

Surgical Importance of Vascular Variations of Liver with Special Reference to Liver Transplantation

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Dear Editor:

Liver transplantation involves implant of a whole or part of a donor liver into a recipient with liver failure. Classically a liver transplant operation involves three vascular anastomosis and one biliary anastomosis. The vascular anastomosis includes - two inflows namely Hepatic artery Portal vein and one venous outflow. While the reconstruction is standard in a cadaveric liver transplant operation (where the whole liver is transplanted), a Living donor liver transplant operation is more complex as only part of a liver is implanted. Division of the liver in the donor is wholly dependent on the vascular anatomy as the parenchymal transection follows vascular planes. Any variation in the vascular anatomy will alter surgical plans, both in the donor and in the recipient during implantation. Rarely vascular anomalies in the donor might even contraindicate donation where the blood supply to the remnant donor liver may be compromised. Examples include, intraparenchymal division of segment 4 artery from the RHA, Intra parenchymal origin of the right anterior sectoral portal vein from the left portal vein. Sometimes early and extrahepatic division of the hepatic arteries into the sectoral branches make the recipient operation more complex as the number of vascular anastomoses increase and this has been directly correlated with increased incidence of complications post-transplant¹.

Incidence of variant hepatic arterial anatomy (Michel Classification)² varies between 23-45%^{3,4,5}. Classical Portal venous division into right and left portal veins occur only in about 80% of patients with the rest of the patients having some form of variation⁶. (Trifurcation, right posterior vein as the first branch of the main PV, Left PV arising from the right anterior sectoral PV, etc). In addition, the segmental venous drainage may also vary with different sectoral veins draining independently into the vena cava instead of draining into the right or the middle hepatic veins. Normally segment 8 and segment 5 veins drain into the middle hepatic vein and require reconstruction using a conduit before implantation. Sometimes accessory veins are present which pose a challenge as they

also will require reconstruction before the implant operation.

The various modifications utilised during re-implantation of the liver are beyond the scope of this study, but the most common ones include:

Double portal vein anastomosis - where two anastomoses are fashioned by anastomosing the anterior and posterior sectoral veins to the right and left branches of the portal vein of the recipient.

“Quilting” technique - where the anterior and posterior sectoral veins are joined together by interposing a small vein patch harvested from the recipient. This facilitates the performance of a single portal vein anastomosis. The same technique can be used when multiple short hepatic veins exist in the donor graft⁷.

Anastomosis of an accessory or replaced Left hepatic artery to the gastro-duodenal arterial stump in a cadaveric liver transplant.

Fashioning a Neo-Middle Hepatic Vein using a synthetic graft or a Cadaveric vein graft by anastomosing the segment 5 and segment 8 veins before implantation of the liver.

Presence of any variation in the hepatic venous and portal venous anatomy will also affect other Liver related procedures like Transjugular Intra parenchymal Porto-Systemic Shunt (TIPSS)⁸ for refractory ascites and bleeding in portal hypertension. Here a metal stent is placed to connect the hepatic vein to the left portal vein to divert blood away from the cirrhotic liver which decreases the portal pressures.

Hence accurate knowledge of the vascular anatomy of the liver is essential before planning not only a Liver transplant operation, but any liver surgery. Presence of aberrations in vascular anatomy should never be a surprise to the surgeon and detailed imaging studies need to be performed on the patient before planning the surgery. As detailed above precise knowledge of vascular anatomy will help the surgeon plan, modify as needed and execute a complex surgery in a safe manner.

Evaluation of Potential Living Donor for Liver Donation by CT Scan

Preliminary Plain CT scan to look for Liver attenuation index to rule out Fatty Liver.

Next Contrast enhanced CT scan to delineate Vascular anatomy.

Arterial anatomy: Michael's Classification.

Portal venous anatomy: Nakamura's classification. Relative contraindications for donation will be Single portal vein with intrahepatic branching, Segment 4 PV branch coming from intrahepatic Right anterior PV branch.

Conditions which will need modification of surgical technique: Trifurcation of the portal vein, Extrahepatic branching of the Right portal vein into anterior and posterior divisions.

Hepatic Venous anatomy: Segment 5 and segment 8 veins drain into the middle vein. Presence of significant sized accessory segment 5 and 8 veins and accessory inferior hepatic veins will need implantation during the transplant. If no significant segment 4 vein drains into the middle vein, the entire MHV is procured during the donor operation. If there is significant drainage of segment 4 into the MHV, the MHV is left behind in the donor.

Surgical techniques in Live Donor Liver Transplantation:

First donor operation starts. Once the liver is visualised and deemed good, the recipient is taken to OT and operation starts.

Donor Operation:

Right lobe is mobilised and RHV Looped.

Hilar dissection begins and the RHA and RPV is Looped.

Once demarcation line between Right lobe and Left lobe is visualised, transection starts. The hepatic veins are identified and ligated and divided.

Once transaction is completed, the liver is removed from the field and flushed with preservative solution.

Recipient operation:

The Liver is mobilised.

The hilar structures are dissected and divided.

The RHV, MHV and LHV are ligated, and the cirrhotic liver removed.

Back Benching of the donor Liver:

If segment 5 and 8 veins need reimplantation, then they are anastomosed to a cadaveric vein graft / PTFE graft to allow for a single anastomosis in the recipient

If two portal veins are present, then they are either stitched together or "Quilted" together using a piece of the cadaveric vein to facilitate a single anastomosis.

If a significant IRHV is present, then that will also need reimplantation

Implantation in the recipient:

The venous anastomosis is completed first. RHV is anastomosed to the RHV stump. The segment 5 and 8 vein conduit is anastomosed to the Left/ Middle hepatic vein stump. IRHV is anastomosed to the Venacava

The Portal venous anastomosis is completed next

Finally, the arterial anastomosis is completed.

Adequate knowledge of normal vascular anatomy and any variation in its branching pattern will help in correct interpretation of radiological reports and planning of liver surgeries. The present report gives overview of surgical implications of vascular anatomy of liver.

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