European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 09, Issue 04, 2022

TO STUDY THE MORPHOMETRIC ANALYSIS OF ABDOMINAL AORTA AND ITS BRANCHES

K D V Santhi Priya[1],*, Dr. Nageswara Rao Gutti [2]

1 Associate Professor, *Dept. of Anatomy, Katuri Medical College and Hospital, Guntur, Andhra Pradesh, India*

2. Assistant Professor, *Dept. of Anatomy, Sri Venkateswara Medical College, Tirupati, , Andhra Pradesh, India.*

Corresponding author: **K D V Santhi Priya**

ABSTRACT:

Introduction: Knowing the morphology of abdominal aorta (AA) and its branches are important as regards to diagnosis and surgical treatments. Despite that, data on morphometry of abdominal aorta branches and abdominal viscera are lacking.

Aim: To investigate this subject authors performed a morphometric study on 80 adult fresh and embalmed Asian cadavers and examined abdominal aorta branches to make morphometric measurements of AA and its branches, to investigate sites of the origins of the branches and their relationships and variations and to compare the results with literature. We believe that our results add knowledge on abdominal aorta branches and viscera morphometry and are valuable for new radiologic and clinical applications including stent grafts and chemoembolisation materials and surgical applications including visceral arteries' aneurysms investigation, treatment, and transplantation precedures.

Materials and Methods:

The study was conducted on 80 AA specimens that were obtained from human cadavers during autopsies Guntur General Hospital from March 2020 to October 2021. These specimens of AA and its branches were measured with a metal scale morphometrically to determine diameter of Aorta and distances between branches

Result: The mean diameter of AA was studied at various levels and recorded. The study showed a decrease in caliber from above to below. In both sexes, diameter of Aorta is more in > 40yrs age group than age group < 40yrs. The average distance from CT-AB, CT-SMA, SMA-IMA and IMA-AB were measured as 10.99cm, 0.76cm, 4.89cm, 3.54cm, respectively in males with average age and height was 38.26 and 158.2 respectively. Similarly, in females the average distance from CT-AB, CT-SMA, SMA-IMA and IMA-AB were measured as 10.12cm, 0.68cm, 4.69cm, 3.32cm, respectively with average age and height was 36.24 and 145.9 respectively. Numerous variations were observed during the study which include absence of renal artery, origin of renal arteries one above the other, 3pairs of lumbar arteries etc.

Conclusion: Knowledge of morphology of AA and its branches is important in regards to the diagnosis, surgical treatment and endovascular interventions of these vessels. We think our study will contribute to the medical education and clinical medicine.

Keywords: Morphology, Abdominal aorta, Renal Arteries, CT-SMA, CT-AB

Introduction:

vascular variations regarding the morphology of AA, branching pattern of the aorta are important in different laparoscopic surgeries, liver and kidney transplantation, oncologic resections, and various interventional radiological procedures, renal trauma surgery, radiological imaging and surgical treatment of aortic aneurysms[1,2]. Variations of GA should be noted while performing surgical and radiological procedures on kidneys (4). IPA is the most common source of extrahepatic collateral blood supply for hepatocellular carcinoma (HCC) and frequently supplies HCCs located

in the bare area of the liver. Therefore, anatomy of IPA should be known for surgical treatment of this tumor[3]. Knowledge of the anatomical variations of LA is important for surgical operations involving the retroperitoneal region[4]. The abdominal aorta (AA) begins at aortic hiatus of the diaphragm, anterior to the inferior border of the 12th thoracic vertebra and the thoracolumbar intervertebral disc. It descends anterior to the lumbar vertebrae to end at the lower border of the 4th lumbar vertebra, slightly to the left of the midline, by dividing into two common iliac arteries. It diminishes in calibre from above downward, giving off its branches. The branches of AA are grouped into anterior, lateral and dorsal branches. The anterior and lateral branches are distributed to the viscera. The dorsal branches supply blood to the body wall, vertebral column, vertebral canal and its contents (1,2). The celiac trunk (CT) is the first anterior branch of AA and it arises from the AA immediately below the aortic hiatus at the level of T12-L1 vertebra. It is c. 1.5-2 cm long. Superior mesenteric artery (SMA) originates c. 1 cm below the CT, at the level of the L1-L2 intervertebral disc. The inferior mesenteric artery (IMA) arises from the anterior or left anterolateral aspect of the AA at the level of L3 and 3-4 cm above aortic bifurcation (AB). Inferior phrenic arteries (IPA) arise just above the CT. The left and right middle suprarenal arteries (MSRA) arise from the lateral aspect of AA, level with the SMA. The left and right renal arteries (RA) originate just below SMA and the right arises slightly higher than the left. Gonadal arteries (GA) arise inferior to the RA. Lumbar arteries (LA) arise from the posterolateral aspect of AA and there are usually 4 pairs. Median sacral artery (MSA) is a small branch that arises from the posterior aspect of the aorta a little above its bifurcation (1,3). Variations in AA and its branches are frequently observed and they occur due to embryological developmental changes (4-6). For example, IPA and CT may originate from AA as a single common trunk or a fifth pair of LA may occasionally arise from the MSA (1). The aim of this study was to a) make morphometric measurements of AA and its branches, b) to investigate sites of the origins of the branches and their relationships and variations, and c) to compare the results with literature.

Materials and Methods:

The study was conducted on 80 AA specimens that were obtained from human cadavers during autopsies Guntur Generl Hospital from March 2020 to October 2021. These specimens of AA and its branches were measured with a metal scale morphometrically to determine diameter of Aorta and distances between branches (CT-AB, CT-SMA, SMA-IMA and IMA-AB) and the results were noted. The demographic characteristics of the cases (sex, age, height and weight) and any encountered variations and anomalies were recorded during the macroscopical observations.

Results:

Out of 80 specimens taken for the study, 61 were males and 19 were females. The mean diameter of Aorta was studied at various levels and was illustrated in Table 1. The mean diameter of Aorta according to age and sex was studied and it was found that in all specimens at all levels in females is less than that of males and in both sexes diameters > 40 years are greater than < 40 years age group (Table 2). The study of Sonesson B et al. in 1994 concluded that there was a decrease in abdominal aortic wall distensibility with age and this occurs at earlier age in men.11 Lederle, et al.12 analyzed the variation in aortic diameters measured with both CT and ultrasonography in 258 patients. The Ultrasound based measurements were smaller than the CT-based measurements by an average of 0.27 cm. But Wanhainen, et al.13 reported that Ultrasound based measurements were larger by 2.8 mm than CT- based measurements. At present study the average distance from CT-AB, CT-SMA, SMA-IMA and IMA-AB were measured as 10.99cm, 0.76cm, 4.89cm, 3.54cm, respectively in males with average age and height was 38.26 and 158.2 respectively. Similarly, in females the average distance from CT-AB, CT-SMA, SMA-IMA and IMA-AB were measured as 10.12cm, 0.68cm, 4.69cm, 3.32cm, respectively with average age and height was 36.24 and 145.9 respectively. The average lengths of Aortic segments at different age and height in males and females

were shown in Table 3. In both gender the mean length of Rt. Common iliac artery is shorter than Lt. one. In males the average length of Rt. Common iliac artery is 3.15cm whereas Lt. is 3.99cms, whereas in females the average length of Rt. Common iliac artery is 2.69cm whereas Lt. is 3.12cms. Many variations were observed in the study such as absence of left renal artery, bilateral accessory renal arteries, in few origin of one renal artery above the other, 3pairs of lumbar arteries etc., (Figures 1,2,3 and 4).

Table 1: Mean diameter of aorta at various levels (in cms)

No. of specimens	**Level**	**Value**
80	D1	1.35
80	D2	1.65
80	D3	1.95
80	D4	0.56
80	D5	0.33
80	D6	0.99
80	D7	0.58

Table 2: Mean diameter of abdominal aorta according to age and sex (in cms)

Diameter levels	**< 40 years age**		**> 40 years age**	
	Male specimens (34)	**Female specimens (09)**	**Male specimens (27)**	**Female specimens (10)**
D1	1.20	1.69	1.44	1.65
D2	0.694	0.798	1.31	1.98
D3	1.30	0.97	1.46	1.49
D4	0.81	0.89	1.264	1.26
D5	0.89	0.99	1.456	1.55
D6	0.654	0.456	0.792	0.726
D7	0.597	0.439	0.856	0.568

Table 3 Mean Lengths of aortic segments at different levels in centimetres in relation to age and height

		Length in Male	Age	Height	Length in Female	Age	Height
L1 (full length)		10.99	38.26	158.2	10.12	36.24	145.9
L2 (Supra renal segment)	Right	3.15			2.69		
	Left	3.99			3.12		
L3 (Infra renal segment)	Right	7.28			6.69		
	Left	7.45			7.01		
L4 (coeliac to superior Mesenteric artery)		0.76			0.68		
L5 (superior Mesenteric artery to Bifurcation)		4.89			4.69		
L6 (Inferior Mesenteric artery to Bifurcation)		**3.54**			**3.32**		

Table 4 Comparative measurements of proximal and distal Aorta and iliac vessels

Author	Year	**Sample size**	**Proximal Aorta (Supra Renal)**		**Distal Aorta (Infra Renal)**		**Common Iliac Artery**	
Pederson et al [5]	1993	160	< 50	> 50	< 50	> 50	< 50	> 50
			1.69	1.99	1.51	1.68	0.97	1.0
B Sonneson et al[6]	1994	146	< 40	> 40	< 40	> 40	< 40	> 40
			1.59	1.54	1.62	1.75	1.28	1.39
Baniel et al[7]	1995	102	1.31	1.58	1.25	1.18	1.57	1.23
Loukas M et al[8]	2005	330	1.20	1.56	1.34	1.26	1.20	1.46
Ahmet Songür et al[9]	2010	95	1.43	1.38	2.01	1.38	1.24	1.61
Present study	2022	80	< 40	> 40	< 40	> 40	< 40	> 40
			1.20	1.69	1.44	1.65	1.20	1.69

1. Discussion

We think that the demographic information of the cadavers from which the specimens were taken is consistent with the demographic data. Now a day's endovascular surgeries are very important in the management of different vascular problems. Of the many vessels, gross anatomical aspects of coronary, cerebral arteries, abdominal aorta and its branches are very important and were extensively studied by many authors.

In a study by Saldarriaga et al. conducted on 196 cadavers multiple RA were observed in 22.3% of the specimens and also double RA were more frequently observed on the left side (14). We found multiple RA rate to be lower (16.8%) and double RA were more frequently observed on the right side. Our findings were different from those of Saldarriaga et al. Cavdar et al. reported a case of left IPA and left gastric artery arising from the long CT via a common trunk (5). In a series of 330 cadavers, Loukas et al. determined that right and left IPA originated from CT in 40% and 47% of the specimens, respectively (15). We observed in our series that IPA arose from CT as a common trunk in 3 cases (3.1%).

PM Shah et al. studied the morphometry of abdominal aorta, its bifurcation and common iliac arteries. Their study revealed lengths of common iliac arteries which can be compared with present study. According to them, the length of right common iliac in males ranged between 8.2 cm –3.3 cm with an average of 6cm and the left ranged between 7.6 – 3.8cm with an average of 5.8cm. Whereas in females the average length of right and left is 5.63cm and 5.4 cm respectively. This shows that right common iliac artery is lengthier than left common iliac arteries. The present study showed the average lengths of right common iliac in males and females are 3.93cm and 4.10 cm respectively. In females, the right is 3.99cm and left is 4.34cm. This indicates the left common iliac is longer than the right. The present readings are in contradiction to the study of Shah et al. [14]

Ole martin Pedersen et al. and Sonesson B studied diameters of proximal and distal aortic segments and stated that as age advances the diameter of the distal aortic segment and iliac artery increases. Present study also revealed the same (Table 4). [15,16]

In an anatomical study of 102 cases by Baniel et al., it was determined that the number of LA Ranged between 2 and 4 and also there were 3 pairs in 60% of the cases (10). We found in our series that there were 3 pairs of LA in 11.5% of the cases and 3rd or 4th pair of LA arose as a single trunk in 3 cases (3.1%).

According to the study of Ozan H et al., ostium of Rt. Renal artery was more cranial than that of left (53.3%) and in 10% both the ostia are at same level. In the present study, the ostium of Rt. Renal artery is cranial than that of left in 50% and the left renal artery is cranial to Rt in 46%. Both ostia are at same level in the remaining. [17]

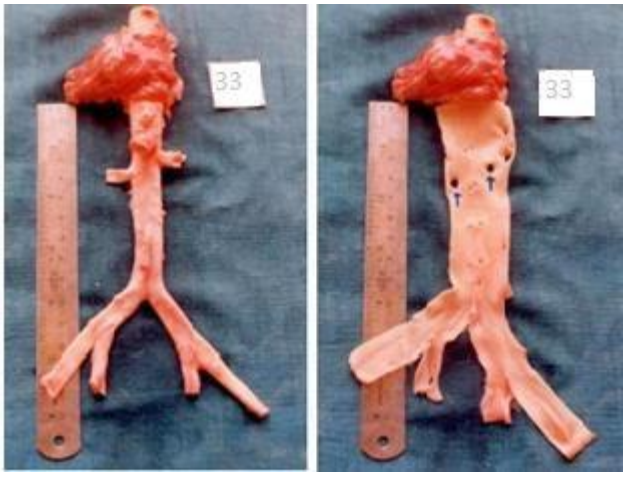

Figure 1: Origin of Lt. renal artery at lower level than Rt.

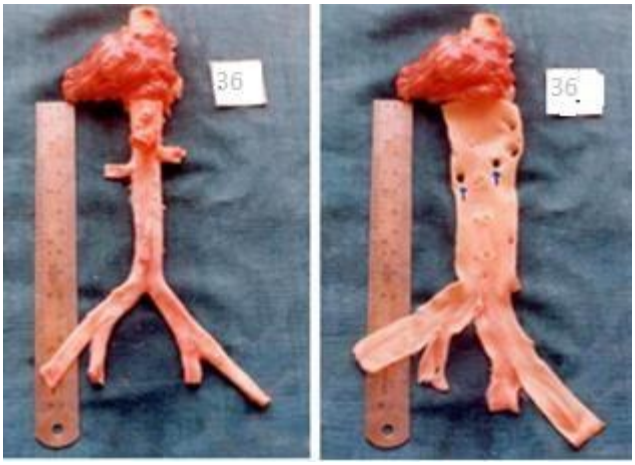

Figure 2: Origin of Lt. renal artery is at higher level than Rt

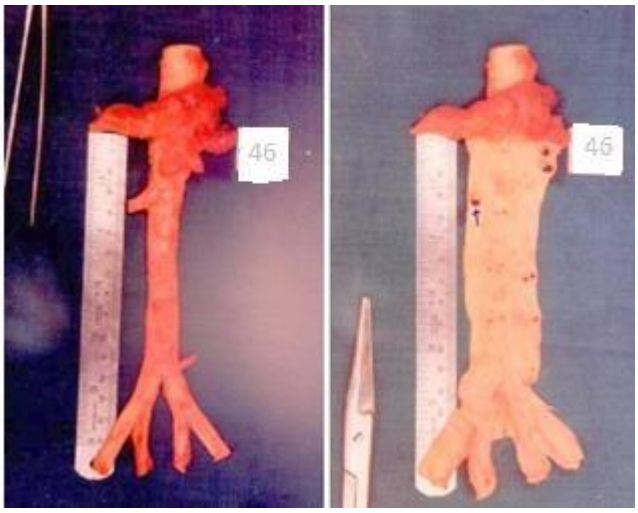

Figure 3: Aorta with absence of Lt. Renal artery

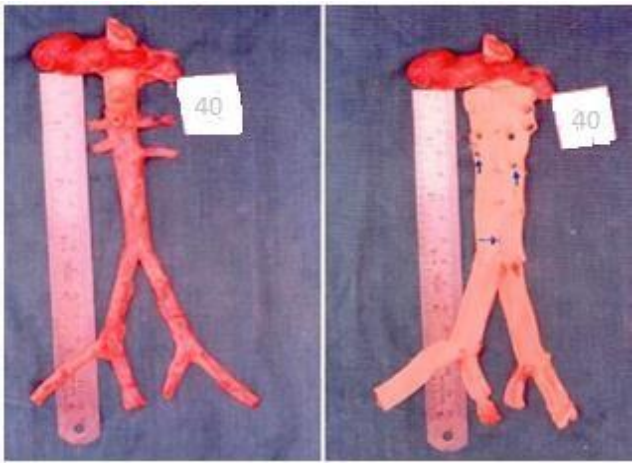

Figure 4: Aorta with bilateral accessory renal arteries

Acknowledgment:
The author is thankful to Department of Anatomy for providing all the facilities to carry out this work.
Conflict of Interest
None
Funding Support
NIL

References:

1. Ozan H, Alemdaroglu A, Sinav A, Gümüsalan Y. Location of the ostia of the renal arteries inthe aorta. Surg Radiol Anat 1997;19:245-7.
2. Bordei P, Sapte E, Iliescu D. Double renal arteries originating from the aorta. Surg RadiolAnat 2004;26: 474-9.
3. Gwon DI, Ko GY, Yoon HK et al. Inferior phrenic artery: anatomy, variations, pathologicconditions and interventional management. Radiographics 2007;27: 687-705.
4. Baniel J, Foster RS, Donohue JP. Surgical anatomy of the lumbar vessels:

implications forretroperitoneal surgery. J Urol 1995;153:1422-5.

5. Pedersen OM, D M. Ultrasound measurement of the luminal diameter of abdominal aorta andiliac arteries in patients without vascular disease. *J Vasc Surg*. 1993;17(3):596–601.
6. Sonneson B. Infrarenal Aortic diameter in healthy person. SO. *Eur J Vasc Surg*. 1994;8:89–95.
7. Baniel J, Foster RS, Donohue JP. Surgical anatomy of the lumbar vessels: implications forretroperitoneal surgery. J Urol 1995;153:1422-5.
8. Loukas M, Hullett J, Wagner T. Clinical anatomy of the inferior phrenic artery. Clin Anat2005;18:357-65.

9. Abdominal Aorta and Its Branches: Morphometry - Variations In Autopsy Cases; AhmetSongür, Muhsin Toktaş , Ozan Alkoç , Tolgahan Acar , İbrahim Uzun, Orhan Baş, OğuzAslan Özen.