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**ORIGINAL ARTICLE**

# Low Concordance Between Left Atrium Diameter and Volume in Patients with Higher Risk of Atrial Fibrillation

## *Baja Concordancia entre Diámetro y Volumen del Atrio Izquierdo en Pacientes con Mayor Riesgo de Fibrilación Atrial*

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## SUMMARY

**Background:** Increased left atrial (LA) is directly related to LV diastolic dysfunction (DD), and both are associated with atrial fibrillation (AF). Although the diameter (LAD) is used as a measure of LA, many evidences show that LA volume index (iLAV) is more accurate. **Objective:** To evaluate the correlation between LAD and iLAV in patients (pt) with DD. **Material and Methods:** Among 892 pt referred to the echocardiography laboratory of a tertiary clinic, from Jan/08 to June/09, 540 pt with clinical and echocardiographic data were selected and 21 were excluded for being <18yo and 18 pt presenting more than mild mitral valve lesion. Diastolic function was considered abnormal when E/e' ratio ≥ 15 (elevated left ventricular filling pressures). Agreement between measures of LAD and iLAV was evaluated: agreement if iLAV ≤ 32ml/m2 and LAD ≤ 40mm or iLAV > 32 and LAD > 40; and disagreement if iLAV ≤ 32 and LAD > 40 or iLAV > 32 and LAD ≤ 40. **Results:** Of 501 pt, 33 (6.6%) presented E/e' ratio ≥ 15 and 468 (93.4%) < 15. There was a good correlation between LAD and iLAV in both patients with E/e' ≥ 15 (r = 0.57), and E/e' < 15 (r = 0.62). The disagreement between LAD and iLAV was higher in p with E/e' ≥ 15 (21.2% vs 9% - p <0.0001). Clinical and echocardiographic data were, respectively, for E/e' ≥ 15 and E/e' < 15: male 54.5% vs 45.5% (p = ns), age 73.2 ± 12.4 vs 50.1 ± 16.5 (p <0.0001), LAD (cm) 38.8 ± 6.3 vs 35.2 ± 5.2 (p <0.0001); iLAV (ml/m2) 35 ± 16.2 x 21.9 ± 7 (p <0.0001), EF (%) 60.7 ± 16.2 vs 70.7 ± 6.9 (p <0.0001), E/e' 21 , 1 ± 8.1 vs 16.5 ± 2.4 (p <0.0001), HBP 81.8% vs. 50.2% (p <0.0001), DM 21.2% vs. 9.4% (p = 0.04); CHF 24.2% vs. 3.2% (p <0.0001), CAD 33.3% versus 9% (p <0.0001). **Conclusion:** Patients with elevated left ventricular filling pressures are older, have larger LA diameter and volume, worse EF and higher incidence of HBP, diabetes, CHF and CAD. There is less agreement between LAD and iLAV in these patients.

**Descriptors:** Heart Atria; Atrial Function; Atrial Fibrillation; Echocardiography

## RESUMEN

**Introducción:** El aumento del atrio izquierdo (AI) está directamente relacionado a la disfunción diastólica del VI (DD) y ambos están asociados a la ocurrencia de fibrilación atrial (FA). Aunque el diámetro (DAI) sea mundialmente usado como medida del AI, muchas evidencias muestran que el volumen indexado a la superficie corpórea (IndVAI) es más preciso. **Objetivo:** Evaluar la correlación entre DAI e IndVAI en pacientes (pt) con DD. **Material y Métodos:** Entre 892 pacientes encaminados al ecocardiograma, (ECO) de una clínica tercera en el DF, entre enero del 2008 a junio del 2009, fueron seleccionados 540 con datos clínicos y ecocardiográficos, de los cuales fueron excluidos 21, debido a la edad < 18 años y 18 pacientes con lesión valvular mitral > discreta. La función diastólica fue considerada, significativamente, anormal si E/e' 15 (elevación de las presiones de llenado ventricular izquierdo). La concordancia entre las medidas de DAI e IndVAI

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fue evaluada de la siguiente forma: concordante (IndVAI  32ml/m2 y DAI  40mm o IndVAI > 32 y DAI > 40) y discordante (IndVAI  32 y DAI > 40 ó IndVAI > 32 y DAI  40). **Resultados:** De los 501 pacientes estudiados, 33 (6,6%) tenían E/e' ≥ 15 y 468 (93,4%) E/e' < 15. Hubo buena correlación entre DAI e IndVAI tanto para pacientes con E/e' ≥ 15 (r= 0,57), cuanto para pacientes con E/e' < 15 (r=0,62). La discordancia entre DAI e IndVAI fue mayor en los pacientes con E/e' ≥ 15 (21,2% VS 9% - p<0,0001). Los datos clínicos y ecocardiográficos, respectivamente, para E/e'  15 y E/e' < 15 fueron: sexo masculino 54,5% versus 45,5% (p= ns); edad(años) 73,2 ± 12,4 vs 50,1 ± 16,5 (p<0,0001); DAI (cm) 38,8 ± 6,3 versus 35,2 ± 5,2 (p< 0,0001); IndVAI (ml/m2) 35 ± 16,2 x 21,9 ± 7 (p< 0,0001); FE (%) 60,7 ± 16,2 versus 70,7 ± 6,9 (p< 0,0001); E/e' 21,1 ± 16,5 versus 8,1 ± 2,4 (p< 0,0001); HAS 81,8% versus 50,2% (p<0,0001); DM 21,2% versus 9,4% (p= 0,04); ICC 24,2% x 3,2% (p< 0,0001); DAC 33,3% x 9%(p<0,0001). **Conclusión:** Los pacientes con señales de elevación de las presiones de llenado ventricular izquierdo presentan edad superior, mayores diámetros e IndVAI, peor FE y mayor incidencia de HAS, DM, ICC y DAC. Hay menor concordancia entre DAI e IndVAI en esos pacientes.

**Descritores:** Atrios de Corazón, Función Atrial, Fibrilación Atrial, Ecocardiografía

# Introduction

Atrial fibrillation (AF) is the most frequent sustained arrhythmia in clinical practice and its prevalence increases with age[1]. AF may lead to structural changes in the heart, causing hemodynamic damages and tromboembolic complications with major economic implications and implications in the morbidity and mortality of the population[2,3].

The size of the left atrium is a strong predictor of AF onset in epidemiological studies[4], and its remodeling contributes to a high incidence of AF, and it is commonly a secondary condition to diastolic dysfunction of the left ventricle (LV)[5].

The diameter of the left atrium (DLA), measured at echocardiogram (ECHO), is usually used in clinical practice. For this assessment, a single unidimensional section is considered in the anteroposterior projection of the LA. The LA volume index (LAVInd) is measured by taking two LA orthogonal planes into consideration, and it has shown to be superior than LAD, with excellent correlation with the measurements taken by magnetic resonance (MR)[6,7].

This study aims at assessing the concordance between echocardiography measurements of the size of the LA in patients with diastolic dysfunction and, therefore, with higher risk of developing AF.

# Material and Methods

## Casuistry

From June 2008 to July 2009, 892 patients were selected and forwarded to the echocardiography lab of an outsource clinic in the Federal District, Brazil because they had been subjected to an echocardiogram with complete assessment of the LV diastolic function, including LAVInd. Out of these patients, 540 were already seen at the clinic and already had a full cardiological file with clinical data (sex, age, obesity, presence of Systemic Arterial Hypertension, diabetes mellitus, coronary arterial disease, congestive cardiac failure, valve disease). 39 patients were excluded (21 were younger than 18 years old and 18 had greater than mild mitral valve lesion). The study group had 510 patients.

## Echocardiography

Echocardiography (ECHO) was performed with the patient at rest, in left lateral decubitus position, in Philips equipment, models IE 33 and Envisor, with 2-5 MHz sector transducer. All exams were performed with electrocardiography monitoring of the patient simultaneously to image capture.  Quantifications were performed by the average of three measurements.

Heart size, parietal thickness, ejection fraction of the left ventricle (LV) and left atrium volume index (LAVInd) were measured according to the recommendations of the American Society of Echocardiography[8].

The maximum left atrium volume was calculated by Simpson's method, at apical 4-chamber and 2-chamber views, indexed to the body surface (LAVInd). Left atrium planimetry on both orthogonal planes was performed at the end of ventricular systole, immediately before the opening of the mitral valve, at the end of the T wave at the simultaneous electrocardiogram. The

outlet of the lung veins and the left atrium appendix were excluded (Figure 1).

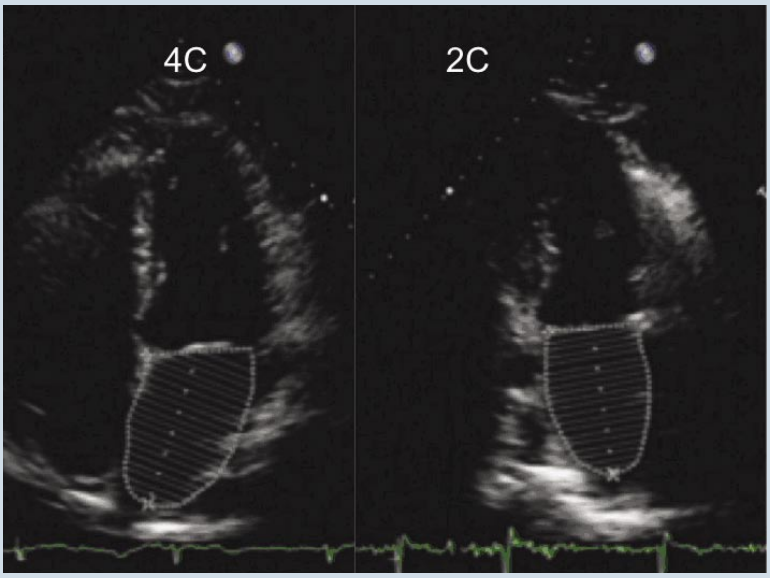



**Figure 1:** LA volume measurement at the echocardiogram, apical 4- and 2-chamber views.

The cut-off value for LAVInd was 32 mL/m2 due to information shown on previous studies demonstrating values above that are related to higher risk of cardiovascular event[5,9,10]. The cut-off value for LAD was 40 mm due to the historical use of this measurement by cardiologists to assess its concordance with a more accurate measurement of the LA, expressed by LAVInd. The concordance between LA measurements was assessed as follows: Concordant when LAVInd < 32 mL/m2 and LAD < 40 mm or LAVInd > 32 mL/m2 and LAD > 40 mm; Discordant when LAVInd > 32 mL/m2 and LAD < 40 mm or LAVInd < 32 mL/m2 and LAD > 40 mm.

The pulsed wave Doppler of the mitral valve flow was obtained at the apical 4-chamber view. The sample was positioned at the end of valve leaflets. E-wave (early filling) and A-wave (atrial contraction) velocities were obtained and the E/A ratio was calculated.

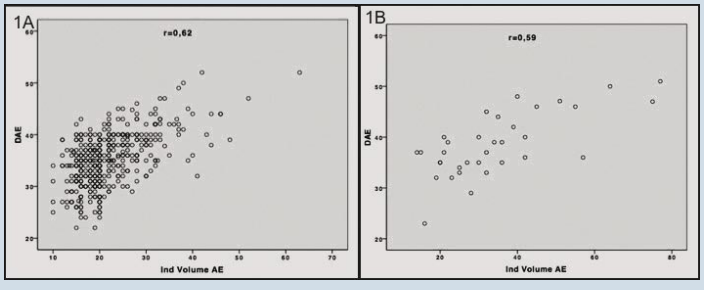
The mitral ring with a tissue Doppler was obtained at the apical 4-chamber window. The sample was positioned at the junction of the mitral ring with the septal and lateral walls. Maximum values of myocardial velocities; e' (start of diastole) and a' (end of diastole) were obtained, and the septo-lateral E/e' ratio was calculated. E/e' ratio > 15 was considered to be a significant diastolic dysfunction, compared to E/e' < 15 and E/e' ≥ 15 groups. The reason for this high cut-off value was an attempt to separate more accurately patients with and without high filling pressures in which an optimal assessment of the LA size would have major clinical implications.

## Statistics

Continuous variables were expressed as mean + standard deviation. When comparing data between two groups (E/e' < 15 and E/e' ≥ 15), continuous variables were compared by Student's t-test or Mann-Whitney test, according to its distribution. Category variables were compared by chi-square test. The correlation between LAD and LAVInd was determined by the Pearson's correlation coefficient.

# Results

501 patients were studied, 240 (48%) were male, aged 51 + 17 years old in average. Out of these patients, 33 (6.6%) had E/e' > 15 and 468 (93.4%) had E/e' < 15. The correlation between LAD and LAVInd was good both on E/e' < 15 patients and E/e' > 15 patients (r =.0.62 and 0.59, respectively), as shown in Figure 2.




1A – in patients with E/e' ratio < 15. 1B – in patients with E/e' ratio > 15.

**Figure 2:** Correlation between LAD and LAVInd.

Clinical and echocardiography characteristics of patients with E/e' < 15 and E/e' > 15 are shown on Table 1. The E/e' > 15 patient group was older (73.2 ± 12.4 versus 50.1 ± 16.5 years old; p< 0.0001), had higher incidence of systemic arterial hypertension (82% versus 50%; p< 0.0001), diabetes mellitus (21.2% versus 9.4%; p= 0.04), congestive cardiac failure (24.2% versus 3.2%; p<0,0001) e coronary arterial disease (33.3% versus 9%, p< 0.0001), when compared to patients of the E/e'< 15 group. Additionally, LAD and LAVInd values were higher than for patients with E/e' > 15 (38.8 ± 6.3 versus 35.2 ± 5.2 cm and 35 ± 16.2 versus 21.9 ± 16.2 mL/m2; p<0.0001), according to Table 1.

**Table 1:** Comparison of clinical and echocardiography data from patients with E/e' > 15 and E/e' < 15.

| | E/e'≥15 (n=33) | E/e'<15 (n=468) | p |
|---|---|---|---|
| Sexo masc | 18 (54,5%) | 15 (45,5%) | ns |
| Idade (anos) | 73,2±12,4 | 50,1±16,5 | <0,0001 |
| DAE (mm) | 38,8±6,3 | 35,2±5,2 | <0,0001 |
| IndVAE (ml/m2) | 35±16,2 | 21,9±7 | <0,0001 |
| FE (%) | 60,7±16,2 | 70,7±6,9 | <0,0001 |
| E/E' | 21,1±16,5 | 8,1±2,4 | <0,0001 |
| HAS | 27 (81,8%) | 235 (50,2%) | <0,0001 |
| DM | 7 (21,2%) | 44 (9,4%) | 0,04 |
| ICC | 8 (24,2%) | 15 (3,2%) | <0,0001 |
| DAC | 11 (33,3%) | 42 (9%) | <0,0001 |
| Obesidade | 7 (21,2%) | 86 (18,6%) | ns |

There was greater discordance between LAD and LAVInd in the group of patients with E/e' ratio > 15 when compared to the group of patients with E/e' ratio < 15 (21% versus 8.6%; p<0.001), according to Table 2.

**Table 2:** Concordance between LAD and LAVInd measurements in patients with E/e' ratio > 15 and E/e' ratio < 15.

| DAE e IndVAE | E/e'<15 | E/e'≥15 | P |
|---|---|---|---|
| discordância | 39/449 (8,6%) | 7/34 (21%) | |
| concordância | 410/449 (91,4%) | 27/34 (79%) | |
| | | | <0,001 |

# Discussion

The main finding of this study was the greater discordance between the left atrium diameter and the left atrium volume index measurements in patients with echocardiography signs of increased left ventricle filling pressure expressed by E/e' ratio > 15. These patients were older, had greater incidence of systemic arterial hypertension, diabetes mellitus, coronary arterial disease and congestive cardiac failure, in addition to a lower ejection fraction of the left ventricle, that is, a population with higher risks of atrial fibrillation.

The LA acts as a reservoir during ventricular systole, like a pipe carrying blood from lung veins to the LV at early diastole, and as a contractile chamber at late diastole[11]. The LA is directly exposed to the pressures of the LV during the diastolic period through the open mitral valve. Thus, its dimensions are highly influenced by the same factors that determine ventricular filling, reflecting the duration and severity of the diastolic dysfunction[12].

The pressure overload on the LA leads to interstitial fibrosis and electrical disconnection of atrial myocytes, which contribute to a high incidence of AF[13]. Atrium remodeling, secondary to pressure overload, leads to a non-uniform dilation of the left atrium[14]. This could explain the finding of this study that showed greater discordance between LAD and LAVInd measurements in patients with E/e' ratio > 15, that is, patients with more pressure overload on the LA secondary to LV diastolic dysfunction.

Additionally, as the single plane LAD measu-

rement is not entirely accurate especially due to the irregular geometry of the LA[15], it is possible to justify the incapacity of this measurement in predicting embolic event in patients with permanent AF[16].

The LA volume measurement is obtained, preferably, by the biplane Simpson's method or by the area-length method, with higher applicability and reproducibility of the actual size of this cavity. Schiller et al.[17] established LA volume index as the best indicator of the actual size of the LA. More recently, a study with multiple echocardiography methods showed the Simpson's technique to be accurate for LAVInd measurement[7].

The left atrium volume was also related to AF risk in different clinical trial. Tsang et al.[18] showed a strong association between LAVInd, degree of diastolic dysfunction of the left ventricle, and risk of developing atrial fibrillation. In this study, in a elderly population with no cardiac disease, a 30% increase in LAVInd went along with a 43% risks of developing AF. In a study conducted to compare measurements of the diameter, area and volume of the LA, the same authors showed that the LA volume is the most accurate measurement to predict risks of future cardiovascular events, including AF[19].

Rossi et al.[20] showed in their study involving dilated myocardiopathy patients that the relation between LA size and LA volume is not linear, and that the measurement of the volume is superior to that of the diameter when it comes to predicting mortality and development of AF.

# Conclusion

The findings in this study draw attention to the importance of a more suitable assessment of LA dimensions in patients with higher risk of developing AF. Considering it is technically easy to get this index and associated information, it becomes an indispensible piece of data in clinical practice.

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