Morphometric Study of Celiac Trunk Specific Reference to Hepatic Artery Pattern in the West-Indian Population

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Abstract The aim of this study was to analyze anatomy of the celiac trunk through its diameter, length, and variation of its branches. We studied 40 cadavers (25 males and 15 females) in the various colleges in the west India for the variation in the celiac trunk. Dissection of the celiac trunk was performed after opening of the peritoneal cavity. The length of the celiac trunk up to the common hepatic artery was observed. Diameter of the celiac trunk and distance between the celiac trunk and the superior mesenteric artery were observed. We found cases of rare vascular variation in the branching pattern and the common hepatic artery, which arises from the superior mesenteric artery and there is abnormal relation between the common hepatic artery portal vein and the bile duct. In a case we have observed that the superior mesenteric artery gives acute angulations downward on the right side. This type of study of celiac trunk and presence of variation in hepatic arteries will allow the surgeon to practice safe laparoscopic cholecystectomy, liver resections, or vascular recombination in transplantation and, thereby, avoid errors and patient morbidity.

Keywords Celiac trunk · Superior mesenteric artery · Common hepatic artery · Portal vein

Introduction

The celiac trunk is the first visceral collateral branch of the abdominal part of the aorta, originating at its anterior contour just below the aortic hiatus of the diaphragm. Introduction of laparoscopic cholecystectomy has stimulated a renewed interest in the anatomy of the celiac trunk and hepatic artery [1]. Division or damage with subsequent thrombosis produces ischemia of the liver or bile duct which can have devastating consequences for the patient. Surgeons undertaking hepatobiliary surgery must know the celiac trunk with specifically hepatic artery anatomy and be able to recognize the multiple variants for safe surgery and low morbidity. The anatomy of the hepatic artery, and its variants, has been described adequately in the literature starting with Haller in 1756 (celiac axis variations), Tidemann in 1822 (multiple anomalies), Adachi in 1928 (28 subgroups), and classic analyses by Flint (1923) and by Michels (1955) [2–5]. A new emphasis was given to this anatomy by the introduction of liver transplantation [6]. The arterial patterns are of importance in planning and performance of all surgical and radiological procedures in the upper abdomen. However, surgical mistakes from failing to appreciate hepatic artery anatomy continue to be made with serious consequences to the patient, and with medicolegal implications. This article builds on a previous report, and reemphasizes the importance of identifying the morphology, anatomy, and variations of the celiac trunk and the hepatic artery. This anatomy will become even more important as computerized surgery develops.

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Material and Method

We observed 25 male and 15 female cadavers during routine dissection in the various government colleges in the west India. These cadavers were dissected by the first-year MBBS students.

With the help of Cunningham manual of dissection, students dissected the anterior abdominal wall and then the celiac trunk and the superior mesenteric artery; the pancreas was removed by piecemeal dissection. The celiac trunk was traced to see all its branches including the common hepatic artery and its two terminal branches, hepatic and gastroduodenal arteries. When the hepatic artery is exposed clearly, the relation of the hepatic artery is observed. A measuring tape was used to measure the length of arteries. For the measurement of external diameter, a vernier caliper was used. Arteries were cut from two points—at the origin of the celiac trunk and just before the bifurcation of the common hepatic artery. The wax was filled in the lumen and then the external diameter was measured with the vernier caliper.

The length was measured between the origin of the celiac trunk and the division of the common hepatic artery and also between the origin of the celiac trunk and the superior mesenteric artery.

Results

Measurement of Length from the Celiac Trunk Up to the Common Hepatic Artery The length of the celiac trunk up to the common hepatic artery in male cadavers had a mean of 17.2 mm, with minimum length of 4 mm and maximum 34 mm. In female cadavers the mean length was 17 mm, the minimum 8 mm and maximum 26 mm. For both sexes mean was 17.1 mm. Statistical analysis showed no significant differences between sexes (statistical analysis by z test; $n_1=25$; $n_2=15$; mean $X_1=17.2$; mean $X_2=17$; at 5 % significance level).

Measurement of the Celiac Trunk Diameter Diameter of the celiac trunk was measured at its origin. Male cadavers had a mean of 6.5 mm, with a minimum diameter of 4 mm and maximum 10 mm. Female cadavers had a mean of 6.7 mm, with minimum diameter of 4 mm and maximum 9 mm. For both sexes mean was 6.6 mm. No statistically significant differences of measures taken from the celiac trunk diameter in both sexes were observed

Distance Between the Celiac Trunk and the Superior Mesenteric Artery In male cadavers, the minimum distance was 3 mm, maximum 18 mm, and the mean of 8.2 mm. In female cadavers, the minimum distance was 3 mm,

maximum 15 mm, and mean of 8 mm. For both sexes average mean was 8.1 mm.

Diameter of the Common Hepatic Artery Diameter of the common hepatic artery in male cadavers ranged from 3 to 9 mm with mean of 5.4 mm, and in female cadavers mean diameter was 5.2 mm, with minimum diameter 2 mm and maximum 8 mm. For both sexes average mean was 5.1 mm.

During dissection we observed the abnormal position of the common hepatic artery below the portal vein in one female case. The diameter of the common hepatic artery is 6 mm at the origin. The position of the structures from anterior to posterior is the portal vein, common hepatic artery, and bile duct. The common hepatic artery, as we can see in Fig. 1, comes from the superior mesenteric artery. After passing behind the portal vein, it divides in the hepatic artery proper and gastroduodenal artery. The distance between the celiac trunk and the superior mesenteric artery is 10 mm. The superior mesenteric artery divides into two major arteries at the distance of 24 mm, one passes below the portal vein and later on divides into the hepatic artery proper and gastroduodenal artery, and the other branch continues as the superior mesenteric artery.

In another case we found tongue-shaped elevation (lobe) of the liver (Fig. 2) and the common hepatic artery from the superior mesenteric artery, but the position of the artery was anterior than the portal vein. The distance between the superior mesenteric artery and the celiac trunk was 18 mm in this case, with diameter of the common hepatic artery 7 mm at the origin from the superior mesenteric artery. The common hepatic artery divided at the distance of 16 mm.

In the other documented case, the superior mesenteric artery shows acute angulations downward and toward right approximately at 1 cm after arises from the abdominal aorta. The distance between the celiac trunk and the superior mesenteric artery is 8 mm (Fig. 3).

Fig. 1 Celiac trunk (1), superior mesenteric artery (2), common hepatic artery (3), portal vein (4), and gastroduodenal artery (5)

Fig. 2 Celiac trunk (1), accessory lobe of liver (2), superior mesenteric artery (3), common hepatic artery (4), portal vein (5), gastroduodenal artery (6), and bile duct (7)

Discussion

It was observed that the distance between the celiac trunk and the superior mesenteric artery, in 40 cadavers, ranged from 3 to 18 mm with a mean of 8.1 mm, differing from the findings of some authors who obtained the following measures: 5–31 mm, with a mean of 16 mm in 38 (George) [7]; 10–20 mm in 70 (Anson and McVay) [8], and a mean of 13 mm (Cauldwell and Anson).

The length from the celiac trunk up to the common hepatic artery ranged from 4 to 34 mm with mean of 17.1 mm. These results are in agreement with that of Rio Branco [9], who reported a length from 5 to 40 mm, and Michels (1951), who observed 8–40 mm, while different from that of Orts Llorca, who found up to 12 mm, and of Latarjet and Ruiz-Liard [10], who observed 10–15 mm. Also, in our study, the celiac trunk did not reach a length of 45 mm, as observed by Yuksel and Sargon (1992).

In our studies, the mean diameter of the celiac trunk was 6.6 mm, minimum 4 mm and maximum 10 mm, similar to

Fig. 3 Celiac trunk (1), abdominal aorta (2), and superior mesenteric artery (3)

that of Rio Branco [9], who observed variations from 4 to 10 mm; Michels (1951) from 3 to 12 mm; Pignataro [11] from 10 to 12 mm; Fumagalli and Cavallotti 7 mm; and Latarjet and Ruiz Liard [10] a mean of 6 mm.

A common hepatic artery (CHA) arising from the superior mesenteric artery (SMA) or directly from the aorta was present in 3.5 % [6]. We found such two (5 %) cases out of 40 cadaveric cases which show statistically significant difference at 5 % level of significance. An intact hepatic artery is the gateway to successful hepatobiliary surgery. Introduction of laparoscopic cholecystectomy has stimulated a renewed interest in the anatomy of the hepatic artery [1]. Division or damage with subsequent thrombosis produces ischemia of the liver or bile duct which can have devastating consequences for the patient. Surgeons undertaking hepatobiliary surgery must know hepatic artery anatomy and be able to recognize the multiple variants for safe surgery and low morbidity. A new emphasis was given to this anatomy by the introduction of liver transplantation [12]. The arterial patterns are of importance in planning and performance of all surgical and radiological procedures in the upper abdomen. However, surgical mistakes from failing to appreciate hepatic artery anatomy continue to be made with serious consequences to the patient, and with medicolegal implications. We studied 40 cadavers for the variation in the superior mesenteric artery and the hepatic artery pattern. We found three significant variations.

The patterns of abnormalities and variations are very important for the hepatobiliary surgery, and nowadays after introduction of the laparoscopic surgery such variations are very important to be taken care for the safe and plain surgeries. We observed the abnormal position of the common hepatic artery below the portal vein. The position of the structures from anterior to posterior is portal vein, common hepatic artery, and bile duct. The hepatic artery comes from the superior mesenteric artery. After passing behind the portal vein, it divides in the hepatic artery proper and gastroduodenal artery. In the other cases, the liver shows tongue-like projections and the common hepatic artery arises from the superior mesenteric artery. A common hepatic artery (CHA) arising from the superior mesenteric artery (SMA) or directly from the aorta was present in 3.5 % [6]. During the hepatobiliary operation, the main complication encountered is hemorrhage in 2.3 % of cases mainly from the cystic or hepatic artery. At the time of the repair, the most serious problem is the injury to the main bile duct. Although the differences are not statistically significant, this injury is more frequently seen in laparoscopic cholecystectomy (1 % of cases) [13–16]. In open cholecystectomy in the operation of portocaval anastomosis, the portal vein is mobilized circumferentially at its midpoint [17]. At this time the common hepatic artery can be easily ligated or injured during the operation. So anatomical

variation in the hepatic artery and the variation in the Calot triangle are important. In the other cases, the liver shows tongue-like projections of the liver and also the hepatic artery arises from the superior mesenteric artery. In another case, the superior mesenteric artery shows acute angulation which leads to the massive bleeding if interrupted during surgery or an aneurysm can develop from such cases in advance age. The hepatic artery pattern and the superior mesenteric artery pattern are also important for the successful operative outcome in liver transplantation as well as hepatobiliary surgery.

Conclusion

This current study shows that there is a pattern of the morphology and variations of the celiac trunk with specific reference to the hepatic artery. We have observed that the distance from the celiac trunk to the hepatic artery and distance between the celiac trunk and the superior mesenteric artery are comparable with other studies.

	Our findings	Other studies
Measurement of length from the celiac trunk up to the common hepatic artery	4–34 mm with a mean of 17.1 mm	Rio Branco: 5–40 mm; Michels: 8–40 mm; Orts Llorca: up to 12 mm; Latarjet and Ruiz-Liard: 10–15 mm
Distance between the celiac trunk and the superior mesenteric artery	3–18 mm with a mean of 8.1 mm	George: 5–31 mm, with a mean of 16 mm; Anson and McVay: 10–20 mm; Cauldwell and Anson: mean 13 mm
Celiac trunk diameter	4–10 mm with a mean of 6.6 mm	Rio Branco: 4–10 mm; Michels: 3–12 mm; Pignataro: 10–12 mm; Fumagalli and Cavallotti: 7 mm; Latarjet and Ruiz Liard: a mean of 6 mm
Diameter of the common hepatic artery	3–9 mm with a mean of 5.1 mm	
Variations observed	In three cases (7.5 %)	

We observed the abnormal position of the common hepatic artery below the portal vein. The relations from anterior to posterior are the portal vein, common hepatic artery, and bile duct. The hepatic artery comes from the superior mesenteric artery. We found such two cases (5 %) in 40

cadaveric dissections. Whereas reports suggest its presence in 3.5 % of cases which is quite less as actually it does occur. This type of study of presence of anomalous hepatic arteries will allow the surgeon to practice laparoscopic cholecystectomy, liver resections, or vascular recombination in transplantation and, thereby, avoid errors and patient morbidity.

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