VALIDITY OF CHEST X-RAY IN ESTIMATION OF CARDIAC SIZE IN COMPARISON TO ECHOCARDIOGRAPHY

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ABSTRACT

This is a cross-sectional study carried out to study the validity of the cardiothoracic ratio as a predictor of cardiac enlargement. The study involved 150 patients attending Alsader Teaching Hospital for various cardiac symptoms. The cardiothoracic ratio (CTR) was measured for 150 posterior anterior (PA) view chest x-ray. Left Ventricular Internal Dimension in systole (LVIDs) and Left Ventricular Internal Dimension in diastole (LVIDd) were measured by 2D echocardiography (through the parasternal axis) in patients who have a PA view chest x-ray within the same week. The study showed that the ability of chest x-ray (by *measuring CTR)* to measure cardiac size in patient with cardiomegaly in comparison to echocardiography *(by measuring LVIDd)* is high (sensitivity 85.71%), while the ability of chest x-ray to exclude cardiomegaly in comparison to echocardiography *is low* (specificity 13.79%). Furthermore, the ability of chest x-ray to detect (sensitivity) or exclude (specificity) cardiomegaly in comparison to echocardiography (by measuring LVIDs) was 90.47% and 17.24% respectively. The study found significant correlation between CTR and LVIDd (using Pearson correlation), and there was no significant correlation between CTR and Body mass index (BMI). The study recommended that because it is easy and cheap to measure the CTR by the chest x-ray for any patient in the emergency department, it can be regarded as a preliminary measure to the size of the heart, but echocardiographic measurements remained the most accurate.

INTRODUCTION

Cardiovascular diseases cause various and complex changes in the cardiac silhouette on the chest radiograph. The cardiomegaly can be judged with reasonable accuracy on the chest x-ray posterior-anterior (PA) view[1]. The determination of heart size, including the size of each of the 4 heart chambers, is important act the physician performs. The estimation of chamber size assists the physician in determining the etiology of the patient's heart disease. Many conditions can cause an enlarged heart[2]. Heart chamber enlargement can be detected by plain x-ray, however, the diagnosis can be made more accurately by other more expensive techniques like cardiac echocardiography, magnetic resonance imaging (MRI), and computed tomography (CT); but chest x-ray PA views remain important as they allow fairly straightforward and inexpensive assessment of changes over time and are routinely and quickly available[3]. The echocardiography is commonly superior to other low-technological methods that are used to determine the size of the heart and its chambers[4], but it is impractical and expensive to obtain an echocardiogram on every patient. Accordingly, the interpretation of the chest x-ray film as an effort to determine the size of the heart remains valuble. The echocardiogram should be used when the history, physical examination, chest x-ray view, and the electrocardiogram stimulate a series of questions that necessitate an echocardiographic examination[5]. The cardiothoracic ratio (CTR) is the maximum transverse diameter of the heart divided by the greatest internal diameter of the thoracic cage (from inside of rib to inside of rib) at the level of the right diaphragmatic cupula[6]. In normal people, the CTR is usually less than 50%. Therefore, the CTR is a handy way of separating most normal hearts from most abnormal hearts[6]. A heart may be greater than 50% of the CTR and still be a normal heart[7]. This can occur if there is an extracardiac cause of cardiac enlargement, due to inability to take a deep breath because of pregnancy and ascites or abnormalities of the chest that compress the heart such as pectus excavatum deformity and straight back syndrome[1]. Sometimes the heart can be smaller than 50% of the cardiothoracic ratio but still be an abnormal heart. This occurs when there is something obstructing the flow of blood from the ventricles since the ventricles respond at first by undergoing hypertrophy, which does not produce cardiomegaly[6]. Echocardiography (two-dimensional slices), is

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very useful in establishing the cause of cardiomegaly and is the usual method for determining internal cardiac dimensions. Normal dimensions should be corrected for patient size[8]. Echocardiography accurately identifies isolated or generalized chamber enlargement, thickening of the myocardium, or pericardial effusion. When echocardiography is unable to visualize the heart adequately, MRI accurately defines cardiac dimensions[9]. This study was carried out to study the validity of chest x-ray in the estimation of cardiac size in comparison to echocardiography.

METHODOLOGY

This is a cross-sectional study carried out on 150 adult patients attending Alsader Teaching Hospital for various cardiac symptoms for the period from October 2005 - April 2006. They were subjected to chest x-ray and echocardiography. The CTR was measured on 150 PA view chest x-ray. Chest x-ray was analyzed by one observer who was blind for echocardiographic findings. The CTR was obtained by the relation between the transverse diameter of the heart and the transverse diameter of the thorax at the level of the right diaphragmatic cupula. The transverse diameter of the heart was calculated by adding the greatest segment obtained in the cardiac area to the right of the central axis (TI) and the greatest segment obtained in the cardiac area to the left of the central axis (T2), a CTR greater than 50% would indicate cardiac enlargement. Views in which an accurate ratio could not be determined (i.e., patient rotated, presence of pleural effusion, part of thorax off edge of film) were excluded. The echocardiograph parameters were obtained by an echo-cardiographer who was blind for the findings of the chest x-ray. LVIDs and LVIDd were measured by 2D echocardiography in patients who had a PA chest x-ray within the same week. A LVIDs of greater than 3.7 cm and a LVIDd of greater than 5.7 cm would indicate Left ventricular enlargement. The validity (sensitivity and specificity) of chest x-ray as a screening test was estimated in comparison to echocardiography as a standard test[10]. SPSS program (Version-11) was used to analyze the data

RESULTS

The study involved 150 adult patients, 99 males (66%) and 51 females (44%), half of the patients were above 50 years of age (Table-1).

Table 1. The age distribution of the patients.

Age (Years)	No.	%
18-30	21	14
31-50	54	36
> 50	75	50
Total	150	100

Eighty seven patients (58%) were overweight and 18(12%) were obese. (Table-2).

Table 2. Distribution of patients according to Body mass index.

BMI	No.	%
Under weight (<18.5)	0	0
Normal (18.5 - 24.9)	45	30
Over weight (25.0- 29.9)	87	58
Obesity class I (30.0-34.9)	6	4
Obesity class II (35.0-39.9)	3	2
Obesity class III (> 40)	9	6
Total	150	100

(Table-3) shows the distribution of patients according to the echocardiography and PA view chest x-ray, it shows that the ability of chest x-ray to detect cardiomegaly in patients with cardiomegaly according to the echocardiography *(by measuring LVIDd)* was high (sensitivity 85.71%), while the ability of chest x-ray to exclude cardiomegaly in comparison to echocardiography *(by measuring LVIDd)* was low (specificity 13.79%), with a positive predictive value of 41.86%, and a negative predictive value of 42.85% for cardiac enlargement. Furthermore the ability of chest x-ray PA view to detect or exclude cardiomegaly in comparison to echocardiography *(by measuring LVIDs)* were with sensitivity of 90.47% and specificity of 17.24% and with a positive predictive value of 44.18%, and a negative predictive value of 28.57%. Table 4.

Table 3. Distribution of patients according to CTR by chest x-ray and echocardiography by LVIDd.

Cardiomegaly by CTR	Cardiomegaly by echocardiography		Total
	+ ve	- ve	
+ ve	57	72	129
- ve	6	15	21
Total	63	87	150

The correlation coefficient between CTR and LVIDd was 0.384 (Fig-1), showed a significant correlation, while the correlation between CTR and BMI was 0.78 which showed no significant correlation. (Fig-2)

Table 4. *Distribution of patients according to CTR by chest x-ray and echocardiography by LVIDd.*

Cardiomegaly by CTR	Cardiomegaly by cardiography		Total
	+ ve	- ve	
ve	54	75	129
- ve	9	12	21
Total	63	87	150

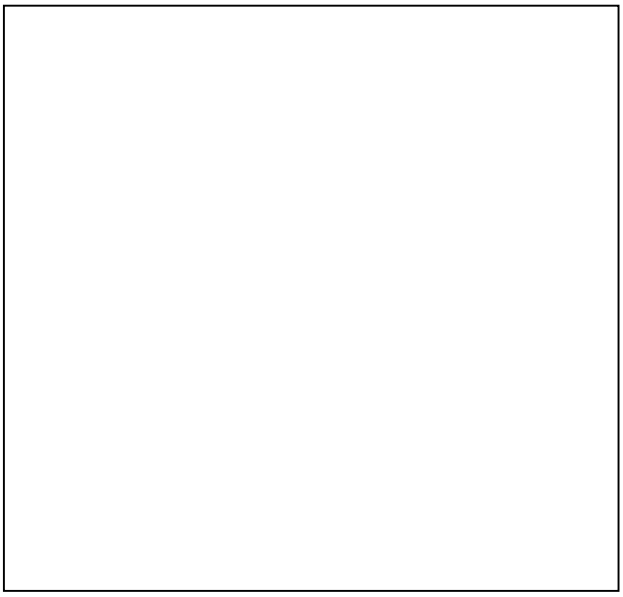

Fig 1.The correlation between LVIDd and CTR

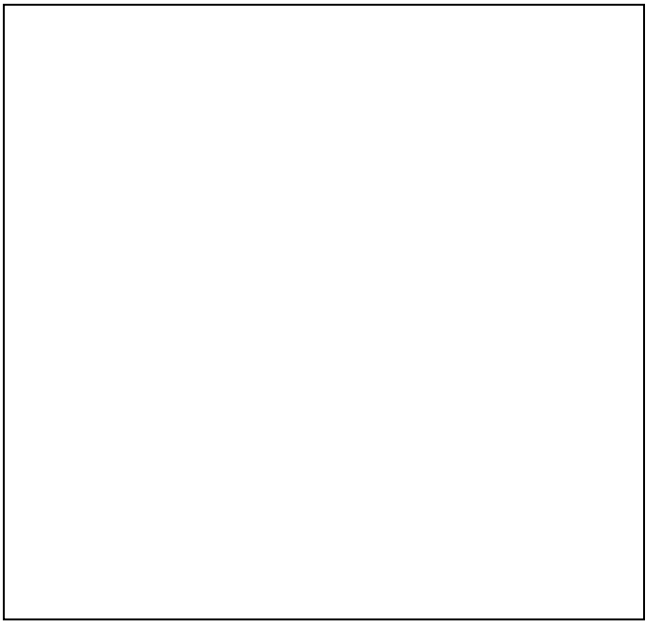

Fig 2. Correlation between CTR and BMI

DISCUSSION

The value of measuring cardiac size based on chest x-ray PA view has decreased as compared with that based on 2-D echocardiography, which provides more precise analysis of the dimension of the cardiac chambers[2]. Although cardiac size may be determined by chest radiography, many cardiac and extracardiac factors influence this measure, such as the examination technique, the patient's biotype, the patient's physiological status, thoracic alterations (scoliosis or pectus excavatum), the size of the lungs, the breathing phase, the cardiac cycle phase and heart rate at the time of examination[2,11]. Therefore, chest radiography may only provide an objective estimation of the cardiac size through the classification of the cardiac silhouette as normal or enlarged. More objective numerical parameters provided by noninvasive examinations, such as 2-D echocardiography, are required for an accurate estimation of the diameter of the cardiac chambers[12]. In this study it was referred to echocardiography as a standard test because it is highly sensitive and specific[12]. The study showed that using CTR in PA view of the chest x-ray in comparison with LVDd measured by 2-D echocardiography was highly sensitive but

was of low specificity. This finding was comparable to a study done by Lupow, et al. who found that the sensitivity of CTR in chest x-ray PA view was 78% and specificity 42%. Also the positive predictive value in this study was comparable to that found by Lupow, et al[5] while the negative predictive value was lower than that found by Lupow et al, this may be explained by the difference in the cut off point used in measuring the CTR, the authors considered a CTR of 0.5 as abnormal[5], contrary to the maximum limit value adopted for the CTR in this study. This study showed a significant linear correlation between LVIDd and CTR which means that as far as LVIDd get more the CTR become more sensitive in measuring cardiac size which is comparable to Lupow, et al study[5]. Furthermore CTR in chest x-ray PA view in comparison with LVIDs was also measured by 2-D echocardiography which was highly sensitive but low specificity, however the correlation was not significant. Although more than half of the patients involved in the study were overweight, the correlation between CTR and BMI was not significant. In accordance with the results obtained by similar studies[5,12], chest radiography alone can to a some extent, reflect cardiac size with its high sensitivity, low specificity and low negative predictive value, as well as a significant correlation has been observed between the cardiothoracic ratio and the left ventricular diastolic diameter, but there was a weak correlation between the cardiothoracic ratio and the BMI.

In conclusion, the cardiothoracic ratio is highly sensitive but of very low specificity in measuring heart size. The study recommended that because it is easy and cheap to measure the CTR by the chest X-ray for any patient in the emergency department, it can be regarded as a preliminary measure to the size of the heart, but the echocardiographic measurement remains the most accurate.

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