

Original Research Article

Branching Pattern of Abdominal Aorta - A Cadaveric Study

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ABSTRACT

The abdominal aorta which is the major arterial supply of the abdominal organs begins at the median aortic hiatus of the diaphragm, anterior to the inferior border of the 12th thoracic vertebra. It is the main arterial supply carrying oxygenated blood to the various abdominal organs, anterior, posterior and lateral abdominal wall, also lower limbs and male and female genitals. In this study, 20 cadavers were dissected (16 males & 4 females) to find out any variations or abnormality during the period from 2013 to 2016 in SMIMS, Gangtok. The branching pattern of celiac trunk and inferior phrenic artery was almost constant. The observations of branching pattern of the abdominal artery to its various branches are noticed and compared with the observations of other authors. The knowledge of branching pattern of abdominal aorta is essential for vascular surgeons, laparoscopic surgeons, liver and kidney transplant surgeons.

Key words: abdominal aorta, celiac trunk, inferior phrenic artery.

INTRODUCTION

The abdominal aorta begins at the median aortic hiatus of the diaphragm, anterior to the inferior border of the 12th thoracic vertebra. It descends anterior to the lumbar vertebrae to end at the lower border of the 4th lumbar vertebrae, to the left of the midline by dividing into two common iliac arteries. It is the main arterial supply to the abdominal organs, anterior, posterior and lateral abdominal wall lower limb and male and female genitals. The branches of abdominal aorta are classified as dorsal, ventral, terminal and lateral groups. Ventral and lateral group distribute to the viscera, dorsal branches supplying the body wall, vertebral canal, and its contents. The ventral branches are the celiac trunk, superior mesenteric artery, inferior mesenteric artery.

The dorsal branches are the four pairs of lumbar arteries and median sacral artery which is the direct continuation of

primitive dorsal aorta. The antero lateral branches are paired and mentioned from above downwards, these are inferior phrenic arteries, middle suprarenal arteries renal arteries, gonadal arteries. The terminal branches are the common iliac and left common iliac arteries.

The coeliac trunk, a wide ventral, short, thick branch about 1.25cm long and arises just below the aortic hiatus, opposite lower border of twelfth thoracic vertebra. The superior mesenteric artery leaves the front of the aorta about one centimetre below the celiac trunk, at the level of intervertebral disc between L1 and L2 vertebra. Inferior mesenteric is smaller in diameter than the superior mesenteric, arising three or four centimetres above the aortic bifurcation, posterior to the horizontal part of the duodenum. The middle suprarenal vessels arise laterally from each side of the aorta just below the inferior

mesenteric artery. The gonadal artery arises anteriorly from aorta a little inferior to the renal arteries. The inferior phrenic arteries are two small vessels ascending laterally anterior to crus of diaphragm near the medial border of the suprarenal gland at the lower border of twelfth thoracic vertebra.

The lumbar arteries are arranged in four pairs on each side arising posterolaterally from aorta, opposite the lumbar vertebra. The median sacral artery arises from the back of aorta above aortic bifurcation. The right common iliac artery is about 5 cm long and passes obliquely across part of fourth and fifth lumbar vertebra.

The left common iliac artery is about four cm long.

The branching pattern of abdominal aorta is essential for vascular surgeons in surgical treatment of patients with aortic aneurysms and ischemic heart diseases, laparoscopic surgeries, liver and kidney transplantation and for oncosurgeons for oncogenic resection in the abdominal regions. Hence the present study on the branching pattern of abdominal aorta in eastern Indian population has been taken to observe if any note worthy branching pattern is available in comparison to the common patterns described in the previous literatures.

MATERIALS AND METHODS

This study was conducted on 20 cadavers 16 males and 4 females during

process of routine dissection of abdomen for MBBS in the year 2013 to 2016. The abdominal aorta was exposed after careful dissection. The relation of important structures in connection with abdominal aorta was identified. The kidneys and the suprarenal glands on each side of the vertebral column and the aorta on the anterior surface of the vertebral column were identified.

The coeliac trunk was exposed after removing the dense autonomic plexus around its branches. The kidney and the suprarenal gland were exposed on the right side.

The numerous suprarenal arteries and inferior phrenic artery on the left side were also identified. After tracing the small intestine along with its mesentery attached to the posterior abdominal wall, the fat was removed from the mesentery and the superior mesenteric vessels were exposed. The small intestine was then turned to the right along with its mesentery. The peritoneum and the fat on posterior abdominal wall were removed to expose the inferior mesenteric vessels.

The superior part of the left kidney and the suprarenal gland was exposed along with the suprarenal arteries and the inferior phrenic artery on the left crus of diaphragm. The abdominal aorta was now exposed along with its branches. The level of origin and the presence of any anatomical variation were examined.

Table 1: Showing Branches Of Abdominal Aorta In Relation To Vertebra

SN	Branches of abdominal aorta	T12			L1			L2			L3			L4		
		U	B	L	U	B	L	U	B	L	U	B	L	U	B	L
		P	O	O	P	O	O	P	O	O	P	O	O	P	O	O
		P	D	W	P	D	W	P	D	W	P	D	W	P	D	W
		E	Y	E	E	Y	E	E	Y	E	E	Y	E	E	Y	E
		R		R	R		R	R		R	R		R	R		R
1	Coeliac Trunk	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
2	Superior mesenteric	0	0	0	8	6	6	0	0	0	0	0	0	0	0	0
3	Inferior mesenteric	0	0	0	0	0	0	0	0	8	2	10	0	0	0	0
4	Inferior Phrenic	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0
5	Middle supra renal	0	0	0	2	6	12	0	0	0	0	0	0	0	0	0
6	Right renal	0	0	0	0	0	0	10	6	4	0	0	0	0	0	0
7	Left renal	0	0	0	0	6	8	4	2	0	0	0	0	0	0	0
8	Gonadal Branch	0	0	0	0	0	0	0	4	8	6	2	0	0	0	0
9	Median Sacral	0	0	0	0	0	0	0	0	0	0	2	6	8	4	0
10	Right iliac	0	0	0	0	0	0	0	0	0	0	0	2	10	8	0
11	Left iliac	0	0	0	0	0	0	0	0	0	0	0	2	10	8	0

RESULTS AND OBSERVATIONS

Out of 20 specimens dissected the observation was made between the specimens, there was no significant difference seen. Observations carried out in the specimens for their origins with respect to the lumbar vertebra in 16 males and 4 female's specimens.

The following observations were made;

Both Coeliac trunk and Inferior phrenic arteries (100%) are arising near the upper margin of aortic opening at the level of lower border T12 in all specimens.

Superior mesenteric artery in all specimens is arising from front of the aorta. In 40%, the origin was from the upper border of L1 vertebra. In 30% of specimen the origin was origin was from lower border of L1 vertebra.

The inferior mesenteric artery, in 40% of specimen from upper border of L3 vertebra, 10% from the body and 50% from lower border of L3 vertebra.

The middle supra renal artery, 10 from the body of L1 vertebra and 30% of specimen the % from upper border of L1, 30% from the body of L1 and 60% from lower border of L1.

The right renal artery, 50% from upper border of L2, 30% from body of L2 and 20% from lower border of L2.

The left renal artery, 30% from body of L1, 40% from lower border of L1, 20% from upper border of L2 and 10% from body of L2.

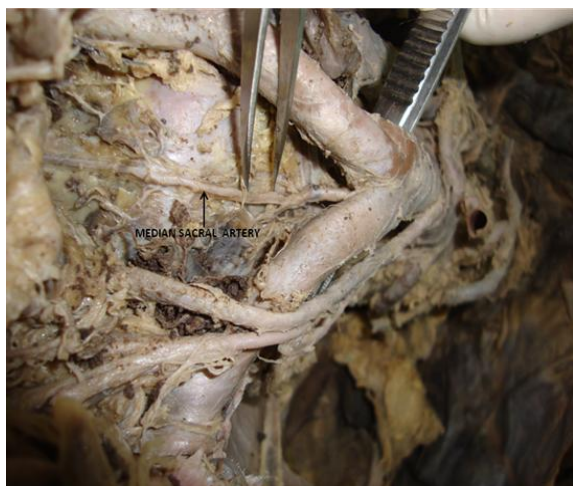


Fig 1: Showing median sacral artery arising from the abdominal aorta.

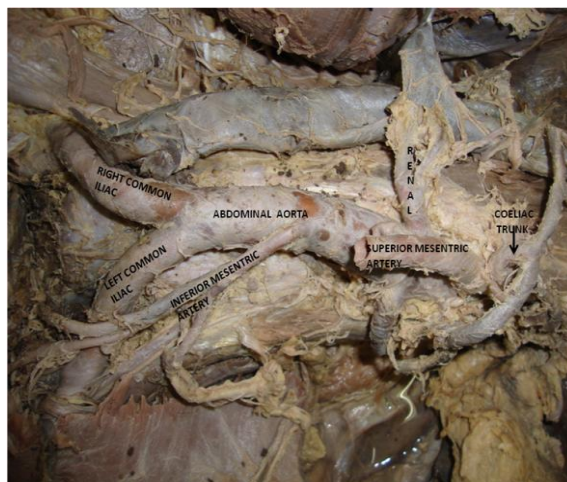


Fig 2: Showing the branches of the abdominal aorta.

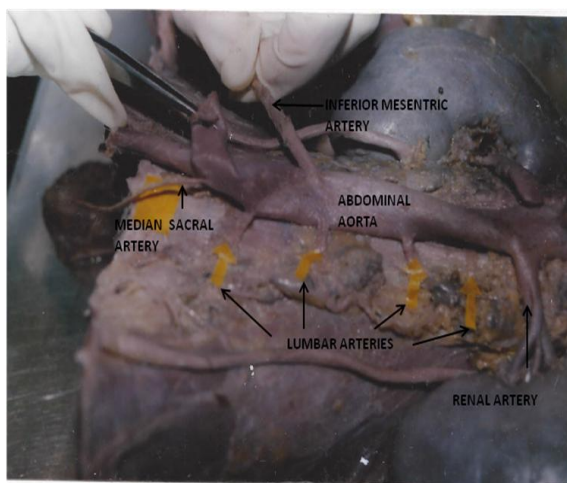


Fig 3: Showing the branches of the lumbar arteries.

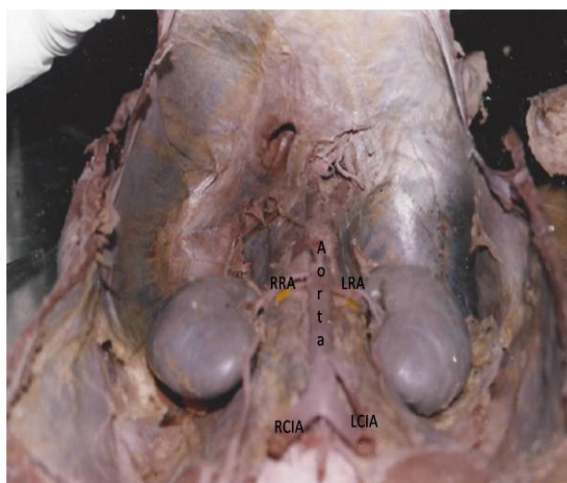


Fig.: 4

Gonadal artery, 20% from body of L2, 40% from lower border of L2 30% from upper border of L3 and 10% from the body of L3.

The median sacral artery, 10% from the lower border of L3, 30% from upper

border of L4, 40% from body of L4 and 20% from lower border of L4.

The origin of right and left iliac artery was 10% from upper border of L4, 50% from the body of L4 and 40% from the lower border of L4 respectively.

DISCUSSION

The abdominal aorta is the major artery of the abdomen begins at the median aortic hiatus of the diaphragm anterior to the inferior border of the 12th thoracic vertebra and it descends anterior to lumbar vertebra to end at the lower border of the 4th lumbar vertebra, a little to the left of midline, by dividing into two common iliac arteries.

Variation in the arrangement of arteries and their branches are common and surgically important. The superior mesenteric artery may be the source of common hepatic, and accessory pancreatic or splenic arteries. It may arise from a common coeliac-mesenteric trunk.” [1]

According to Quain, 10 out of every 13 subjects examined, the bifurcation of the aorta occurred within 1.2cm above or below the level of highest point of iliac crest, more frequently below the crest than above it. [2]

The author also reported that the direct branches of abdominal aorta sometimes include an accessory inferior phrenic, splenic, hepatic, supreme pancreatic, accessory superior mesenteric, inferior suprarenal, accessory gonadal accessory and fifth lumbar, internal iliac, umbilical, and/or accessory medial sacral.

According to a study by Bergman et al, reported origin of typical three- branched celiac trunk occurring in 86% of 756 cases. They also showed that the coeliac trunk may be absent; the branches usually arising from it then arose from aorta. The trunk may be shorter or longer than usual. In the latter case, the branches commonly arise separately from the instead of radiating from a single point. [3]

Cavdar S., studied the anatomical variations of the celiac trunk were due to developmental changes in the ventral splanchnic arteries. Their report described a

case in which the left inferior phrenic artery and left gastric artery arose from the long celiac trunk [4.3 cm] via a common trunk. [4]

According to Poynter, inferior mesenteric artery had not been extensively studied [i.e, before 1922] and the literature was not very extensive. The artery appeared to be rather stable and not subjected to much variation. [5]

Koizumi and Horiguchi (1990), reported that the superior mesenteric artery was considered developmentally as part of the celiac complex and it follows that variations in the superior mesenteric artery were related, in large measure, to the celiac trunk. The variations in this artery were very common and numerous. The artery may be doubled arising from the aorta as two trunks. The artery might give rise to branches usually derived from other sources: the hepatic or its right or left branch, the cystic, the gastro duodenal or its right epiploic branch, the left, an accessory colic (superior left colic artery) or a larger pancreatic branch. They found an accessory colic artery which arose from the superior mesenteric artery more proximal than the first jejunal artery and made the marginal artery at the splenic flexure; it was reported found in 32 of 65 subjects (49.2%). The authors, noting the constant nature of this unnamed artery proposed the name “superior left colic artery (arteria colicasinistra superior; CSS). [6]

Variations in the origin of phrenic arteries were numerous and supplementary phrenic vessels are common. The inferior phrenic arteries arose from a common trunk [55%, Poynter] from aorta or the celiac trunk in 18-30% of cases, or as independent branches from these same sources in 62%. Other sources might be the hepatic, left gastric, renal, suprarenal, or superior mesenteric arteries in about 8% of cases. [5]

A study by Sykes, suggested that “A superior accessory artery is a separate apical artery and an inferior accessory artery is a separate lower segmental artery”. Doubled renal arteries occurred in 10% of cases [based on 10,967 kidneys studied]. They

may be side by side, one in front of the other, or spaced so that they enter the kidney at opposite ends of the hilum. [7]

Adachi [1928] reported more rarely, a gonadal artery can originate from the suprarenal, inferior phrenic, superior mesenteric, lumbar, common iliac or internal iliac or inferior polar renal artery. Adachi reported that testicular and suprarenal arteries arose from a trunk with a frequency of one in 26 suprarenal glands. [8]

Newman, suggested that the relationship between aortic size and shape was a possible causative factor in the development of abdominal aorta aneurism. [9]

Shah, gave special interest to a study of the geometry of aortic bifurcation which contained the most expensive data so far recorded including the diameters and angle of deviations, iliac lengths and curvatures and dorsal angulations of these vessels as they entered the pelvis. [10]

Nitetti SS showed that in Behcet's syndrome rare aneurisms were among the arterial lesions, affecting various arteries but mostly the abdominal aorta. [11]

According to Prakash, the origin of celiac trunk was most commonly [in 64% of cadavers] located at the level of the T12 vertebra, the superior mesenteric in 76% at L1, inferior mesenteric in 68% at L3, left and right gonadal 84% and 86% respectively, at L2, whereas the aortic bifurcation was most common at 54% at the level of L4 vertebra. [12]

Swati Tiwari et al. [2014] found the inferior phrenic arteries arising from the celiac trunk as independent branches. [13]

Naik KS et al. [2015] observed right gonadal artery arises from ventral surface of abdominal aorta left gonadal artery arises from left accessory renal artery. [14]

Our study agree with earlier finding of Quain [1844] where the bifurcation of aorta occurred above or below the level of the highest point of iliac crest. The site of bifurcation is opposite the level of lower border of the body of the fourth lumbar vertebra. The renal arteries were arising at

right angles from the aorta slightly below the superior mesenteric artery and left renal artery was at higher level. The median sacral artery was seen arising from the back of the aorta at the level aortic bifurcation at the level of lower border of fourth lumbar vertebra. There was no significant difference seen in the origin of middle suprarenal artery in all the specimens. The left renal artery is higher than the right artery in origin. There was normal pattern of lumbar arteries and most significant was that of the absence of 5th lumbar artery.

CONCLUSION

The conclusion of the study of branching pattern of abdominal aorta was no significant difference was observed in branching pattern of abdominal aorta. There was no differences seen in the origin of celiac trunk and inferior phrenic arteries arising at the lower border of 12th thoracic in all specimens. Our studies suggest that superior mesenteric arteries may get origin either at the level of upper border or opposite of the body and\ or lower border of the 1st lumbar vertebra. Inferior mesenteric artery may get origin at the level of upper border or opposite the body and\ or lower border of 3rd lumbar vertebra. There was no significant difference seen in the origin of middle suprarenal artery, the Gonadal vessels and lumbar arteries except for absence of 5th lumbar artery. There was no difference in the origin of the common iliac arteries.

The limitations of this study are the size of the sample used, so a further study is suggested on a larger population.

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