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A Road Map to Hepatic Artery in Live Liver Donors

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Abstract: ***Aim of this study is to document the prevalence of anatomical variations of hepatic artery from MDCT abdomen images of live liver donors who have attended to a tertiary care hospital in Kochi. Images of 300 live liver donors were assessed and grouped according to the classification done by Michel. Of the MDCT images in arterial phase observed, hepatic artery is classified as type I in 57.33% cases, type II in 7% cases, type III in 8.33% cases, type IV in 2.33% cases, type V in 9% cases, type VI in 0.67% cases, type VII in 1% cases, type VIII in 2.33% cases, type IX in 0.67% cases and 11.33% cases were grouped as "Others". Type V is the most common hepatic arterial variant in the study as opposed to the most frequently encountered variant in literature (Type III) which stands second here. Type V is the most desired variant by the surgeons in right lobe liver transplantation as the right lobe can be resected with a long arterial trunk and the left lobe supply is not compensated.***

Keywords: Living donor liver transplantation (LDLT), Multi-detector computed tomography, hepatic artery

1. Introduction

Liver transplantation has matured from an experimental procedure to an accepted life saving operation for long time survival in patients with advanced liver diseases who have reached the limits of medical intervention. In LDLT donor safety is paramount and donor evaluation is done to find out whether the donor is suitable for donation and also to evaluate the vascular anatomy, segmental anatomy and the bile duct anatomy. The understanding of internal anatomy of liver has greatly facilitated liver surgery[1]. Preoperative clinical and radiological evaluation of the transplant candidate is critical for appropriate patient selection. The main objective of preoperative imaging is to provide the surgeon with necessary information to plan and perform liver transplantation and exclude donors with whom surgery is not feasible. Multidetector CT proves to be valuable in the evaluation of a potential live liver donor by providing comprehensive information about the hepatic vascular anatomy[2]. Most of our knowledge is based on the data obtained from Western and East Asian studies. We endeavor to analyze the pattern of hepatic artery in Indian patients with similar studies in the past.

2. Materials and Methods

The data required for this retrospective study is collected from the Department of Radiology, Amrita Institute of Medical Sciences, Kochi. This includes the MDCT images of the hepatic vasculature of 300 live liver donors who had undergone hepatectomy during the period 2006-2014. For imaging 64 multidetector CT scanner (SEIMENS SENSATION CARDIA-64) is used. The pre-contrast series is taken in 5 mm slice thickness. An average of 80 ml of low osmolar non-ionic contrast medium (Omnipaque 350mg) is given at 5 ml/sec. The post-contrast CT images are taken at 6s, +20s and +30s for arterial, portal and delayed phase respectively. The images that had undergone three-phase, dual-enhancement are analyzed from their source images and from three-dimensional (3D) post processing images like maximum intensity projections (MIP) and reconstructed image as volume renderings (VR). The MDCT images of each case are reviewed and interpreted with the help of an experienced GI surgeon and Radiologist. The course of the hepatic artery, portal vein and hepatic vein is observed and recorded. The normal and variant architecture of these vessels are tabulated based on existing standard reference classifications. The classifications used in the study are selected with a view to help in liver resection from LDLT standpoint. Hence we classified the hepatic artery according to Michel classification.

Table 1: Anatomical Classification of the hepatic artery and its variants by **Michel** et al in 1955 [3]

Michel's Classification of Hepatic Artery	
Type	Description
I	Normal anatomy
II	The left hepatic replaced from left gastric artery
III	The right hepatic replaced from superior mesenteric artery
IV	The right hepatic artery replaced from superior mesenteric artery and the left hepatic replaced from left gastric artery
V	An accessory left hepatic from left gastric artery.
VI	An accessory right hepatic from superior mesenteric artery
VII	An accessory left hepatic from left gastric artery. The accessory right hepatic from superior mesenteric artery
VIII	Combination patterns of replaced right hepatic and an accessory left hepatic or an accessory right hepatic with a replaced left hepatic
IX	Entire hepatic trunk derived from superior mesenteric artery
X	Entire hepatic trunk from left gastric artery
XI	*Others*

3. Results

Out of the 300 MDCT images of the hepatic vasculature observed the hepatic artery was classified as type I in 72 cases (57.33%), type II in 21 cases (7%), type III in 25 cases (8.33%), type IV in 7 cases (2.33%), type V in 27 cases (9%), type VI in 2 cases (0.67%), type VII in 3 cases (1%), type VIII in 7 cases (2.33%), type IX in 2 cases (0.67%) and 34 cases (11.33%) were grouped as "Others".

Table 2: Comparison of Percentage of the Hepatic artery

CLASSIFICATION OF THE HEPATIC ARTERY		
Type	Percentage in this study	Percentage In Michel's[3] study
I	57.33%	55%
II	7.00%	40%
III	8.33%	10%
IV	2.33%	1%
V	9.00%	8%
VI	0.67%	7%
VII	1.00%	1.00%
VIII	2.33%	2.33%
IX	0.67%	0.5%
X	0	2.5%
OTHERS	11.33%	0

4. Discussion

Liver resection has gained importance in the field of surgery as a therapeutic means for several liver diseases. LDLT has added another dimension for liver resection. Success of liver surgeries is not only due to refinements in surgical, anaesthetical and critical care developments but also due to the precision of anatomical assessment. The precise preoperative anatomical road map helps the surgeon make a complex surgery technically feasible. In LDLT, the recipient and the donor, both will be benefitted by the information on minute details of the hepatic vasculature. The advent of MDCT has made it a single stop method preferred technically to assess the information regarding potential liver donors[2]. For assessing the results of the present study on the variants of hepatic artery, we use the classification done by Michel[3].

Our study reveals normal hepatic arterial anatomy (type I) in 172 cases (57.33.%) which is almost similar to Michel's cadaveric study (55%)[3] but lower when compared to studies of Kishi et al (61%)[4], Covey et al (61.3%)[5] and Ozsoy et al (64%)[6]. Prevalence of replaced left hepatic artery from the left gastric artery (type II) is 7% in our study, 10% in Michel's study, 40% in Schroeder et al[7] and 17% in Ahmed's [8]work.

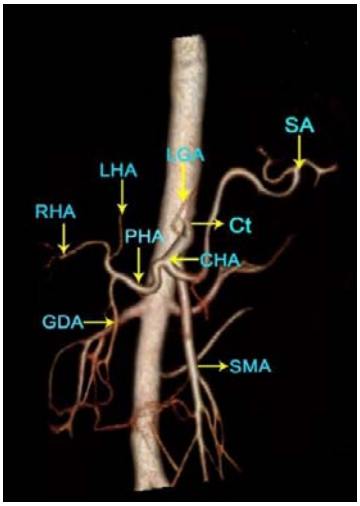

Figure 1: MDCT VR image showing the hepatic arterial anatomy TYPE I(right image)

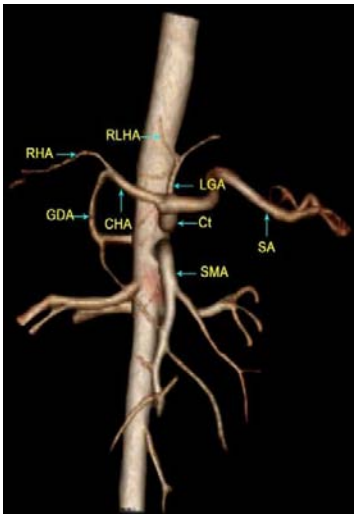

Figure 2: MDCT VR image showing the hepatic arterial anatomy TYPE II(left image

The frequency of type III variant is 8.33%. Similar prevalence is seen in studies of Kamel (7.5%)[9], Lopez et al (7.8%)[10], Badrawy et al (8.3%)[11] and Schroeder et al (8.4%)[12]. A greater percentage of distribution is seen in the studies done by Ugurel et al (17%)[13] and Ekholy et al (15%)[14]. In the literature the most frequently encountered variant is type III.

Incidence of type IV (2.33%) in the present study is a little higher when compared to Michel's (1%)[3]. Similar results to that of our study are seen in studies by Kamel (2.5%)[9], Zuang et al (2.9%)[15], Suzuki et al (2%)[16] and Sari et al (2%)[17]. Prevalence of type V is 9% in our study, which is similar to that seen in Michel's study 8%[3], Ali's 9.4%[18]. Higher rates are given by Zuang et al (10.8%)[15] and Covey et al (10.7%)[5]. Type VI (0.67%) in the present study showed a very low prevalence when compared with that of Michel's 7%[3] but was almost similar to that of Schroeder et al (0.8%)[12], Tsang et al (0.8%)[19] and Lopez et al (0.6%)[10]. Prevalence of type VII (1%) and type VIII (2.33%) in the present study are same as that by Michel[3], Ugurel et al[13] and Covey et al[15]. Prevalence of Type IX (0.67%) is also very low in our study as seen in Michel (0.5%)[3] and Ahmed (0.6%)[8]. Type X, a rare variant, was reported by Michel[19] (2.5%)[3]. No cases of this variant were seen in the present study. In the present study 34 cases classified as 'Others', contained rare anomalies that are not consistent with any type described in Michel's classification.

Liver segment IV is of critical importance in transplant surgery for the reason that it is important to know the origin of its blood supply, as the segment IV is spared during the surgery[20]. In our study the segment IV is supplied by the LHA in 72.33% of the cases. This is supported by studies by Salisoy et al[21], Ali et al[18], Ahmed[8] and Ekholy et al[14] with a prevalence of 75% and Kamel's study (62.5%)[19]. Only 23% of the cases were supplied by the RHA in our study.

The strength of this study is its sample size, the results were confirmed intraoperatively and this is the first study done in liver donors in an Indian setup. However the limitations of the study are that the study group included only the donors who underwent liver resection

5. Conclusion

Variations in the hepatic vasculature are frequently encountered and reported in several studies. LDLT is a procedure requiring detailed evaluation of the hepatic vascular anatomy to ensure successful postoperative results. The triphasic CT protocol using 64 detector-row permits comprehensive and accurate assessment of the detailed hepatic vascular anatomy in liver transplant potential donors, thereby preventing surgical complications arising from vascular variations.

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