Original Article

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Multidetector Computed Tomography in Hepatic Artery Variation – A Cross-Sectional Study

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Abstract

Background: Hepatobiliary surgery requires a detailed preoperative evaluation of vascular anatomy through a non invasive modality. The purpose of our study was to determine the anatomical variation in the hepatic arteries and classify them according to Michels classification in patients who underwent abdominal angiography for various reasons. **Subjects and Methods:** This was a prospective study done in a tertiary care hospital in northern India which included 500 consecutive patients undergoing triple-phase abdomen CT for various abdominal indications. Plain CT followed by triple-phase CT angiography of the abdomen was performed. The origin and branches of the hepatic artery were examined in detail and classified according to Michels classification. The unnamed variants and other abnormal findings were mentioned separately. **Results:** Out of 500 patients, there were 268 males and 234 females. Three hundred and eleven out of the 500 patients (62.2%) had the classic arterial anatomy identified at CT angiography. The most common variant identified was Michels type V (9%). The second most common variant identified was Michels type III (6.4%). Ninety-seven (19.4%) had a single arterial aberration, and 25 patients (5%) showed more than one arterial variant. There was a trifurcation pattern identified in 20 patients (4%). Different combinations of accessory and replaced hepatic arteries were identified in 26 patients (5.2%).Both Males and females had type 5 as the most common variation in our study followed by type 3. **Conclusion:** Our study shows a high prevalence of the hepatic arterial variation in our population (37.8 %).

Keywords: Hepatic artery, Computed Tomography Angiography, Cross sectional study.

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Introduction

Hepatobiliary surgery requires a detailed preoperative evaluation of vascular anatomy through a noninvasive modality. The diagnostic modality should provide a detailed description of the anatomy without much complication. Diagnostic imaging with Multidetector computed tomography (MDCT) has emerged as an accurate diagnostic modality for preoperative evaluation.[1, 2]
Hepatic arterial anatomy is important in liver transplant, hepatic resections, pancreaticobiliary surgeries and arterial chemotherapy of liver tumors.[3-14]The frequency of iatrogenic injury increases with variant anatomy. Normal liver tissue is mainly perfused by the portal vein. The hepatic metastasis generally derives maximum blood supply from hepatic arteries. Infusion pumps in hepatic arteries reduce dosage to normal liver parenchyma and allow maximum doses to tumours.[15]
The most frequently used classification system for hepatic artery anatomy is one given by Michels in 1955. Michels[16] classification is based on dissection of 200 cadavers. Michels classification describes 10 types with normal anatomy classified as type I and rest as variants (II-X). [Table 2], [Figure 1-9].
In the Michels type I the celiac trunk arises in the upper abdomen from the ventral abdominal aorta. It then divides into the left gastric artery, splenic and common hepatic artery. The common hepatic artery bifurcates in to the gastroduodenal artery and proper hepatic artery. The hepatic artery bifurcates into the right and left hepatic arteries which then supply the liver parenchyma.
Diagnostic subtraction angiography (DSA) is an invasive modality which is the gold standard for vascular anatomy. There is an excellent correlation between conventional angiography and MDCT in hepatic artery evaluation.[17]MDCT has various post-processing tools like volume rendering(VR) and maximum intensity projections (MIP) which allow better characterizations of the anatomy.
The purpose of our study was to determine the anatomical variation in the hepatic arteries and classify them according to Michels classification in patients who underwent abdominal angiography for various reasons.

Subjects and Methods

This prospective study was undertaken at a tertiary hospital in northern India.The study included 500 consecutive patients with hepato-biliary-pancreatic diseases and patients undergoing triple-phase abdomen CT for other abdominal indications. The period of study was from Jan 2011-June 2012.Male and female patients between the age group of 1 year to 70 years were included in the study. Patients who did not give consent, patients with past history of surgery involving resection of liver or any intervention involving hepatic artery, patients with h/o major trauma abdomen, patients who had contraindications for MDCT and patients of Takayasu's arteritis were excluded from the study.

Plain CT followed by CTA was performed using a 64 slice Multidetector CT scan (Philips) and 128 slice MDCT (Siemens). The area covered was from diaphragm to the symphysis pubis. The patient was positioned supine.100 ml of non-ionic contrast medium was injected at the rate of 5 ml/sec followed by saline flush through the antecubital vein with 20G cannula using a power injector. The time of delay was chosen using smart prep (bolus tracking software) placing the region of interest on abdominal aorta.

The scan was automatically started once a threshold of 150 HU was reached. Source images, thus obtained were transferred to the workstation dedicated to the scanner where the processing was done. Image post-processing was performed using the work station of the CT equipment. The estimated time for post-processing was recorded. For the detection and characterization of vessels, both 3D volume-rendered images and MIP images were studied. The data was reviewed by one diagnostic radiologist (15 years experience). The arterial tree was examined from celiac to the hepatic artery branches. The origin and branches of the hepatic artery were examined in detail and classified according to Michels classification. Unnamed variants were mentioned separately.

Statistical Analysis

This prospective study was approved by the institutional ethics committee. Descriptive statistics were applied- absolute and relative frequencies.

Results

Out of 500 patients, there were 268 males and 234 females. The age distribution of our study population is given in Table I.Three hundred and eleven out of the 500 patients (62.2%) had the classic arterial anatomy identified at CT angiography. The most common variant identified was an accessory left hepatic artery arising from the Left gastric artery in 45 patients (9%).The second most common variant identified was a replaced right hepatic artery originating from the superior mesenteric artery, seen in 32 patients (6.4%). Ninety-seven (19.4%) had a single arterial aberration, and 25 patients (5%) showed more than one arterial variant. The common hepatic artery originated from the superior mesenteric artery in 5 patients (1%) and from the aorta in one patient (0.2%). Apart from the Superior mesenteric artery, the right hepatic artery originating from the celiac axis was seen in 11 patients (2%), the common hepatic artery in 5 patients (1%) and from the aorta in one patient (0.2%). A left hepatic artery was identified originating from the common hepatic artery in 21 patients (4.2%), from the LGA that arose from aorta in 4 patients (0.8%) the gastroduodenal artery in 2 patients (0.4%) and SMA in one patient (0.2%). There was a trifurcation pattern identified in 20 patients (4%) in which the gastroduodenal artery the right and the left hepatic arteries arose simultaneously just after the common hepatic artery. Different combinations of accessory and replaced hepatic arteries were identified in 26 patients (5.2%).Males had type 5 as the most common variation in our study followed by type 3. In females also type 5 was most common followed by type 3. The frequencies of the different types of arterial variants identified were reported as suggested by Michelset al[16] in table II.

Table 1: Age-wise distribution of the study population

Age (Years)	Number
0-19	16
20-29	47
30-39	63
40-49	122
50-59	114
60-69	96
70-79	40
80-89	2

Table 2: Arterial variations as per Michels classification[16]

Arterial abnormalities		N= (500)
1	Classic (normal)	311(62.2%)
2	Replaced left hepatic artery from the left gastric artery	11(2.2%)
3	Replaced right hepatic artery from the superior mesenteric artery	32(6.4%)
4	Replaced right hepatic artery + left hepatic artery	2(0.4%)
5	Accessory left hepatic artery	45(9%)
6	Accessory right hepatic artery	9(1.8%)
7	Accessory right hepatic artery + left hepatic artery	6(1.2%)
8	Replaced right hepatic artery and accessory left hepatic artery or replaced left hepatic artery and accessory right hepatic artery.	18(3.6%)
9	Common hepatic artery from the superior mesenteric artery	5(1%)
10	Common hepatic artery from the left gastric artery	0
-	Other variants	61(12.2%)

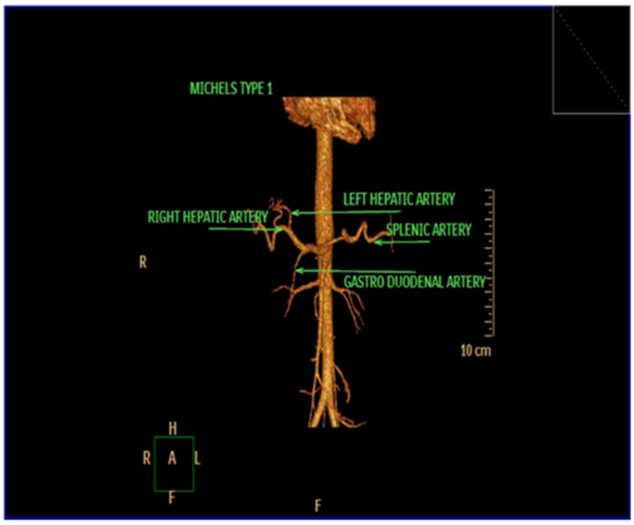

Figure 1: Coronal volume-rendered MDCT image showing MICHELS TYPE I variation.

Figure 2: Coronal MIP MDCT image showing MICHELS TYPE II variation.

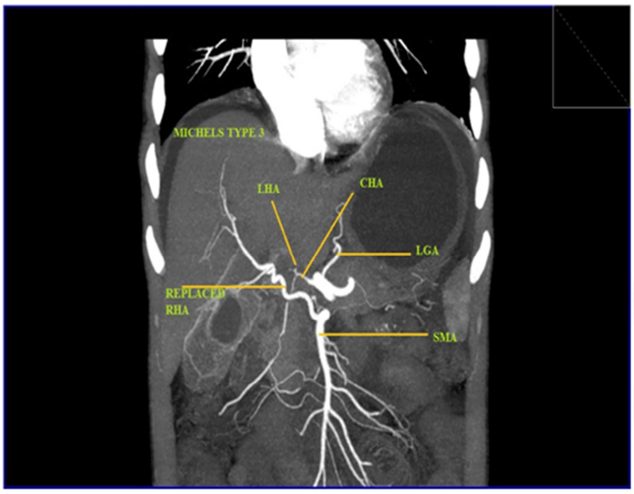

Figure 3: Coronal MIP MDCT image showing MICHELS TYPE III variation.

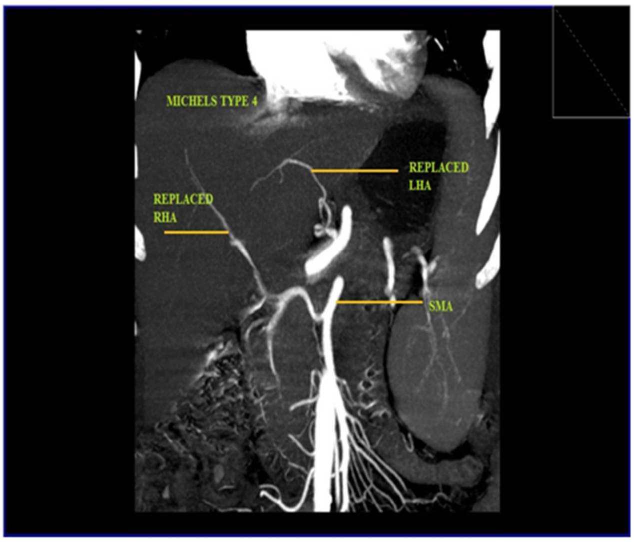

Figure 4: Coronal MIP MDCT image showing MICHELS TYPE IV variation.

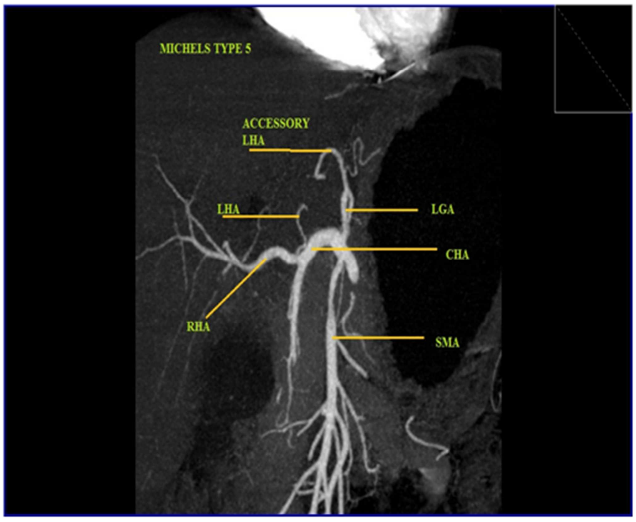

Figure 5: Coronal MIP MDCT image showing MICHELS TYPE V variation.

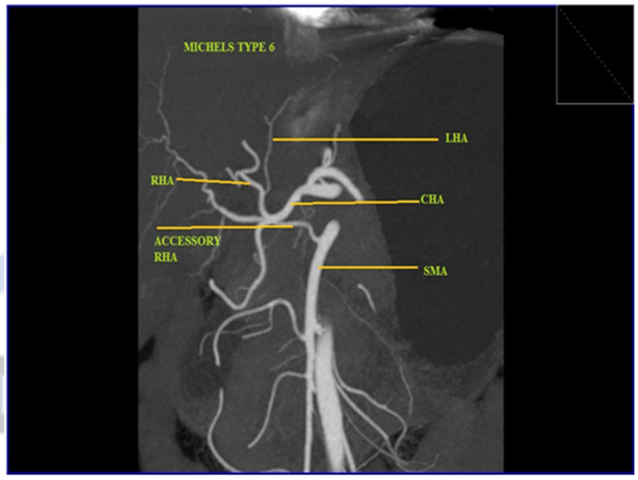

Figure 6: Coronal MIP MDCT image showing MICHELS TYPE VI variation.

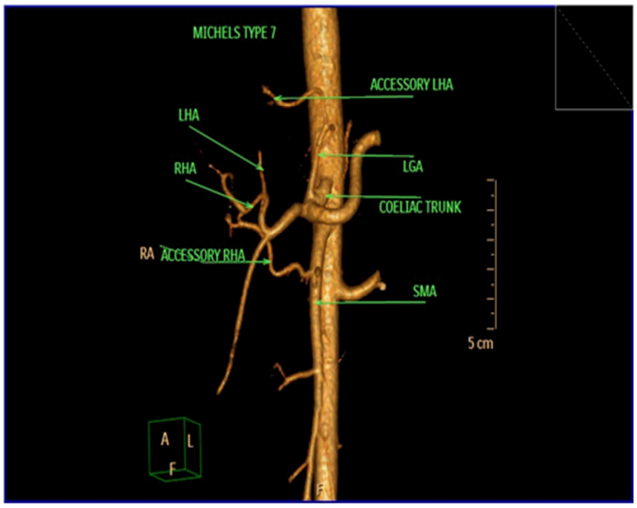

Figure 7: Coronal volume-rendered MDCT image showing MICHELS TYPE VII variation.

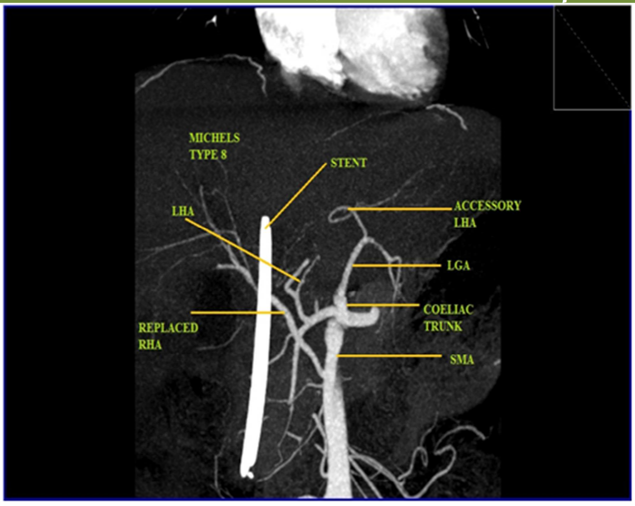

Figure 8: Coronal MIP MDCT image showing MICHELS TYPE VIII variation.

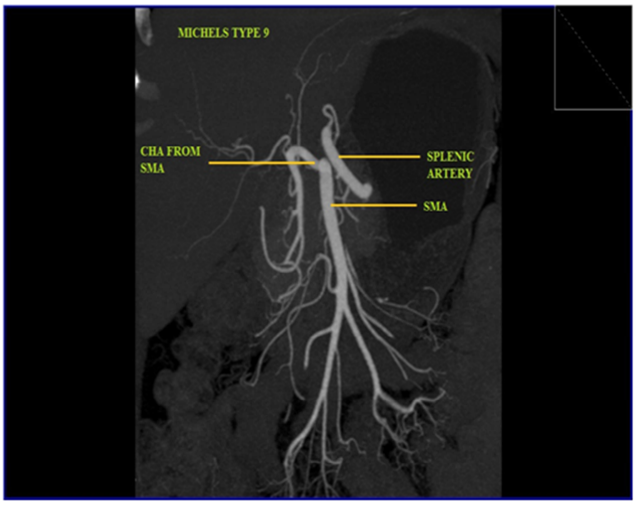

Figure 9: Coronal MIP MDCT image showing MICHELS TYPE IX variation.

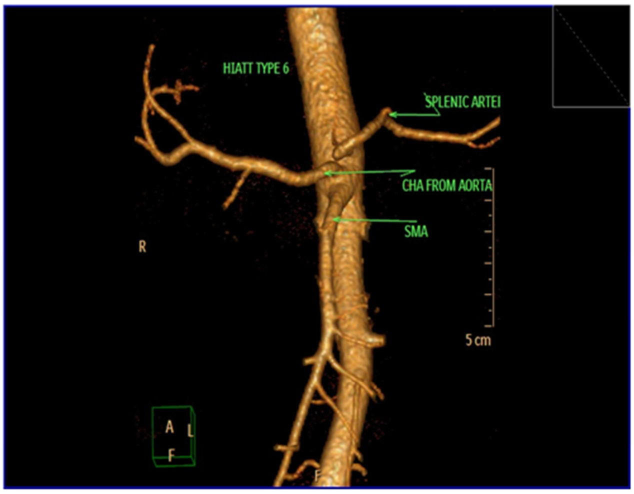

Figure 10: Coronal volume-rendered image of the abdominal aorta showing the common hepatic artery directly arising from the aorta.

Discussion

In Our CT angiographic study reveals the same incidence as Michelsstudy for type I. Our most common variant was type V in which accessory left hepatic artery originated from the left gastric artery. This was different from Michels who found type III as the most common variant. In this aspect, our study showed similar results as the Covey[18] study of 700 patients. Replaced Left hepatic artery was seen in 2.2% and replaced right hepatic artery 6.4%. In Michels type 8 all were replaced Right Hepatic Artery with accessory Left Hepatic Artery and none were replaced Left Hepatic Artery with accessory Right Hepatic Artery. We did not encounter a common hepatic artery arising from the left gastric artery (Michels type X) but in one case we saw a common hepatic artery arising from aorta (Fig 10) which was not described by Michels.

In our study, we discovered 61 variants (12.2%) not described by Michels classification. Among these unnamed variants, we found that there was a trifurcation pattern identified in twenty patients in which the gastroduodenal artery, the right, and the left hepatic arteries arose simultaneously from the common hepatic artery without the formation of the proper hepatic artery. In ten patients the Right Hepatic Artery arose directly from the celiac trunk. Out of these, 1 patient had Left Hepatic Artery from Left Gastric Artery and another had Left Hepatic Artery arising from Left Gastric Artery that originated directly from the aorta and the rest had normal Left Hepatic Artery from Hepatic Artery Proper. In five patients the Right Hepatic Artery arose from the Common Hepatic Artery. Out of these 5 patients, 1 had Left Hepatic Artery arising from Gastro Duodenal Artery and one from Left Gastric Artery. In one patient Right Hepatic Artery directly arose from aorta. The other variants consisted of Left Hepatic Artery arising from the Common Hepatic Artery in twenty-one patients, from Left Gastric Artery arising from aorta in three patients and Superior Mesenteric Artery one patient.

Our study confirms that variant anatomy of the hepatic arteries is common, occurring in 37.8% of our patients.

The significance of our study is in hepatic surgeries and tumor embolization. The trifurcation pattern in which common hepatic artery trifurcates into the right hepatic artery left hepatic artery and gastroduodenal artery is important because inadvertent clamping or ligation of common hepatic arterieswill result in bowel ischemia. Similar relevance is for right or left hepatic arteries arising from the common hepatic artery before the origin of gastroduodenal artery.[19] If an infusion pump is to be placed then more than one catheter needs to be placed if there is variant hepatic arterial anatomy for adequate tumor perfusion.[20] Replaced or accessory left and right hepatic arteries will increase the complexity of surgeries in liver transplant recipients.[19]

Our study had a few limitations. First,it was reviewed by a single diagnostic radiologist and second, we did not have a DSA comparison.

Conclusion

Our study shows a high prevalence of the hepatic arterial variation in our population (37.8 %). The most common variation wasMichels type V followed by type III. This was similar in males and females.

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