ORIGINAL ARTICLE

EVALUATION OF NORMAL DIAMETER OF INFRA-RENAL AORTA IN A PAKISTANI POPULATION USING CONTRAST-ENHANCED COMPUTED TOMOGRAPHY

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Background: It is a common observation that the aortic size of Pakistani population is relatively less as compared to western population. Till now there is no study which has measured the dimensions of abdominal aorta in local population.The standard diameter of an artery across the body is critical for clinicians to recognize when an artery has become aneurysmal. This study aims to present the results of a local population's normal diameter of an infrarenal aorta and how it varies by age, gender, weight, height, body mass index (BMI) and body surface area (BSA). **Methods:** This cross-sectional observational study was conducted in Vascular Surgery Department, at Combined Military Hospital (CMH), Peshawar, from July 2020 to November 2021.Participants in the study included all patients who underwent a contrast-enhanced computed tomography (CT) scan of the abdomen for any reason other than cardiovascular disease.The infrarenal abdominal aorta's mean internal diameter (anteroposterior and transverse diameter) was assessed. SPSS v 23 was used to analyze the data and present it as frequency and percentages. The Pearson correlation coefficient assessed the correlation between aortic diameters, weight, height, BMI, and BSA. **Result:** Recruitment of a total of 250 patients was done in this study. Males were 194 (77.6%), while the rest were female patients. The patients' mean age was 39.6±12.8 years. The mean anteroposterior (AP) diameter of the infrarenal aorta was 16.13±2.32 mm. The mean transverse diameter (TD) was 15.96±2.34 mm. The infrarenal diameter of the aorta was smaller in women when compared to men, and the calibre of the aorta increased with the increasing age of the patients. There was a statistically significant positive relationship between their age and the average diameter of the infrarenal aorta (p<0.001) among both men and women. **Conclusion**: Clinicians and vascular surgeons will benefit from the findings in diagnosing and treating abdominal aortic aneurysms. Hence, thoughtful consideration should be made before formulating intervention protocols.

Keywords: Infra-renal Aorta (IRA); Weight (kg); Body Mass Index (BMI); Height (cm); Asians; Peshawar.

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INTRODUCTION

It has been observed by many vascular surgeons who are trained in the west that infra renal aortic dimensions in Pakistani population were relatively less as compared to western population. Unfortunately there was no study which has determined the size of the aorta in our population. The standard diameter of an artery across the body is critical for clinicians to recognize when an artery has become aneurismal. Secondaly this can guide us in arranging commonly used graft sizes in our hospitals.

The abdominal aorta, which begins at the diaphragm's hiatus at the twelfth thoracic vertebra, is the largest vessel in the abdominal cavity. It divides into the common iliac veins at the fourth lumbar vertebra during its ascent.[1] Aortic infrarenal segment is weakest because of the thin middle layer primarily composed of elastic fibres and smooth muscle cells.[2] Previous research has found a link between maximal infrarenal aortic diameter and cardiovascular disease (CVD) prevalence and all-cause death.[3]

According to the International Society for Cardiovascular Surgery/Society for Vascular Surgery Ad Hoc Committee, the maximum infrarenal aorta's diameter is 1.5 times greater than the estimated average to be labeled as an aneurysm.[4] The mechanism through which hypertension is considered a risk factor for AAA is thought to be a rise in the pressure gradient across the aorta wall, which results in an increase in the force required to dilate and enlarge the diameter of the artery.[5] AAA are usually

asymptoms[6,7] before rupture, but they may cause abdominal pain radiating to the back.[8]

Because ultrasound is safe, easy, economical, and accurate, it is a helpful diagnostic imaging modality. However, due to intestinal gas and obesity, certain infrarenal aortas are difficult to see.[9] In general European populations, ultrasound-based infrarenal aortic diameter (IAD) reference values are scarce. Aortic diameter distribution in women of various ages is poorly understood.[10] Non-contrast CT scanning may be a more reliable alternative to contrast CT scanning for AAA screening. Although they have not been tested as a screening tool, contrast-enhanced CT scans are thought to be more accurate, with near-perfect specificity and sensitivity.[9]

Between the ages of 25 and 70, the infrarenal aortic diameter grew by 25%, as per ultrasonography studies.[11] Enlarged aortic diameter is a risk factor for aortic dissection and aortic aneurysms. Aneurysmal aortic dilation has been associated with a higher risk of cardiovascular disease in previous investigations.[12] When the infrarenal aortic diameter surpasses 3cm, it is considered clinically significant and is the acknowledged threshold to label an infra renal an abdominal aortic aneurysm (AAA). This is unusual, as it has a proclivity to dilate and eventually burst if not treated.[13] The infrarenal aortic diameter has traditionally been of more clinical interest as it is common site for various surgical intervention. The infrarenal aorta has been proven to play an essential role in predicting cardiovascular events and mortality risk in studies.[14] Most of the endovascular repair (EVAR) procedures are performed on the infrarenal aorta and common iliac artery. Knowing the inner diameter and growth rate of the normal infrarenal aorta and the common iliac artery will help in the management of AAA patients as well as the selection of acceptable covered stents/graft sizes for these patients.[15]

There has been no previous researchon the typical infrarenal artery diameter in Pakistani population. This is the first ever study in Pakistan on this topic which has lot of impact on management of abdominal aortic aneurysms in local populations.This study used a contrast-enhanced computed tomography (CT) scan at CMH in Peshawar, Pakistan, to determine the typical reference diameter for the infrarenal aorta and to see how it differed by age, gender, body weight, height, body surface area (BSA), and body mass index (BMI).

MATERIAL AND METHODS

An observational study with a cross-sectional design was conducted in the Vascular Surgery Department of the Combined Military Hospital (CMH), Peshawar, from July 2020 to November 2021. All patients who had contrast-enhanced CT scans during the study period were included in the study population.Total 194 (77.6%) patients were males and 56 (22.4%) were females.

After departmental approval and informed written consent from each patient, 250patients undergoing abdominal CT scan with contrast for non-cardiovascular purposes and aged 21–65 years of either gender enrolled from July 2020 to November 2021. Age distribution among patients was analyzed as n=76 patietns were found in age range <30 years, followed by n=56 in 30–40 years, n=57 in 41-50 years, n=47 in age range 51–60 years & n=14 in age range >60 years. Mean age was 43 years and standard deviation was calculated as 15.92.

Patients with a history of cardiovascular disease, peripheral vascular disease, chronic kidney disease, large abdominal masses distorting the infra-renal aorta, vasculitis, and those with a history of vascular surgery were excluded.

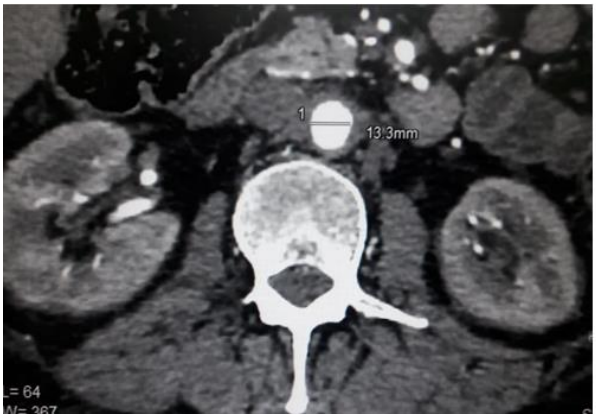
Height of patients was measured in centimeters. Weight was measured in Kg. Throughout study weighing balance was checked for proper function and was compared with others. BSA and BMI was calcuted from height and weight. A 160-slice multidetector CT (MDCT) scanner is used for all abdominal CT studies (Aquilion, Prime; Toshiba, Japan). Contrast images were acquired after an antecubital injection of an intravenous nonionic contrast mixture containing 300 mg/ml iodine. 1.5–3 ml/s was the injection rate. After commencing the injection, a 20–25 second delay is used to perform a helical CT scan. On the PACS workstation, images are scrolled through.

The size of the infrarenal aorta was determined by measuring it just below the lower renal artery. Using software given on the CT console, the mean values of the infrarenal aorta, the anteroposterior diameter (AP) and transverse diameter (TD) [internal diameters] were obtained. The Statistical Package for Social Sciences (SPSS) was used to do the statistical analysis (SPSS, version 23; Chicago, IL, USA).For quantitative variables, data were presented in frequency and percentages through tables.The Pearson correlation coefficient studied the association between weight, height, BMI, body surface area (BSA), and infrarenal aorta's diameter. The Mosteller formula was used to compute the BSA [BSA = SQR height (cm) x weight (kg)/3600]. For the purpose of comparing men's and women's aortic diameters, an independent sample t-test was used. A 0.05 p-value was used to define the significance level.

RESULTS

The infrarenal aortic diameter was measured just below the lower renal artery in 250 patients. The study was composed of 194 (77.6%) males and 56 (22.4%)

females, and the mean age was 39.6±12.8 years old. The mean age was 39.5±13.2 in men and 40.16±11.6 in women. The descriptive statistics of the patients and the age groups are given in Tables 1 & 2. The infrarenal aortic mean anteroposterior (AP) diameter was 16.13±2.32 mm. The mean transverse (TD) was 15.96±2.34 mm. The men's mean anteroposterior (AP) and transverse (TD) diameter of the infrarenal aorta was 16.63±2.18 mm and 16.51±2.21 mm, respectively.The infrarenal aorta's mean anteroposterior (AP) and transverse (TD) diameters in women were 14.38±1.89 mm and 14.03±1.64 mm, respectively. Table-3 shows the average.



Figures-1 & 2: Infrarenal abdominal aorta diameter for men and women. The mean AP and TD measurements of the infrarenal abdominal aorta.

In both men and women, there was a significant positive relationship between their age and the average infrarenal aorta diameter measured during the study (p<0.001)Table-4. The mean diameters of the infrarenal aorta AP & TD with BMI categories are tabulated in Table-5. Men had a BSA of 1.87±0.1 m^2 while women had a BSA of 1.71±0.1 m^2. According to the findings, a positive correlation between BSA and the diameter of the infrarenal aorta was shown to be statistically significant, as shown in Table-6.

Table-1: Descriptive Statistics of the patients (N=250)

Variables	Mean±SD	Minimum	Maximum
Age (years)	39.6±12.8	21	65
Height (cm)	171.6±7.8	152.4	183.4
Weight (kg)	71.1±8.8	53	88
BSA	1.83±0.17	1.57	2.12
BMI	24.2±3.3	17.56	35.59

Table-2: Patients' Age Groups and Genders (N=250)

Age Groups	Frequency (n)	Percentages (%)
< 30	76	30.4%
30-40	56	22.4%
41-50	57	22.8%
51-60	47	18.8%
> 60	14	5.6%
Gender		
Female	56	22.4%
Male	194	77.6%

Table-3: Mean Diameters of infrarenal aorta of the patients

Variables	Male Mean±SD (mm)	Female Mean±SD(mm)
Anteroposterior (AP)	16.63±2.18	14.38±1.89
Transverse (TD)	16.51±2.21	14.03±1.64

Table-4: Mean diameters of infrarenal aorta of the patients on CT scan

Age Ranges	Male Mean±SD (mm)	Female Mean±SD (mm)
< 30	15.78±1.78	14.00±1.18
30-40	15.84±1.63	14.25±1.30
41-50	16.89±2.16	14.69±2.52
51-60	18.37±2.48	14.39±1.94
> 60	17.66±1.18	-

Table-5: Mean diameters of the infrarenal aorta AP & TD with BMI categories (N=250)

BMI Categories	Anterioposterior (AP) Diamter Mean±SD (mm)	Transverse (TD) Diatmeter Mean±SD (mm)
Under weight	15.20±.000	14.60± .000
Normal Range	16.07±2.17	16.00±2.13
Over weight	16.40±2.48	15.88±2.52
Obese	15.80±2.97	16.12±3.40

Table-6: Correlation between BSA and infrarenal aorta diameters

	BSA Pearson correlation coefficient (r)	p-value
Infrarenal aorta (AP)	0.338	0.001
Infrarenal aorta (TD)	0.357	0.001

DISCUSSION

Infra renal aorta is a common site affected by atherosclerosis. It is also the most common site for

AAA. Knowing the average dimensionsin particular population is of immense importancein diagnosing any pathology especially aneurysm. Most of the available studiesgive results of a particular population. Till now there has been no studywhich has measured the dimensions of infra renal aorta in Pakistani population.

The significance of these dimensions is not just to diagnose and categorise an aortic aneurysm but there is another issue which vascular surgeons in our country face. There is scarcity of vascular grafts in our country which are required to repair these aneurysms. There are very limited companies that import these grafts and they keep a limited range of graft sizes. The usual infra renal aortic size in our elderly group will also help vascular surgeons to keep the stock of vascular grafts accordingly.

The precise anatomic interpretation of the infrarenal aorta is necessary to diagnose abdominal aortic aneurysm, and for the clinicians to assess the size of the vascular graft for intervention properly.

Previous research looked into the morphometry of the abdominal aorta using several imaging modalities. Still, it was limited because the abdominal aorta was only measured in one plane [anteroposterior dimension (AP)]. Rather than one plane, two planes in the infrarenal aorta were adequate for the aorta measurement. Our study computed the normal aorta diameters at the infrarenal aorta for adults of different ages, weights, and heights of both genders.

In a study conducted by Gameraddin M[(1)]in Saudi Arabia, the infrarenal aorta's mean AP diameter was 13.473±1.23, and the mean TD was 15.380±2.13. While in our study,the infrarenal aorta's mean AP diameter was 16.13±2.32 mm, and the mean transverse (TD) was 15.96±2.34 mm. It should be noted that they studied a different ethnic group and used ultrasonography. In our study we used contrast enhanced CT scan which is definitely more precise than USG and is also not operator dependent.

A similar study was conducted in Tamil Nado, India by Jasper A *et al.*[16] In this study men's average age was 46.4±12.3, while women's average age was 45.4±13.7. While in our study,the mean age was 39.5±13.2 in men and 40.16±11.6 in women. In the same study, the mean infrarenal diameter of the aorta was 13.8±1.9 for males and 12.0±1.6 for females. While in our study, we calculated the AP & TD of the infrarenal aorta in both males and women. The infrarenal aorta dimensions in our population were 16.63±2.18 mm AP and 16.51±2.21 mm TD in men and 14.38±1.89 mm AP and 14.03±1.64 mm TD in women. In Jasper *et al* study, men had a BSA of 1.65 m^2 while women had a BSA of 1.49 m^2. Furthermore, there was a significant positive correlation between the infrarenal diameter of the aorta and BSA like our study. In our study, men had a BSA of 1.87 m^2 while women had a BSA of 1.71 m^2. The smaller average diameter in their study is most likely due to lower BSA in the population studied.

A study carried out by Li Kun *et al* at China,[17] demonstrated that the infrarenal aortic diameter was smaller in females (14.4±2.4mm) in comparison to males (15.6±2.8mm). In our study, the results were parallel to the survey, which showed that infrarenal aortic diameter in both AP and TD in females (14.38±1.89 mm and 14.03±1.64 mm) was smaller than in males (16.63±2.18 mm and 16.51±2.21 mm).
A study by R. Wei *et al*.[2] demonstrated that the average mean infrarenal diameter of the aorta was 15.7±2.1mm in men and 14.0±2.0 in women. Our study showed that the average mean infrarenal diameter was 16.63±2.18 mm (AP) in men and 14.38±1.89 mm (AP) in women variable ethnicity were studied.

In a study conducted on elderly population in Netherlands by F.zhu[10] *et al* showed mean crude diameter in men to be 19.5 mm±2.6 mm and 17 mm±2.4 mm in women. This is close to our measurements in the elderly population. Although the mean crude diameter was greater in men than women but when BSA was considered the difference was small. This study also showed that after seventh decade the aortic diameter value does not change with increasing age.

In a MRI based study[18] conducted in Sweden on 70 year old men and women the infra renal aorta diameter was 24 mm in men (SD 0.5) and 22mm in women (SD 0.3). This is significantly greater than measurements in our study.

In a systemic review and meta analysis of normal infra renal aortic diameter in the world the pooled mean aortic diameter[19] was 20.1mm in males and 17.8mm in females. The largest mean aortic diameter was seen in Oceania and the smallest was in Asia.

CONCLUSION

The mean infra renal aortic diameter both in men and women was significantly less in our population as compared to western population. This study will help the operating surgeons in pre operatively arranging/selecting prosthetic graft for aortic diseases.

Conflict of interest:
The authors declare that they have none to disclose.

AUTHORS' CONTRIBUTION

SU, NI did study design, statistical analysis, manuscript writing & editing of the manuscript. SU,

MSF did literature review, statistical analysis & manuscript writing. SU, UN, NI did data collection & data correction. SU, NI did the editing, review & final approval of the manuscript

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