Original Article

The Value of the chest X-Ray for diagnosing left ventricular Dysfunction

Layth R. Shareef* **FICMS**
Kasim M. AL- Doori* **CABM**

Fac Med Baghdad
2009; Vol. 51, No.1
Received June 2008
Accepted Oct. 2008

Summary:

Background: The use of the chest x-ray measurements which includes the cardiothoracic ratio(C-T) and frontal area (FA) of the heart by the CXR are useful measures for primary assessment of the cardiac dysfunction.

Patients and Methods: A Prospective study was done from the 1^{st} of January 2005 to the 1^{st} of October in the same year on a 120 consecutive patients who have been admitted for coronary and L.V angiogram at IBN-AL-BITAR hospital. The C-T ratio and the frontal area were measured.

Results: The study comprised 120 subjects who were admitted for coronary and L.V angiogram for diagnostic reasons. 89subjects (74.2%) are male and 31subjects (25.8%) are female .17(14%) subjects have left ventricular dysfunction and dilated L.V with EDV≥110 cm^2 by angiogram. (76) Subjects (71%) had LAD (Left anterior descending artery disease), (40) subjects (37%) had LCX (Left circumflex artery disease), 10subjects (9%) had LMS (Left main stem artery disease) and (38) subjects (34%) RCA (disease). 13subjects (10%) had valve disease , 2subjects (1%) of them have aortic stenosis , 5 subjects (4%) had A.I (aortic inche), 4 subjects (3%) had M.S(Mitral stenosis) , 6 subjects (5%) had M.R Mitral regurgitation and combined valve disease .The abnormal chest radiogram C/T Ratio had a sensitivity of 56.6%, a specificity of 78.6%, and positive ,negative predictive values and accuracy of 95.2% ,19.3% and 59.2% respectively, in the diagnosis of left ventricular dysfunction.while the abnormal chest radiogram FA/BSA £ had a sensitivity of 47.2%, specificity of 42.9%, and positive ,negative predictive values and accuracy of 86.2% ,9.7% and 46.7% respectively.

Conclusion: The radiological study of the thorax is not an accurate indicator of left ventricular dysfunction; its use as a screening method to initially approach the patient with ventricular dysfunction should be reevaluated.

Key words: cardiothoracic ratio, frontal area, left ventricular dysfunction.

£ BSA=Body surface area, FA=frontal area

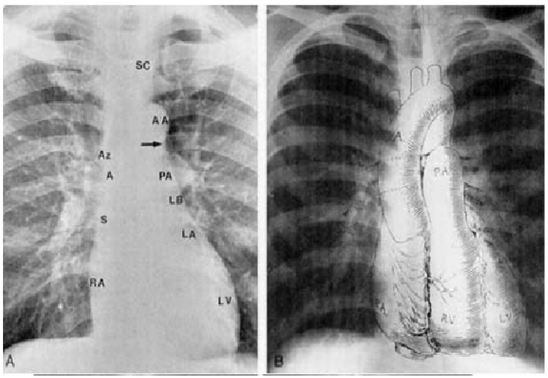
Introduction:

Chest X – Ray is one of the most common clinical methods for assessing cardiac enlargement, also it remains the most common X – Ray examination and one of the most difficult examinations to interpret (1). Chest X – Ray contains a large amount of anatomical and physiological information, but it is difficult and sometimes to interpret objectively. There are major variation in the information as a function of radiographic technique, body habitus , age, underlying physiological status , training and focus of the interpreter . (1) nMost of the Cardiomegaly is a result of Ischemia and dilated Cardiomyopathy following one or more myocardial infarctions (1-5) ‘ Which can be judged with reasonable accuracy on the frontal view by noting the diameter of the heart exceeds half the diameter of the thorax.(1-16) The cardiothoracic ratio is measured by taking the sum of the horizontal distance from the midline to the most prominent part Of the left heart border and the horizontal distance Maximum thoracic diameter was measured as the maximum horizontal distance from the midline to the most prominent part of the Right heart border between the internal margins of the chest wall. (1-11, 17-19) In addition to the cardiothoracic ratio, the frontal area of the heart on the P-A view can be measured from the product of multiplying the length(L) by the Width (w) and by the л/4 (as shown in picture-2-) which is stated by Ungerleider and Gubner et al, in which the use of frontal area is significantly related to the EDV(End diastolic volume) and EF(Ejection fraction) as proved by L.V angiogram . (3) In this study we get the benefit from the Echo for the exclusion of an enlarged chamber i.e. (Left atrium, right atrium and right ventricle) which may affect the C/T (cardiothoracic Ratio) or the FA / BSA measurements. The mainstay of the Echo examination is the transthoracic two dimensional Echo, which forms a returning ultrasound signal which is then registered and converted into a two- dimensional image of interrogated plane, the process is repeated 20 to 120 times per second, resulting in a frame rate of 20 to 120 Hz, the sequence of imaged frames results in a real- time moving image of the heart (20, 21, 22, 23).

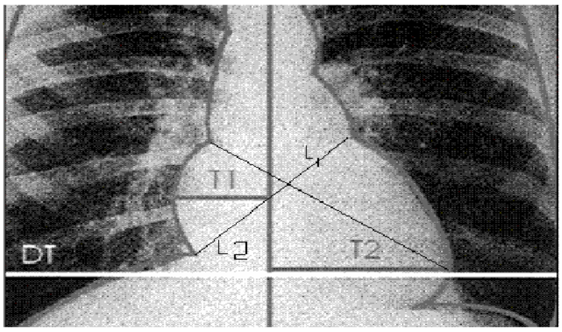
**Department of cardiology, Ibin Al Al Bitar hospital for cardiac surgery.*

Methods:

The exclusion criteria were as follows: 1. Thoracic wall or spinal deformation. 2. Inadequate inspiration(less than five ribs visible above the diaphragm anteriorly or nine ribs posteriorly). 3. Over expanded chest (greater than seven ribs above the diaphragm anteriorly or 11 ribs posterior). 4. Inability to determine one or both heart borders with confidence (e.g. large pleural effusion). 5. Incompletely erect positioning C-X-Ray. 6. Mediastinal deviation, or significant rotation. 7. The exclusion of the prominently enlarged L.A, R.A or R.V, which is diagnosed by ECHO. 8. Severe Aortic Stenosis or severe left ventricular hypertrophy .The L.V angiogram parameters were obtained by obtaining a fluoroscopic view of (RAO 45□). The Left ventricular dysfunction measured by fluoroscopy is defined by the presence of end diastolic volume ≥ 110 cm^2 or depressed ejected fraction < 50% or both, obtained by L.V angiogram (1, 21, 22, 23). All the patients whom selected for the study underwent complementary CXR (P-A view) before doing L.V. and coronary angiogram. Chest radiography was performed according to the conventional technique at the radiological unit of the hospital of IBN-AL-BITAR for cardiac surgery , and the finding were analyzed by one observer who ignored the angiogram and Echo finding and it was reviewed by a specialist of radiology. The C-T ratio was assessed by subdivision of the maximal transverse diameter of the heart to the transverse diameter of the thorax at the level of the maximal distance between the internal sides of the ribs above the diaphragm (1, 2, 3, 4, 5, and 6). The frontal area were measured by multiplying the length between the connection of superior vena cava and RA with the connection of the LV apex & the diaphragm, the other length is the site of the connection between the right cardiac silhouette with the diaphragm & the LA(3,6). The volume determination were done according to the method of Dodge and associated. (6) The cardiac silhouette was classified as normal or enlarged, based on the subjective analysis of the cardiac area observed on chest radiography in P.A view with the C-T ratio >=0.50 or the enlarged surface area of the cardiac silhouette(≥8600 mm^2 for the body surface area) or both, were considered abnormal.(3,6) R.A , L.A and R.V enlargement were excluded by Echo (because these chambers dilation can affect the cardiac silhouette by the chest x-ray(1,2,3,4)),and according to the normal Echo range measures used to exclude the enlarged chambers.(20)



Picture-1-Frontal projection of the heart and great vessels. *A*, Left and right heart borders in the frontal projection. *B*, A line drawing in the frontal projection demonstrates the relationship of the cardiac valves, rings, and sulci to the mediastinal borders (1)



Picture-2- C/T ratio was obtained by dividing the transverse diameter of the heart on the transverse diameter of the thorax at the level of the right diaphragmatic cupola. 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 (T1) and the greatest segment obtained in the cardiac area to the left of the central axis (T2). FA obtained by multiplying L1 by L2 by 3.14/4. (3, 4)

Results:

The study comprised 120 subjects who were admitted for coronary and L.V angiogram for diagnostic reasons. 14 (11%) of the subjects admitted for coronary angiogram had a history of chest pain , were found to have normal coronary ,L.V angiogram and other medical and investigational measures .Those people were considered as a control for the sample that we chose. 89 patients (74.2%) are male and 31 (25.8%) are female.The age ranges from 20 to 84years. 17(14%) subjects have left ventricular dysfunction And dilated L.V with EDV>=110. (76)(71%) subjects had LAD disease, (40) (37%) subjects had LCX disease, 10(9%) subjects had LMS disease and (38) (34%) subjects RCA. 13(12.2%) subjects had valve disease , 2(1.8%) subjects of them have aortic stenosis , 5(4.7%) subjects had A.I , 4(3.7%) subjects had M.S , 6(5.6%) subjects had M.R and combined valve disease . Table 1 and 2 show The Correlations between the EDV/BSA, ESV, SV and EF in the control and diseased group.

Table -1- The Correlations between the EDV/BSA, ESV, SV and EF in the CONTROL group

		ESV	SV	EF	CTRATIO	FA/BSA
EDV/BSA	r	0.608*	0.898**	-0.246	-0.157	0.480
	P	0.021	0.0001	0.396	0.593	0.082
ESV	r		0.726**	0.122	-0.080	0.030
	P		0.003	0.679	0.785	0.919
SV	r			0.119	-0.212	0.472
	P			0.685	0.467	0.089
EF	r				-0.266	0.202
	P				0.358	0.488
CT RATIO	r					-0.271
	P					0.349

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table -2- The Correlations between the EDV/BSA, ESV, SV and EF in the Disease group

		ESV	SV	EF	CTRATIO	FA/BSA
EDV/BSA	r	0.805**	0.694**	-0.370**	0.134	0.301**
	P	0.0001	0.0001	0.0001	0.171	0.002
ESV	r		0.202*	-0.741**	0.187	0.294**
	P		0.038	0.0001	0.055	0.002
SV	r			0.307**	-0.025	-0.036
	P			0.001	0.797	0.716
EF	r				-0.271**	-0.318**
	P				0.005	0.001
CT RATIO	r					0.419**
	P					0.0001

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Discussion:

The C/T ratio is a very common and popular measure, which is commonly used by the doctors, it is considered as a primary tool for assessment of the cardiac status , even some of the physicians consider it as a cornerstone for the diagnosis of cardiac enlargement and dysfunction , because it is a simple and non expensive measure for primary cardiac assessment .(19) The calculation of the cardiac silhouette(frontal area and C/T Ratio) from the P-A view has got an important correlation with the Left Ventricular enlargement ,this can be explained by the large frontal area that the L.V. comprises on the CXR (60% of P.A view). (3, 6) Chest radiography may only provide a raw and subjective 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 echocardiography, which are required for an accurate estimation of the diameter of the cardiac chambers. (19, 25) There is a wide discrepancy among the different previous trials concerning the sensitivity ,specificity and accuracy of the CXR tests ,some of which declare the benefit of the C/T Ratio by its acceptable sensitivity ,specificity and accuracy in the assessment of cardiac size as in the (Jung-g et al study and Chikos et al study) , while other trials did not find this accurate benefit from the cardiac silhouette, as in the Amanda et al study and others.(3,6,7) In this study , The results of the C/T Ratio show low sensitivity and accepted level of specificity and high predictive value making the test a useful measure for the cardiac dysfunction with accepted sensitivity , but the test can not be used successfully as a screening test for LV dysfunction. These results should be reassessed according to the correlation of the test to the EDV and EF which is low.The results of the FA/BSA show low sensitivity and low level of specificity ,high predictive value and weak correlation to the EDV(end diastolic volume)& EF(ejection fraction), these finding make the benefit of the FA is restricted .These results are similar to the Amanda et al study results in which , the chest radiography alone was not an accurate indicator for the degree of left ventricular dysfunction in patients with Chagas' disease, although a weak and significant correlation has been observed between the cardiothoracic ratio and the left ventricular diastolic diameter and between the cardiothoracic ratio and the ejection fraction, it was considered as a crud way of measurement for the LV dysfunction .(19) Finally we found the use of a value higher than 0.5 for the C/T will be more accurate for the primary assessment of cardiac enlargement and heart failure ,this final conclusion is supported by the finding stated by Murray G. Baron , that a value of less than 0.6 can be considered within the limits of normal . Setting this value at 0.5, as is often done, produces too many false positive results. (27, 28, 29)

Conclusion:

Chest radiography has little sensitivity in diagnosing left ventricular systolic dysfunction; and its use as a screening method in the initial approach to patients with left ventricular dysfunction should be reevaluated. These finding doses not argue with the benefit of the CXR as a primary examination procedure.

References:

1. *Michael A. Bettmann: The chest radiograph in cardiovascular disease. In: Douglas P. Zipes ; Peter*

Libby ; Robert O. Bonow ; Eugene Braunwald . Braunwald's Heart Disease. Philadelphia, 7th edition, Elsevir Saunders, 2005 p.271.
2. W. Dallas Hall. Diagnostic evaluation of the patient with systemic arterial hypertension .In: RWayne, Alexander, Robert C., Schlant Valentin et al. Hurt's the heart. New York, Ninth edition, Mc Graw Hill, 1998, 57:8 -60.
3-B.Paul M.Chikos. , Melvin M, Figley and Lloyd Fishev .Correlation bet. Chest film and angiographic assessment of left ventricular size. Am J Roentgenol .1977; 128:367 – 373.
4. Paul M.Chikos; Melvin M.Figley; and Lloyd fisher. Visual assessment of total heart volume and specific chamber size from standard chest radiographs. Am J. Roentgenol , 1977 :128 :375 – 380.
5. Theodorc E. Keats; Ivar P. Enge – Cardiac mensuration by the cardiac volume method department of radiology, University of Virginia school of medicine Charlottesville, 1965; vol.5,p 850 – 855 .
6. Lester Glover, William A. Baxley, and Harold T. Dodge. Quantization & Evaluation of heart size from chest roentgenograms measurements .Circulation; 1973; XLV Π, 1289 – 1296.
7. Jung –G; Landwcher –P; Schanzenbacher –G; F Acber –B; Lackner –K. Value of thoracic radiography in the assessment of cardiac size. A comparison with Left Ventricular Cardiograph. Rofo –Fortschr – Geb Rontgenste – Neuen – Bildgab – Verfahr . 1995 May; 162 (5):368 – 72.
8. J. Ward Kennedy; William A. Baxley; Melvin M.Figley; Harold T. Dodge; John R. Blackman. Quantization Angiocardiography, Circulation, XXXIV, 1966 272 – 278.
9. Charles E.Rackley; Harold T.Dodge; Yank D.Coblejr; and Robert E.Hay. A Method for determining left ventricular mass in man. Circulation, 1964 XXIX, 666 – 671.
10. Marvin L.Murphy; Leon R.Blue; Erness J.Ferris ; and James R.Phillips. Sensitivity and specificity of chest roentgenogram criteria for right ventricular hypertrophy .Invest Radiol. 1988; 23:853 – 856.
11. Walker J. Cardiac outlines and chamber anatomy. In J.B. Partridge et al. Radiological Diagnosis textbook. London, 1985 p.1-31.
12. Danzer Cs: The cardio – thoracic ratio: An index of cardiac enlargement. Amer. J Med science, 1919; 157:513.
13. C. Hart and G.D Smith. Knowledge of cardiothoracic ratio adds to cardiovascular risk stratification. BMJ, November 1998; 317 (7168):1321.
14. The committee of the New York Heart Association criteria. Nomenclature and Criteria for diagnosis of diseases of the heart and great vessels. 9th Ed. New York: copyright, 1994:vol.41, p259 – 63.
15. Philbin EF, Garg R, Danisa K, et al. The relationship between cardiothoracic ratio and left ventricular ejection fraction in congenstive heart failure. Arch Intern Med 1998; vol.52, p501 – 6.
16. Dodge HT, Sandler H, Baxely WA, and Hawley RR: Usefulness and limitations of radiographic methods for determining left ventricular volume. Amer J Cardiol. 1966; 18:10.
17. G. J.E.Kabala; CH.B; P.Wilde .The measurement of heart size in antero – posterior chest radiograph. The British Journal of Radiology 1987: vol.82, p981 – 986.
18. Jefferson, K. & Rees. Radiological anatomy and assessment of heart size. In: Paul Butler (editor). Worths , Sevenoaks. Clinical cardiac radiology. Feb, 1980: p.3-9.
19. Amanda Arantes Perez; Antonio Luiz Pinho Ribeiro; Márcio Vinícius Lins Barroset al. Value of the radiological study of the thorax for diagnosing left ventricular dysfunction in Chagas' disease Arq. Bras. CardiolSão Paulo Feb. 2003: vol.80 no.2
20. William F. Armstrong. In :Douglas P. Zipes ; Peter Libby ;Robert O. Bonow ; Eugene Braunwald ; Braunwald's Heart Disease , Philadelphia , 7th edition , Elsevir Saunders , 2005 p.271.
21. Shimazaki, Y; Kitamnras; Hata S; Nakano S; et al. Right ventricular volume estimation by two – dimensional echocardiogram. J. Cardiogr. , 1981:11:187.
22. Popp,R.L; Wolfe S.B ; Hirata T ; and Feigenbaum H: Estimation of right and left ventricular size by ultrasound . A study of the Echoes from the interventricular septum. Am. J. cardiol. 1969:24:523.
23. Harvey Feigenbaum . In: Harvey Feigenbaum Echocardiography Instrumentation, Philadelphia, 4th edition, Lea and Febiger 1986: p.1.
24. Kennedy JW, Baxley WA, Figley MM, Dodge HT, Blackman JR. Quantitative angiocardiography, the normal left ventricule in man. Circulation: 1966:34 – 272.
25. Murphy ML, Blue LR, Thenabadu PN, Philips JR, Ferris EJ. The reliability of the routine chest roentgenogram for determination of heart size based on specific ventricular chamber evaluation at postmortem. Invest Radiol. 1985 Jan-Feb;20(1):21-5 26 . Hemingway H, Shipley M, Christic D, Marmot M. Is cardiothoracic ratio in healthy middle aged men an independent predictor of coronary heart disease mortality? Whitehall study 25 year follows up. BMJ 1998; 316:1353-1354.
27. Haninibal D, Neufang KF, Mager G, Vogel U, Klocke RK. The place of thoracic plain film in the assessment of left heart insufficiency. Aktuelle Radiol. 1992 Mar; 2(2):86-91
28 .Murray G. Baron. Radiology of the heart .,In Drazen, Gill, Grigg et al , Cecil text book of medicin , Philadelphia., 22nd ., W.B.Saunders company, 2004, vol.49,p262-263.
29. Thomass H Lee. The Use of Echo. In: Douglas P. Zipes; Peter Libby. 30; Robert O. Bonow; Eugene Braunwald. Braunwald's Heart Disease, Philadelphia, 7th edition, Elsevir Saunders, 2005 p.271.