Research Article

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STUDY OF VARIATIONS OF COELIAC TRUNK IN WESTERN MAHARASHTRA POPULATION

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ABSTRACT

Aim: Aim was to study the variations of coeliac trunk and its branches.

Methodology: Fifty embalmed donated cadavers (24 male and 26 female) were dissected in Department of Anatomy. Variations in branching pattern of coeliac trunk were observed. Diameters of coeliac trunk and its branches left gastric, splenic and common hepatic arteries along with that of superior mesenteric artery were studied. Length of coeliac trunk from its origin to origin of its first branch and of its last branch were taken. Distance between origin of coeliac trunk and superior mesenteric artery was measured on abdominal aorta. Sex differences for all these parameters were also studied. Photographs were taken for proper documentation.

Results: Normal branching pattern of coeliac trunk was found in 88%. More than three branches arising from coeliac trunk were found in 8%. Incomplete coeliac trunk was found in 2% where common hepatic artery arose from superior mesenteric artery (hepatomesenteric trunk). 2% case showed absence of coeliac trunk. Mean diameter of coeliac trunk was 8.0 mm; left gastric artery 5.0 mm; splenic artery 6.9 mm; common hepatic artery 6.6 mm and superior mesenteric artery 8.3 mm. Mean length of coeliac trunk was 28.6 mm. Mean distance between coeliac trunk and superior mesenteric artery was 19.3 mm. Splenic artery diameter has shown statistically significant difference between male and female.

Conclusion: The knowledge of anatomy of coeliac trunk and its branches are of utmost importance for various surgical and radiological procedures to prevent any complications.

Key Words: Coeliac trunk, Left gastric artery, Splenic artery, Common hepatic artery, Superior mesenteric artery

INTRODUCTION

The coeliac trunk (coeliac axis, coeliac artery) is one of the unpaired visceral branches of the abdominal aorta. Superior and inferior mesenteric arteries are other two unpaired visceral branches [1p590]. The coeliac trunk typically arises from the anterior surface of the abdominal aorta at about the level of upper part of the first lumbar vertebra [1p591]. The coeliac trunk is a large, short trunk only some 1 to 3 cm long, which typically arises from the aorta while aorta lies between the two crura of the diaphragm. While the coeliac trunk typically arises a short distance above the superior mesenteric artery, these two vessels sometimes have a common stems known as coeliacomesenteric trunk [1p452].

In the embryonic life, yolk sac is supplied by vitelline arteries. Later these arteries gradually fuse and help in formation of the arteries dorsal to the mesentery of the gut. In the adult, they are developed as coeliac trunk, superior mesenteric and inferior mesenteric arteries [2p292]. These arteries supply the derivatives of foregut, midgut and hindgut respectively. Coeliac trunk supplies the parts of the foregut like liver, stomach, pancreas, spleen and proximal part of duodenum [Fig. 1 - 4].

Arterial diameter of coeliac trunk and hepatic branches has gained importance especially due to development of techniques for liver transplantation. Hepatic artery thrombosis is one of the most devastating postoperative living-related liver transplantation complications and this risk is related to the use of small diameter arteries (< 2 mm) [3]. Preoperative information on the anatomical features of the hepatic arteries is very important in hepatobiliary surgery, because there is no anastomosis between hepatic arteries and an injury to these vessels during operation would result in hepatic damage with serious morbidity [4]. The vascular variations are usually asymptomatic. These are important in patients undergoing coeliacography, prior to procedures like transcatheter therapy and chemoembolization of pancreatic and hepatic tumours [5].

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Keeping in mind all these factors, this study was undertaken to observe the branching patterns and diameter and length of coeliac trunk and its branches along with superior mesenteric artery.

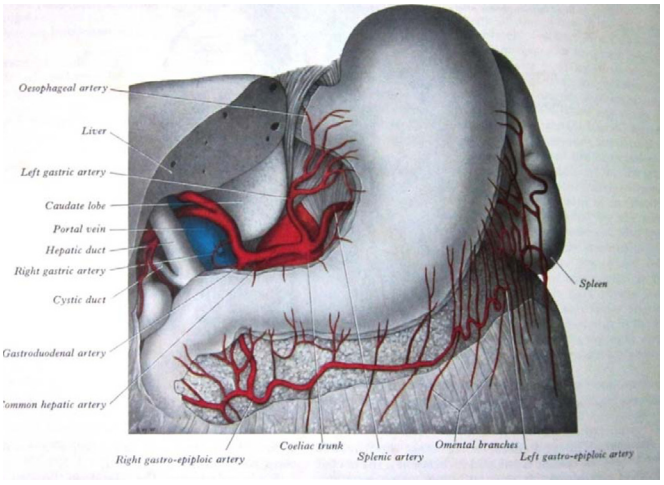


Figure 1: The coeliac trunk and its branches. Part of the liver and all the lesser omentum have been removed, as well as the posterior wall of the omental bursa and part of the anterior layer of the greater omentum [6].

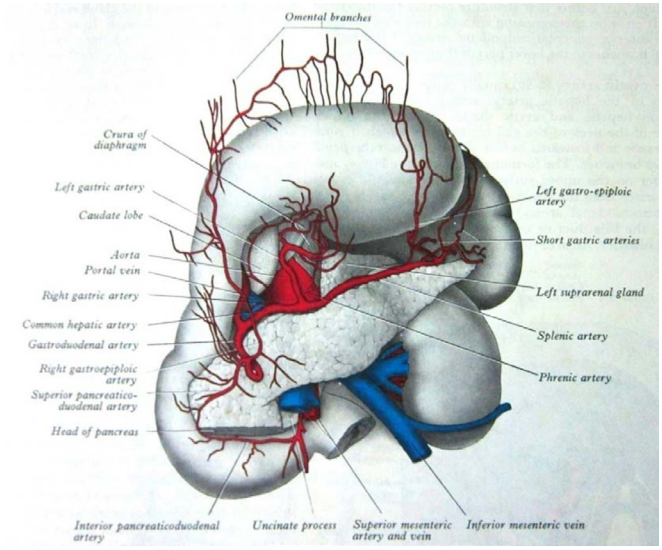


Figure 2: The coeliac trunk and its branches exposed by turning the stomach upwards and removing the peritoneum on the posterior abdominal wall [6].

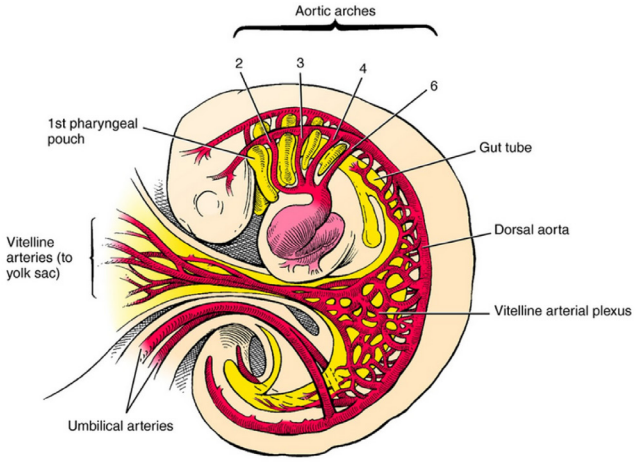


Figure 3: In the 4th week, a multitude of vitelline arteries emerge from the ventral surfaces of the dorsal aortae to supply the yolk sac [7].

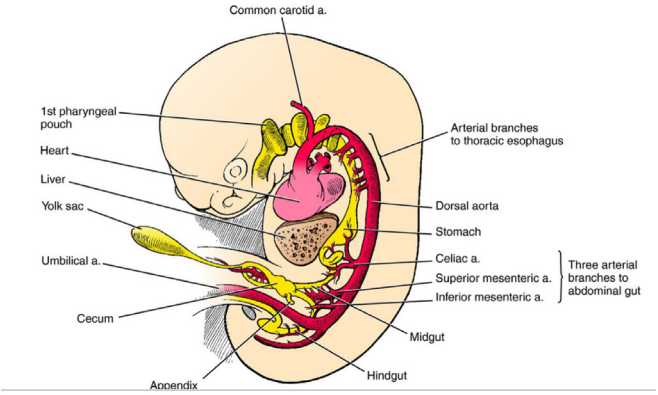


Figure 4: After the paired dorsal aortae fuse at the end of the 4th week, many of the vitelline channels disappear, reducing the final number to about five in the thoracic region and to three (the coeliac, superior mesenteric, and inferior mesenteric arteries) in the abdominal region [7].

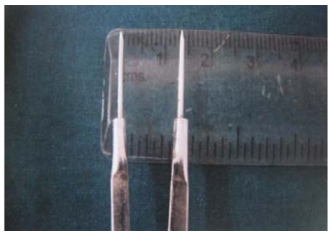
MATERIALS AND METHODS

1. The present study was conducted on total of fifty adult embalmed cadavers allotted to M.B.B.S. and B.D.S. students from medical and dental colleges in Western Maharashtra region. Out of these cadavers, 24 were male and 26 female. We excluded cadavers which showed signs of any trauma or surgical scars on the abdomen.
2. Instruments used were- Scissors (pointed, blunt, curved, 4" and 6" size), Scalpel (blade no. 23), Forceps (plane and tooth), Thread, Divider, Measuring scale etc [Photographs 1 and 2].
3. Each cadaver was dissected in supine position and numbered and sex was noted. Dissection was carried out according to guidelines of "Cunningham's

Manual Of Practical Anatomy" volume two, fifteenth edition [8p91-127]. A midline skin incision from the xiphisternal junction to the pubic symphysis, encircling the umbilicus, was made. Then a transverse incision from the xiphoid process to a point on the midaxillary line was made. Skin incision was extended from pubic symphysis to anterior iliac spine followed by extension upto to a point on midaxillary line. The skin was reflected from medial to lateral aspect towards the midaxillary line. Anterior abdominal wall was dissected layer wise. Muscles of anterior abdominal wall were incised and reflected laterally. Peritoneal cavity was opened and branches of coeliac trunk were identified. As dissection proceeded these branches were traced to their origins and coeliac region was dissected and cleared of nervous and connective tissue network and thus coeliac trunk was completely exposed on abdominal aorta.

1) Superior mesenteric artery was identified below the origin of coeliac trunk posterior to pancreas and was exposed.
2) The sites of origins of coeliac trunk and its all branches were noted and the branches were traced and variations were recorded. Origin of Superior mesenteric artery was also noted.
3) Circumferences of coeliac trunk, its all branches and superior mesenteric artery at their origin were measured with help of thread and measuring scale. Thereafter diameter was calculated from value of circumference with help of formula, "diameter = circumference/3.14". [Circumference = $2\pi r$ and diameter = 2r where 'r' is radius and $\pi = 3.14$. Hence Circumference = 3.14 x Diameter; therefore Diameter = Circumference/ 3.14.]
4) Distance from origin of coeliac trunk to origin of its first branch, its last branch and to the origin of superior mesenteric artery was measured with help of divider and measuring scale. The length of coeliac trunk was considered as distance between origin of coeliac trunk and origin of its last branch.
5) **Percentage** was calculated for the branching patterns of coeliac trunk.
6) **Means, standard deviations** and **significance of difference between two means** of independent samples were calculated for quantitative data and data was analyzed by **unpaired t test** as test of significance.
7) A '**p**' value of <0.05 is deemed statistically significant.

Photograph 1: Materials used for study of coeliac trunk.



Photograph 2: Method for measurements.

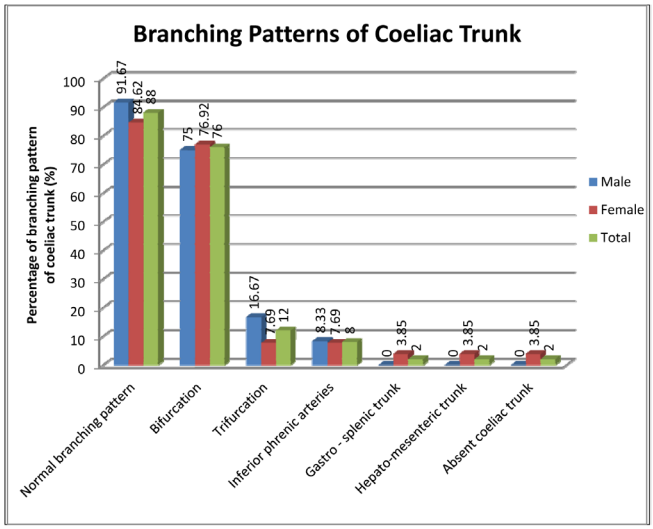
3. Results and Discussion

There are good numbers of studies done previously on coeliac trunk and its branches such as Rossi and Cova (1904), Malnar et al (2010), Michels (1953), Petrella et al (2007), Chitra (2010), Lukas et al (2005) etc. We studied branching patterns and length of coeliac trunk along with diameters of it, its branches and superior mesenteric artery in donated cadavers of medical colleges in Western Maharashtra region.

3.1. Branching Pattern of Coeliac Trunk

Table 1: Branching patterns of coeliac trunk.

Coeliac trunk	Normal branching pattern	Normal bifurcation	Normal trifurcation (Haller's tripod)	Inferior phrenic arteries	Gastro - splenic trunk	Hepato-mesenteric trunk	Absent coeliac trunk
Male	22 (91.67%)	18 (75%)	4 (16.67%)	2 (8.33%)	0 (0%)	0 (0%)	0 (0%)
Female	22 (84.62%)	20 (76.92%)	2 (7.69%)	2 (7.69%)	1 (3.85%)	1 (3.85%)	1 (3.85%)
Total	44 (88%)	38 (76%)	6 (12%)	4 (8%)	1 (2%)	1 (2%)	1 (2%)



Graph 1: Percentages of branching patterns of coeliac trunk.

Normal branching pattern giving rise to only its three classic branches was found in 88%. Rossi & Cova (1904) [9] showed 87.27%, Song et al (2010) [10] observed 89.1% and Prakash et al (2012) [11] showed 86% for such pattern.

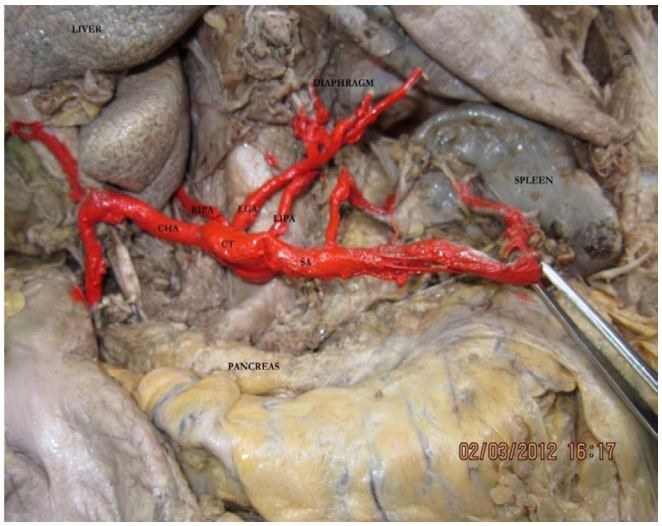
Haller's tripod where all three normal classic branches arise from a single point (trifurcation) was found in 12% cadavers. Michels (1953) [12,13] showed 25%, Prakash et al (2012) [11] observed 10% for this pattern.

Inferior phrenic arteries arising from coeliac trunk were observed in 8% cadavers. 4% cases showed both right and left inferior phrenic arteries arising from coeliac trunk [Photograph 3] and rest 4% has shown either right or left one arising from coeliac trunk. Mburu et al (2010) [14] observed 4.9% cases inferior phrenic arteries arising from coeliac trunk. Petrella et al (2006) [15] observed 34.83% for such pattern where 5.62% cases have shown bilateral inferior phrenic arteries arising from coeliac trunk.

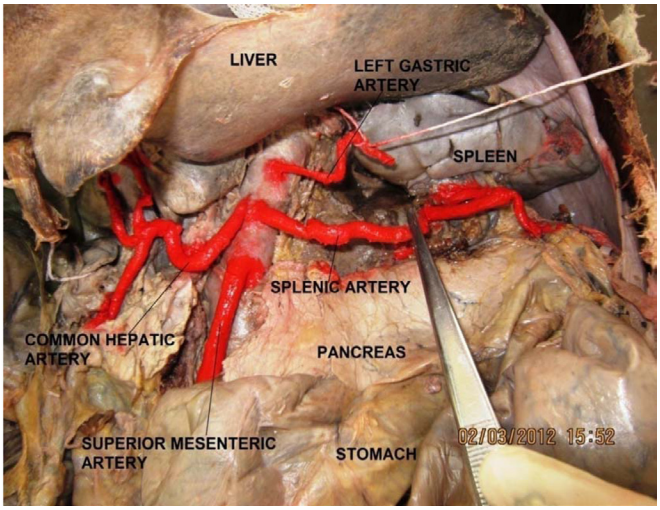
Absent coeliac trunk was observed in 2% where all its three branches directly originated from abdominal aorta [Photograph 4]. Rio Branco (1912) [16] found 8.0% and Venieratos et al (2012) [17] observed 2.6% incidence for absent coeliac trunk.

Coeliac trunk was found to be incomplete in 2% of cases where gastrosplenic and hepatomesenteric trunks were arising independently from abdominal aorta [Photograph 5]. Gastrosplenic trunk also gave rise to bilateral inferior phrenic arteries from its base of origin along with left gastric and splenic arteries. Hepatomesenteric trunk bifurcated into common hepatic and superior mesenteric arteries. Michels (1951) [18] observed 2.5% and Chitra (2010) [19] found 2% cases for hepatomesenteric trunk. Rossi & Cova (1904) [9] found 1.82%, Rio Branco (1912) [16] observed 2% and Ugurel et al (2010) [20] observed 4% cases for gastrosplenic trunk.

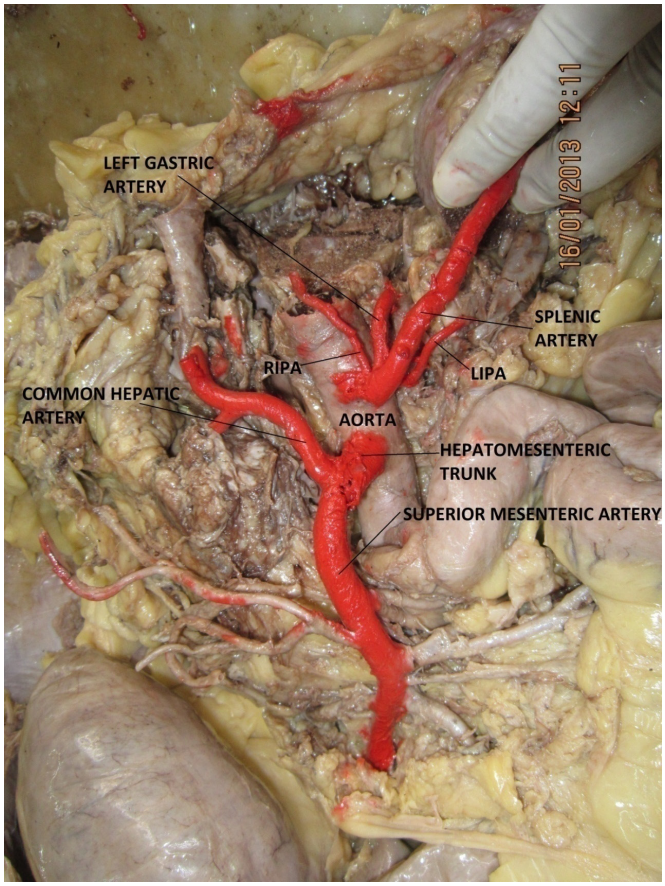
Thus in present study the observed branching patterns of coeliac trunk was comparable to similar studies conducted by previous authors.



Photograph 3: Right and left Inferior phrenic arteries (RIPA and LIPA) originating from coeliac trunk (CT). [CHA – common hepatic artery; LGA – left gastric artery; SA – splenic artery.]



Photograph 4: Absence of coeliac trunk.

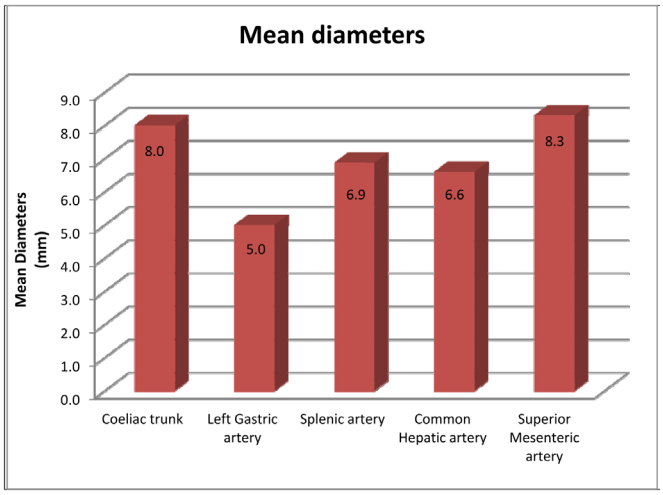


Photograph 5: Gastrosplenic trunk with right and left inferior phrenic artery (RIPA and LIPA) and hepatomesenteric trunk.

3.2. Diameters of Coeliac trunk, its branches and Superior mesenteric artery

Table 2: Diameters of arteries

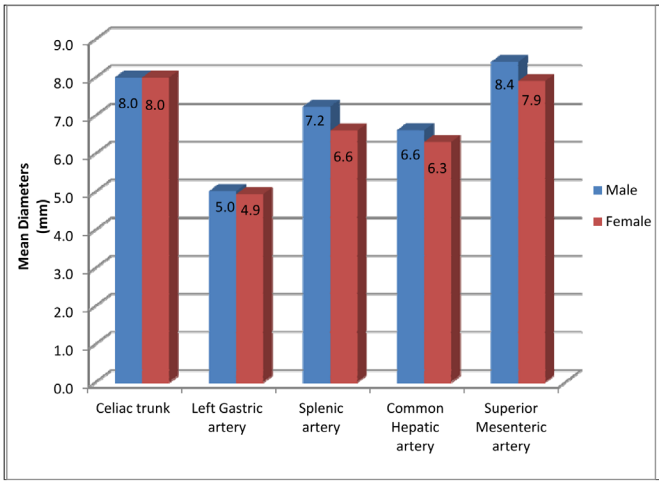
Diameters	Mean (mm)	Standard Deviation	Range	Minimum	Maximum
Coeliac trunk	8.0	1.4	6.1	5.1	11.1
Left Gastric artery	5.0	1.1	5.1	2.5	7.6
Splenic artery	6.9	1.0	4.1	5.1	9.2
Common Hepatic artery	6.6	1.0	3.8	4.8	8.6
Superior Mesenteric artery	8.3	1.1	6.4	5.7	12.1



Graph 2: Mean diameters of arteries.

Table 3: Sex wise comparison of diameters of arteries.

Diameters	Male		Female		
	Mean (mm)	Standard Deviation	Mean (mm)	Standard Deviation	p – value
Coeliac trunk	8.0	1.4	8.0	1.4	1.00
Left Gastric artery	5.0	1.2	4.9	0.9	0.80
Splenic artery	7.2	1.0	6.6	0.8	0.03
Common Hepatic artery	6.6	1.1	6.3	0.9	0.35
Superior Mesenteric artery	8.4	1.2	7.9	1.0	0.17



Graph 3: Mean diameters of arteries in male and female cadavers.

Table 4: Comparison of observed diameters of arteries in previous studies with present study:

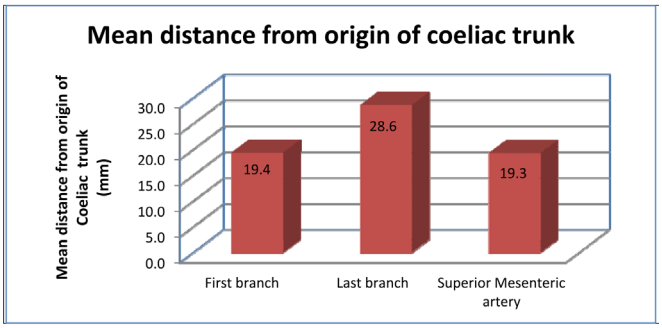
Mean Diameters (mm)	Silveira et al (2009) [21]	Malnar et al (2010) [22]	Samuilis (2011) [23]	Present study
Coeliac trunk	7.9 ± 0.4	7.8 ± 0.8	--	8.0 ± 1.4
Left Gastric artery	3.8 ± 0.3	3.8 ± 0.3	--	5.0 ± 1.1
Splenic artery	5.3 ± 0.3	6.1 ± 0.5	--	6.9 ± 1.0
Common Hepatic artery	5.0 ± 0.4	--	--	6.6 ± 1.0
Superior Mesenteric artery	--	--	6.9 ± 1.5	8.3 ± 1.1

We can conclude from above tables and graphs that the observations of present study are comparable to previous studies. Mean diameters of coeliac trunk, left gastric, splenic, common hepatic and superior mesenteric arteries are 8.0 mm, 5.0 mm, 6.9 mm, 6.6 mm and 8.3 mm respectively. The sex wise significant difference has been observed for diameter of splenic artery with p-value of 0.03. No such significant difference has been stated in previous studies. A Large number of sample sizes are required to establish such statistical significance in future.

3.3. Distances between the origins of arteries

Table 5: Distances between origins of arteries

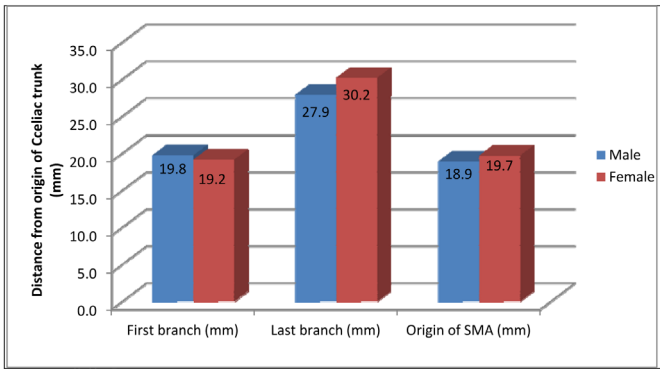
Distance from origin of Coeliac trunk to origins of	Mean (mm)	Standard Deviation	Range	Minimum (mm)	Maximum (mm)
First branch	19.4	6.3	40.0	0.0	40.0
Last branch	28.6	5.4	24.0	18.0	42.0
Superior Mesenteric artery	19.3	4.9	22.0	10.0	32.0



Graph 4: Mean distances from origin of coeliac trunk.

Table 6: Sex wise comparison of distances between arteries.

Distance from origin of Coeliac trunk to origins of	Male		Female		p – value
	Mean (mm)	Standard Deviation	Mean (mm)	Standard Deviation	
First branch	19.8	5.1	19.2	7.4	0.75
Last branch	27.9	4.7	30.2	5.7	0.15
Superior Mesenteric artery	18.9	4.1	19.7	5.6	0.57



Graph 5: Mean distances from coeliac trunk in male and female cadavers.

Table 7: Mean distances between origins of arteries.

Distance from origin of coeliac trunk to origin of	George (1935) [24]	Veniera-tos et al (2012) [17]	Pant et al (2013) [25]	Present study
First branch (mm)	--	--	--	19.4 and S.D. 6.3
Last branch (mm)	--	28.0 and S.D. 8.0	18.6	28.6 and S.D. 5.4
Superior mes-enteric artery (mm)	16.0 and S.D. 5.0	--	--	19.3 and S.D. 4.9

The mean length of coeliac trunk thus was found to be 28.6 mm i.e. mean distance between origin of coeliac trunk from abdominal aorta and origin of its last branch. No significant difference was observed with p- value of 0.15.

Mean distance between origins of coeliac trunk and superior mesenteric artery was found to be 19.3 mm.

CONCLUSION

In conclusion, as aimed at the beginning we could find that some of observations in present study are in agreement with previous studies as mentioned in the discussion. This study can be helpful in various diagnostic and surgical procedures.

The present study can be applied in various radiological procedures like computed tomography angiography, intra-arterial digital subtraction angiography, etc. where the radiologists should have knowledge of various branching patterns and calibres of blood vessels.

The results of this study can also be highly useful to the surgeons who can plan their line of treatments in cases like liver transplantation, hepatobiliary tumours, splenic aneurysm, pancreatic carcinoma, coeliac axis compression syndrome, gastric carcinoma, mesenteric ischemia etc.

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