and **1B** shows the graphics of the waveform of flow and RI readings



**Fig. 2:** Anastomosis performed at the Porta Hepatis in an 11 year old male patient. Arrow points to the site of anastomosis between the right HA of recipient and left HA of graft very close to the surface of the graft.

**Table IV:** Types of arterial anastomoses used

Arterial Anastomosis	No.	%
RHA to RHA	61	81.30
LHA to LHA	7	9.30
RHA to LHA	4	5.40
RHA to Splenic A.	2	2.70
RHA to MHA	1	1.30
Total	75	100

RHA: Right Hepatic Artery, LHA: Left Hepatic Artery, MHA: Middle Hepatic Artery

In two cases we had to do the anastomosis at the Porta-hepatis due to intimal dissection in the graft's hepatic artery (Fig. 2). In all cases the same technique was done using interrupted 8/0 or 9/0 nylon sutures.

Three of the recipients (4%) experienced a hepatic arterial thrombosis (HAT) in the early post-operative days, this was diagnosed by a continuous rise of liver enzymes during routine liver function tests carried twice daily and proved by CDU examinations and CT angiography.

Case I was a 51 year old male patient with cryptogenic liver cirrhosis developed the HAT in the first postoperative day and retransplantation was done on emergency basis, but he died 24

hours after the operation.

Case II was a 57 year old female patient with fulminant Hepatitis B developed HAT on the 11<sup>th</sup> postoperative day, thrombectomy was performed by the interventional radiologist but failed and the patient died. Case III was a 47 year old male patient with fulminant Hepatitis B; he developed HAT 7 days post-transplant on top of multi organ failure and died before any intervention.

One recipient developed bleeding from a branch of the hepatic artery (distal to the anastomosis) one day after transplantation. This recipient was successfully treated with re-opening and ligation of the bleeding branch.

## Discussion

Liver transplantation is an effective life-sustaining treatment for selected patients with end-stage liver disease, however due to lack of cadaveric organs there is a tendency nowadays to use living donors for liver transplantation.<sup>(2,9)</sup>

The liver is well known to have a dual blood supply from the portal system and the HA; however the HA is the sole supply of oxygenated blood to the biliary tree.<sup>(10)</sup> Failure of HA reconstruction during LDLT has serious outcomes on the graft and the patient survival.<sup>(11-15)</sup> This fact makes HA reconstruction a stressful and challenging procedure. Many factors contribute to the complexity of this procedure; these include continuous movement of the operative field due to heart beats and ventilation, size discrepancies between the graft and recipient arteries, small size of the arteries, and diseased or short arteries.<sup>(16,17)</sup>

In our series the rate of HAT was 4% and this slightly higher than the international rate for adult to adult LDLT of 2.9% which was stated by Bekkeret *et al*<sup>(18)</sup> in their systematic review of over 70 studies comprising 21,822 liver transplantations and 843 cases of HAT. This was the rate for early HAT occurring in the first month after transplant, all our HAT cases occurred in the first two weeks and all were in adult patients.

The risk factors for HAT include recipient weight <10 Kg, graft hepatic artery diameter <3mm,<sup>(16)</sup> excessive use of intraoperative plasma,<sup>(10,19)</sup> hypercoagulable state, severe intraoperative hypotension, long cold ischemic time, occlusion of HA outflow owing to hepatic congestion and systemic infection.<sup>(13)</sup> In case I of HAT the cause was prolonged procedure (16 hours) and intimal dissection of the graft HA. In case II the cause of HAT was sepsis due to chest infection, and in case III it was multi organ failure.

All the cases of HAT occurred early in the series, the last one was in 2009. We believe that better patient care and shorter procedure time along with the gain in experience has led to performing 29 consecutive cases without HAT or serious complications.

In this study we did not look at the rate of late HAT; since this has no clear correlation with technical aspects of the HA reconstruction at the

time of transplant according to Gunsar *et al*.<sup>(20)</sup> Risk factors are a low donor-recipient age ratio, immunologic factors, coagulation abnormalities, smoking, and infections.

CDU was performed immediately after the reconstruction of the HA and in the early post-operative period once daily in the first week and then at least twice weekly for the next month. The results of CDU were used as a guide to the arterial, portal and venous blood flow to the graft. All the cases of HAT were picked by CDU as soon as they occurred. The main parameter for the evaluation of the arterial flow was the resistive index (RI) which allows a semi quantitative estimation of the resistance to arterial flow into the liver and its normal value is 0.55-0.80.<sup>(14)</sup> Abnormally high or low RI values indicate stenosis or thrombosis in the vessels.

## Conclusion

Because of the inherent difficulties and the serious complications related to Hepatic artery reconstruction, we believe a microsurgeon with huge experience in microvascular anastomosis should participate in the LDLT surgery. There is a learning curve during the progress of our program in LDLT. The results have been significantly improved with time and technical refinement. This is clearly shown by performing 29 consecutive cases without HAT or serious complications.

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