ORIGINAL ARTICLE

A Study on the Correlation between the Radiographic and CT-Scan Measurement of Cardiothoracic Ratio

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ABSTRACT

Background: The standard index for measurement of heart size is cardiothoracic ratio (CTR) that is measured based on chest radiograph. A small number of heart size assessments are performed using CT-scan.
Aim: To evaluate the correlation between the radiographic and CT-scan measurement of CTR.
Methods: The CXR and CT images were collected from the patients hospitalized in Imam Khomeini Hospital, Ahvaz, Iran. CTR was calculated by the ratio of the maximum transverse cardiac diameter to the largest transverse thoracic diameter in both CXR and CT-Scan (T, C) methods. Two methods were used to calculate CTR by CT-scan. In second method, the long cardiac axis and the short axis were used to calculate CT-Scan (L, S). The correlation of age and CTR was also evaluated.
Results: 122 patients with mean age of 54.89±18.53 years were studied. In all but 9 patients (92.62%), the values obtained from CT-Scan (T, C) were equal or smaller than CXR, and the difference in mean of CTR between two methods was 1.86% per patient. In all but 3 (97.54%) cases, the values obtained from CT-Scan (L, S) were equal or less than CXR, and the difference in mean of CTR between two methods was 0.14 per patient.
Conclusion: The CTR values showed no significant difference between diagnostic values of CXR and CT-scan on assessment of increasing heart size. There was a significant positive correlation between CTR and age. Therefore, CTR can be a convenient way to measure the heart size.
Keywords: Heart Size, Cardiothoracic Ratio, Chest Radiograph, computed tomography scan

INTRODUCTION

Cardiothoracic ratio (CTR) is measured on a posterior-anterior (PA) chest radiograph (CXR), and is the ratio of maximal horizontal cardiac diameter (CD) to maximal horizontal thoracic diameter (TD) (inner edge of ribs/edge of pleura) The normal CTR is between 0.39 and 0.50, with an average of 0.45 (1). The CTR less than 0.5 was the normal heart rate and more than 0.5 as cardiomagality[2-5]. The CTR is normally used to detect Cardiomegaly and to estimate left ventricular size[1,2,6], which could be easily measured by CXR[7,8]. In several studies, CTR measured in CXR was considered as an independent predictor of mortality[9-12]. Another study showed that CTR with a high negative predictive value is important in rejection and cardiac dysfunction[13]. Although the results of several studies showed a limited CTR value in CXR as a predictor of mortality and left ventricular dilatation[14-16], it is still a routine method used for radiologists to evaluate the rapid increase in heart rate and potential cardiac pathologies[7,8,12,16-18] and is also a suitable method for screening and tracking heart disease[19]. Precise axial measurements have been made available using CT-scan recently[20], and CTR can be used as a reliable, easy and renewable method for detecting cardiomegaly using CT-scan in Axial View[21]. Quantitative studies have been performed on CT scan and CXR comparisons of CTR and there is no global standard for obtaining CT scan heart rate. Given the prevalence of heart disease and its importance as the cause of mortality in the universe, it looks as if the further studies on CTR and the evaluation of heart rate criteria including non-specialized imaging techniques such as CT-scan and CXR, which are commonly used necessary. The present study tried to compare CTR calculated by CXR in the posterior-anterior view with CT-scan calculated CTR in the axial view and the effect of age and gender on CTR separately in both methods.

METHODS

This was a retrospective and analytic study conducted on the medical records and CXR and CT images of the patients (n=122) hospitalized in Imam Khomeini Hospital, Ahvaz, Iran (Code of ethics: GP95149). The data collection process had been conducted one week. The CT-scan data and patient graphs including the largest transverse diameter of the heart, the largest cross-sectional diameter, CTR, age and sex of the patients were extracted from the packs-radiology system of the hospital.

Axial view was used in CT-scan images. In these images, the surface of the largest diameter of the heart on the pivot plate was used to obtain the largest transverse diameters of the heart and the surface at which the dome of the left-hand side of the diaphragm appeared to get the largest transverse turret diameters. In the graph, the distance between the midline of the vertebrae and the outer edge of the apex of the heart and the right atrium was measured and their sum was obtained. The largest transverse turret diameters are measured at the surface of the shadow of the left-hand side of the aperture. Then, the CTR ratio was calculated by dividing the largest transverse diameters of the heart into the largest transverse turret diameters.

The radiographies that were excluded from the study were cases of deformity of the vertebral column or chest wall, inadequate breath (less than 5 visible ribs are visible above the diaphragm of the anterior, or 9 ribs from the

posterior part), over expanded chest (more than 7 upper diaphragm ribs are seen). They were also the anterior and 11 from the posterior, incomplete standing radiographs, mediastinal divergence, high patient turnover, inability to accurately determine the periphery of the heart with certainty (for example, the presence of extensive pleural effusion), placement of a part of the thoracic out of films.

RESULTS

122 patients (male/female: 71/51) with age range of 17 to 90 years and mean age of 54.89 ± 18.5345 years were studied. The number of male patients was significantly higher than female ones ($P < 0.05$), but no significant difference was observed between their mean ages ($P > 0.05$). Distribution of patients by different age groups was not significantly different ($P > 0.05$) (Table 1).

The mean CTR on the basis of PA CXR was not significantly different with the values obtained from CT scan (T, C) and CT scan (L, S) measurements (Table 2).

Except for nine patients, in all patients (92.62%), the values obtained from CT scan (T, C) method were smaller or equal to those of the CXR method, and the difference in mean values of the two methods was 1.86 per patient. In addition, except for three patients, in all patients (97.54%), the values obtained from CT scan (L, S) method were smaller than or equal to those of the CXR method, and the difference in mean values of the two methods was 0.14 per patient. The values of CTR obtained from the three measurement methods, i.e. PA CXR, CT scan (T, C), and CT scan (L, S), showed a positive and significant correlation with age, so that with increasing age, CTR also increased. It should be noted that this increase was higher in middle aged people than in the elderly (Table 3).

Table1:: Distribution of patients by gender and age

Variable	Women	Men	P value
Gender	51(41.8%)	71(58.2%)	0.032
Age(Mean±SD)	58.29±16.738	52.77±19.419	0.42
Age range	N	%	
15 - 24	16	13.12%	
25 - 34	18	14.75%	
35 – 44	16	13.12%	0.112
45 – 54	15	12.29%	
55 – 64	20	16.39%	
65 – 74	23	18.85%	
75 – 84	8	6.56%	
85 - 94	6	4.92%	

Table 2. Comparison of the mean CTR based on PA CXR and CT scan (T, C) and (L, S)

Parameters (cm)	Mean ± SD	CTR	P-Value
CXR (T,C)			
A+B	14.34±2.02	0.51±0.08	0.452
C	28.63±2.67		
CT-Scan (T,C)			
T	12.78±1.56	0.52±0.07	
C	24.29±3.16		
CXR (L, S)			
A+B	14.34±2.02	0.51±0.08	0.088
C	28.63±2.67		
CT-Scan (L, S)			
L	0.53±0.16	0.49±0.56	
S	0.42±0.15		

Table 3. Relationship between CTR and age separately for each measuring method

Age (year)	CTR (Mean ± SD)	r	P value
CXR			
15 - 24	0.50±0.073	0.21	0.016
25 - 34	0.49±0.10		
35 – 44	0.49±0.08		
45 – 54	0.50±0.09		
55 – 64	0.54±0.07		
65 – 74	0.53±0.06		
75 – 84	0.52±0.64		
85 - 94	0.52±0.09		
CT-Scan (T , C)			
15 - 24	0.50±0.063	0.30	0.022
25 - 34	0.50±0.07		
35 – 44	0.50±0.54		
45 – 54	0.51±0.77		
55 – 64	0.55±0.045		
65 – 74	0.56±0.95		
75 – 84	0.53±0.51		
85 - 94	0.52±0.73		
CT-Scan (L, S)			
15 - 24	0.48±0.055	0.19	0.045
25 - 34	0.49±0.023		
35 – 44	0.49±0.065		
45 – 54	0.50±0.075		
55 – 64	0.52±0.081		
65 – 74	0.51±0.022		
75 – 84	0.051±0.042		
85 - 94	0.050±0.044		

DISCUSSION

The present study was aimed to compare the CTRs obtained from CXR and CT scan of the lung. In the present study, the number of male patients (58.2%) was significantly higher than the female ones (41.8%), but no significant difference was observed between their mean ages. In addition, the distribution of patients in different age groups was almost uniform and did not differ significantly. The mean CTR on the basis of PA CXR and the values obtained from the two measuring methods, CT scan (T, C) and CT scan (L, S),were almost equal and did not have a statistically significant difference.

In the study of Miller et al., there was no significant difference between the CTRs obtained from CXR and Helical CT, and they concluded that both methods can be used quickly, usefully, and renewably as a standard for determining the size of the heart its volume[22]. The study of Winklhofer et al. suggested that calculating CTR by CT scan is useful and reliable for postmortem diagnosis of cardiomegaly, and can lead to a reduction in the number of autopsies performed to detect the cause of death[23]. The above studies were consistent with the results of the present study.

Except for nine patients, in all patients (92.62%), the values obtained from CT scan (T, C) method were smaller or equal to those of the CXR method, and the difference in mean values of the two methods was 1.86 per patient. Also, except for three patients, in all patients (97.54%), the values obtained from CT scan (L, S) method were smaller than or equal to those of the CXR method, and the difference in mean values of the two methods was 0.14 per patient. Also, in the study of Miller et al., the values of CTR

obtained from the measurement of transverse diameter of the heart by CT scan (T, C) and CT scan (L, S) methods with a mean difference of 2.92 and 0.038, respectively, were smaller than those of the CXR, which were consistent with the results of the present study.

The values of CTR obtained from the three measurement methods, i.e. PA CXR, CT scan (T, C), and CT scan (L, S), showed a positive and significant correlation with age, so that with increasing age, CTR also increased.The study of Potter et al. showed that TD of middle-aged people was larger than that of young people, but the TD of the elderly was smaller than that of middle-aged people, and overall, the CTR values for the age group of 50 to 90 years increased[12].

The findings of the study conducted by Taghavi Shavazi et al. revealed that the CTRs obtained from echocardiography and chest X-ray had a significant correlation with age, so that those with a CTR greater than 50% had a mean age higher than those with a CTR less than 50% (24).The results of Inoue et al. showed an increase in CTR and CD, and a reduction in TD in women of older age groups based on CXR, so that the percentage of cardiomegaly was significantly increased in older age groups. They concluded that because of the possible changes that are caused by normal aging, the classical upper limit (50%) for CTR should not be generalized to old women[25]. The above studies were consistent with the results of the present study.

CONCLUSIONS

The results of this study showed that the values obtained in determining the CTR using CT scan as a simple and retrievable method were very close to those obtained from the CXR as a standard method for measuring CTR. There was no significant relationship between gender and CTR values, but there was a positive and significant correlation between CTR and age.

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