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Measurement of Abdominal Aortic Diameters in Normal Saudi Population Using Computed Tomography

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KEYWORDS

Abdominal Aorta, diameter, aneurysm, computed tomography, AP, TR

ABSTRACT:

Aim: The purpose of this study was to determine the normal reference diameters of the abdominal aorta in Saudi population, and to study the variations in aortic diameters among age and sex. **Materials and Methods**: Cross-sectional study, using archival abdominal enhanced contrast CT scan images from PACS, axial plane was used to apply all aortic measurements including the antropostrior (AP) and transverse (TR) diameters at three levels of AA which were the level immediately superior to exit of coeliac axis at level of T12, infra renal at level of L2, and supra bifurcation at level of L4. Measurements were tested for correlation, variance in diameters, and mean differences were tested using paired t-test. **Results:** One hundred and twenty-four people were enrolled. 62 male and 62 female, the measurements of AP and TR diameters at proximal, middle, and distal levels of the AA, the AP diameters at proximal aortic level were found to be 17.787 ±2.430mm in male, and 20.239 ±2.630mm in female, and the TR diameters at this level presented 18.477 ±2.359mm in male, and 17.565 ±2.620mm in female. While the AP diameters at middle aortic level in male and female respectively were 14.582 ±2.373mm, 13.729 ±2.110mm, and TR diameters at same level were 14.340 ±1.928mm, 13.247 ±1.529mm. Whereas the AP diameters at distal aortic level were 13.663 ±1.658mm, 12.569 ±1.465mm, and the TR diameters were 13.942 ±1.737mm, 12.892 ±1.340mm in male and female respectively.

Conclusion: This study established a set of normal values for the proximal, middle and distal abdominal aorta in Saudi population and concluded that age and gender considered as factors affect the diameters of abdominal aorta, aortic diameters were found to be greater in male than female and showed a significant increase with age.

1. Introduction

Arteries are complex organ because of their divergence and subdivisions at different levels in the body [1]. The normal abdominal aortic (AA) dimensions are important in the risk assessment of aortic pathology, aneurysms, dissection, and rupture [2]. Diameter of aorta is expected to be <3.0 cm, but with age the size of the aorta varies [1]. The diameter of the AA is important to be evaluated since it is frequently affected by vascular disorders in older adults. Maximum diameter is an important parameter in the definition of abdominal aortic aneurysm (AAA) and is also used to predict the risk of rupture of AAA. Awareness of the normal aortic diameter would be useful in management of patients presenting with aortic aneurysms. Therefore, it is the most commonly used quantitative criterion for screening, surveillance and decision for intervention [2]. If the increase in diameter of abdominal aorta exceeds 50%, this results in the presence of ectasia which further turns into the formation of aneurysm [3]. Previous studies reported that the prevalence of AAA increased with age and is more common in the elderly. It is more frequent in men than in women, accounting for 1–3% of all deaths among men aged 65–85 years in developed countries [4].

There are various imaging modalities available to screen or to detect the early abnormal changes in size of abdominal aorta among these, ultrasonography (US)

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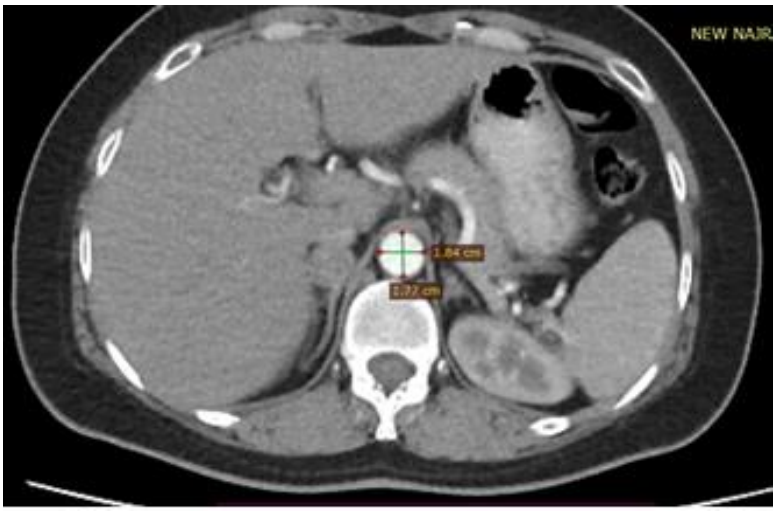
and computed tomography (CT), are commonly used. Ultrasound (US) is the reference imaging technique for screening and is used for regular monitoring of small AAA. Computed tomography (CT) is the superior technique in the decision-making process for intervention [5,6]. CT has many different tools and techniques to measure the size of arteries [7], also it is less operator-dependent and more objective [8]. In addition, CT based measurements are not affected by gastrointestinal gas or other body features [9].

Many countries had established normal reference diameters of AA for their population. This study aimed to establish standard normal diameters of the abdominal aorta measured at three regions, T12, L2, and L4 vertebral levels in the Saudi population and to study the variations in aortic diameters with age and sex.

2. Research Methodology

This study was a retrospective, quantitative, descriptive, and cross-sectional study conducted at Najran General Hospital in Najran province, (K.S.A), used archival abdominal enhanced contrast CT scan images from PACS in this study to avoid the principled issue of patient's irradiation. Based on patient's records, axial plane was used to apply all inner to inner aortic measurements including the antropostrior (AP) and transverse diameters (TR) at three levels of AA, proximal level immediately superior to exit of coeliac axis at level of T12, middle level which is measured inferior to exit of renal arteries at level of L2, and distal level that immediately measured superior to aortic bifurcation at level of L4. The program that used to view images was RadiAnt DICOM Viewer which an application for processing and displaying medical images in DICOM format (Digital Imaging and Communications in Medicine) and allow different measurements. All patients reported with abdominal aortic aneurism, stenosis, hypertension, or cardiovascular diseases were excluded from this study. Collected data were analyzed using SPSS 16 software.



Figures 1 showing the AP and TR measurements of the abdominal aorta in axial CT.

3. Results

Independent sample t-test were performed to know the significant correlation between the average anteroposterior (AP) and transverse (TR) diameters of abdominal aorta and the age and gender of participants.

The abdominal aorta (AA) was measured at three levels proximal, middle, and distal level, antroposterior and transverse diameters were measured at each level in 124 healthy adults population, 62 male and 62 female, their mean age were 38.82 ±16.779 years for male, and 41.65 ±13.545 years for female (table 1). (Table 2) shows the mean diameters of AA in Saudi adults population, the mean of AP diameters were 19.013 ±1.864mm, 14.156 ±2.277mm, and 13.116 ±1.652mm, while the mean TR diameters were 18.021 ±2.525mm, 13.794 ±1.818mm, and 13.427 ±1.633mm, at the level of proximal aorta (T12), middle aorta (infra renal - L2), and distal aorta (supra bifurcation L4) respectively.

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The measurements of AP and TR diameters at proximal, middle, and distal levels of the AA compared to gender shown in (table 3), where the AP diameters at proximal level were found to be 17.787 ±2.430mm, and 20.239 ±2.630mm, and the TR diameters at this level presented 18.477 ±2.359mm, and 17.565 ±2.620mm. While the AP diameters at middle aorta were 14.582 ±2.373mm, 13.729 ±2.110mm and TR diameters at same level were 14.340 ±1.928mm, 13.247 ±1.529mm. Whereas the AP diameters at distal aortic level were 13.663 ±1.652mm, 12.569 ±1.465mm, and the TR diameters were 13.942 ±1.737mm, 12.892 ±1.340mm in male and female respectively. There was increase in aortic diameters in male compared to female in the proximal, middle and distal levels of aorta, except proximal AP diameter where it reported less value in male, otherwise there was gradually decreasing in aortic AP and TR diameters from proximal to middle to distal levels. The results reflected a significant correlation between male and female and the mean AP and TR diameters of the AA at different levels (p-value <0.05) (table 4). Figure (2) and table (4) demonstrate the significant correlation between age and AP and TR at all levels of AA.

Table 1: Descriptive statistics of population age.

	N	Min	Max	Mean
Male	62	18	80	38.82
Female	62	20	75	41.65

Table 2: Descriptive statistics of measurements of mean abdominal aortic diameters in Saudi population.

	N	Mean	Std. Deviation	Std. Error Mean
patient ages	124	40.23	15.252	1.370
PROX AP	124	19.013	1.864	1.6746
PROX TR	124	18.021	2.525	.2267
MIDD AP	124	14.156	2.277	.2045
MIDD TR	124	13.794	1.818	.1633
DIST AP	124	13. 116	1.652	.1484
DIST TR	124	13. 427	1.633	.147

Table 3: Measurements of anteroposterior (AP) and transverse (TR) diameters of abdominal aorta at different levels compared to gender.

	N	Mean	Std. Deviation	P-value
PROX AP				
Male	62	17.787	2.430	.000
Female	62	20.239	2.630	.000
PROX TR				
Male	62	18.477	2.3597	.000
Female	62	17.565	2.620	.000
MIDD AP				
Male	62	14.582	2.373	.000
Female	62	13.729	2.110	.000
MIDD TR				
Male	62	14.340	1.928	.000
Female	62	13.247	1.529	.000

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	N	Mean	Std. Deviation	P-value
DIST AP				
Male	62	13.663	1.658	.000
Female	62	12.569	1.465	.000
DIST TR				
Male	62	13.942	1.737	.000
Female	62	12.892	1.340	.000

Table 4: Correlation of age and gender with abdominal aortic diameters at different levels

		PROX AP	PROX TR	MIDD AP	MIDD TR	DIST AP	DIST TR
patient gender	Pearson Correlation	.066	-.182-*	-.188-*	-.302-**	-.332-**	-.323-**
	Sig. (2-tailed)	.466	.044	.036	.001	.000	.000
	N	124	124	124	124	124	124
patient age	Pearson Correlation	.314**	.803**	.690**	.628**	.597**	.563**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	124	124	124	124	124	124

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

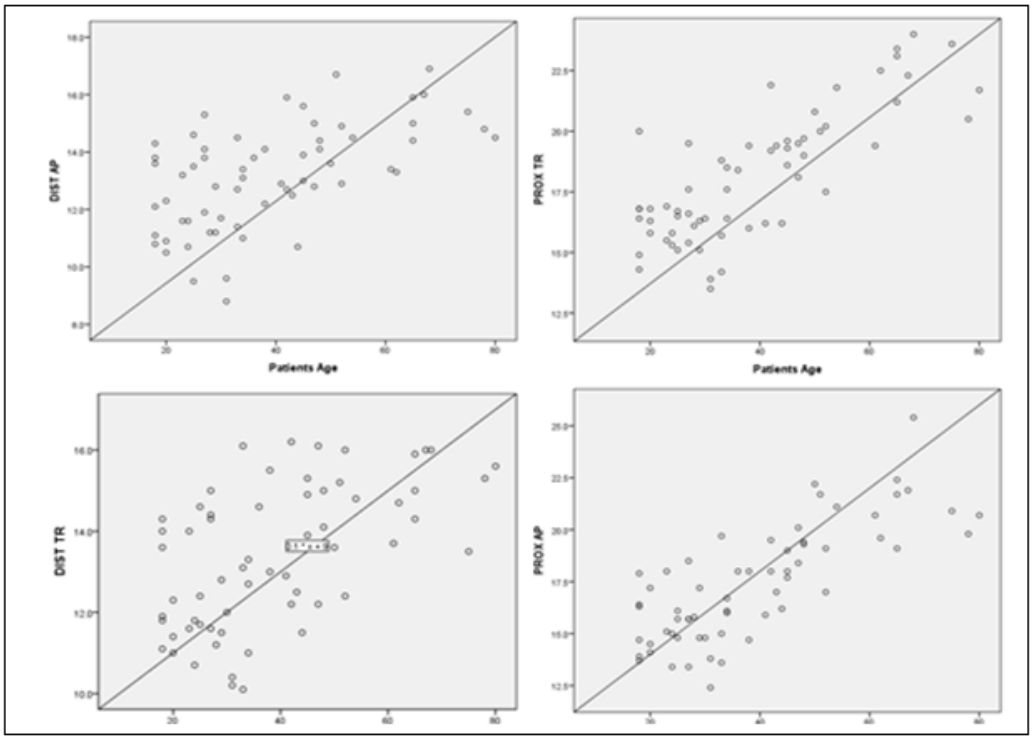

Figure 2. Correlation of age with the abdominal aorta diameters at different levels.

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4. Discussion

Aortic diameters measurement are important in the risk assessment of aortic pathology and complications [10]. The measurement in three levels with two planes was effective for the aorta rather than one plane [11]. There are various modalities available to measure the diameters of abdominal aorta such as CT, US, and MRI, however, this study aimed to stablish normal reference diameters for the abdominal aorta in Saudi population, anteroposterior (AP) and transverse diameters (TR) were measured at three levels on contrast enhanced axial plane of abdomen CT images for normal adults male and female population of different ages.

Regarding normal AA diameters in Saudi population, our study found that the mean of AP diameters were 19.013 ±1.864mm, 14.156 ±2.277mm, and 13.116±1.652 mm, while the mean TR diameters were 18.021 ±2.525mm, 13.794 ±1.818mm, and 13.427 ±1.633mm, at the level of proximal aorta (T12), middle aorta (infra renal - L2), and distal aorta (supra bifurcation L4) respectively. Similar results at infra renal level TR diameters were achieved in a previous study by Wazzan, et al., [12] who estimated normal abdominal aortic diameter in KSA, Jeddah using CT, and reported that the mean diameter at the level of the suprarenal aorta was 1.68 cm and 1.36 cm at the level of the infrarenal aorta. Mild variations in aortic diameters achieved in our study, may be due to different levels where it were measured.

There is a report evaluating the difference in aortic diameters between the races, Laughlin, et al., [13] reported that the aortic diameters of Chinese, African, and Hispanic descent people are smaller than the aortic diameters of Caucasians even after adjusting for differences in body size and other factors. infrarenal aorta was 19.0 mm in male and 17.9 mm in female in a Korean population [8]. Also study on an Indian population by Jasper et al., [14] reported that, the mean diameters of the suprarenal and infrarenal abdominal aorta measured at T12 and L3 vertebral levels in men were 19.0 ±2.3mm and 13.8 ±1.9mm and in women 17.1 ±2.3 and 12.0 ±1.6mm, respectively. In another study, Sariosmanoglu, et al., [15] reported that the mean aortic diameters were 16 mm in male and 15 mm in female in Turkish population. Variations in the infrarenal aortic diameters may be due to different methods of measurement and different levels where the aorta was measured.

In present study the AP and TR diameters of AA at the proximal level at (T12), middle level (infra renal at level of L2) and distal level (supra bifurcation at L4 level), had a variations in measurements between male and female population, AP and TR diameters were found to be greater in male compared to female, except the TR diameter at the proximal level which was noticed to be greater in female than male as mentioned in (table 2), and the study found that gender has a significant impact on AA diameters at the three levels (p-value <0.05) (table 4). Many previous studies were concluded same results, a study done by Jasper et al. evaluated the normal abdominal aortic diameter using CT, reported that the aortic diameters correlated with gender. They found that the mean diameters of suprarenal and infrarenal aortic diameters were larger in male than in female [15]. Another study done by Erbel & Eggebrecht, was observed that the AP and TR diameters were significantly higher in male than female [1].

Age is also one of the major factors that influence the AA diameters, the current study found that the age has a significant association with proximal, middle and distal aortic diameters, (p-value <0.05) (table 4), the diameters noticed to be increased with age in this study as revealed in (figures 2). Similar findings were found in previous studies which reported a significant correlation of aortic diameters with age [7,8,11.12,15] . Virmani et al. studied the effect of aging on aortic morphology and reported that the diameter of aorta increased with age [16].

This study was limited by the number of samples. However, the correlation with age and gender, were supported with previously published studies. Further studies can be performed using larger population and more variables such as height and body mass index.

5. Conclusion

There is a need to recognize the variations in abdominal aorta diameters to be aware of AAA and other complications. This study established a set of normal values for the proximal, middle and distal abdominal aorta in the Saudi population and concluded that age and gender considered as factors affect the diameters of

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abdominal aorta, aortic diameters were found to be significantly greater in male than female and showed a significant increase with age.

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