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Research Article

A STUDY OF ARTERIAL DIAMETERS AND BRANCHING PATTERNS OF COELIAC TRUNK IN CADAVERS OF ANDHRA REGION

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ABSTRACT

Introduction: The coeliac trunk is the first branch of abdominal aorta at the level of the twelfth thoracic vertebrae. Main classic branches of the coeliac trunk are hepatic, splenic and left gastric arteries.
Material and Methods: Total 56 cadavers were studied during academic year 2008/9 to 2012/13 at Dr. Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation, Chinnaoutpalli, Krishna District (AP), (INDIA).
Observation and Results: The mean diameter of coeliac trunk was 7.28 ± 1.26 mm. The mean diameter of splenic artery was 5.25 ± 1.03 mm. The mean diameter of common hepatic artery was 5.77 ± 0.77 mm. The mean diameter of left gastric artery was 3.13 ± 0.52 mm. Out of 54 cadavers dissected in this study, classical branching pattern of celiac trunk was observed in 45 cadavers.
Discussion and Conclusion: The knowledge of normal arterial diameter in a specific population is of great importance in order to make correct and precise radiological diagnosis of arterial aneurysm. In our opinion; arterial variations should not be ignored during abdominal operative procedures. Complications in abdominal surgeries could be avoided with the accurate knowledge of the anatomical variations of coeliac trunk.
Keywords: Coeliac Trunk, Right Hepatic Artery, Left Hepatic Artery, Arterial Diameter, Variations.

INTRODUCTION

The coeliac trunk is the first branch of abdominal aorta at the level of the twelfth thoracic vertebrae [1]. Main classic branches of the coeliac trunk are hepatic, splenic and left gastric arteries. During the normal development, both dorsal aortas give rise to many ventral segmental (omphalomesenteric) arteries. Both dorsal aortas fuse together in about four weeks. The ventral segmental arteries regress shortly after fusion of dorsal aortas. The dorsal aorta gives off segmental branches to the digestive tube (ventral splanchnic arteries), to the mesonepheric ridge (lateral splanchic arteries) and intersegmental branches to the body wall (somatic arteries)[2,3]. Anatomical variations involving the visceral arteries are common [4]. Also variations of branches of the coeliac trunk were reported by many authors [5]. The unilateral or bilateral origin of inferior phrenic arteries is most common variation of branching pattern of the coeliac trunk[6].

Despite the fact that anatomical variations of the coeliac trunk are well explored in the literature, information on the arterial diameters of its main branches is still scanty. An arterial diameter of coeliac trunk and its hepatic branches has gained importance especially due to development of technique for liver transplantation. Vascular and billiary reconstructions are technically difficult in living-related liver transplantation because of the use of partial graft with small diameter vessels and ducts. Hepatic artery thrombosis is one of the most devastating postoperative living-related liver transplantation complications and this risk is related to use of small diameter arteries[7].

Knowledge of the arterial diameter is mandatory for correct choice of the catheter. Another situation that involves mandatory knowledge of the hepatic arteries diameter is the hepatic arterial infusion chemotherapy for treatment of hepatic metastatic tumors, so that correct size of the catheter can be safely chosen [8]. Thus we have undertaken the present study

with aim of exploring arterial diameter of coeliac trunk and its branches as well as variations in its branching pattern.

MATERIALS AND METHODS

Embalmed human cadavers (fixed in 10 % formaldehyde solution) were included in this study. The abdominal cavities and retroperitoneal spaces have been partially dissected by medical students during each academic session and further dissections were performed by authors. Total 56 cadavers were studied during academic year 2008/9 to 2012/13. Out of these 54 cadavers 11 were from 2008/9 academic year; 11 were from 2009/10 academic year; 10 were from 2010/11 academic year; 11 were from 2011/12 academic year and 11 were from 2012/13 academic year. These cadavers were for study of MBBS, BDS and postgraduate students at Department of Anatomy of Dr. Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation, Chinnaoutpalli, Krishna District (AP), (INDIA). A meticulous evaluation and observation of branching pattern of the coeliac trunk was done in each cadaver. Quantification and description of anatomical variations were carried out for the coeliac trunk and its main branches (left gastric artery, splenic artery and common hepatic artery). Also diameters of the coeliac trunk, the common hepatic artery, the proper hepatic artery, the left gastric artery, the splenic artery, and the left and right hepatic arteries were investigated. These diameters were measured with the help of small spreading caliper and scale in millimeter (mm). This study got the permission from research and ethical committee of Dr. Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation, Chinnaoutpalli, Krishna District (AP), (INDIA). The data was entered in computer and analyzed using NCSS statistical package.

OBSERVATIONS AND RESULTS

From the collected data, statistics were analyzed and observations and results are presented in tabulated from (Table no:1, 2 & 3). The minimum and maximum diameter of coeliac trunk was found to be 6 mm and 11 mm respectively. The mean diameter of coeliac trunk was 7.28 ± 1.27 mm. The minimum and maximum diameter of splenic artery was found to be 4 mm and 8 mm respectively. The mean diameter of common hepatic artery was 5.24 ± 1.03 mm. The minimum and maximum diameter of common hepatic artery was found to be 5 mm and 9 mm respectively. The mean diameter of common hepatic artery was 5.76 ± 0.77 mm. The minimum and maximum diameter of common hepatic artery was found to be 4 mm and 7 mm respectively. The mean diameter of common hepatic artery was 4.91 ± 0.68 mm. The minimum and maximum diameter of common hepatic artery was found to be 2 mm and 4 mm respectively. The mean diameter of common hepatic artery was 3.13 ± 0.52 mm. The minimum and maximum diameter of common hepatic artery was found to be 2 mm and 4 mm respectively. The mean diameter of common hepatic artery was 2.93 ± 0.67 mm. The minimum and maximum diameter of common hepatic artery was found to be 2 mm and 4 mm respectively. The mean diameter of common hepatic artery was 2.89 ± 0.66 mm.

The coeliac trunk was given off as the first branch of the abdominal aorta just below the aortic opening of the diaphragm. In all cases, it was surrounded by the crura of the diaphragm and these were used as landmarks. Out of 54 cadavers dissected in this study, classical branching pattern of coeliac trunk was observed in 45 cadavers (83.33 %). In four cadavers (07.41 %) coeliac trunk was divided into four branches (figure no. 2). In these cadavers either right inferior phrenic artery or left inferior phrenic artery was direct beanch of coeliac trunk. In five cadavers (09.26 %) the coeliac trunk was divided into five branches (figure no. 1). In these cadavers both right inferior phrenic artery and left phrenic artery were direct branches of the coeliac trunk. In a cadaver of 201/11 academic batch, left colic artery arose from proper hepatic artery. In same cadaver both phrenic arteries arose from the coeliac trunk. In a cadaver of 2009/10 academic batch, left gastric artery continues as accessory hepatic into the liver.

DISCUSSION

In the present study, from 54 cadavers, ten presented anatomical variation of the coeliac trunk and its branches. In this way 18.52 % of our sample showed anatomical variations. Following types of variation were found in the present study:

Type 1: The coeliac trunk gave off five branches. Beside three classic branches, two additional branches right and left phrenic arteries arose from coeliac trunk. This type of variation found in four (7.41 %) out of 54 cadavers of the present study.

Type 2: The coeliac trunk gave off five branches. Beside three classic branches, two additional branches right and left phrenic arteries arose from the coeliac trunk. Left colic artery was branch of proper hepatic artery. This type of variation found in one (1.85 %) out of 54 cadavers of the present study.

Type 3: The coeliac trunk gave off four branches. Beside three classic branches, either right phrenic artery or left phrenic artery arose from the coeliac trunk. This type of variation found in four (7.41 %) out of 54 cadavers of the present study.

Type 4: The coeliac trunk gave three classic branches. Left gastric artery after supplying area of stomach around lesser curvature persists as accessory hepatic artery and entered into lobe of liver. This type of variation found in one (1.85 %) out of 54 cadavers of the present study.

In the present study, the mean diameter of coeliac trunk was 7.28 ± 1.26 mm which is slightly lower than the mean diameter of Silveria et al and slightly higher than that of Surucu et al. The mean diameter of common hepatic artery was 5.76 ± 0.77 mm which is slightly higher than that of Silveria et al. The mean diameter of right hepatic artery and left hepatic arteries were 2.93 ± 0.63 mm and 2.89 ± 0.69 mm respectively. These diameters were slightly lower than the mean diameter of Silveria et al. The mean diameter of normal coeliac trunk was 7.27 ± 1.26 mm and of variant coeliac trunk was 7.30 ± 1.49 mm, which are almost equal. But the mean diameter of splenic artery, common hepatic artery, proper hepatic artery, right hepatic artery and left hepatic artery were less than that of the mean diameter of these arteries in variant coeliac trunks.

Mburu KS et al. found trifurcated coeliac trunk in 76 (61.7 %), bifurcated in 22 (17.9 %) and collateral branches in 25 (20.3 %). Collaterals were observed in 25 (20.3 %) of the cases and included dorsal pancreatic, gastroduodenal, inferior phrenic and ileal arteries. Dorsal Pancreatic artery (DPA) was the most common collateral occurring in 14.8 % of the cases, while Inferior phrenic arteries were found in 4.9 % [1]. Piano et al. stated that the right and left inferior arteries occasionally originated as a common trunk from the aorta, coeliac-mesenteric system or adrenorenal system[9]. In Peterella S et al. study inferior phrenic artery origin in the left contour of the coeliac trunk was observed in 19 (21.35 %) of the 89 cases, while the inferior phrenic artery origin in the right contour of the coeliac trunk was observed in 05 of the 89 cases[10]. In Kuo-Hsein Chiang et al. study a single accessory hepatic artery was found in 28.1 % (114) of these cases, more than two hepatic arteries were found in 2.0 5 cases[11].

The anatomical variations of the coeliac trunk are due to developmental changes in the ventral segmental (splanchnic) arteries. These ventral segmental arteries supply the yolk sac, allantois and chorion. Three ventral segmental arteries remain as coeliac trunk, superior mesenteric artery and inferior mesenteric artery. During embryological period, there are longitudinal anastomoses between roots of four upper ventral segmental arteries of abdominal region. The two central roots disappear and the longitudinal anatomoses joins the first root. The hepatic, splenic and the left gastric arteries originate at this longitudinal anastomosis. These braches usually become separated from the fourth root (the future superior mesenteric artery) below their last end. If this separation takes place at the higher level, on one the branches is displaced to the superior mesenteric artery. If the first or fourth root disappears, a coeiacomesentric trunk will be formed [12, 13]. In the present study, the all variations of the coeliac trunks are due to developmental changes in the longitudinal anastomosis between above mentioned ventral segmental arteries.

The high incidence of anatomical variations of the coeliac trunk and its branches arterial pattern was widely explored in the literature, including a more recent review, focused on the surgical anatomy of the hepatic arteries and donor selection for liver transplantation. The coeliac trunk is a main dominant vascular structure of the upper abdominal cavity, responsible not only but also for the liver arterial supply. Recent progress on the liver transplantation brought the need of a precise knowledge of the frequency of anatomical variations on the arteries involved. Nevertheless, very little is known about the diameter of these arteries and based on this knowledge, new surgical reconstructive techniques can be proposed [14-16]. Despite that formalin fixed cadavers were used in the present study, our data is reliable since it is compatible to those obtained in fresh cadavers or in vivo, through non invasive methods to access vascular caliber.

The knowledge of normal arterial diameters in a specific population is of great importance in order to make correct and precise radiological diagnosis of arterial aneurysms. Also, evaluation of arterial diameters is fundamental for liver transplantation follow up. Previous knowledge of the normal and expected values for a specific artery might help the early diagnosis, through radiological exams, of an arterial stenosis, even before clinical signs of low arterial flow[14,18].

It seems to be consensual from the literature that arteries with diameters < 0.3 cm are considered of high surgical risk on liver transplantation surgery [15]. An important consideration about our results is that the hepatic arteries (common and proper) had always diameters > 0.3 cm, even those with anatomical variations. The authors mention that hepatic arteries less than 0.2 cm in diameter was an absolute exclusionary criteria for living related liver transplant donor while arteries between 0.2 and 0.3 cm in diameter were a relative exclusionary criteria. Variant artery anatomy in liver transplant recipient increases the risk of complications after transplantation and that the smaller caliber of the native common hepatic artery may contribute to the higher risk. In our opinion; arterial variations should not be ignored during abdominal operative procedures. Complications in abdominal surgeries could be avoided with the accurate knowledge of the anatomical variations of coeliac trunk.

CONCLUSION

Our result shows that the mean diameter of the coeliac trunk was 7.28 ± 1.26 mm. The values are in accordance with cadaveric studies and can be used as criteria for diagnosis of the coeliac trunk narrowing and aneurysms for Andhra Pradesh population and also South Asian population. Almost 20 % of cadavers dissected in this study showed variation. Most common type of variation of branching pattern of the coeliac trunk was unilateral or bilateral origin of inferior phrenic artery from the coeliac trunk which was found in almost 20 % of cadavers. Our result also suggest that there was a reduction of the arterial diameters of branches of the coeliac trunk in the presence of anatomical variations of these arteries, which have direct clinical implication for liver transplantation.

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Table 1: Showing mean, minimum, maximum and standard deviation of arterial diameter of the celiac trunk and its branches.

Variable	n	Minimum	Maximum	Mean	S.D.
Diameter of CT (mm)	54	06	11	7.28	1.2
Diameter of SA (mm)	54	04	08	5.24	1.0
Diameter of CHA (mm)	54	05	09	5.76	0.7
Diameter of PHA (mm)	54	04	07	4.91	0.6
Diameter of LGA (mm)	54	02	04	3.13	0.5
Diameter of RHA (mm)	54	02	04	2.93	0.6
Diameter of LHA (mm)	54	02	04	2.89	0.6

Table 2: Showing mean, standard deviation and P value of arterial diameter of variant and normal the celiac trunk and their branches.

Variable	n	Mean	S.D.	P value
Diameter of normal CT (mm)	44	7.27	1.26	0.9527
Diameter of variant CT (mm)	10	7.30	1.49	0.9527
Diameter of SA (mm) in normal CT	44	5.23	0.91	0.5100
Diameter of SA (mm) in variant CT	10	5.00	1.25	0.5100
Diameter of CHA (mm) in normal CT	44	5.79	0.73	0.4771
Diameter of CHA (mm) in variant CT	10	5.60	0.97	0.4771
Diameter of PHA (mm) in normal CT	44	4.92	0.65	0.3090
Diameter of PHA (mm) in variant CT	10	4.70	0.95	0.3090
Diameter of RHA (mm) in normal CT	44	2.96	0.63	0.2402
Diameter of RHA (mm) in variant CT	10	2.7	0.82	0.2402
Diameter of LHA (mm) in normal CT	44	2.91	0.68	0.6433
Diameter of LHA (mm) in variant CT	10	2.8	0.63	0.6433

mm- millimeter

Table 3: Showing no. of branches the celiac trunk and variant branches in the present study.

No. of branches of CT	No. of cadavers	Percentage	Variant branches
02	00	----------	----------
03	45	83.33 %	----------
04	04	07.41 %	One each case right inferior phrenic artery orleft inferior phrenic artery was direct branches from coeliac trunk.
05	05	09.26 %	All cases right and left inferior phrenic arteries were direct branches from coeliac trunk.
Total	54	100.00 %	----------

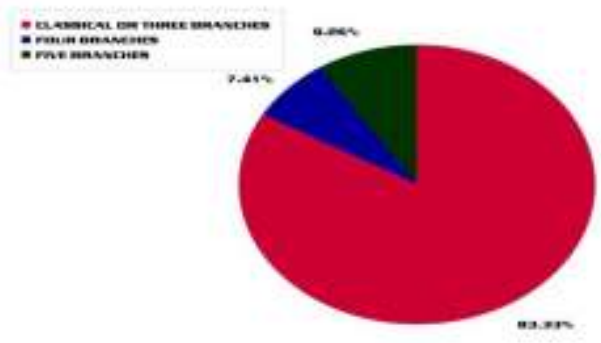

Figure 1: Showing percentage of numbers of branches of the celiac trunk in the present study

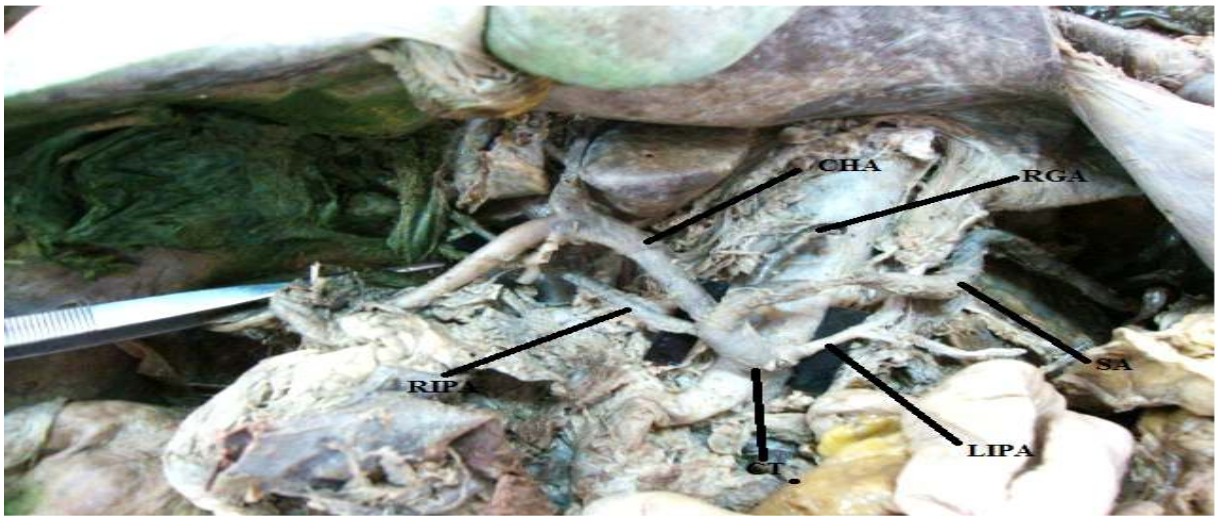

Figure 2: Dissection of abdomen showing five branches of coeliac trunk found in the present study.

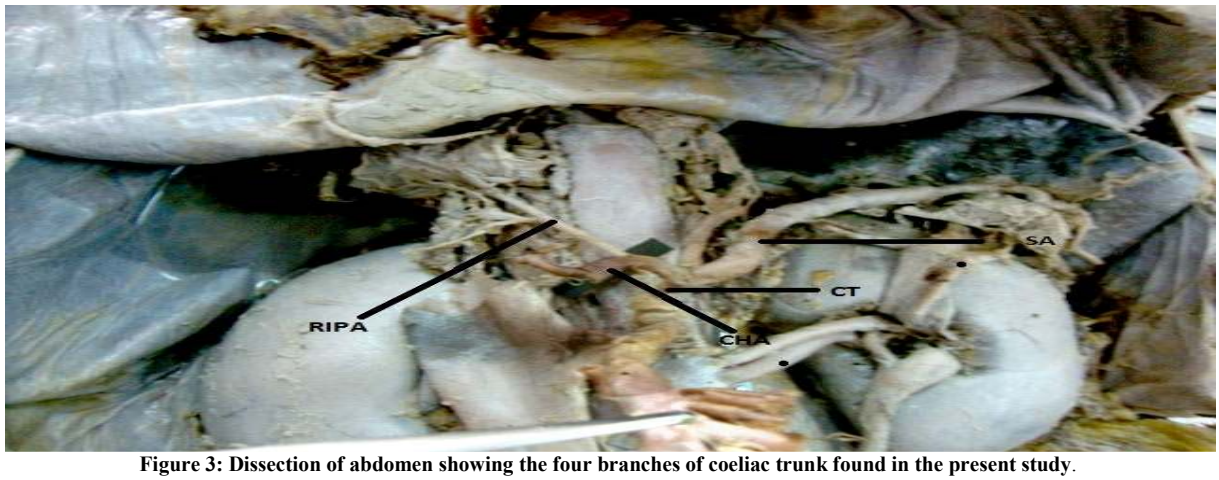

Figure 3: Dissection of abdomen showing the four branches of coeliac trunk found in the present study.

LEGENDS;-
CT – Coeliac trunk, SA – Splenic artery, CHA – Common hepatic artery, RGA – Right gastric artery, PHA – Proper hepatic artery, RHA – Right hepatic artery, LHA – Left hepatic artery, RIPA - Right inferior phrenic artery, LIPA - Left inferior phrenic artery

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