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Defining Normal Abdominal Aorta, Common Iliac And Common Femoral Artery Dimensions In Indian Population

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Abstract:

Background : It is important to define the normal diameter of Aorta so that clinicians are able to decide when the aorta becomes aneurysmal. However, there is a paucity of literature on the normal diameter of Aorta in the general Indian population and most of the available data are from the West and Anatomic studies. The purpose of this study is to determine the normal reference diameters of the abdominal aorta, Iliac arteries and common femoral arteries in the Indian population. The diameter of the Iliac arteries and common Femoral arteries are important as they form a critical conduit for taking Aortic endoprosthesis in Endovascular Aneurysm repair

Purpose: To establish normal diameters for suprarenal and infrarenal segments of abdominal aorta, common Iliac, external Iliac and common femoral arteries and to study the correlation of arterial diameters with age, sex, height, weight, Body mass index (BMI) and Body surface area (BSA)

Materials and methods : Six hundred and six patients who underwent multidetector computed tomography (CT) scans of the abdomen for non-cardiovascular reasons were recruited.The mean internal diameters of the suprarenal and infrarenal abdominal aorta (maximum anteroposterior and transverse diameter) were measured at T12 and L3 vertebral levels, mid segments of common iliac artery, external iliac and common femoral artery at the level of the femoral head were tabulated according to various age groups for both men and women. Pearson correlation coefficient was used to evaluate the correlation between arterial diameters, gender, height, weight, BSA, and BMI.

Results : The mean diameters of the suprarenal and infrarenal abdominal aorta measured at T12 and L3 vertebral levels in males were 17.9 ± 2.29mm and 14.67 ± 1.93 mm and in females 17.5 ± 1.96mm and 14 ± 1.69mm, Common iliac

artery in males were 10.33 ± 1.31mm and 10.02 external iliac artery in males were 9.27± 1.02mm and 8.99 ±0.81mm ,Common femoral artery in males were 8.44±0.89mm and 8.23 ± 0.77mm in females respectively. The aortic diameter progressively increased in caliber with increasing age of the patients and was smaller in women than men.

Conclusion : We obtained a set of normal values for the arterial diameters at different anatomical level in the Indian population. The aortic diameters at suprarenal and infrarenal segments,common iliac, external iliac and common femoral artery were correlated with age, gender, and body size of the patients as seen with previously published data in the Western population. A brief comparison of data between Indian and Western population showed that the values obtained were less than published elsewhere and hence, this should be considered while formulating intervention protocols.

Keywords : abdominal aorta diameter , Indian population, MDCT

Introduction : It is important to define the normal diameter of Aorta so that clinicians are able to decide when the aorta becomes aneurysmal. However, there is a paucity of literature on the normal diameter of Aorta in the general Indian population and most of the available data are from the West and Anatomic studies. The purpose of this study is to determine the normal reference diameters of the abdominal aorta, iliac arteries and common femoral arteries in the Indian population. The diameter of the Iliac arteries and Common Femoral arteries are important as they form a critical conduit for taking Aortic endoprosthesis in Endovascular Aneurysm repair (EVAR).

Methods and materials : This prosepective observational study was conducted in Department of Radio-diagnosis, Amrita Institute of Medical Sciences between May 2016 to October 2018 after obtaining approval from the Thesis Protocol Review Committee (Scientific & Financial) and Institutional Review Board, Amrita Institute of Medical Sciences. The subjects were explained about benefits of the study and written informed consent was taken from all the study subjects. Cost of the study was borne by the patient as part of treatment and evaluation

Selection and description of participants: All the adult patients undergoing MDCT contrast scan of the abdomen and pelvis who are referred to the department of Radio-Diagnosis of Amrita Institute of Medical Sciences research centre, Kochi. After obtaining approval from the Thesis Protocol Review Committee (Scientific, Ethical & Financial), Amrita Institute of Medical Sciences, this prospective cross-sectional observational study design was carried out. An informed consent was taken from all the patients undergoing study.

Inclusion criteria for patients:

All the patients above 20 years undergoing MDCT scans of the abdomen for non-cardiovascular diseases.

Exclusion criteria for patients:

Age less than 20 years and those with large abdominal masses distorting the aorta, common iliac and common femoral arteries preventing accurate measurement of the arteries. Patients with a history of collagen vascular diseases like Marfan's syndrome, Ehler Dahnlos syndrome and vasculitis.

Sample size:

Based on earlier publication "Evaluation of normal abdominal aortic diameters in the Indian population using computed tomography'' by Jasper et al; The mean and standard deviation of arterial diameters in males and females corresponding to age group 20-40 years (17.25±1.92 mm and 16±1.62mm), 40-60 years (19.5±1.9mm and 17.15±2.35mm) and > 60 years age groups (20.9±3.9 mm and 18.9±2.1mm) with 95% confidence and 80% power, the sample size comes to 32 per groups for 20-40 age groups, 13 per group 40-60 age groups and 28 per group in > 60 age groups. Minimal sample size comes to 32 per groups based on gender. Therefore, total minimum sample size comes to 192.

Formula used to calculate the sample size is,

$n = 2s_p^2[Z_{1-\alpha/2} + Z_{1-\beta}]^2 / \mu_d^2$

$s_p^2 = s_1^2 + s_2^2 / 2$

Where,
s_1 : Standard deviation in the first group
s_2 : Standard deviation in the second group
μ_d : Mean difference between the samples
α : Significance level
1-β : Power

We studied 606 patients over a period of 2 years starting from the date of approval of thesis protocol.

Statistical Analysis : Statistical analysis was done using IBM SPSS Statistics 20 Windows (SPSS Inc., Chicago, USA). The results are given in Mean ± SD for all continuous variables and in frequency (percentage) for categorical variables. Using independent sample t-test, the mean diameters at different anatomical levels were compared between male and females. ANOVA was used for comparing mean diameters with respective different age groups 20-40 years, 41-60 years and above 60 years. Pearson correlation was applied for finding the correlation of arterial diameters with age, height, weight, BSA and BMI p value <0.05 was considered statistically significant difference. All the tests of statistical significance were two tailed.

Results :

- Normal reference diameter of the suprarenal abdominal aorta in the study population is 17.9±2.29 mm in males and 17.53±1.96 mm in females.
- Normal reference diameter of the infrarenal abdominal aorta in the study population is 14.67±1.93 mm in males and 14.02±1.69 mm in females.
- Normal reference diameter of the common iliac artery in the study population is 10.33±1.31mm in males and 10.02±1.31 mm in females.
- Normal reference diameter of the external iliac artery in the study population is 9.27±1.02 mm in males and 8.99±0.8 mm in females.
- Normal reference diameter of the common femoral artery in the study population is 8.44±0.89mm in males and 8.23±0.77 mm in females
- Age is the most important factor for the increment in the abdominal aorta diameter
- Diameters of abdominal aorta at different anatomical levels are smaller compared to the published western data.

Conclusion: Our subjects were undergoing MDCT scans of the abdomen and pelvis for other indications and were not subjected to additional ionizing radiation for the purpose of this study. Six hundred and six subjects were enrolled, 403 were males and 203 were females and they were evaluated under three age groups (20-40 years, 41-60 years and more than 60 years). Measurements were taken at T12 vertebral level for supra renal abdominal aorta, L3 vertebral level for infra renal abdominal aorta, at mid segments for both common iliac and external iliac arteries and at femoral head level for common femoral arteries. The arterial diameters were correlated with gender, age, height, weight, BMI and BSA at different anatomical levels. In our study, the mean diameter of the suprarenal abdominal aorta was 17.9 ± 2.29 mm (range 15.6mm to 20.19mm) in males and 17.53±1.96 mm (range 15.57mm to 19.49mm) in females. The mean diameter of the infrarenal abdominal aorta was 14.67±1.93 mm (range 12.74mm to 16.6mm) in males and 14.02±1.69mm (range 12.33mm to 15.7mm) in females The mean common iliac artery diameter was 10.33±1.31mm (range 9.02mm to 11.64mm) in males and 10.02±1.31mm (range 8.71 mm to 11.33mm) in females. The mean external iliac artery diameter was 9.27±1.02 (range 8.25mm to10.29 mm) mm in males and 8.99±0.811mm (range 8.17mm to 9.8mm) in females. The mean common femoral artery diameter was 8.44±0.89mm (range 7.55mm to 9.33mm) in males and 8.23±0.77mm (range 7.46mm to 9mm) in females.

In a study by Norman et al, in Australian population, the infrarenal aortic diameter measured using USG ranged from 19-21mm in males and 16-18mm in females (1).

In the Framingham heart study, by Rogers et al, using MDCT, the average infra renal abdominal aortic diameter of 19.3 mm in males and 16.7mm in female (2).

In a study in by Sariosmanoglu et al, in Turkish population using USG, the mean subdiaphragmatic aortic diameter was19±4mm in males and 18±3mm in females and at aortic bifurcation was 16±4mm in men and 15±3mm in females (3).

In a necropsy study by da Silva et al, in Brazilian population the mean diameter of the infrarenal aorta mean diameter of the infrarenal aorta in males and females was 17mm and in those more than 70 years was 18-20mm (4)

In a study by Jasper et al, in Indian population using CT scan, the average suprarenal aortic diameter was 19±2.3mm in males and 17.1±2.3 mm in females in suprarenal aorta and the infrarenal aortic diameter was 13.8±1.9mm in males and 12±1.6 mm in females (5)

The mean values of aortic diameters obtained in our study are comparable with the study conducted in India using CT scan by Jasper and colleagues at both suprarenal and infra renal segments of abdominal aorta (5). The published values for the aortic diameters other than the Indian literature are higher than in our study (1-4) suggesting differences in body habitus and ethnic variability.

In our study, the arterial diameters of aorta, common iliac, external Iliac and common femoral arteries vary with age and gender. There is a low positive correlation with height, weight, body mass index and body surface area and a strong positive correlation with age. Gender has only a weak influence on arterial diameters. A difference of 0.39mm in the suprarenal and 0.65mm in the infrarenal aortic diameters (p value <0.05) was observed between males and females. This gender difference is similar to that in previous studies (1-5). Concerning the influence of age, this study confirms that age plays an integral role in incremental increase in aortic diameters. Hickson and colleagues (6) suggested a multifactorial aetiology for changes in arterial diameters with age and the most important factors were plaque formation and elastin fragmentation by elastolytic enzymes which increases the diameters in the abdominal aorta. This study also matches with the study of Chen and associates (7) which showed that aortic diameters increases by about 1 mm per decade during adulthood.

Any influence of anthropometry on arterial diameters was not significant in our study. This is consistent with other studies, which similarly did not show any influence of height, weight, BMI or BSA on aortic dimensions in adults when these data were adjusted for age and gender (5).

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RESULTS

Gender distribution:

Table 1: Frequency of Males and Females

GENDER	FREQUENCY	PERCENTAGE
MALE	403	66.5%
FEMALE	203	33.5%
TOTAL	606	100%

Distribution of cases according to age groups:

Table 2: Total case distribution by age group irrespective of the gender.

AGE GROUP (Yrs)	TOTAL CASES	PERCENTAGE
20-40	152	25.1
41-60	302	49.8
>61	152	25.1

Case distribution with respect to age groups and gender:

Table 3: Case distribution with respect to age groups and gender

AGE GROUP (yrs)	TOTAL CASES	MALES	FEMALES
20-40	152	101	51
41-60	302	201	101
>61	152	101	51

Table 4: Mean diameters at different anatomical levels.

Anatomic level	Male (n=403) Mean ± SD (mm)	Female (n=203) Mean ± SD (mm)	p – value*
Suprarenal AA	17.92±2.29	17.53±1.96	<0.001
Infrarenal AA	14.67±1.93	14.0±1.69	<0.001
Right Common Iliac A	10.33±1.31	10.02±1.01	<0.001
Left Common Iliac A	10.33±1.31	10.02±1.02	<0.001
Right External Iliac A	9.27±1.02	8.99±0.811	<0.001
Left External Iliac A	9.27±1.02	8.99±0.811	<0.001

Right common Femoral A	8.44±0.89	8.23±0.77	<0.001
Left Common Femoral A	8.44±0.89	8.23±0.77	<0.001
*With Student's t-test			

Table 5:Mean arterial diameters stratified to age groups irrespective of the gender.

Total cases	Age group	Supra renal AA	Infrarenal AA	Right CIA	Left CIA	Righ t EIA	Left EIA	Right CFA	Left CFA
152	20-40	16.25±1.73	13.27± 1.61	9.71±0.94	9.72±0.94	8.85±0.86	8.85±0.86	8.10±0.76	8.10±0.76
302	41-60	17.86±1.88	14.65± 1.76	10.26±1.29	10.26±1.29	9.20±1.01	9.20±1.01	8.41±0.75	8.41±0.75
152	>61	19.17±2.19	15.25± 1.80	10.67±1.16	10.67±1.16	9.45±0.87	9.45±0.87	8.56±0.76	8.56±0.76

* Values expressed in millimetres

Table 6: Correlations of multiple variables at different anatomical level based on r values by Pearson co efficient

	BSA (n= 606)	
	Men (403)	Women(203)
Mean	**1.75 ± 0.2 m^2**	**1.65 ± 0.1m^2**

	BMI (n= 606)	
MEAN	MINIMUM	MAXIMUM
24.7±2.5	17.4	34.33

Variables	Supraren al aa	Infrarenal aa	R&L CIA	R& L EIA	R &L CFA	p value
Age	0.466	0.371	0.271	0.221	0.210	<0.05
Height	0.092	0.121	0.072	0.079	0.059	<0.05
Weight	0.211	0.186	0.079	0.017	0.095	<0.05
BMI	0.201	0.153	0.081	0.067	0.057	<0.05
BSA	0.187	0.178	0.101	0.097	0.100	<0.05

Correlation between suprarenal segment of AA and age

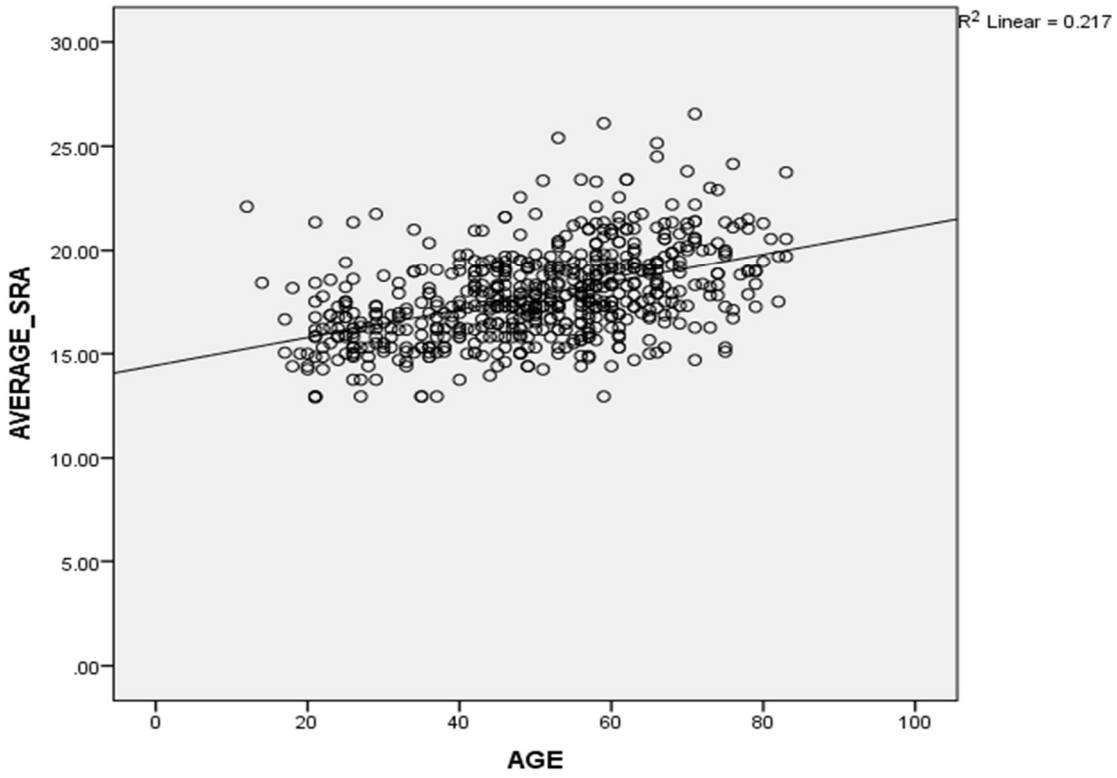


Figure 1:Scatter plot showing positive correlation suprarenal AA and age (Pearson r = + 0.466) (X axis age in years and Y axis diameter in millimetres)

The significant positive correlation with positive slope indicates that incremental changes in arterial diameters with respect to the age (Pearson r = 0.466, p < 0.001) (Figure 1)

Correlation between infrarenal segment of AA and age

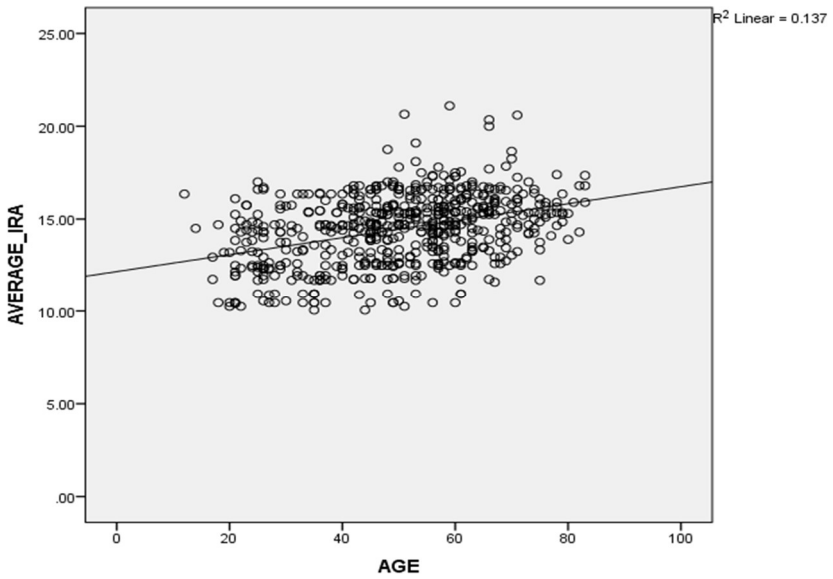
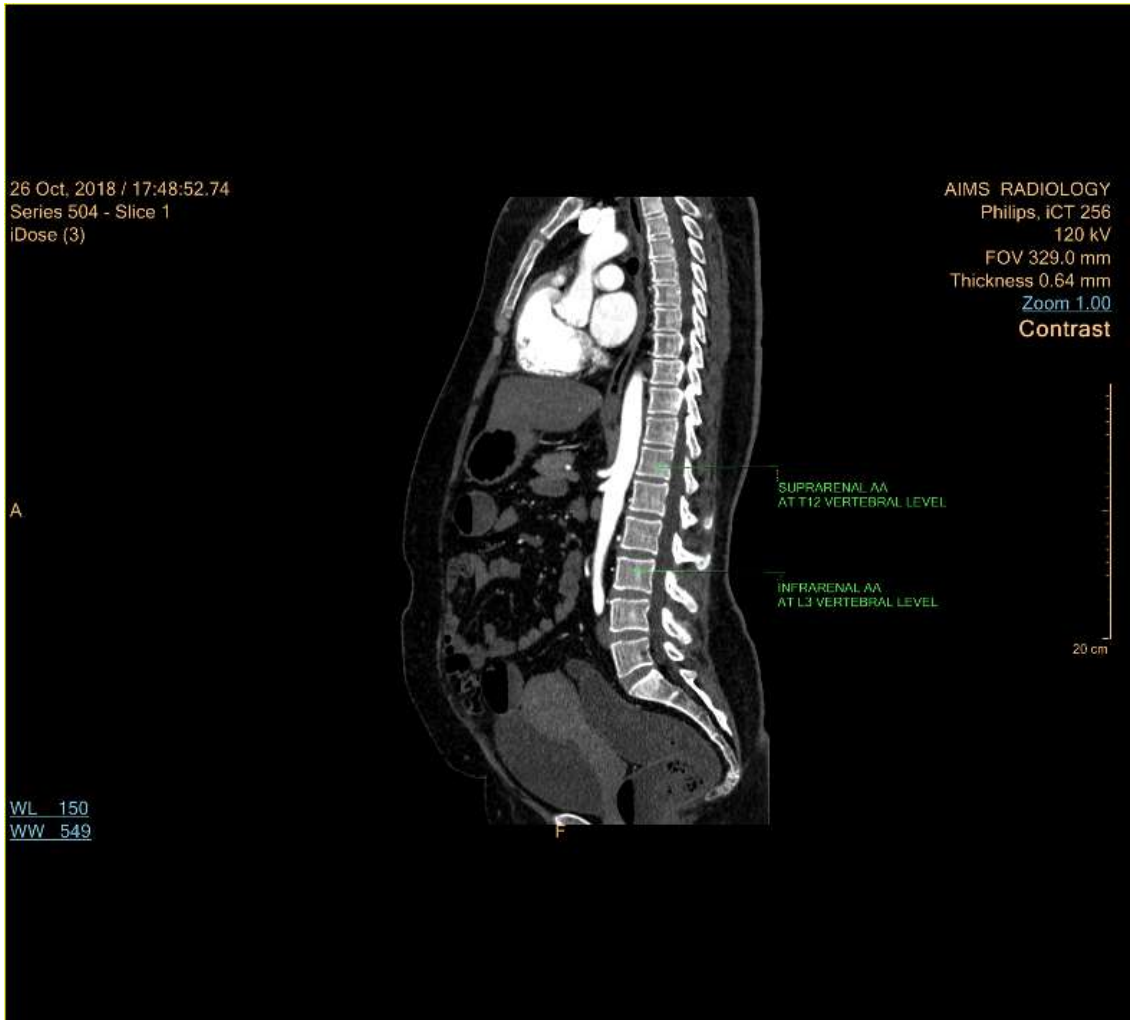


Figure 2: Scatter plot showing positive correlation infrarenal AA and age (Pearson r = + 0.371) (X axis

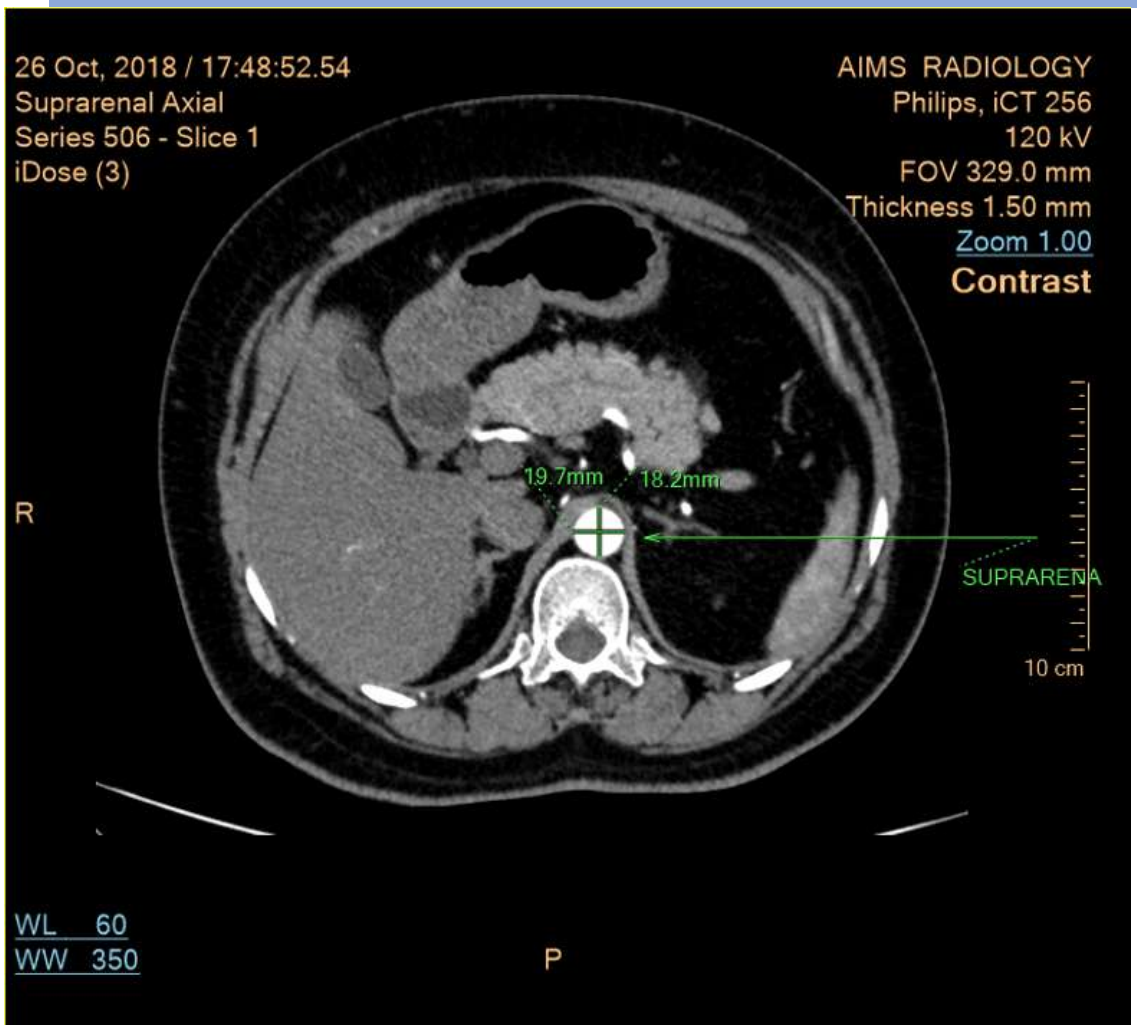
age in years and Y axis diameter in millimetres)

The significant positive correlation with positive slope indicates that increment changes in arterial diameters with respect to the age (Pearson r = 0.371, p < 0.001) (Figure 2).

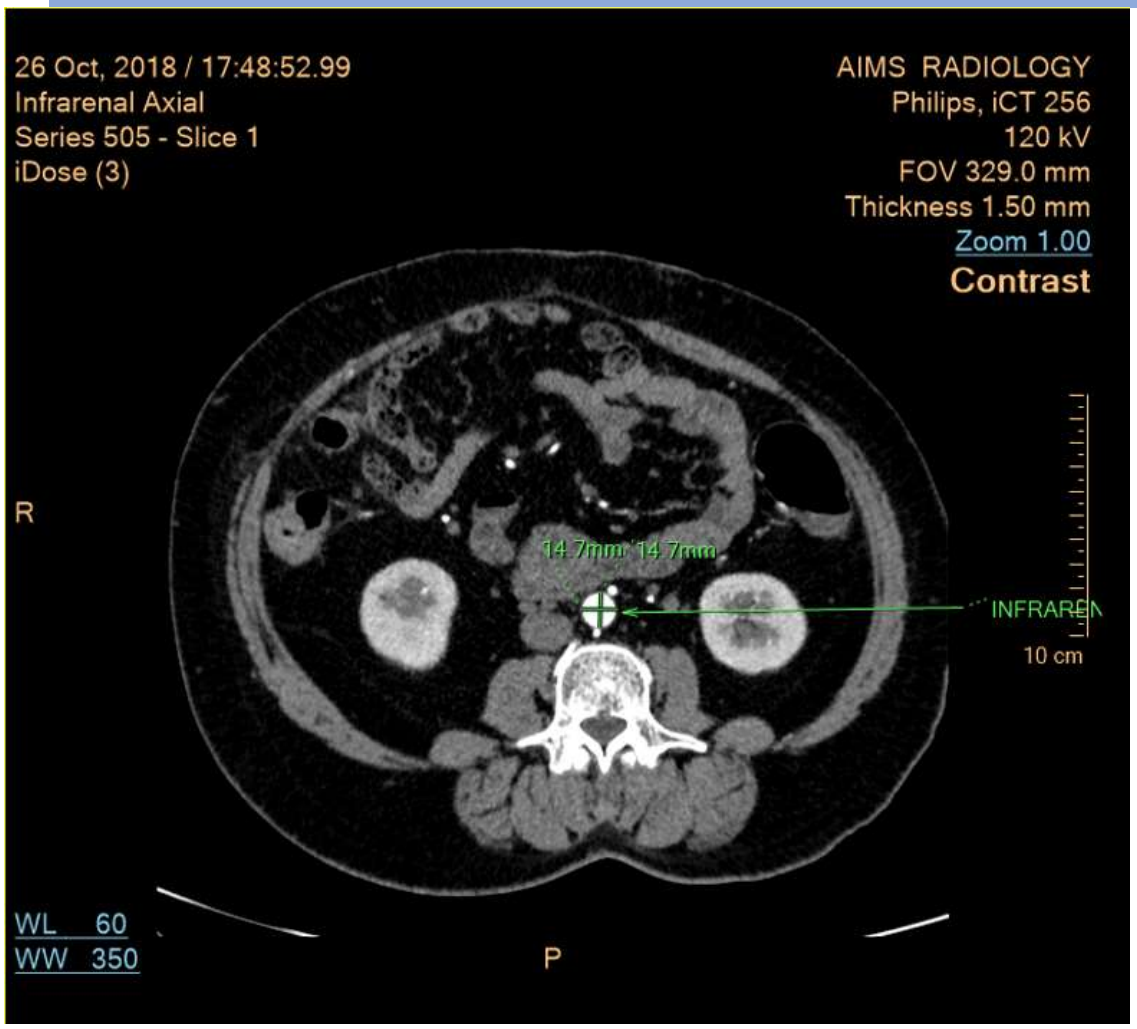
Images



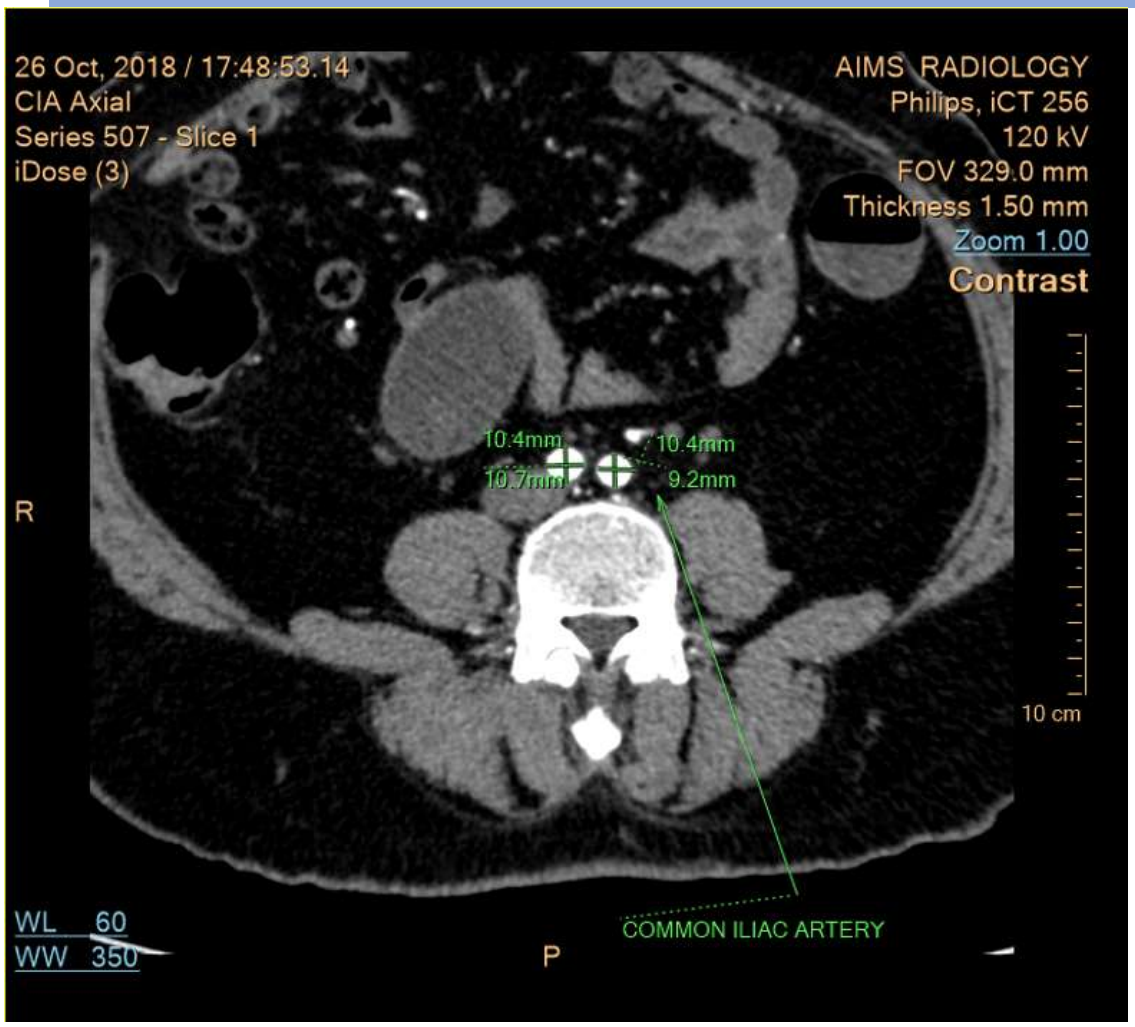
Sagittal reconstruction of the abdominal aorta on a contrast enhanced CT abdomen corresponding to T12 and L3 vertebral level.



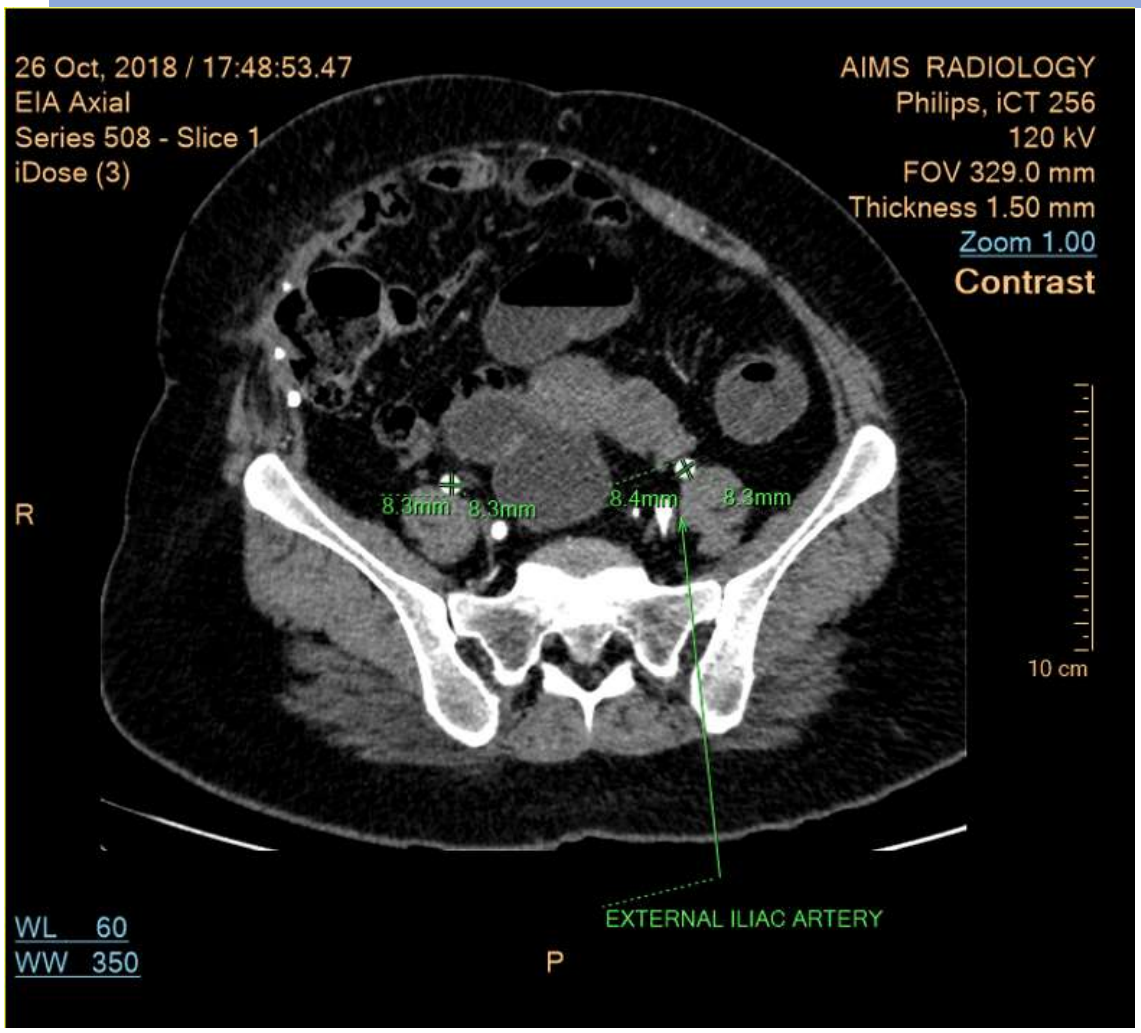
Axial section of the abdominal aorta on a contrast enhanced CT abdomen corresponding to suprarenal AA at T12 vertebral level



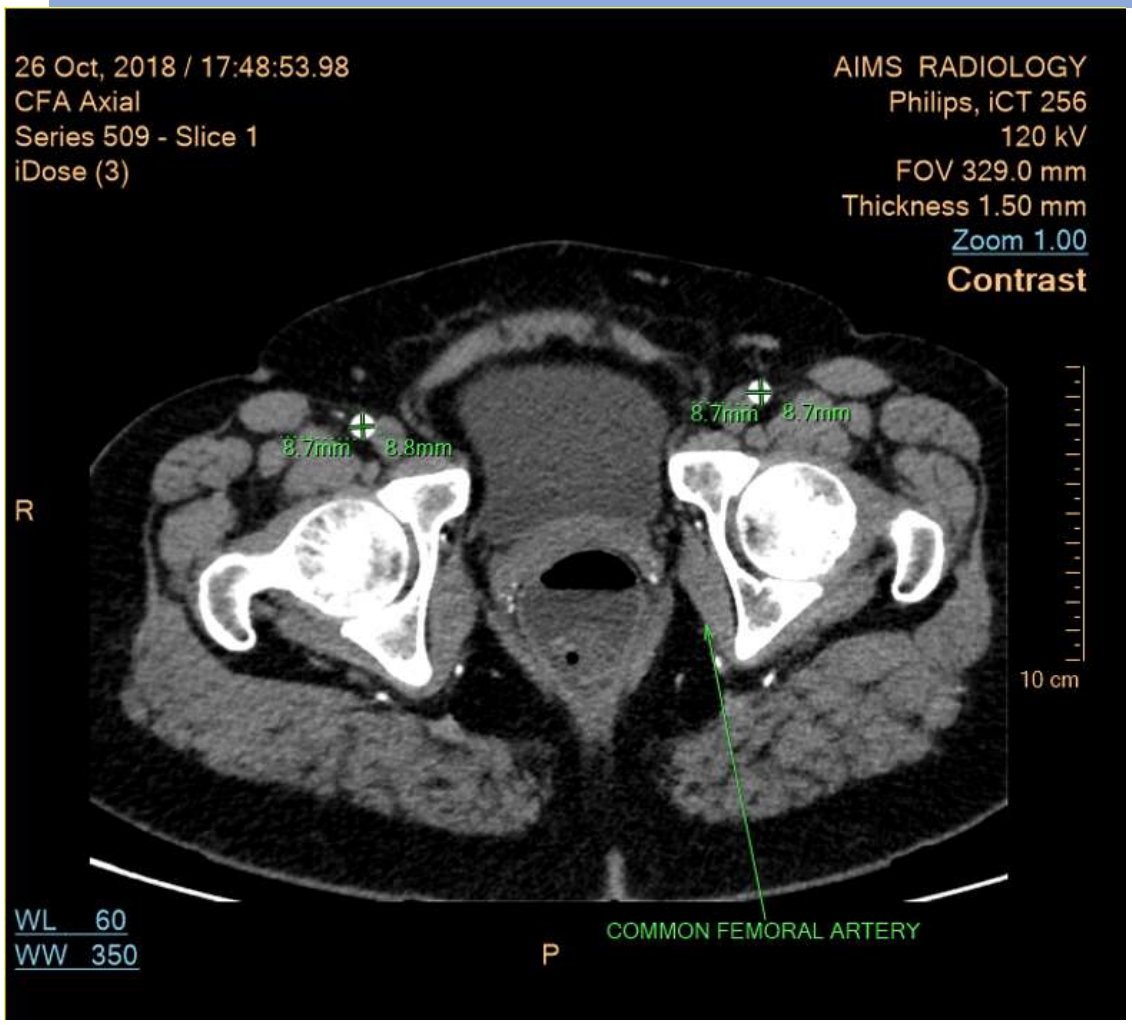
Axial section of the abdominal aorta on a contrast enhanced CT abdomen corresponding to infrarenal AA at L3 vertebral level



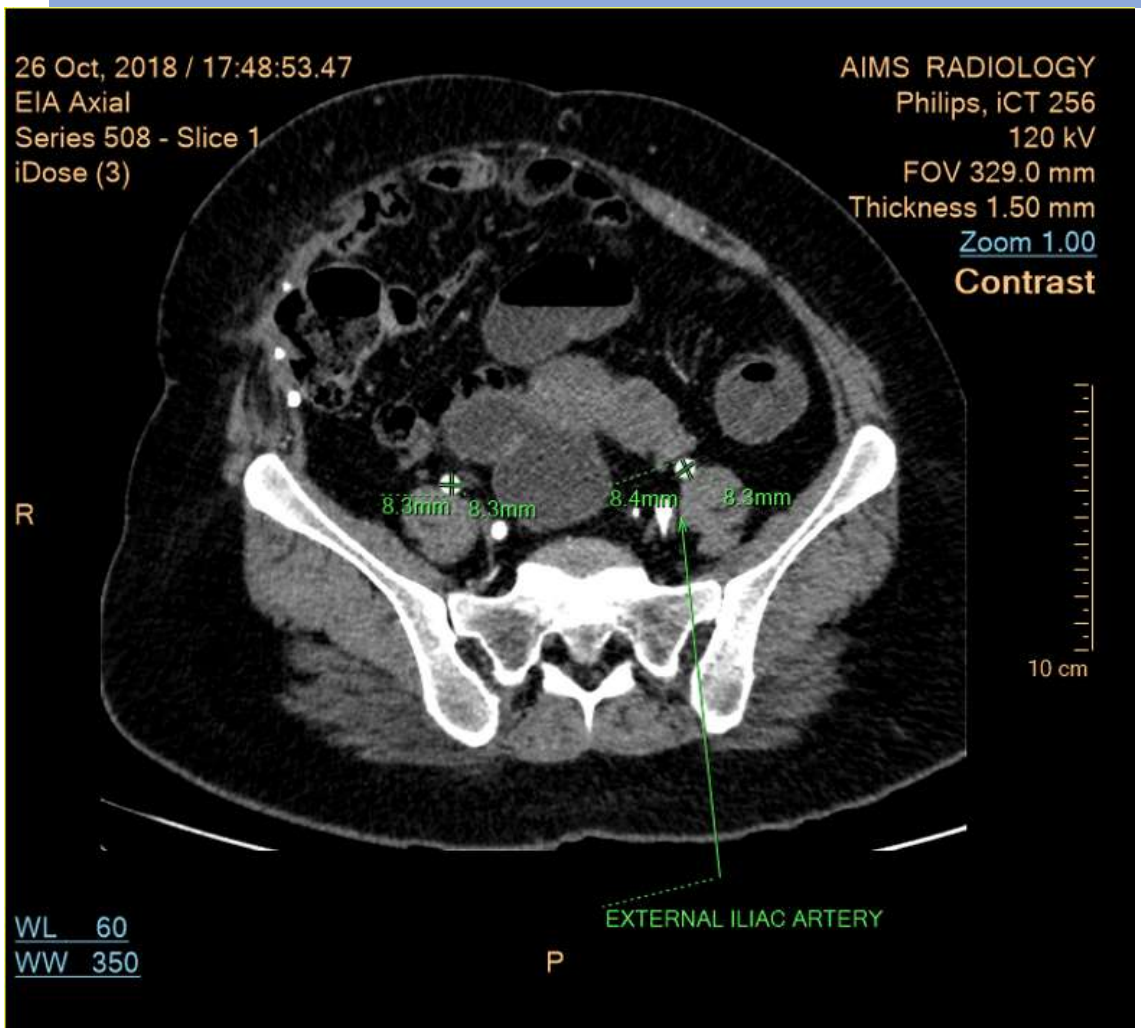
Axial section of the common iliac artery in its mid segment on a contrast enhanced CT abdomen



Axial section of the external iliac artery in its mid segment on a contrast enhanced CT abdomen.



Axial section of the common femoral artery at the level of the femoral head on a contrast enhanced CT abdomen.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