CASE REPORT

# A Successful Deceased Donor Orthotropic Liver Transplantation Involving Variant Arterial Patterns: A Case Report

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## Abstract

The liver is a common organ that has frequent variants of arterial anatomy. The presence of variations in arterial supply can lead to various morbidity and mortality in surgical procedures like liver and intra-abdominal surgeries and liver transplantation. A 46-year-old male diagnosed with CLCD complicated with portal hypertension underwent successful orthotropic deceased-donor liver transplantation. The donor's liver had replaced the RHA and LHA from SMA and LGA, respectively. The recipient's liver had an accessory RHA raised from SMA. Despite vascular variations, transplantation was successful and had an uneventful recovery. Classical anatomy of the liver arteries is seen in 55-70% of the population, and the others can have various anatomical variations due to the presence of replaced and accessory arteries. The unique embryological development is responsible for this plethora of anatomical variations. These variations can complicate the liver transplant procedure. Early anticipation and proper assessment of these variations in blood supply are important to minimize liver transplant-related morbidity and mortality.

**Keywords:** liver transplantation; arterial anatomical variations; replaced hepatic artery; accessory hepatic artery

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## Introduction

The liver is one of the organs in the abdomen that has a wide range of vascular variations (1). Knowledge regarding these variations is important during liver surgeries, such as organ retrieval, transplantation, laparoscopic or open abdominal surgeries including liver resection, penetrating abdominal trauma. Further this knowledge becomes important in interventional radiological procedures as well to prevent morbidity and mortality (2, 3). During liver transplantations, the presence of variations of the arterial anatomy in the donor as well as in the recipient can lead to diagnostic and reconstructive difficulties. It can adversely affect post-operative transplant survival due to mechanical and flow-related problems (4).

Liver transplantation is the definitive management of patients with Chronic Liver cell disease (5). Post-transplant hepatic artery thrombosis is a well-known complication of the surgery and occurs in 2-12% of transplantations (6). Abnormal hepatic arterial anatomy can predispose to post-operative thrombosis and stenosis (7).

According to the classical description, the liver gets its arterial supply from the common hepatic artery, which is a branch of the coeliac trunk. The common hepatic artery continues as the proper hepatic artery after giving gastroduodenal artery (GDA). The proper hepatic artery divides into the right hepatic artery (RHA) and left hepatic artery (LHA) at the liver hilum. This anatomy is only seen in 55% to 70% of the population (8). These variations are mainly due to replaced and accessory vessels. In the context of vascular variations, an accessory hepatic artery is defined as an artery that supplies the liver lobe in addition to its usual vessel. A replaced hepatic artery is defined as an artery that supplies the liver lobe replacing its normal anatomical artery (9). We present a case of successful liver transplantation done in a donor and a recipient with abnormal arterial anatomy.

## Case report

The liver recipient was a 62-year-old male, diagnosed with Chronic Liver Cell Disease (CLCD) due to alcoholic cirrhosis, which is complicated with portal hypertension. At the time of transplantation, the severity of the CLCD was Child-Pugh B, and his MELD score was 17.

The liver donor was a 46-year-old male deceased donor following a warfarin-induced intracerebral hemorrhage and was diagnosed with brain death. During surgery, arterial variations were noted in the donor hepatic arteries. In addition, arterial variations were also noted in the recipient. In the donor liver, the left hepatic artery (LHA) and right hepatic artery (RHA) were replaced. The LHA and RHA arose from the left gastric artery and the superior mesenteric artery (SMA), respectively (Figure 1). In the recipient's liver, the common hepatic artery arose from the coeliac trunk as usual, and there was an accessory RHA from the SMA.

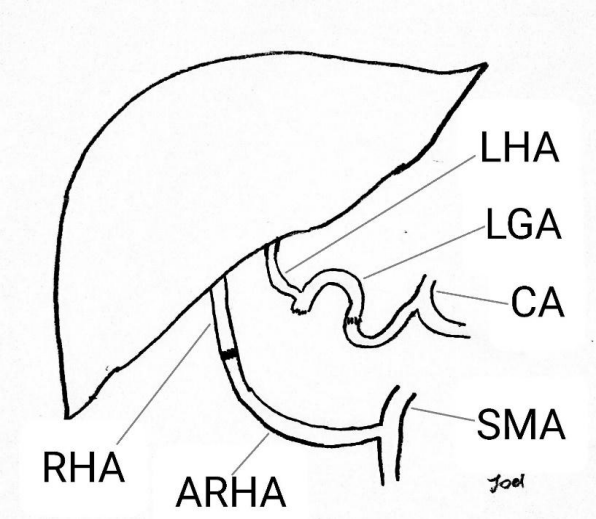



***Figure 1: Deceased donor liver with anatomical variant arteries. A – Superior mesenteric artery (SMA), B – Left gastric artery (LGA), C – Replaced Right Hepatic*** Artery (rRHA), ***D – Replaced Left Hepatic Artery (rLHA)***

During surgery, the donor's liver was explanted. The donor inferior vena cava (IVC) was anastomosed to the recipient using the 'Piggyback' technique. The donor-replaced RHA was anastomosed to the recipient's accessory RHA and the donor's LGA-replaced LHA was anastomosed to the recipient's CHA using the end-to-end technique (Figure 2). The liver was perfusing well with good Doppler waveforms on duplex ultrasound scan assessment. Postoperatively, the patient had an uneventful recovery and transplantation was successful.




***Figure 2: Schematic diagram showing the anastomosis of the transplanted liver. RHA – Right hepatic artery, ARHA – Accessory right hepatic artery, SMA – Superior mesenteric artery, CA – Coeliac artery, LGA – Left gastric artery, LHA – Left hepatic artery***

**Discussion**

In the literature, about 70% of transplants show standard arterial tree anatomy, and the rest show variant anatomy (10). The clinical significance of this is that anatomical variations can lead to post-transplant arterial complications like hepatic artery thrombosis (HAT) and stenosis (5). These are lethal complications and have a positive correlation with the anatomical variations of the arterial pattern (11). Even though arterial anatomical variations can increase the risk of post-surgical HAT, it is not a contraindication for transplantation involving aberrant anatomy, as the incidence is low and there are other causes for HAT in addition to the anatomy (12).

During liver harvesting, it is important to perform dissections after correct identification of the anatomy to prevent inadvertent damage to graft arteries. That can lead to complex vascular reconstructions and increase the back-table workload (11).

Multiple authors have studied the anatomical variations in the hepatic vasculature. The coeliac trunk variations were described first in 1756. Mitchell (1966) and Hiatt (1994) classifications of the hepatic vascular anatomy are considered gold standards to date (8). Mitchell described 10 variations of the hepatic arterial supply, and Hiatt organized it into six variations (Table 1) (1). The common anatomy of the coeliac trunk is to trifurcate into the left gastric, splenic, and common hepatic arteries. After giving GDA, CHA continues as the proper hepatic artery, and at the porta hepatis, it divides into LHA and RHA. According to Mitchell and Hiatt, this anatomy was found in only 55.6% and 75.7%, respectively (8). According to the Hiatt classification, our donor had type IV arterial anatomy. The recipient had type III anatomy (Table 1).

The wide variation of arterial anatomy can be explained by the embryonic development of the hepatic arteries. During embryological development, the CA and SMA develop by a series of ventral branches from the dorsal aorta: Omphalo Mesenteric Arteries-OMA or vitelline or ventral splanchnic arteries. A ventral longitudinal vessel connects the OMA (ventral longitudinal anastomosis). The first OMA develops into the CA. The common hepatic (CHA), left gastric, and splenic arteries branch out from the longitudinal anastomosis. The pattern of disappearance and persistence

of the segments of the OMA and the ventral longitudinal vessel results in anatomic variations of the hepatic arterial system (Figure 3).

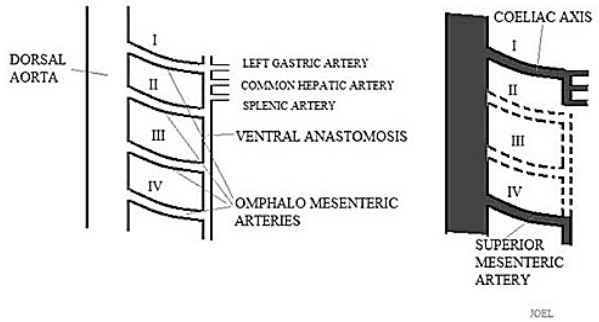



***Figure 3: Development of splanchnic circulation.***

***Table 1: Hepatic artery variations***

| | Type of hepatic arterial anatomy | Mitchels classification (1966) | Hiatt classification (1994) |
|---|---|---|---|
| **1** | Normal Anatomy | Type 1 (55.6%) | Type 1 (75.7%) |
| **2** | Replaced LHA from a branch of LGA | Type II | Type II |
| **3** | Replaced RHA from a branch of SMA | Type III | Type III |
| **4** | Replaced LHA and replaced RHA | Type IV | Type IV |
| **5** | Accessory LHA from a branch of LGA | Type V | Type II |
| **6** | Accessory RHA from a branch of SMA | Type VI | Type III |
| **7** | Accessory LHA and accessory RHA | Type VII | Type IV |
| **8** | Accessory LHA and replaced RHA / Accessory RHA and replaced LHA | Type VIII | Type IV |
| **9** | CHA from a branch of SMA | Type IX | Type V |
| **10** | RHA and LHA are branches of LGA, CHA branch of LGA | Type X | – |
| **11** | CHA is a branch of the aorta | – | Type VI |

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