Journal of Cardiovascular Disease Research

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

ORIGINAL RESEARCH

LEFT ATRIAL FUNCTIONAL INDEX AS MARKER OF LEFT ATRIAL ASSESSMENT IN DIASTOLIC DYSFUNCTION AND ATRIAL FIBRILLATION IN A TERTIARY CARE CENTRE, SOUTH INDIA

Dr. Rajesh M[1*], Dr. Anand Sekar.G[2]

[*1]Assistant Professor, Department of Cardiology, Arupadai Veedu Medical College, Kirumpakkam, Puducherry, India.
[2]Associate Professor, Department of Cardiology, Arupadai Veedu Medical College, Kirumpakkam, Puducherry, India.

Corresponding Author: Dr. **Rajesh M**, Assistant Professor, Department of Cardiology, Arupadai Veedu Medical College, Kirumpakkam, Puducherry, India.

ABSTRACT

Background: Left atrium is not a simple passive transport chamber which transfers blood from the pulmonary circulation to the left ventricle. Left atrium has conduit, reservoir and pump functions and multiple variables have been developed to evaluate those functions. **Aim of the study:** It is comparison of LAFI to traditional echo parameters of Left atrium function in atrial fibrillation and diastolic dysfunction.

Methods: This Prospective cross sectional study was conducted among the patients attending the Cardiology OPD with Atrial fibrillation and Diastolic dysfunction in Tertiary care centre, Chennai .The study was done for a period from Jan 2022 to Jan 2023.The study participants fulfilling the inclusion and the exclusion criteria were included in the study throughout the study period. The final attained sample is 75. After obtaining the Institutional Ethical Committee clearance, the study was started after obtaining patients informed consent. Baseline details of study participants like name, age, sex, residence. Anthropometric measurement like height and weight will be taken.Body mass index will be calculated. Echocardiography investigation will be done. After collecting the data it was entered in MS Excel Windows 10.Statistical analysis was done in SPSS 23..P value of <0.005 is considered to be statistically significant.

Results: Age, sex, height, weight ,Body mass index and Body surface are was found to be not statistically significant between the groups. There is a very weak correlation between LAVI & LAFI in atrial fibrillation group (r= 0.2). There is a strong correlation between A cm/s and LAFI, There is a strong correlation between AVTI and LAFI (r= 0.89). when LAFI <24.5 is set as cut off value , LAFI as a parameter to diagnose left atrial dysfunction has 100% sensitivity, 56%specificity, 53% positive predictive value, 100% negative predictive value.

Conclusion: LAFI is low in chronic AF and Diastolic Dysfunction patients in our study. LAFI has high sensitivity and negative predictive value. LAFI is a rhythm independent Left atrium function marker. Thereby we conclude that LAFI is a comprehensive marker of left atrial structural and functional assessment.

Keywords: Atrial Fibrillation, Diastolic dysfunction, Left atrial functional index, Reservoir

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

INTRODUCTION

Left Atrium was discerned as a conduit, that passively transport blood from pulmonary veins to the left ventricle in the past. But it is a dynamic chamber which will respond to the distension which is due to the atrial natriuretic peptide secretions. Hemodynamic balance and the partial fluid restoration is maintained by the interplay between the vasodilatation, natriuresis , sympathetic system and renin angiotensin-aldosterone system inhibition.

Left atrium receives the pulmonary venous return as a result of left ventricular contraction and the isometric relaxation. Later it stores the energy in the form of pressure ,thus it acts like a reservoir. It acts as a conduit by transferring the blood passively into the left ventricles during the rapid filling phase as soon as the mitral valve opens and in diastasis phases due to pressure gradient. Left atrium also contributes 15% to 30% of LV stroke volume in the final phase of rapid filling. Multiple studies have been done % to find the normal values of left atrium in the 1980 s. Recently left atrium was found to have conduit, reservoir and pump functions and multiple variables have been developed to evaluate those functions[1,2,3,4].

Traditional parameters for assessment of Left atrial function are pulse wave doppler of transmitral flow, pulse wave doppler of pulmonary venous flow, left atrial phasic volume, myocardial velocities, which has its own limitations. Left atrial functional index is an echocardiographic parameter .It is a ratio and has size of the left atrium, left ventricular stroke volume, reservoir function of the left atrium as analogue.

The left atrial functional index is found to be directly proportional to the left atrium reservoir function , left ventricular stroke volume. It is inversely proportional to the left atrial size. This ratio physiological basis is that in normal persons the left atrium will maintain normal size during the normal left ventricular stroke volume and the left atrium have the capability to transfer most of the contents of the left atrium during each cardiac cycle.

So combination of all the above parameters leas to development of this index known as left atrial functional index. With extremes of the heart rate and extremes of the body weight the LAFI adjusts. In this study, we used left atrial functional index(LAFI), a unique parameter that combines atrial reserve function(fractional change), adjusted atrial volume(LAVI) and stroke volume.

Advantages of LAFI are that it provides both anatomical and functional information of left atrium with relation to LV function and it is rhythm independent, therefore, it can be used in patients with atrial fibrillation. The aim of this study is to compare left atrial functional index to the convention echo parameters of left atrial function in patients with atrial fibrillation and diastolic dysfunction.

MATERIALS & METHOD

Study Setting

This study was conducted among the patients attending the Cardiology OPD with Atrial fibrillation and Diastolic dysfunction in Tertiary Care Centre,Chennai.The study was done for a period from Jan 2022 to Jan 2023.

Study Design

Prospective cross sectional study

Sample Size

The study participants fulfilling the inclusion and the exclusion criteria were included in the study throughout the study period. The final attained sample is 75. The study participants were divided into three groups. Group 1 or atrial fibrillation group consist of 25 subjects confirmed with ECG, Group 2 or Diastolic Dysfunction group consist of 25 subjects confirmed with echocardiography. Group3 or controls consist of 25 subjects who were age matched volunteers.

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

Inclusion Criteria

- Patients with chronic AF of any cause
- Patients with diastolic dysfunction of various grades
- Persons in the age group of 45-60 years

Exclusion Criteria

- Critically ill patients,
- pregnant and breast feeding women,
- persons with extremes of age
- persons with very large left atrium i.e. more than 8 cm
- patients with heart rate more than 100beats/min

Controls

Controls are the patients who attend the Cardiology OPD without history of significant valvular disease, peripheral vascular disease, ischemic heart disease, cerebrovascular disease, hypertension, diabetes and who are not on cardioactive medications**.**

M mode, 2D, doppler and tissue doppler recordings were done by Transthoracic echocardiogram using PHILIPS HD 7 Machine.

Measurement of LA diameter:

Left atrial anteroposterior diameter was obtained in the long axis by the M mode

Measurement of LV dimensions:

Left ventricular dimensions were obtained by 2D guided M mode at the level of mitral valve tips or the papillary muscle level in parasternal shot axis view

Measurement of LV ejection fraction:

$$LVEF = \frac{LVEDd^2 - LVSDd^2}{LVSDd^2}$$

Measurement of Mitral Inflow velocity:

Mitral inflow velocity was obtained by pulse wave doppler at the sweep speed of 100cm/s from the apical 4 chamber view by placing the sample volume of the Doppler at the tips of the mitral leaflets.

In atrial fibrillation ,peak velocity of atrial contraction in diastole(A cm/s) and A wave time velocity integral were measured as an average of 3 beats.

Tissue doppler imaging was obtained by placing the doppler sample volume over the junction of basal atrial septum and mitral annulus and recording was done at a sweep speed of 100cm/s and the peak velocity in early diastole ,e' and active atrial contraction in late diastole, e'were recorded.

Measurement of left atrial volume:

Left atrial volume was calculated from apical 4 chamber and 2 chamber view using biplane method of discs.

Biplane area length method needs measurement of LA area from two orthogonal apical views(A1 and A2) and LA length(L) from which LA volume is calculated as (0.85 x A1 x A2)/L.

LAESV: left atrial volume just before opening of the mitral valve

LAEDV: left atrial volume at the time of mitral valve closure

LAESVI: left atrial end systolic volume indexed to the body surface area

LA emptying fraction $LAEF = \frac{LAESV - LAEDV}{LAESV} \; X \; 100$

Left atrial functional index $LAFI = \frac{LAEF \; X \; LVOT - VTI}{LAESVI}$

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

Data Collection Method

After obtaining the Institutional Ethical Committee clearance, the study was started after obtaining patients informed consent**.** The study participants recruited during the study period will undergo a questionnaire asking baseline details like name, age, sex, residence. Anthropometric measurement like height and weight will be taken. Body mass index will be calculated. Echocardiography investigation will be done.

Statistical Analysis

After collecting the data it was entered in MS Excel Windows 10.Statistical analysis was done in SPSS 23.Continuous data were expressed in terms of Mean± Standard deviation and Categorical variables were expressed in terms of numbers (percentages).Chi square test was used for Test of Association for Categorical variables. Anova test or Student t test was used for Test of Association for Continuous variables. Pearson correlation was used for the continuous variables. P value of <0.005 is considered to be statistically significant.

RESULTS

TABLE 1: BASELINE CHARECTERISTICS

BASELINE CHARACTERSISTICS	ATRIAL FIBRILLATION GROUP	DIASTOLIC DYSFUNCTION GROUP	CONTROL GROUP	P VALUE AF vs CONTROL	P VALUE DD vs CONTROL
AGE	52.5±5.0	51.3±4.7	53.4±4.1	0.48	0.09
MALE:FEMALE	10:15	12:13	14:11	0.5	0.5
WEIGHT(kg)	70.5±7.9	74.1±6.3	70.3±7.1	0.92	0.05
HEIGHT(cm)	167.3±6.8	167.9±6.3	166±8.0	0.53	0.35
BMI(kg/m^2)	25.2±2.8	26.3±2.5	25.6±3.1	0.64	0.37
BSA(m^2)	1.7±01	1.8±0.1	1.7±0.1	0.74	0.07
HEART RATE	78.1±7.1	80.1±4.6	72.2±5.4	0.002	<0.0001

Both cases and controls were age, gender, BMI, BSA matched. Age,sex,height ,weight ,Body mass index and Body surface are was found to be not statistically significant between the groups The Heart rate between the groups were found to be statistically significant.

Table 2: Echocardiographic parameters of the study participants

ECHOCARDIOGRAPHIC PARAMETERS	ATRIAL FIBRILLATION GROUP	DIASTOLIC DYSFUNCTION GROUP	CONTROL GROUP	P VALUE AF vs CONTROL	P VALUE DD vs CONTROL
LA DIAMETER mm	48.4±4.2	42.8±6.1	35.3±3.1	<0.0001	<0.0001
LA ESV ml	56.8±3.1	62.1±13.1	39.0±2.5	<0.0001	<0.0001
LA ESVI ml/m^2	31.8±3.4	33.8±6.7	22.0±1.9	<0.0001	<0.0001
LAEDV ml	43.8±3.8	47.4±13.1	20.3±2.2	<0.0001	<0.0001
LAEF %	22.9±3.2	24.5±5.6	47.8±5.2	<0.0001	<0.0001
LASV ml	13.0±1.5	14.6±1.7	18.7±2.5	<0.0001	<0.0001
LVEF %	46.6±4.7	53.5±1.3	66.5±3.9	<0.0001	<0.0001
LVOT VTI ml	21.4±1.5	21.1±1.2	21.3±1.9	0.8708	0.6032
LAVI	37.01±2.2	36.6±9.5	25.2±1.2	<0.0001	<0.0001
LAFI	15.6±3.2	16.5±6.7	46.5±6.5	<0.0001	<0.0001

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

Echo parameters were increased in cases compared to controls and the difference between the groups was found to be statistically significant.

Table 3: Echo Doppler derived Diastolic Measurements

ECHO - Doppler Derived Diastolic Measurements		A cm/s	A VTI cm	FRACTION OF A	E/A	a' cm/s
Diastolic Dysfunction Group	Mean	72.44	11.84	37.28	1.12	6.28
	SD	12.85	4.71	14.44	0.47	1.57
Control Group	Mean	62.40	7.72	38.32	1.11	8.52
	SD	8.10	1.14	2.63	0.15	1.05
P value Unpaired t Test		0.0018	0.0001	0.7247	0.9349	<0.0001

The Echo Doppler values in the Diastolic dysfunction group was less compared to control group in all parameters except A VTI cm. The difference between the group was also found to be statistically significant in some parameters.

Table 4: Correlation of LAFI with Echo parameters in patients with Atrial fibrillation

Correlation Of LAFI With ECHO Parameters In Patients With Atrial fibrillation	**Pearson's 'r' Correlation Coefficient**	**P value**
E cm/s	0.839	<0.0001
A cm/s	0.773	<0.0001
AVTI cm	0.885	<0.0001
FRACTION OF A	0.889	<0.0001
E/A	-0.875	<0.0001
e' cm/s	0.708	<0.0001
a' cm/s	0.754	<0.0001
E/e'	-0.891	<0.0001
LA DIA mm	-0.867	<0.0001
LAESV ml	-0.892	<0.0001
LAESVI ml/m2	-0.923	<0.0001
LAEDV ml	-0.932	<0.0001
LASV ml	0.309	0.1868
LAEF %	0.951	<0.0001
LVOT VTI cm	0.408	0.0922
LVEF %	0.029	0.8590
LAVi	-0.799	<0.0001

Table 5: Correlation Of Lafi In Atrial Fibrillation Group

correlation of LAFI in Atrial fibrillation Group	LAVI
LAFI	0.20
P value ANOVA	0.2159

Table 2 shows, there is a very weak correlation between LAVI & LAFI in atrial fibrillation group as indicated by the Pearson's R correlation value of 0.2. This means as LAVI increases the LAFI decreases and it is true 20% of times. This direct correlation is not significant with a p value >0.05.

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

Table 6: Correlation Of Lafi In Diastolic Dysfunction Group

Correlation of LAFI in Diastolic Dysfunction Group	A cm/s	A VTI cm	FRACTION OF A	LAVi
Pearson's r (Pearson correlation coefficient)	0.77	0.77	0.89	0.89
P value ANOVA	<0.0001	<0.0001	<0.0001	<0.0001

It shows there is a strong correlation between A cm/s and LAFI, as indicated by the pearson R correlation of 0.77. this means as A cm/s increases, the LAFI increases and this is true 77% of times. This direct correlation is significant with a p value of < 0.0001.
There is a strong correlation between A VTI and LAFI ,as indicated by the pearson R correlation of 0.77. this means as A VTI increases, the LAFI increases and thisis true 77% of times. This direct correlation is significant with a p value of < 0.0001.
There is a strong correlation between FRACTION OF A and LAFI ,as indicated by the pearson R correlation of 0.89. this means as FRACTION OF A increases, the LAFI increases and this is true 89% of times. This direct correlation is significant with a p value of < 0.0001.
There is a strong correlation between LAVI and LAFI ,as indicated by the pearson R correlation of 0.89. this means as LAVI increases, the LAFI increases and this is true 89% of times. This direct correlation is significant with a p value of < 0.0001.

Table 7: Accuracy Analysis

Accuracy Analysis	Sensitivity	Specificity	PPV	NPV	Accuracy	AUC	Cut Off	P value
LAVI	100.00	74.00	65.80	100.00	82.00	0.996	>34	<0.0001
LAFI	100.00	56.00	53.20	100.00	50.00	0.977	<24.5	<0.0001

It shows when LAFI <24.5 is set as cut off value , LAFI as a parameter to diagnose left atrial dysfunction has 100% sensitivity, 56%specificity, 53% positive predictive value, 100% negative predictive value.

DISCUSSION

Liza Thomas et al[5] ,found that LAFI was lower in patients with atrial fibrillation when compared to normal. They also demonstrated that LAFI was lower in people with chronic AF than those reverted to sinus rhythm.Our study also confirmed that LAFI was lower in patients with AF. Peak A velocity, A wave VTI and fraction of atrial contraction could not be assessed in AF, so LAFI will be a notable echo parameter for evaluation of atrial function in atrial fibrillation.

Christian welles et al[6] used LAFI, to evaluate Left Atrium function, as an independent marker for heart failure hospitalization in persons with preserved ejection fraction.Our study also confirmed that measurement of LAFI is a useful marker in left atrial function in persons with abnormal filling patterns of Left Ventricles.

Mayank sardana et al[7] used LAFI as a predictor of atrial fibrillation , heart failure and CVA..Luis sargento et al[8] found that LAFI predicts long term survival in patients with systolic heart failure

Enlargement of Left Atrium is a reliable predictor of adverse cardiovascular outcomes[9,10,11]Although MRI, CT can assess Left Atrial phasic function, they tend to overestimate

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

the dysfunction and echocardiogram is reproducible, and suitable for follow up and risk assessment.[9,10]

Traditional parameters of Left atrial function are age and load dependant[11], whereas LAFI is not restricted by these factors and it is also rhythm independent.

Limitations

Our study had a small sample size .In our study age group belonging to 45 to 60 so extrapolation of findings to other age group needs further evaluationThis study is a single time measure of left atrial function and the patient cohort were not followed over a period of timeEcho measures of Left atrium function like strain , strain rate and atrial response to exercise were not examined.

CONCLUSION

It is evident that Left atrial function assessment is rapidly evolving and traditional parameters are replaced with advanced parameters. The merits, demerits and limitations of each method is important for clinical and research work up. We observed that LAFI is low in chronic AF and Diastolic Dysfunction patients. LAFI has high sensitivity and negative predictive value. In addition to diagnosis of left atrial dysfunction, it can also be used in risk stratification in heart failure with preserved ejection fraction and atrial fibrillation patients. LAFI is a rhythm independent Left atrial function marker. Thereby we conclude that LAFI is a comprehensive marker of left atrial structural and functional assessment.

Funding:

None of the authors received funding for this study

Competing Interest:

There is no competing interest

Authors Contribution:

All authors in our study contributed to the data collection of the patients

Acknowledgement:

The authors like to thank the Dean of the Medical College, Head of the Department of Cardiology, Vinayaka Mission Medical College ,Karaikal ,Tamil Nadu.

REFERENCES

1. Gustavo G. Blume, Christopher J. Mcleod, Marion E. Barnes, James B. Seward, Patricia A. Pellikka, Paul M. Bastiansen, Teresa S.M. Tsang, Left atrial function: physiology, assessment, and clinical implications, European Journal of Echocardiography, Volume 12, Issue 6, June 2011, Pages 421–430
2. Hoit BD.Left Atrial size and function:role in prognosis.J Am Coll Cardiol.2014.63:493-505
3. Dermellis J.M,Stefenadis CI,Zacharoulis AA,Toutouzas P.K.Left atrial mechanical adaption to long standing hemodynamic loads based on pressure-volume relations.Am J Cardiol.1998.81:1138-1143
4. Moller JE,Hillis GS,Oh JK,Seward JB,Reeder GS,Wright RS,Park SW,Bailey KR,Pellikka PA.Left atrial volume:a powerful predictor of survival after acute myocardial infarction.Circulation:2003:107:2207-2212
5. Liza Thomas, Michelle Hoy, Karen Byth, Nelson B. Schiller, The left atrial function index: a rhythm independent marker of atrial function, European Journal of Echocardiography, Volume 9, Issue 3, May 2008, Pages 356–362, https://doi.org/10.1016/j.euje.2007.06.002
6. Welles CC, Ku IA, Kwan DM, Whooley MA, Schiller NB, Turakhia MP. Left atrial function predicts heart failure hospitalization in subjects with preserved ejection fraction and coronary

ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 6, 2024

heart disease: longitudinal data from the Heart and Soul Study. J Am Coll Cardiol. 2012;59(7):673-680. doi:10.1016/j.jacc.2011.11.012

7. Mayank Sardana, Darleen Lessard, Nisha Parikh, Adedotun Ogunsua, Aditya Vaze, Gregory Nah. Left Atrial Function Index As A Predictor Of Cardiovascular Disease And Atrial Fibrillation: Data From The Framingham Offspring Study.J Am Coll Cardiol. 2017 Mar, 69 (11 Supplement) 1527.
8. Sargento L, Vicente Simões A, Longo S, Lousada N, Palma Dos Reis R. Left atrial function index predicts long-term survival in stable outpatients with systolic heart failure. Eur Heart J Cardiovasc Imaging. 2017;18(2):119-127. doi:10.1093/ehjci/jew196
9. Tsang TS, Abhayaratna WP, Barnes ME, et al. Prediction of cardiovascular outcomes with left atrial size: is volume superior to area or diameter?. J Am Coll Cardiol. 2006;47(5):1018-1023. doi:10.1016/j.jacc.2005.08.077
10. Emelia J. Benjamin, Ralph B. D'Agostino, Albert J. Belanger, Philip A. Wolf, and Daniel Levy. Left Atrial Size and the Risk of Stroke and Death.The Framingham Heart Study. Circulation. 1995;92:835–841 doi.org/10.1161/01.CIR.92.4.835
11. Laukkanen JA, Kurl S, Eränen J, Huttunen M, Salonen JT. Left Atrium Size and the Risk of Cardiovascular Death in Middle-aged Men. Arch Intern Med. 2005;165(15):1788–1793. doi:10.1001/archinte.165.15.1788
12. Kircher B, Abbott JA, Pau S, et al. Left atrial volume determination by biplane two-dimensional echocardiography: validation by cine computed tomography. Am Heart J. 1991;121(3 Pt 1):864-871. doi:10.1016/0002-8703(91)90200-2
13. Rodevan O, Bjornerheim R, Ljosland M, Maehle J, Smith HJ, Ihlen H. Left atrial volumes assessed by three- and two-dimensional echocardiography compared to MRI estimates. Int J Card Imaging. 1999;15(5):397-410. doi:10.1023/a:1006276513186
14. Christopher Y. Chong, Arthur E. Weyman. Preload Dependence of Doppler-Derived Indexes of Left Ventricular Diastolic Function in Humans. J Am Coli CardioI1987;lO:800-8.