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Correlation Between Aortic Knob Diameter and Cardiothoracic Ratio on Plain Chest Radiograph in Indian Population

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Abstract

Purpose: The identification of the aortic knob in a chest radiograph holds significance, as it can serve as an initial indicator of cardiovascular disease. The cardiothoracic ratio, a cost-effective and straightforward tool, plays a crucial role in estimating heart size. This study aims to assess the relationship between aortic knob diameter and cardiothoracic ratio based on age and gender.

Method: This was an observational prospective study of 315 individuals between the ages of 10-70 years were assessed, had no thoracic deformity with no past or present cardiovascular disease were included.

Result: The mean value of aortic knob diameter for males & females was 2.7 & 2.5cm it increases with age and males have higher value. The mean cardiothoracic ratio was 0.46 for females and 0.44 for males, it increased with age until the fifth decade and was higher in females.

Conclusion: The present study shows the demonstrate a significant positive correlation between aortic knob diameter and cardiothoracic ratio. The mean aortic knob diameter increased with age and males had higher values than females. The mean CTR increased gradually with age and females had greater values than males. Aortic knob diameter was positively correlated with transverse heart diameter (THD), transverse thoracic diameter (TTD), and cardiothoracic ratio (CTR).

Keywords*: Aortic knob diameter, Transverse Heart Diameter, Transverse Thoracic Diameter, Cardiothoracic Diameter.*

Introduction:

The chest radiograph is a commonly used diagnostic imaging technique for evaluating conditions within the chest cavity and respiratory systems [1]. Among the various radiographic variables employed, the cardio-thoracic ratio (CTR) is frequently utilized to assess heart size, often determined through chest radiographs. Cardiomegaly, characterized by a CTR exceeding 50%, is a common finding [2]. Additionally, the aortic knob diameter, a measurement involving a segment of the descending aortic arch, is considered in the evaluation [3].

The objective of this study is to establish a correlation between the aortic knob diameter and cardiothoracic ratio, as existing research has not definitively confirmed a link between these two variables. This implies that an abnormal

aortic knob diameter may potentially serve as an early indicator of cardiovascular diseases. For example, conditions such as high blood pressure could lead to an enlargement of the aortic knob, contributing to hypertension and ultimately resulting in cardiomegaly. The study was conducted to investigate the association between aortic knob diameter and cardiothoracic ratio across various age groups and genders.

Materials and Methods:

Study area

The study was carried out at the Teerthanker Mahaveer Hospital. It is an approximately 750 bedded tertiary medical facility located in Moradabad, U.P.

Study designs and search strategy:

A prospective observational study was carried out in the Department of Radio diagnosis, between March 2022 to March 2023 Teerthanker Mahaveer Hospital TMU, Moradabad U.P. Clinical and Pathological data were retrieved from the Console room.

Patient Selection:

The source of data for this study are victims referring in unit of Imaging and interventional radiology from OPD/IPD of Teerthanker Mahaveer Hospital, Moradabad. we reviewed in detail the records of the Patient case file which was used to confirm information from other data sources. 315 patients match are inclusion criteria 176 males and 139 female patients. examined ranged in age from 10 to 70.

Inclusion Criteria

All the patients aged between 10-70 years had no thoracic deformity with no past or present cardiovascular disease.

Exclusion Criteria

Patients not included who are not fitted in Imaging, Pregnant women are exclude for the data collection. All other lesions mimicking cardiovascular disease & Patient who did not give consent. All post-operative cases as illustrated in Fig 1.

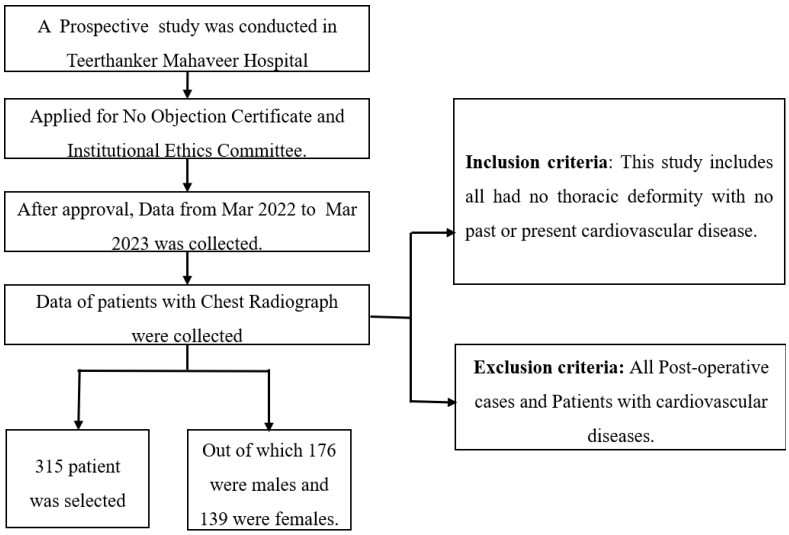

Fig 1: Study of flow chart

Imaging protocols:

All patients are screened before entry into the x-ray room for metallic objects of the interest of part. Patients were examined in the Errect position on the vertical bucky, proper positioning, and proper interaction for breath holding, and immobilization of the chest was obtained. we analyzed the PA chest x-ray on 1000mA Shimadzu Digital Radiography system was used for the study

Data Analysis

The statistical analysis was carried out using version 26.0 of SPSS. The mean (SD) for quantitative variable was calculated while the frequencies and percentages for qualitative variable were calculated. The Independent t- test was used to compare age, aortic knob diameter, THD, TTD, and CTR according to gender. The One-way ANOVA to compare aortic knob diameter, THD, TTD, and CTR according to age. The post hoc analysis Tukey test for the multiple comparisons of aortic knob diameter, THD, TTD, and CTR according to age. The Pearson correlation coefficient, to find the relation between aortic knob diameter, THD, TTD, and CTR.

Result:

A total of 315 were included in the study their aortic knob diameter, transverse heart diameter, the transverse thoracic diameter was measured and the cardiothoracic ratio was calculated.

Table 1: Representation of males and females

(n = 315)		Frequency	%
Age	10-20	53	16.8
	21-30	73	23.2
	31-40	51	16.2

	41-50	71	22.5
	51-60	39	12.4
	61-70	28	8.9
Gender	Male	176	55.9
	Female	139	44.1

The table1 shows the frequency and percentage of male and female which are total 315 patients. The mean age is 37.7 years [SD=15.7]in which 55.9% about 176 were males and 44.1% about 139 were females.

Table 2: Representation of Mean & Standard deviation for given variables

Variables	**Range**	**Mean**	**S.D.**
Age (Years)	10 to 70	37.7	15.7
Aortic Knob Diameter	1 to 4	2.6	0.5
THD	6.2 to 17.2	11.8	1.6
TTD	13.1 to 32.7	25.8	2.6
CTR(THD/TTD)	0.31 to 0.68	0.45	0.06

The mean age for the entire population was 37.7 [SD=15.7] ranging from 10-70 years. The mean value for aortic knob diameter was 2.6 [SD=0.5] ranging from 1 to 4 cm. The mean value for transverse heart diameter was 11.8 [SD=1.6] ranging from 6.2 to 17.2 cm. The mean value for transverse thoracic diameter was 25.8 [SD=2.6] ranging from 13.1 to 32.7 cm. The mean value for the cardiothoracic ratio was 0.45 [SD=0.06] ranging from 0.31 to 0.68 as shown in table 2.

Table 3: Comparison of age, aortic knob diameter, THD, TTD, and CTR according to gender

		Mean	S.D.	"t"	p-value
Age (Years)	Male	38.7	15.9	1.342	0.181
	Female	36.4	15.5		
Aortic knob diameter (Cm)	Male	2.7	0.6	2.779	0.006*
	Female	2.5	0.5		
THD (RV+LV dia.) Cm.	Male	12.0	1.5	2.923	0.004*
	Female	11.5	1.7		
TTD (Cm.)	Male	26.9	2.4	9.466	< 0.001*
	Female	24.5	2.0		
CTR (THD/TTD)	Male	0.44	0.05	-3.385	0.001*

	Female	0.46	0.06		

(* Significant)

[In Table 3] The Independent sample "t" test was used to compare age, aortic knob diameter, THD, TTD, and CTR according to gender. There was a difference ($p < 0.05$) in aortic knob diameter, THD, TTD, and CTR between males and females.

Table 4: Comparison of aortic knob diameter, THD, TTD, and CTR according to age

		Mean	S.D.	"F"	p-value
Aortic knob diameter (Cm)	10-20	2.1	0.3	29.734	< 0.001*
	21-30	2.4	0.4		
	31-40	2.6	0.5		
	41-50	2.9	0.5		
	51-60	2.9	0.4		
	61-70	3.0	0.6		
THD (RV+LV dia.) Cm.	10-20	10.1	1.5	20.3	< 0.001*
	21-30	11.7	1.3		
	31-40	11.9	1.6		
	41-50	12.6	1.4		
	51-60	12.1	1.5		
	61-70	12.4	1.2		
TTD (Cm.)	10-20	23.2	2.8	17.246	< 0.001*
	21-30	26.2	2.2		
	31-40	26.4	1.9		
	41-50	26.3	2.1		
	51-60	26.3	2.4		
	61-70	26.7	2.3		
CTR (THD/TTD)	10-20	0.43	0.05	5.726	< 0.001*
	21-30	0.44	0.05		
	31-40	0.45	0.06		
	41-50	0.48	0.06		
	51-60	0.45	0.05		
	61-70	0.46	0.05		

(* Significant)

[In Table 4] The One-way ANOVA test was used to compare aortic knob diameter, THD, TTD, and CTR according to age. There was a difference ($p < 0.05$) in aortic knob diameter, THD, TTD, and CTR according to age.

Table 5: Represent the correlation between aortic knob diameter, THD, TTD, and CTR

		Aortic knob diameter (Cm)	THD (RV+LV dia.) Cm.	TTD (Cm.)	CTR (THD/TTD)
Aortic knob diameter (Cm)	"r"	1	0.576	0.414	0.344
	p value	--	< 0.001*	< 0.001*	< 0.001*
THD (RV+LV dia.) Cm.	"r"		1	0.563	0.715
	p value		--	< 0.001*	< 0.001*
TTD (Cm.)	"r"			1	-0.156
	p value			--	0.005*
CTR (THD/TTD)	"r"				1
	p value				--

(* Significant)

[In table 5] The Pearson correlation coefficient, “r” was used to find the correlation between aortic knob diameter, THD, TTD, and CTR. Aortic knob diameter was positively correlated ($p < 0.05$) with THD, TTD, and CTR. Also, THD was positively correlated ($p < 0.05$) with TTD, and CTR. There was a positive correlation ($p < 0.05$) between TTD and CTR.

Discussion:

A chest X-ray is an essential examination across various medical disciplines, known for its widespread availability, affordability, and significant diagnostic utility, especially in rural areas of India. Extensive research has been conducted on the normal width of the aortic knob in the chest PA view. An enlarged aortic knob serves as an initial indicator for certain conditions, such as chronic systemic hypertension, atherosclerosis, cystic medial necrosis of the aorta, and aortic dissection. Consequently, our objective was to establish the average values of aortic knob diameter in a sample population. Elevated data values may suggest the expansion of the aortic arch, aiding in the early detection of the aforementioned diseases within the western population. [5]

The cardiothoracic ratio serves as a practical and straightforward method for assessing heart size and detecting cardiovascular disorders. This index is valuable for evaluating cardiac size, with a 50% value commonly regarded as the upper limit of normal. Establishing the mean within the local population is crucial for precise assessments. In our investigation, we observed a progressive increase in both transverse heart diameter and transverse thoracic diameter with age. Additionally, the cardiothoracic ratio exhibited a gradual rise in tandem with age. This suggests that the incremental growth in transverse heart diameter contributes to the age-related increase in the cardiothoracic ratio, reaching its peak around the age of 50.[6]

Y. B. Mensah et al. conducted their study on 1989 subjects, in their study they divided the greatest internal thoracic diameter by the transverse cardiac diameter to determine the cardiothoracic ratio. In conclusion, their study was able to determine the mean CTR values are 0.459. Age-related increases in the mean CTR were moderate, with females having higher values than males. In our study, we used this formula and found that the mean value of the cardiothoracic ratio for males and females are 0.44 and 0.46. [6]

Abhijit Ray et al. in their study 650 people meeting the deserved criteria were selected. The aortic knob diameter, heart diameter, and transverse thoracic diameter were measured, along with a chest X-ray. As a result, they discovered that the average diameter of the aortic knob was 3.10 cm in men and 3.076 cm in women, respectively. Males was having somewhat larger aortic knob diameters than females. Additionally, they observed a positive correlation between aortic diameter, heart diameter, and thoracic transverse diameter. In our study, we measure the aortic knob diameter, and the mean diameter in males and females is 2.7 and 2.5. [5]

Alhaji Modu Ali et al. their research examined healthy persons' average heart size and cardiothoracic ratios to develop demographic reference ranges for comparison with cardiac disorders. In their study, they included 172 healthy individuals who were referred to Radiology Department. They concluded that until the fourth decade, the CTR gradually increased with age; thereafter, it decreases with age. Therefore, in a situation when a potential cardiac illness is being investigated, defining normal ranges of CTR is required for comparison. Taking these values takes into consideration and in our study, we found that the cardiothoracic ratio gradually increases up to the fifth decade and then decreases with increasing age. [7]

Sunil O et al. 648 people between the ages of 18 and 75 were included to compare healthy people with those who have cardiovascular comorbidities and examine the role of the aortic knuckle in the left cardiac outline using posterior-anterior chest radiography. And found the result that the aortic knuckle's contribution to the left cardiac outline among normal and co-morbid individuals was 18.4% and 25.5% in co-morbid patients. By considering these values we found that the value of the aortic knob or aortic knuckle for normal and co-morbid individuals is 21% to 30%. [8]

Conclusion:

The Present study has been able to illustrate that 2.6 and 0.45 are the mean aortic knob diameter and mean cardiothoracic ratio (CTR) values respectively for the Western Uttar Pradesh population. It has also shown the relationship between the age of the patient's aortic knob diameter, transverse heart diameter and transverse thoracic diameter, and cardiothoracic ratio. The mean aortic knob diameter increased with age and males had higher values than females. The mean CTR increased gradually with age and females had greater values than males. Aortic knob diameter was positively correlated with transverse heart diameter (THD), transverse thoracic diameter (TTD), and cardiothoracic ratio (CTR). The present study also provides the reference values with clinical clues which might be helpful for the medical supervision based on specialized diseases like pulmonary embolism, pulmonary thromboembolism, pulmonary hypertension, hypertension, diabetes mellitus, and heart diseases.

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