

## Validity of Hoffman and Rigler Sign in the Evaluation of Left Ventricular Enlargement

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**Background** --- Hoffman and Rigler in 1965 had proposed a radiologic diagnosis of left ventricular enlargement using autopsy specimen as reference standard. However, this finding was contested by Braunwald due to the obliquity of the chest and the back displacement of the left ventricle owing to the right ventricular enlargement, which may influence this measurement. With the advent of echocardiography, there is now a much better and easier alternative to review Hoffman and Rigler's original work of more than 40 years ago. Thus, this study was conducted to validate the Hoffman and Rigler sign in the detection of left ventricular enlargement.

**Methods** --- This was a validation study involving 200 adult patients who had chest radiograph in lateral projection and 2D echocardiography done within three months from the chest radiograph. Hoffman and Rigler sign was determined by drawing a 2 cm line upward along the inferior vena cava from the point where the left ventricle and the inferior vena cava cross in the lateral projection. At the upper end of this line, a second line will be drawn posteriorly parallel to the endplates of the vertebral bodies up to the point where it crosses the posterior margin of the left ventricle. When the value is more than 18 mm, one can postulate left ventricular enlargement with considerable degree of certainty. The radiographic findings were compared with echocardiography to determine presence or absence of left ventricular enlargement.

**Results** --- The Hoffman and Rigler sign has a sensitivity of 92.5 %, specificity of 83.3%, positive predictive value of 78.7 % and negative predictive value of 94.3 % in the diagnosis of left ventricular enlargement. The kappa test results proved that there is a strong agreement of Hoffman and Rigler sign of >18 mm with the left ventricular enlargement by 2D echocardiogram.

**Conclusion** --- The Hoffman-Rigler sign is a valuable alternative in the evaluation of left ventricular enlargement when cardiac ultrasound is not readily available. *Phil Heart Center J 2008; 14(1):39-41.*

**Key Words:** Hoffman-Rigler Sign ■ Left ventricular enlargement ■ 2D Echocardiography ■ Chest X-ray

**S**pecific chamber enlargement indicates an earlier stage of disease than general cardiac enlargement. Furthermore, it suggests the site and nature of underlying structural changes.(1) When there is increased workload on a cardiac chamber, the muscle fibers elongate in response to the added work and dilatation results.(2) Any disease that produces an increase workload on the left ventricle (LV), dilatation results. Diseases resulting in increase LV work may also result in hypertrophy of this chamber. This indicates that the ventricle is hypertrophied without significant dilatation, so there is very little enlargement.

Chest radiography is often the first means by which a clinician can evaluate cardiac chamber enlargement.(3) Cardiothoracic ratio in the postero-anterior projection of the chest has been traditionally employed in the initial approximation of the cardiac size. Left ventricular dilatation produces an

increased in the length of the LV segment making up the left lateral cardiac contour. As a result, there is downward and leftward enlargement, the cardiac apex may extend below the dome of the diaphragm as visualized in the frontal chest radiograph. Hypertrophy of the left ventricle causes alteration in shape, but little if any change in size results. It has long been recognized that the enlargement of the left ventricle occurs more posteriorly than laterally and Parkinson first made this point in 1942. Hence, there is evidence to suggest that early enlargement of the left ventricle will be missed if the frontal chest radiograph taken in postero-anterior projection alone is used. In an article by Hoffman and Rigler in *Radiology* 1965, they concluded that when the posterior border of the LV extends posteriorly to the posterior border of the inferior vena cava (IVC) by more than 18 mm at a level 2 cm above the crossing of the IVC and the LV on the lateral position of the chest

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in an adult, one can postulate left ventricular enlargement with a considerable degree of certainty. However, according to Braunwald, although the Hoffman and Rigler sign may be helpful, it is far from being accurate because of the obliquity of the chest and the back displacement of the left ventricle owing to the right ventricular enlargement, which may influence this measurement. Whereas Hoffman and Rigler made use of autopsy studies as comparatives for their radiological findings, the advent of echocardiography would offer a much better and easier alternative to review Hoffman and Rigler's original work of more than 40 years ago. It is also worthwhile to highlight the fact that in most secondary and smaller hospitals in the Philippines, echocardiography is not readily available. If the accuracy of a simple radiological measurement like this can be validated using echocardiography as the gold standard, this can, in support of history, physical findings and electrocardiogram (ECG) evidence, assist the clinician in detecting left ventricular enlargement with much more certainty in the absence of echocardiography.

Thus, this study was conducted to determine the validity of Hoffman and Rigler sign in the determination of left ventricular enlargement using echocardiography as the gold standard.

### Methods

This was a validation study done in the Radiologic Sciences Division of the Philippine Heart Center from June to September 2007. Included were patients above 20 years old who had CXR taken with lateral view, which are adequate for cardiac evaluation and 2D echo done within 3 months from each procedure. Excluded were the following: patients with significant large pleural effusions; patients with lung parenchymal disease overlying the lower lung fields; patients with anomalies involving cardiac rotation; patients with thoracic and vertebral deformities; and patients who had surgical intervention done within this time period.

### Chest Radiography

The enlargement of the left ventricle was determined in the lateral projection of the chest utilizing Hoffman and Rigler method with the use of a 12-inch measuring ruler. This measurement was determined by drawing a 20mm line upward along the inferior vena cava from the point where the left ventricle and the inferior vena cava cross in the lateral projection. At the upper end of this line, a second line was drawn posteriorly parallel to the endplates of the vertebral bodies up to the point where it crosses the posterior margin of the left ventricle. A value of less than or equal to 18 mm

is considered to have no left ventricular enlargement. Hoffman and Rigler method is depicted in Figure 1 as measurement A.

### Echocardiography

Left ventricular end-diastolic diameters were acquired from standard M-mode echocardiographic image. Measurements were defined as normal or enlarged comparing to the reference values. LV (ed) of 4.5 – 5.0 is considered normal.

### Statistical Analysis

Data was described as frequency and percent distribution. Validity measures such as sensitivity, specificity, positive predictive value, negative predictive value and overall accuracy were determined. Significance of agreement of test criteria was determined using Kappa test.

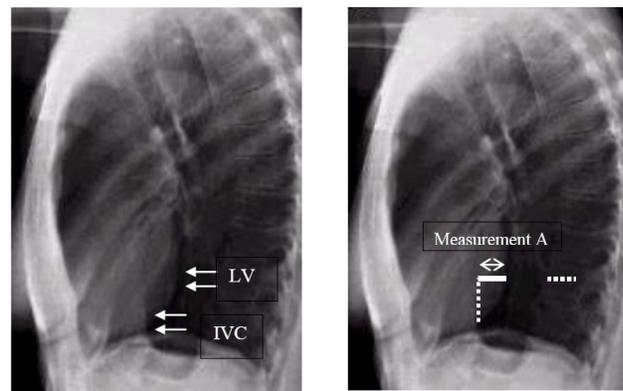


Figure 1. Hoffman and Rigler Method of determination of Left Ventricular Enlargement

### Results

Left ventricular enlargement was assessed in chest radiography using Hoffman and Rigler sign (measurement A) in 200 patients above 20 years old who had CXR taken with lateral view which are adequate for cardiac evaluation and 2D echo done within 3 months. These patients were followed-up from June to September 2007.

Table 1. The relation of left ventricular enlargement on chest radiography and echocardiography

Chest Radiography	LV Enlargement by 2D Echocardiogram		TOTAL
	Present	Absent	
Hoffman and Rigler >18 mm	74	20	94
Hoffman and Rigler < 18 mm	6	100	106
TOTAL	80	120	200

From table 1, it can be seen that among 200 patients with chest x-ray (lateral view) and echocardiogram, left ventricular enlargement was present in 94 (47%) on chest radiography (lateral) and 80 (40%) patients on echocardiography. Among 94 patients with measurement A of >18 mm on chest radiography, 74 (78%) patients had echocardiographic evidence of LV enlargement, while among the 106 patients with measurement A of <18 mm on chest radiography, 6 (5%) patients had left ventricular enlargement on echocardiography. These 6 patients had LV (ed) ranging from 5.3 to 5.4. Among the 94 patients with measurement A of >18 mm, 20 (21%) had no LV enlargement on echocardiography. Of these patients, 13 (65%) had right ventricular enlargement while 7 (35%) had left atrial enlargement on echocardiography.

**Table 2.** Validity of Hoffman and Rigler Sign in the determination of left ventricular enlargement.

	Sensitivity	Specificity	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)	Overall Accuracy
Hoffman and Rigler Sign for Diagnosis of Left Ventricular Enlargement	92.5 %	83.3 %	78.7 %	94.3 %	87%

Kappa coefficient = 0.737 ± 0.070 P value = 0.000

Validity measures of Hoffman and Rigler Sign in the determination of left ventricular enlargement is shown in Table 2. The probability of left ventricular enlargement among patients with measurement A of > 18 mm is 78.7 %, while the probability of having no left ventricular enlargement among patients with measurement A of <18 mm is 94.3 %. The ability of the test to detect left ventricular enlargement is 92.5%. The kappa test results proved that there is a strong agreement of Hoffman and Rigler sign of >18 mm with the left ventricular enlargement by 2D echocardiogram.

## Discussion

The purpose of this study was to evaluate the validity of the Hoffman and Rigler sign for determination of left ventricular enlargement. Using this method, Hoffman and Rigler concluded that when measurement A is >18 mm, left ventricular enlargement can be postulated with considerable confidence. It was found out that only 78.7 % of patients with left ventricular enlargement in echocardiography were correctly identified. 17% were false positive, whereas 8% were false negative.

This study found that Hoffman and Rigler sign is a useful tool to assist clinician in evaluating left ventricular enlargement. In the majority of cases, this method provides additional support for assessing the severity of the cardiac disease and offers reasonable motivation for early referral to cardiac units. Although this measurement has a sensitivity of 92.5 % and specificity of 83.3 %, it can never be used as the sole criterion for diagnosis.

## Conclusion

When left ventricle extends more than 18 mm posterior to the posterior border of the inferior vena cava at a level 2 cm cephalad to their crossing, Hoffman and Rigler sign is a valuable alternative in the evaluation of left ventricular enlargement. History and clinical findings

remain the paramount arms in decision-making. This sign should therefore be used to complement other evidence of left ventricular enlargement when echocardiography is not readily available.

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