

Variations In The Anatomy of the Hepatic Artery in Living Donor Liver Transplantation

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ABSTRACT

Knowledge of the anatomic variations of the hepatic artery in living donor liver transplantation is crucial for the surgical technique of the anastomosis as well as the precipitation, diagnosis and management of the postoperative complications. The study was done on 40 patients 20 donors and 20 recipients, who underwent living donor liver transplantation in both Kasr el Aini and Dar el Fouad hospitals since 2004 till 2007. Data was collected and analyzed with special regard to demographic data, preoperative assessment of the donor and recipient, hepatic arteries of the graft and recipient ,results of intra-operative and postoperative doppler ultrasound , preoperative magnetic resonance angiography, the use of postoperative anticoagulation , postoperative arterial complications and management, and finally the mortalities. Only 80% of the donors had a normal anatomy of the hepatic artery. In 5% of the donors the hepatic artery originated directly from the aorta, the right hepatic artery originated from the superior mesenteric artery in 5%of the cases, 5% of the donors had a trifurcated hepatic artery, 5% had the right and left hepatic arteries originating separately from the celiac trunk. The operative findings of the donors did not match the preoperative angiographies in 20% of the cases.10%of the recipients had anomalies of the hepatic artery in the form of a trifurcated artery and common hepatic artery arising from the superior mesenteric artery. Anatomic variations are common, but do not contraindicate donations. Surgeons should be prepared to recognize and manage them. A clear treatment strategy for non complicated hepatic artery kinks needs to be established.

Key words: Hepatic artery anatomy, liver transplantation

INTRODUCTION

Living donor liver transplantation has emerged in countries where there is scarcity of deceased donor organs⁽¹⁾. Right lobe liver living donor transplantation is an innovative and challenging surgical procedure that has become a viable alternative for adult patients with end stage liver disease⁽²⁾. Anatomic variations of the hepatic artery are classified into five types⁽³⁾. Type I (75.7%), where the common hepatic artery arises from the celiac trunk and forms the gastroduodenal artery and proper hepatic artery, which divides distally into a left and right branch. Type II (9.7%), a replaced or accessory left hepatic artery arises from the left gastric artery. Type III (10.6%), a replaced or accessory right hepatic artery arises from the superior mesenteric artery. Type IV (2.3%), a double replacement of the right hepatic artery arises from the superior mesenteric artery, and the left is a branch of the left gastric artery. Type V (1.5%), the common hepatic artery arises from the superior mesenteric artery

PATIENTS & METHODS

The study was done on 40 patients, 20 donors and 20 recipients who underwent living donor liver transplantation in both Kasr El Aini and Dar el Fouad hospitals since 2004 to 2007. Data of all patients was collected, tabulated and analyzed with special regards to:

1. Demographic data: name, age and weight, the donors were 14 males (70%) and 6 females (30%). Ages ranged from 18 to 39 (mean 23.75 years). The recipients were 16 males (80%) and 4 females (20%), their ages ranging from 14 months to 6 years. The mean weight of the recipients was (13.3kg); the mean weight of the donors was (66.6kg)
2. Results of the preoperative assessment on the hepatic artery using ultrasound doppler and magnetic resonance angiography
3. Graft: The type of the graft, graft weight, and the graft to recipient weight ratio. The type of the graft was the right lobe in 14 cases; segment II and III in 5 cases, and the left lobe

in 1 case. The graft weight ranged from 230g to 500 g for segments II and III (mean332g), and from 650g to 1100 g for right lobe grafts (mean 888g) .The graft to recipient / weight ratio ranged from 1.8 to 5.5 (mean2.94) in pediatric patients, and from 1.1 to 1.7 (mean1.47) in adult recipients

4. Hepatic arteries of the grafts and recipients : Diameters and sizes, anomalies and the number of graft arteries, the recipient artery chosen, the backflow in the graft artery, presence of mismatch, type of anastomosis and number of stitches .The recipient right hepatic artery was the usual vessel chosen for the anastomosis in 18 cases (90%) ,the left artery in 2 cases (10%). A small mismatch between the diameter of the donor and recipient hepatic arteries , was managed by anastomotic stitches of the anterior wall. A large mismatch was managed by funneling of the smaller vessel. Mcirovascular technique was used for the anastomosis, needing 11 to 14 stitches.
5. The results of the intra-operative ultrasound: The wave form, acceleration time, and resistivity index.
6. The results of the routine postoperative doppler ultra sound.
7. The use of postoperative anticoagulation, its form and duration
8. The presence of postoperative arterial complications and their management
9. Mortality

RESULTS

The preoperative assessment for the hepatic artery in the donors, revealed a normal anatomy in 16 cases (80%). In case 10, the hepatic artery originated directly from the aorta (fig.1). In case 11, the hepatic artery originated from the celiac trunk and divided into the left hepatic artery and gastroduodenal artery, and the right hepatic artery originated from the superior mesenteric artery (fig.2). Case 16 had a trifurcated hepatic artery (fig.3). In case 17, the right and left hepatic arteries originated separately from the celiac trunk (fig.4).

The comparison between the operative findings and preoperative assessment of the anatomy of the hepatic artery did not match in 4 cases (20%). Case 1 had a normal preoperative

anatomy but the operative findings revealed a trifurcated hepatic artery. Case 16 revealed preoperatively a trifurcated artery but the operative findings confirmed the trifurcation but showed also an accessory left hepatic artery arising from the left gastric artery. Case 17 revealed preoperatively the left and right hepatic arteries originating separately from the celiac trunk but the operative findings revealed a normal anatomy of the hepatic artery. Case 18 revealed a normal preoperative anatomy of the artery, but the operative findings revealed an accessory right hepatic artery originating from the superior mesenteric artery

The results of the intra-operative doppler ultrasound revealed normal Doppler criteria in 13 cases (65%), in terms of the waveform, acceleration time and resistivity index .Six cases showed abnormal patterns in the intra-operative duplex (35%).Case 8 revealed criteria of a spastic artery, yet clamping of the portal vein improved the signal. Case 10 showed a mild kink, but the artery was patent, and no further management was required .Case 11 had an insignificant small flap in the pre-anastomotic region, and it was conserved upon .Cases 15,17 and 20 showed the pattern of spastic arteries, which was reversed after application of papaverine. The results of the routine postoperative duplex scanning, which was done twice daily showed 3 cases having doppler criteria of hepatic artery thrombosis. The first case had early thrombosis and received local catheter directed thrombolytic therapy in the form of streptokinase with complete resolution of the hepatic artery thrombosis ,but the post-angiography duplex revealed a kink (fig.5).The second case, a trial of angiography failed so surgical revascularization via thrombectomy and revision of the anastomosis was performed (fig.6).The third case angiography was performed and streptokinase infusion given, but re-thrombosis occurred and the patient was re-explored and revision of the anastomosis was done (fig.7).A total of 6 mortalities (30%) were recorded, but none was related to a complication in the hepatic artery. Among the 3 patients who developed hepatic artery thrombosis, there were 2 mortalities, yet both deaths were not related to the hepatic artery complication. One died from severe chest infection and the second from multiple organ failure.

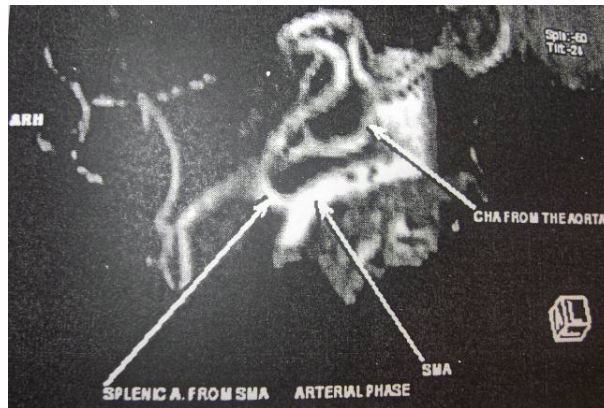


Fig. (1) : Magnetic Resonance Angiography of case 10 of the donors revealing the common hepatic artery arising directly from the aorta

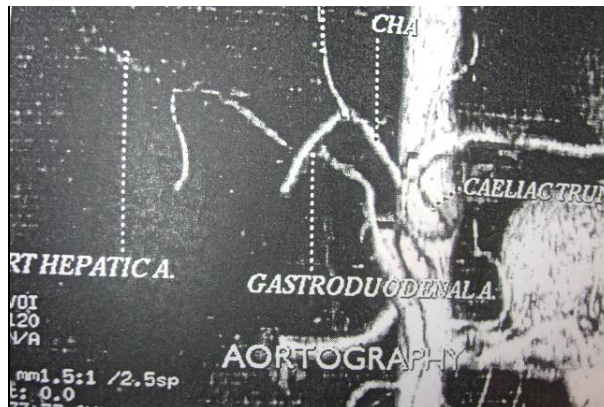


Fig.(2) : Magnetic resonance angiography of case 11 of the donors revealing the hepatic artery arising from the celiac trunk and dividing into left hepatic artery and gastroduodenal artery. The right hepatic artery arising from the superior mesenteric artery



Fig.(3): Magnetic resonance angiography of case 16 of the donors revealing trifurcation of the hepatic artery

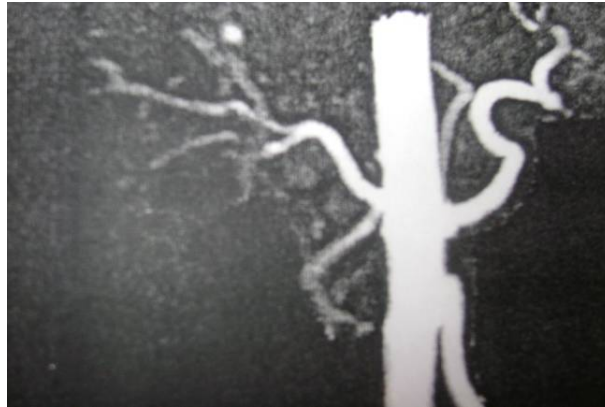


Fig.(4) : Magnetic resonance angiography of case 17 of the donors revealing the right and the left hepatic arteries arising separately from the celiac trunk

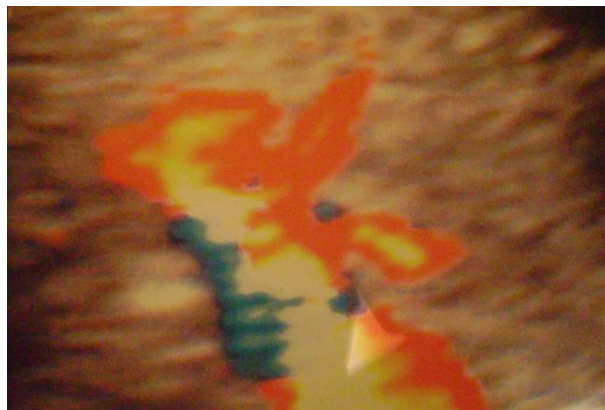


Fig. (5) : Post-angiography duplex of case 9 of the recipients showing a patent but kinked hepatic artery after complete resolution of the thrombosis following endovascular streptokinase injection



Fig.(6) : Postoperative duplex of case 10 of the recipients revealing good flow in the hepatic artery following thrombectomy and revision of the anastomosis



Fig.(7) : Intra-operative re-exploration duplex of case 10 of the recipients after thrombectomy and streptokinase showing re-establishment of the hepatic flow

DISCUSSION

Analysis of the hepatic artery anatomy in our group, revealed that 20% of the donors had anomalies, which is less frequent than the 45% incidence reported by Michel's in 1966⁽⁴⁾

It is noteworthy that 4 out of 20 cases (20%) showed inconsistencies between the operative findings and the preoperative assessment. This result is in discordance with the study of Fraioli et al⁽⁵⁾, who were able to identify all the 5 anomalies preoperatively of the hepatic artery. Tanaka⁽⁶⁾ stated that evaluation of the hepatic artery by ultrasonography or three dimensional computed tomogram is not indispensable for surgery, as intra-operative findings are usually sufficient for safe reconstruction. In our study the findings of the preoperative assessment of the hepatic artery did not preclude any donor from liver donation.

All patients included in our study had microsurgical hepatic artery reconstruction. There has been a significant reduction in the incidence of hepatic artery complications since the introduction of microsurgery⁽⁷⁾. Flow re-establishment in patients with hepatic artery thrombosis uncovered anatomic defects in the form of hepatic artery stenosis and or hepatic artery kinking in a study done by Zhao in 10 out of 11 patients⁽⁸⁾. Regarding the incidence of hepatic artery thrombosis in our series there were 3 patients. They had a trial of thrombolytic therapy which succeeded in 1 patient and failed in the other 2 patients. Both were managed

eventually surgically in the form of a thrombectomy, local thrombolytic therapy and re-anastomosis.

CONCLUSIONS

The incidence of hepatic artery anomalies is slightly less than stated in previous reports. Preoperative evaluation of the donor hepatic artery anatomy is not indispensable to safe hepatic artery reconstruction. Experience is the mainstay of microvascular arterial reconstruction. Operative factors as vessel size discrepancy requiring funneling, intimal edema and friability, the choice of the artery to be anastomosed and intra-operative arterial spasm did not affect the outcome. Intra-operative duplex is a good means to determine the hepatic artery at risk for thrombosis. The presence of an arterial kink is the only clear predisposing factor for hepatic artery thrombosis in our study. Hepatic artery kink and hepatic artery stenosis unveiled after thrombolysis have to be corrected via stent/angioplasty to achieve definitive endoluminal technical success. Pre and intra-operative parameters of the optimal arterial length need to be clarified. A clear treatment strategy for non complicated hepatic artery kinks needs to be established.

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