

# Detection of Abdominal Aortic diameter at the level of T12 vertebrae by using three Dimensional Multidetector Computed Tomography (MDCT) Angiography in subset of Karachi Population

ROSHEENA NABEEL KHAN<sup>1</sup>, MARIA MOHIUDDIN<sup>2</sup>, MUBINA LAKHANI<sup>3</sup>, MADEEHA SADIQ<sup>4</sup>, NUZHAT HASSAN<sup>5</sup>, ABDUL REHMAN<sup>6</sup>

<sup>1</sup>Assistant Professor, Department of Anatomy, United Medical & Dental College, Karachi.

<sup>2</sup>Assistant Professor, Department of Anatomy, Hamdard University, Karachi.

<sup>3</sup>Assistant Professor, Department of Anatomy, Ziauddin University, Karachi.

<sup>4</sup>Assistant Professor, Department of Anatomy, Ziauddin University, Karachi.

<sup>5</sup>Professor, Department of Anatomy, Ziauddin University, Karachi.

<sup>6</sup>Assistant Professor, Department of Anatomy, Liaquat College of Medicine & Dentistry, Karachi.

Correspondence to: Dr. Rosheena Nabeel Khan, Email: [rosheenakhan12@gmail.com](mailto:rosheenakhan12@gmail.com), Cell: 0322-2822855.

## ABSTRACT

**Objective:** To determine the diameter of abdominal aorta at T12 vertebral level by the use of Multidetector Computer Tomography Angiography (MDCTA).

**Study Design:** It is a Cross-sectional study.

**Place and Duration of Study:** This study was executed in Ziauddin University (Hospital) Clifton campus Karachi, at Radiology Department, from March 2017 to August 2017.

**Materials and Methods:** Total 160 individuals were enrolled, 75 (46.9%) were females and 85 (53.1%) were males who do not have any abdominal and arterial or venous problems, approach to Radiology Department, for Abdominal 3D Computed Tomography Angiography. Patients who were enrolled in current study were referred to department of Radiology for different indications like adrenal and renal pathologies altered bowel habits and abdominal aches. In current study abdominal aortic dimension (diameter) was analyzed at T12 vertebral levels in both sexes. The SPSS version used in current study was 20 for statistical analysis. Pearson correlation was applied to check the relationship between variables, Independent sample T test was applied. P-value is less than or equal to 0.05 was considered significant.

**Result:** The results of current study revealed that the mean diameter of the abdominal aorta, measured at T12 vertebral level was  $20.402 \pm 2.54$  mm in total 160 individuals. It was observed that male having diameter with  $21.47 \pm 2.25$  and female have  $19.18 \pm 2.31$  mm. It clearly showed that male having greater diameter with highly significant values  $P=0.001$ . It was also found that there was a high positive correlation was evident in between diameter of abdominal aorta & age with highly significant difference  $P=0.001$  and  $r=0.713$ . This correlation showed that as the age increases the thickness of abdominal aorta also increases.

**Conclusion:** It is the first study conducted in Pakistan on detection of abdominal aortic diameter at T12 vertebral level by Multidetector computed tomography angiography. The current study showed that male having greater aortic diameter than in females it also revealed that the age have a great impact on the diameter of abdominal aorta.

**Keywords:** Multidetector computed tomography, aorta, abdominal, heart, tunica Intima.

## INTRODUCTION

Abdominal aorta (AA) is the largest artery of a body<sup>(1)</sup>, which originates from the heart (left ventricle) & extends down towards the abdomen, where commonly it is divided into 2 common iliac arteries<sup>(2)</sup>. At the aortic hiatus of the diaphragm abdominal aorta begins, i.e. anterior to the lower border of T12 vertebra<sup>(3,4)</sup>. Anterior to the vertebral bodies abdominal aorta descends through the abdomen and it end at the level of L4 vertebra more slightly lie on the left side to the midline<sup>(5)</sup>.

The Aorta is an elastic artery which has distensible properties<sup>(6)</sup>. The vascular wall of the aorta is like other arteries which consists of 3 layers, which includes Tunica Adventitia (an outer layer), A Tunica Media (a middle layer) & Tunica Intima (an internal layer)<sup>(7)</sup>. A Tunica Intima has a layer of endothelial cells which lie on the basement membrane<sup>(8)</sup>. A tunica media has having smooth muscles and lamina (internal elastic) while outer layer i.e. tunica adventitia is consists of nerve, collagen, and fibroblast cells<sup>(9, 10)</sup>. This layer of the aorta consists of concentric musculo-elastic layers<sup>(11)</sup>. The activated smooth muscles not only alter the diameter of aorta but also increases the viscoelasticity and elasticity of the aortic wall<sup>(12)</sup>. The wall of aorta changes with increasing age<sup>(13)</sup>, the main feature of aging in aorta is atherosclerosis and thickening of tunica intima, with elastin fragmentation, cystic necrosis, elastin fragmentation, fibrosis in tunica media and adventitia<sup>(14)</sup>. Changes in abdominal aorta with increasing age, there is a decrease in aortic elasticity. With decreasing distensibility of aorta there will be more abdominal aortic destruction and widening of pulse pressure<sup>(15)</sup>.

Abdominal aorta is the largest artery of the body with normal diameter of approximately 20 mm<sup>(16)</sup>. Abdominal aorta supplies oxygenated blood to abdominal organs like, spleen, liver, gonads,

diaphragm & pelvis<sup>(16)</sup>. The diameter of aorta changes in advance age and there is a gradual widening of lumen because of the weakening of an aorta<sup>(17)</sup>. Overall the diameter that is more than 3.0 cm of abdominal aorta is considered as abnormal in overall diameter<sup>(18)</sup>. Aneurysm is considered when there is a focal dilatations of an aorta<sup>(17)</sup>. A rupture of aortic aneurysm may lead to death within minute. Approximately 90% of the population die before reaching to hospital<sup>(17)</sup>.

Vascular disorders are more commonly diagnosed in old patients so it is essential to determine aortic diameters earlier in older ones. It is important to evaluate diameter of abdominal aorta for AAA Abdominal aortic aneurysm<sup>(19)</sup>. The main risk factor which affects the diameter of abdominal aorta is advancing age<sup>(20)</sup>. It has been documented that approximately 1-3% of deaths takes place due to Abdominal Aortic Aneurysms, which are common in male aged between 65-85 years old than in female<sup>(21)</sup>.

Gender is the most influential factor with advancing age which affects the diameter of Abdominal aorta<sup>(22)</sup>. Few studies mention the high risk of widening of abdominal aorta in man over the age of 65 years than in women<sup>(22)</sup>.

## METHODS

It was a Cross-Sectional research which was performed in 2017 from March till August. Data collection was done through Non-probability sampling (convenience) technique. Sample size of this study was 160 subjects. WHO sample size calculator was used to calculate sample size which was 138 subjects by keeping the frequency at 10%<sup>3,17,18</sup>, with bound of error at 5% and confidence level of 95%. With the sample size was 160 where,  $n = z^2P(1-P)/d^2$  where  $n$  = number of samples,  $z$  = standard error of mean,  $P$  = prevalence and  $d$  = absolute precision. Formula used was  $N =$

z2pq/d2, with Prevalence 10%, Precision 0.05 and Confidence level 95%. In this study 160 individual were taken, aged between 20-60 years. Patients who were recruited in this study was referred to the radiology department for abdominal contrast CT (computed tomographic) examination for various indications. Persons having age between 20-60 years (males and females) with serum creatinine level of less than 1.4mg/dl with no hepatobiliary pathologies, pancreatic or abdominal vascular lesions were included in the study. Patients having pancreatic or abdominal vascular lesions, hepatobiliary pathologies, or previous history of liver transplants, any history of upper abdominal malignancies and surgeries, abdominal malignancy distorted vascular anatomy, atherosclerosis and vasculitis were excluded. Persons having previous history of allergic reactions to contrast agent and pregnant women were also excluded from this research project.

Ethics Review Committee from Ziauddin University approved this study. After taking consent from each individual questionnaire was filled. In present study abdominal aorta of each subject was examined by multidetector computed tomographic angiography on 16 slice scanner (Toshiba Alexion, Japan) in arterial phase. Before examination a contrast material was given intravenously then asked each subject to lie on a platform of CT scanner in a supine position. It was instructed to the subject to hold their breath for 15 second and then the scanning was started.

The arterial pattern of analysis was done in different planes (axial, coronal and sagittal) with reconstruction technique which includes maximum intensity projection (MIP) multiplanar reformatting images (MPR), and volume rendered (VR) techniques. The slice thickness was taken as 5 mm to evaluate the diameter of abdominal aorta at T12 vertebral levels (figure1). The Images were taken in craniocaudal fashion from the dome of the diaphragm to the pubic symphysis.

Analysis of data was done on SPSS 20 version. Variables that are showing in this study are presented in mean and standard deviation.

For variables Independent T test was applied. Pearson's correlation is used to test the correlations between variables.

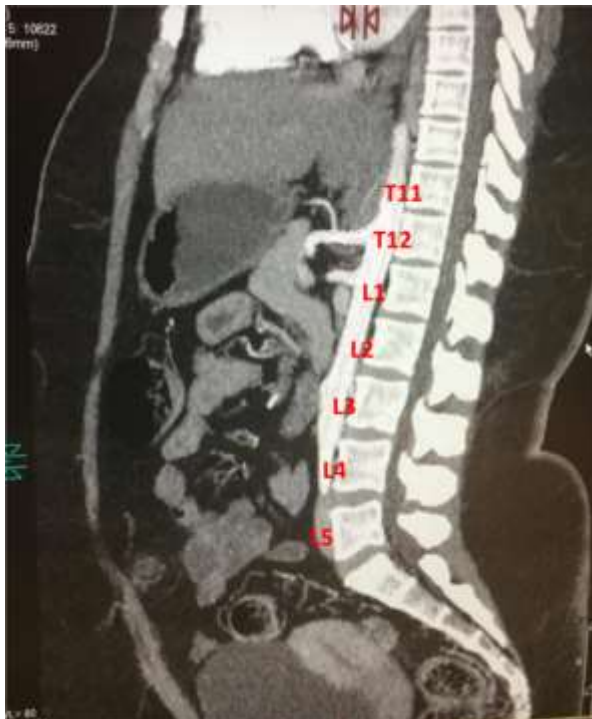


Figure 1: Showing MDCT scan (MPR) and (MIP) sagittal contrast CT enhanced image depicts T12 vertebra at which diameter of abdominal aorta was taken.

**RESULT**

**Diameter of abdominal aorta at T12 vertebral level:** Diameter of abdominal aorta was observed in 160 individuals at T12 vertebral level in 85 males and 75 females (total 160 individuals) as shown in (Table 1). The mean diameter of abdominal aorta at T12 vertebral level in male was 21.48± 2.25 mm and 19.18± 2.31 mm in female is shown in (table 2). The mean diameter of 160 individuals of abdominal aorta at T12 vertebral level was 20.402 ± 2.54 mm. High positive correlation was found between diameter of abdominal aorta and age (r= 0.713) with highly significant difference of 0.001\* shown in (Table 3).

The mean diameter of abdominal aorta at T12 vertebral level between gender shows highly significant results with P=0.001(Table 4).

Table 1: General characteristic of study participants

Variables	Total Number %(n)	Age years Mean ± Sd
Total participants	100 % (160)	47±12
Males	53.1 % (85)	49±10
Females	46.9 % (75)	46±13

n = total number, SD = standard deviation.

Table 2: Diameter of Abdominal Aorta with respect to gender

Gender	Diameter in mm	St. Deviation
Male	21.47	2.25
Female	19.18	2.31

Table 3: Correlation of age and diameter of abdominal aorta at T12 vertebral level

Variable	Mean	St.deviation	R <sup>2</sup>	P-value
Age	47.50	11.69	0.713	0.001
Diameter	20.402	2.54		

Abdominal aorta. \*p-value less than 0.05 was considered as significant.

Table 4: Diameter of Abdominal Aorta with respect to the gender

Variable	Male n	Female n	P- value
Diameter	21.47	19.18	0.001

Abdominal aorta. \*p-value less than 0.05 was considered as significant

**DISCUSSION**

Various pathologies and diseases can damage aorta which includes Hypertension, Atherosclerotic stenosis & Occlusions, Aortic Dissection, Aortic Aneurysm, Coarctation of Aorta, Inflammatory disease like Takayasu or Horton disease, genetic disorders like Osteogenesis Imperfecta, Marfan syndrome, Scleroderma, Polychondritis, Turners Syndrome and Polycystic Kidney Diseases, Syndrome, Connective Tissue disorders such as Ehler-Danlos disorder, (23).

Tumors can also affect the aorta. Benign tumors include endothelial papillary fibroelastoma arising in the aortic sinuses and intra-aortic myxomas. Malignant tumors of an aorta are the sarcomas arising from intimal cells, angio-sarcoma or leiomyosarcomas, malignant hemangio-endothelioma, schwannoma and fibrous histiocytoma, have also been reported to arise in the great vessels(23).

It is essential to know about the changes of arterial anatomy during advance age. It will be beneficial for the doctors during performance of invasive procedures like for the diameter of angioplasty ballooning and placement of stents during different endovascular procedure as well.

It will be also very useful in future for manufacturers who will design endovascular devices with specific diameters & curvature which will be fit better according to the age and sex of patient group (24)

Normative anatomic data of Abdominal aorta is important for the analysis of arterial diseases specifically for the diagnosis of abdominal aortic aneurysm. In many studies the morphometry of the AA was determined by using different imaging methods like

ultrasonography, magnetic resonance imaging (MRI) as well as Computer tomography.

In literature, only few studies had done on the diameter of abdominal aorta by MDCT. To the best of our knowledge the present study is the first morphometric analysis of abdominal aorta at T12 vertebral level by MDCTA on Pakistani population. In order to make a correct and precise analysis of arterial aneurysms, the knowledge of normal arterial diameters in a particular group or population is necessary<sup>(25)</sup>.

Our results showed that the mean diameter of Abdominal aorta was  $20.402 \pm 2.54$  mm. In Saudi population the mean diameter of Abdominal Aorta at T12 vertebral level was  $20.38 \pm 1.78$  mm<sup>(19)</sup>. In another study by using MDCT conducted in Sudanese showed that abdominal aortic diameter at T12 vertebral level was  $20.205 \pm 1.62$  mm which showed that their results are quite similar to our results. A study conducted in Nigeria which showed abdominal aortic diameter was  $15.1555 \pm .55$  mm<sup>(26)</sup> and a study conducted in India on CT which showed that the mean diameter of abdominal aorta was less than that of our study participant.

The mean diameter of present study at T12 vertebral levels were  $19.18 \pm 2.31$  mm in female and  $21.47 \pm 2.25$  mm in male. A study conducted in Sudanese population the aortic diameter in female was  $19.44 \pm 1.5$  mm and in male was  $20.97 \pm 1.74$  mm<sup>(27)</sup>. Another study supports our results which was conducted in India in 2014 on CT, the mean diameter of AA was  $17.1 \pm 2.3$  mm in female and  $19 \pm 2.3$  mm in male<sup>(28)</sup> which shows that mean aortic diameter are more in males than in female. The mean diameter in male and female was very close to Sudanese<sup>(27)</sup> but slightly larger than Indian population<sup>(28)</sup>. It is evident from this discussion that the gender also has high risk that may influences the dimensions of the aorta. In present study, there was a significant difference found in between male and female at T12 vertebral level. This difference in aortic diameters at T12 levels between male and female is perhaps due to the reason that male have larger body size as compared to female as organ size is a true reflection of general body size<sup>(29)</sup>.

A study conducted in Brazil showed that the diameters of several aortic segments progressively increase with advancing age in both male and female while it is also evident that diameters of vessels are higher in males than in female in the same age groups<sup>(24)</sup>. It has been seen that age and gender has a high impact on diameter of abdominal aorta. It is also found that diameter of abdominal aorta has positive correlation with age which shows that as age increase diameter also increases<sup>(30)</sup>. A study conducted in 2015 which was based on influence of environment and genetics on development of aorta shows that diameters of abdominal aorta increases in healthy individuals<sup>(30)</sup>. Another study conducted in china reported that the effects of aging on abdominal aorta which demonstrates that morphology and circumference of aorta change with aging and size increases continuous with life<sup>(31)</sup>. In this research, we also found strong correlation between diameters of aorta and age.

A study conducted in Indian population also showed strongest correlation of age on aortic diameters<sup>(19)</sup>. It has been evident from different studies that increasing age is a major variable which can affect the dimensions of aorta. Gender is also one of the significant variable that may affect the dimensions of the aorta. In present research, significant difference found between aortic mean diameter of male and female at T12 vertebral level.

The purpose of current research was to find out the abdominal aortic diameter specifically in Pakistani population & to evaluate the association with age & gender. The finding of current research will be beneficiary for vascular surgeons, clinicians & radiologists for correct diagnosis & better management of Abdominal Aortic Aneurysms.

## CONCLUSION

This is the first study executed on Pakistani population which was based on determination of diameter of abdominal aorta at vertebral T12 level on MDCTA. The mean aortic abdominal diameter at T12

vertebral level is more in males than in female. Through current research it is evident that as age increases, diameter of aorta also increases. We suggested that aortic diameters must be evaluated by CT scan carefully before any laparoscopic procedure. This study can be utilized by radiologists, anatomist and surgeons to reduce complications related to abdominal aortic surgeries & interventional procedures. The current study can also be utilized for the designing of catheter and stents, for the wellbeing of patients.

## REFERENCE

1. Qin S, Chen R, Wu B, Shiu W-S, Cai X-C. Numerical Simulation of Blood Flows in Patient-specific Abdominal Aorta with Primary Organs. *Biomechanics and Modeling in Mechanobiology*. 2021;20(3):909-24.
2. Shetty S, Kantha L, Sheshgiri C. Bilateral absence of common iliac artery—a cadaveric observation. *Int J Anat Var*. 2013;6:7-8.
3. Matusz P, Jacob N, Mićlaus GD, Pureca A, Ples H, Loukas M, et al. An unusual origin of the celiac trunk and the superior mesenteric artery in the thorax. *Clinical Anatomy*. 2013;26(8):975-9.
4. Arudchelvam J. Study on the variations of the ventral abdominal aortic branches: a computed tomography based study. *Sri Lanka Journal of Surgery*. 2021;39(1).
5. Perez-Roman RJ, Kumar V, Basil G, Wang MY. Revisiting anterior longitudinal ligament release: Are we ready for an endoscopic approach? *Journal of Clinical Neuroscience*. 2021;94:166-72.
6. Pan Y, Lin J, Wang Y, Li J, Xu P, Zeng M, et al. Association of aortic distensibility and left ventricular function in patients with stenotic bicuspid aortic valve and preserved ejection fraction: a CMR study. *The International Journal of Cardiovascular Imaging*. 2022:1-9.
7. Lei C, Kan H, Chen W, Yang D, Ren J, Xu F, et al. Different gene co-expression patterns of aortic intima-media and adventitia in thoracic aortic aneurysm. *Gene*. 2022;819:146233.
8. Kim S-E, Jeong S-I, Shim K-M, Jang K, Park J-S, Lim Y-M, et al. In Vivo Evaluation of Gamma-Irradiated and Heparin-Immobilized Small-Diameter Polycaprolactone Vascular Grafts with VEGF in Aged Rats. *Polymers*. 2022;14(6):1265.
9. Rahman M, Siddik AB. *Anatomy, Arterioles*. StatPearls [Internet]. 2020.
10. Thiene G, Basso C, Della Barbera M. Pathology of the Aorta and Aorta as Homograft. *Journal of Cardiovascular Development and Disease*. 2021;8(7):76.
11. Dahlstrom JE, Subramaniam A, Faye-Petersen OM. Maternal Vascular Malperfusion and Associated Maternal Diseases. *Benirschke's Pathology of the Human Placenta: Springer*; 2022. p. 507-54.
12. Coccarelli A, Carson JM, Aggarwal A, Pant S. A framework for incorporating 3D hyperelastic vascular wall models in 1D blood flow simulations. *Biomechanics and Modeling in Mechanobiology*. 2021;20(4):1231-49.
13. Clayton ZS, Brunt VE, Hutton DA, Casso AG, Ziemba BP, Melov S, et al. Tumor necrosis factor alpha-mediated inflammation and remodeling of the extracellular matrix underlies aortic stiffening induced by the common chemotherapeutic agent doxorubicin. *Hypertension*. 2021;77(5):1581-90.
14. Virmani R, Sato Y, Sakamoto A, Romero ME, Butany J. Aneurysms of the aorta: ascending, thoracic, and abdominal and their management. *Cardiovascular Pathology: Elsevier*; 2022. p. 353-406.
15. Boutouyrie P, Chowienczyk P, Humphrey JD, Mitchell GF. Arterial stiffness and cardiovascular risk in hypertension. *Circulation Research*. 2021;128(7):864-86.
16. Okpaleke MS, Ikamaise VC, Ugwu A, Agwu K, Ogoodom M. Sonographic Reference Luminal Diameter of the Abdominal Aorta among Subjects in Nigeria. *Journal of Health Sciences*. 2020;2(005):179-809.
17. Uimonen M. Synthesis of multidimensional pathophysiological process leading to type A aortic dissection: a narrative review. *JOURNAL OF THORACIC DISEASE*. 2021.
18. Litmanovich D, Bankier AA, Cantin L, Raptopoulos V, Boiselle PM. CT and MRI in diseases of the aorta. *American Journal of Roentgenology*. 2009;193(4):928-40.
19. Gameraddin M. Normal abdominal aorta diameter on abdominal sonography in healthy asymptomatic adults: impact of age and gender. *Journal of Radiation Research and Applied Sciences*. 2019;12(1):186-91.
20. Hannawa KK, Eliason JL, Upchurch Jr GR. Gender differences in abdominal aortic aneurysms. *Vascular*. 2009;17(Suppl 1):S30-S9.
21. Sakalihan N, Limet R, Defawe OD. Abdominal aortic aneurysm. *The Lancet*. 2005;365(9470):1577-89.

22. Zommorodi S, Leander K, Roy J, Steuer J, Hultgren R. Understanding abdominal aortic aneurysm epidemiology: socioeconomic position affects outcome. *J Epidemiol Community Health*. 2018;72(10):904-10.
23. Kumar R, Rauniyar RK. Normal Aortic Diameter on Multi Detector Computed Tomography In Nepalese Population Of Eastern Nepal. *International Journal of Health and Clinical Research*. 2021;4(2):202-8.
24. Góes Junior AMdO, Albuquerque FBAd, Beckmann FA, Centeno FV, Andrade MCd, Vieira WdB. Age and sex and their influence on the anatomy of the abdominal aorta and its branches. *Jornal Vascular Brasileiro*. 2020;19.
25. Silveira LAd, Silveira FBC, Fazan VPS. Arterial diameter of the celiac trunk and its branches: anatomical study. *Acta cirurgica brasileira*. 2009;24(1):43-7.
26. Okpaleke MS, Ikamaise VC, Ogolodom MP, Agbo J, Mbaba AN, Egwuanmku K, et al. Sonographic Reference Luminal Diameter of the Abdominal Aorta among Subjects in Nigeria. *Health Science Journal*. 2020:1-5.
27. Albager S, Yousef M, Abdelaziz I, Salih M, Abdoh H. Normative Reference Values of Abdominal Aortic Diameters of Sudanese Using Computed Tomography.
28. Jasper A, Harshe G, Keshava S, Kulkarni G, Stephen E, Agarwal S. Evaluation of normal abdominal aortic diameters in the Indian population using computed tomography. *Journal of postgraduate medicine*. 2014;60(1):57.
29. Mohiuddin M, Manzoor A, Ali M, Hassan N. Analysis of renal artery morphometry in adults: A study conducted by using Multidetector computed Tomography Angiography. *Pakistan journal of medical sciences*. 2017;33(4):943.
30. Tarnoki AD, Tarnoki DL, Littvay L, Garami Z, Karlinger K, Berczi V. Genetic and environmental effects on the abdominal aortic diameter development. *Arquivos Brasileiros de Cardiologia*. 2015;106:13-7.
31. Virmani R, Avolio A, Mergner W, Robinowitz M, Herderick E, Cornhill J, et al. Effect of aging on aortic morphology in populations with high and low prevalence of hypertension and atherosclerosis. Comparison between occidental and Chinese communities. *The American journal of pathology*. 1991;139(5):1119.