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Alternative procedure for failed reconstruction of a right replaced hepatic artery in liver transplantation

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Abstract A right replaced hepatic artery (RRHA) arising from the superior mesenteric artery (SMA) is the most frequent variation of the hepatic arterial supply requiring backtable reconstruction. There are several widely used techniques for backtable reconstruction of the RRHA to a single conduit. If these reconstructions fail, due to technical reasons or size discrepancies, an alternative method of rearterialization is needed. We describe six cases in which an RRHA was anastomosed to the donor's gastroduodenal artery (GDA) stump utilizing a loupe magnification technique. In four cases the reconstruction was performed at the time of the backtable procedure and in two after reperfusion and failure of the original RRHA to splenic artery (SA) reconstruction. In all cases, the anastomoses remained patent. All patients had Doppler sonography and two had subsequent arteriograms that verified anastomotic patency. This method of reconstruction is more demanding technically but obviates the awkward 90-degree twist of the hepatic artery when an RRHA is anastomosed to the SA stump.

Key words Liver transplantation, vascular reconstruction · Vascular reconstruction, liver transplantation · Hepatic artery, right, liver transplantation

Introduction

The hepatic arterial supply has many anatomical variations [5, 7]. These variations challenge both the donor and the recipient transplant surgeon [1, 2, 4, 6, 8]. A right replaced hepatic artery (RRHA) coming off the superior mesenteric artery (SMA) is a common variation and the one that most often requires a backtable reconstruction to a single conduit [1, 4, 5, 7, 8]. While some surgeons utilize recipient arterial stumps for reconstruction, this technique requires an additional anastomosis at the time of transplantation and relies on the availability of appropriate arterial supply. Failure to identify the RRHA during the harvesting procedure can lead to the loss of the graft. The most commonly used backtable reconstruction of the RRHA is to anastomose it to the splenic artery (SA) stump, although use of an iliac graft or SMA to celiac axis anastomosis has also been commonly used (Fig. 1) [4, 6]. We describe an alternative procedure for reconstruction of the RRHA utilizing the gastroduodenal artery (GDA) stump of the donor liver. This alternative procedure is appropriate when the usual reconstruction fails for technical reasons or is impossible to perform due to harvesting errors. This procedure can potentially prevent graft loss or graft discarding. Although technically more demanding, it is anatomically superior to an RRHA-to-SA reconstruction.

Materials and Methods

Reconstruction of the hepatic arterial tree of the donor RRHA to the donor GDA was performed in six cases. The anastomoses were performed using a microvascular technique with loupe mag-

Fig. 1a–d Four methods of reconstruction of an RRHA to a single conduit: **a** RRHA-to-GDA; **b** SA-to-RRHA. Notice 90-degree twist in HA; **c** SMA-to-CA. Notice long graft; **d** Int. I. A.-to-RRHA, Ext. I. A.-to-CA; Notice long graft (*CHA* common hepatic artery, *RRHA* right replaced hepatic artery, *GDA* gastroduodenal artery, *SA* splenic artery, *LGA* left gastric artery, *CA* celiac artery, *CIA* common iliac artery, *PV* portal vein, *CBD* common bile duct, *SMA* superior mesenteric artery, *Int. I. A.* internal iliac artery)

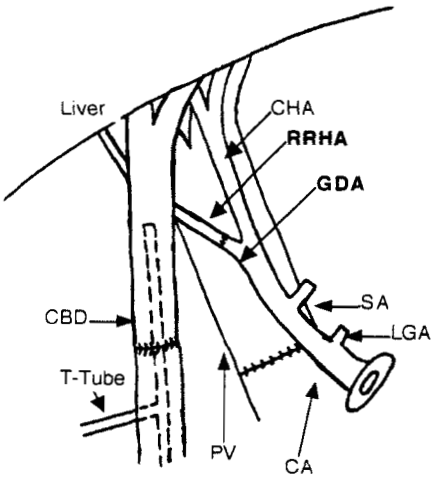

figure 1a: RRHA to GDA

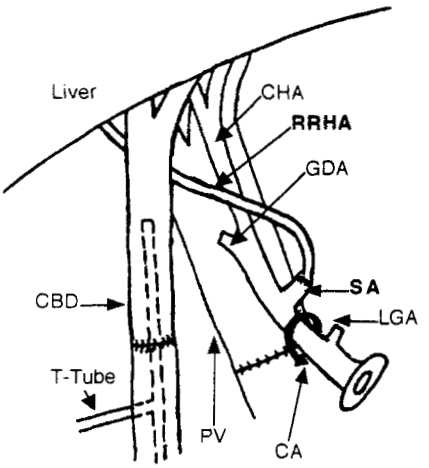

figure 1b: SA to RRHA

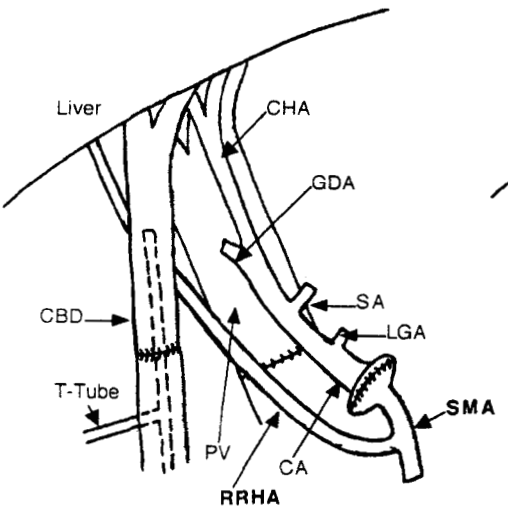

figure 1c: SMA to CA

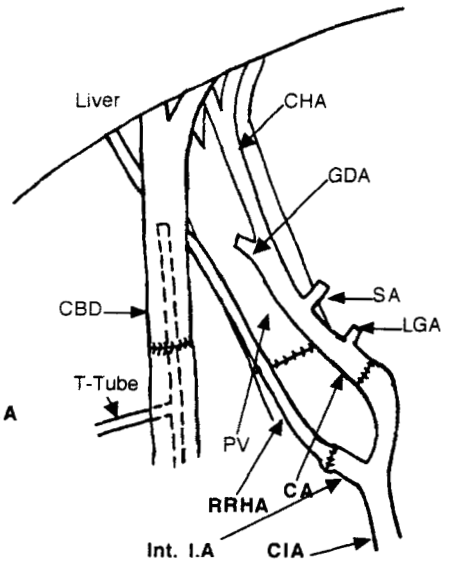

figure 1d: Int I. A. to RRHA; Ext. I.A. to CA

nification. We used an 8-0 prolene suture in interrupted or continuous sutures. In four cases, the anastomoses were performed at the time of the backtable procedure. In one case, the SA stump was ligated too close to the celiac trunk to permit utilization of the splenic stump. In two cases, the RRHA was severed at the time of harvesting and was either too short to reach the splenic stump without kinking or there was a significant size discrepancy between the RRHA and the SA stump. In an additional case, the donor GDA was of the same caliber and size as the donor SA and, due to the superior anatomical positioning, we preferred to perform the RRHA-to-GDA anastomosis (Fig. 1 a). When the anastomosis was performed at the backtable, a 5 Fr feeding tube was used as a temporary stent across the anastomosis to facilitate suture placement. In two cases, the original RRHA-to-SA stump anastomosis failed after reperfusion. In one of these cases, the anastomosis continued to bleed due to inadequate technique; in the second case, a clot formed across the anastomosis immediately following reperfusion due to an intimal dissection of the SA stump. The hepatic artery (HA) was clamped and irrigated with heparinized saline through the SA stump. The RRHA was likewise irrigated and the anastomosis of the RRHA to the GDA, as described, was then carried out.

Doppler ultrasound examination was performed postoperatively on all patients. Celiac angiography was performed postoperatively in two patients when ultrasonography failed to clearly demonstrate the right HA.

All human studies referred to in this paper were approved by the appropriate ethics committee and were performed in accordance with the ethical standards set down in the 1964 Declaration of Helsinki. Furthermore, all participants gave their informed consent prior to their inclusion in the studies.

Fig. 2 Angiography of a triple vessel variation with reconstruction of the RRHA to the stump of the gastroduodenal artery *(GDA)*. The left hepatic artery *(LHA)* comes out of the left gastric artery *(LGA)*. An iliac arterial graft from the aorta was used for inflow. The hepatic artery, distal to the GDA, is diminutive and partially hidden by the drain. There is a small intrahepatic aneurysm of the LHA

Results

Five patients had an excellent postoperative course with no postoperative surgical complications. Doppler ultrasound and/or angiography verified patency of the RRHA in all cases (Fig. 2). No patient had a significant elevation of transaminases that could be ascribed to vascular complications. In one patient, a biliary leak from the donor cystic duct remnant was diagnosed. In that patient, the RRHA was found to be patent during laparotomy for the leak. It was, indeed, inadvertently injured but later repaired. The patient's subsequent course has been excellent. Patient follow-up is 8–34 months.

Discussion

With the improvement in surgical technique and the increased experience of liver transplant surgeons, variations of the hepatic arterial supply rarely constitute a reason for discarding an organ. Anastomosis of the HA and RRHA to an iliac artery graft and anastomosis of the SMA to the celiac axis are quite common [1, 3, 7], though many surgeons utilize the RRHA-to-SA stump reconstruction when confronted with this common variation (Fig. 1) [6, 8]. A Carrel patch from the SMA is usually needed to bridge the size discrepancy between the RRHA and the usually larger SA. This size discrepancy can, however, lead to problems as the change in caliber may cause turbulent flow which, in turn, may lead to thrombosis. In addition, some donor surgeons dissect the celiac axis completely and ligate the SA very close to the celiac artery. This will prevent the usage of the SA stump for anastomosis. Although relatively rare, harvesting injury to the RRHA does occur, leaving the backtable surgeon with both a short RRHA and loss of the SMA. The SA-to-RRHA reconstruction may lead to a 90-degree twist of the HA because the SA arises to the left side of the celiac artery. Reconstruction of the RRHA to the GDA stump obviates these problems and increases the flexibility of the backtable or recipient surgeon in handling arterial variations and technical errors.

The success of this reconstruction in six patients underscores the feasibility of this technique and its value as an alternative technique in orthotopic liver transplantation when other methods of reconstruction have failed or are technically impossible to perform. We used Doppler ultrasound in all cases and angiography in two cases to verify vessel patency. It must be stressed, however, that Doppler ultrasound is an unreliable technique for verification of patency of small arterial branches and, to a certain degree, its resolution is dependent upon operator experience and skill. In the absence of clinical signs of arterial flow problems, we did not want to expose the patients to an invasive procedure such as angiography with its attendant risks. In three of six patients, we established patency at angiography ($n = 2$) or laparotomy ($n = 1$).

Additional advantages of this technique are the lack of change in flow pattern due to size discrepancies and the more natural anatomic position of the RRHA. Also, this technique offers a way to safely harvest the pancreas despite the presence of an RRHA. The RRHA is cut as it emerges from the pancreas, leaving the SMA intact for the pancreas graft. In this situation, the SA would be cut very close to the celiac artery, thereby preventing use of the SA for reconstruction. The main disadvantage is the need to perform an anastomosis between small vessels without the luxury of a Carrel patch. This, however, is addressed by the use of a microvascular technique (loupe magnification) and fine suture material. We used 3.5 loupe magnification and 8-0 or 7-0 prolene sutures.

With the present shortage of cadaveric organs, it is crucial not to lose any graft to harvesting errors or failed arterial anastomoses. Donor surgeons should be constantly aware not only of the possible variations of the arterial tree but also of the various methods of reconstruction. The celiac artery should be harvested with an adequate patch of the aorta. In additon, generous stumps (10 mm or more) of the SA, the left gastric artery, and the GDA should be harvested when possible. This will increase the flexibility of the backtable or recipient surgeon in planning and performing the most adequate arterial reconstruction.

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