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# LEFT ATRIAL FUNCTION INDEX – A RISK PREDICTOR IN DIASTOLIC DYSFUNCTION

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## BACK GROUND

The two atria maintain the equilibrium of heart. Structure and function of atria gets altered in many pathological conditions of heart. Assessment of atrial function by imaging is always challenging. This study was designed to assess the changes in left atrial function index (LAFI) in patients with diastolic dysfunction (DD)

Materials and methods

The study population was divided into cases and controls. Cases included 25 patients with diastolic dysfunction. Controls included 25 healthy volunteers. LAFI was calculated in both groups using echocardiography. LAFI = Left Atrial emptying fraction (LAEF) x Left Ventricular outflow tract velocity time integral) / Left atrial end systolic volume indexed to BSA (LAESVI)

Results

Patients with diastolic dysfunction showed higher atrial diameters (42.79 ± 6.08 vs 35.29 ± 3.09, $p<0.0001$) and left atrial end systolic volume index (33.76 ± 6.69 vs 22.03 ± 1.95, $p<0.0001$), depressed left atrial emptying fraction (56.47 ± 1.32 vs 66.48 ± 3.87, $P<0.0001$) and LAFI (16.48 ± 6.69 vs 46.51 ± 6.39, $p<0.0001$).

Conclusion

In our study, LAFI decreased as diastolic dysfunction grade increased

Keywords

Echocardiography, Atrial function

## INTRODUCTION

Assessment of LA function is always challenging. Many parameters are available to assess LA function like LA ejection fraction, myocardial strain rate, trans mitral atrial filling velocity (A) and myocardial tissue late diastolic velocity (a)'. Each of these parameters have their own disadvantages and inaccurate in non-sinus rhythms (1). Recent studies had shown that LAFI is a sensitive and promising parameter to assess LA function and is rhythm independent (2, 3).

Diastolic dysfunction elevates LV filling pressures. An elevated LV filling pressure affects LA function. LA decompensates and causes LA enlargement and reduction in LA function. So far no study had been done directly to assess the effect of diastolic dysfunction on LAFI. The main objective of our study was to analyze, LAFI in Diastolic Dysfunction Group was equal in effect and outcomes compared to Control group

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## MATERIALS AND METHODS

We conducted a single centre prospective case control study in Vinayaka Misson Medical College and Hospital, after hospital ethical committee clearance.

Study cohort consists of 25 patients with diastolic dysfunction attending to our cardiac OPD, selected by judgment sampling method. Control comprises of 25 age matched healthy volunteers. Patients with established coronary artery disease (CAD), valvular heart disease, peripheral vascular disease, stroke and arrhythmias were excluded from the study.

Both groups were subjected to 2D echo, Doppler echo and tissue Doppler imaging by using Esoate my Lab Gamma equipped with a phased array transducer.

Diastolic dysfunction was graded as per 2009 ASE recommendations

| | Grade I | Grade II | Grade III |
|---|---|---|---|
| E/A | < 0.8 | 0.8 – 1.5 | >2 |
| DT (ms) | > 200 | 160 – 200 | <160 |
| E/e’ | ≤ 8 | 9 – 12 | ≥ 13 |

Left atrial end systolic volume (LAESV) and left atrial end diastolic volume (LAEDV) were calculated using area length method, by averaging the respective measurements in apical two and four chamber views (4).

Left atrial end systolic volume index (LAESVI), was calculated by dividing LVESV by the body surface area (BSA).

LAESV Index = LAESV / BSA

LA emptying fraction (LA-EF) was calculated using the formula,

LA-EF = (LAESV – LAEDV) / LAESV

By Simpson’s method, LV end-diastolic volume (LVEDV) and LV end-systolic volume (LVESV) were calculated in apical two chamber view.

Stroke volume (SV) was calculated using the formula, SV = LVEDV - LVESV

LV ejection fraction (LVEF) was calculated by, LVEF = SV/ LVEDV

LV outflow tract (LVOT) diameter was measured in the parasternal long-axis view. LVOT area was calculated by, LVOT area = $\pi$ (LVOT diameter/2)$^2$

LVOT velocity time integral (LVOT VTI) was calculated by, LVOT VTI = SV / LVOT area

Left atrial function index (LAFI) was calculated using the formula (5),

LAFI = (LA-EF) x (LVOT-VTI) / LAESV Index

Descriptive statistics was done for all data and were reported in terms of mean values and percentages. Suitable statistical tests of comparison were done. Continuous variables were analyzed with the unpaired t test.. Categorical variables were analyzed with the Chi-Square Test and Fisher Exact Test. Statistical significance was taken as P < 0.05. The data was analyzed using SPSS version 16.

## RESULTS

Table 1: Baseline characteristics of Cases and Control

| | CASES | CONTROL | P VALUE |
|---|---|---|---|
| AGE | 51.33 ± 4.71 | 53.45 ± 4.09 | 0.0973 |
| GENDER<br>MALE<br>FEMALE | <br>12<br>13 | <br>14<br>11 | 0.5271 |
| WEIGHT (KG) | 74.09 ± 6.29 | 70.28 ± 7.08 | 0.0512 |
| HEIGHT (KG) | 167.85 ± 6.25 | 165.9 ± 8.01 | 0.3547 |
| BMI (KG/M$^2$) | 26.29 ± 2.45 | 25.51 ± 3.11 | 0.3759 |

| | | | |
|---|---|---|---|
| BSA ($M^2$) | 1.83 ± 0.09 | 1.77 ± 0.12 | 0.759 |
| HEART RATE (BEAT/MINUTE) | 80.14 ± 4.62 | 72.19 ± 5.41 | <0.0001 |
| DIABETES MELLITUS | 8 | 7 | 0.8292 |
| HYPERTENSION | 10 | 8 | 0.7897 |

Table – 1 shows that baseline characteristics are comparable between the two groups. Though p value for heart rate was statistically significant, when considered insignificant clinically because value falls within normal limits

Table 2: Echo Diastolic function analysis

| | CASES | CONTROL | P VALUE |
|---|---|---|---|
| E (Cm/S) | 75.67 ± 16.97 | 68.75 ± 7.87 | 0.0409 |
| e’ (cm/s) | 5.73 ± 1.02 | 9.31 ± 1.12 | <0.0001 |
| E/e’ | 13.87 ± 5.05 | 7.39 ± 0.83 | <0.0001 |
| A (cm/s) | 72.39 ± 12.81 | 62.35 ± 7.9 | 0.0017 |
| A-VTI (cm) | 11.85 ± 4.72 | 7.73 ± 1.13 | <0.0001 |
| Fraction Of A | 37.19 ± 14.25 | 38.21 ± 2.51 | 0.7239 |
| DT (ms) | 180.2 ± 8.3 | 229.1 ± 13.5 | <0.001 |
| E/A | 1.11 ± 0.46 | 1.12 ± 0.16 | 0.9351 |
| a’ (cm/s) | 6.28 ± 1.55 | 8.55 ± 1.08 | <0.0001 |

(E – early diastolic filling velocity, e’ - myocardial early diastolic velocity, A- atrial filling velocity, A-VTI atrial filling velocity – velocity time integral, a’ - myocardial late diastolic velocity, DT – deceleration time)

Table – 2 shows the results of ECHO - Doppler Derived Diastolic Measurements of the two groups. Patients having diastolic dysfunction reflected significantly higher E cm/s, A cm/s, AVTI cm, E/e’ and lower e' cm/s, a' cm/s values compared to control patients.

Table 3: Echo - Left atrial dimensions and volumes

| | CASES | CONTROL | P VALUE |
|---|---|---|---|
| LA diameter (mm) | 42.79 ± 6.08 | 35.29 ± 3.09 | <0.0001 |
| LAESV (ml) | 62.09 ± 13.08 | 39.12 ± 2.59 | <0.0001 |
| LAESVI (ml/$m^2$) | 33.76 ± 6.69 | 22.03 ± 1.95 | <0.0001 |
| LAEDV (ml) | 47.39 ± 13.09 | 20.31 ± 2.22 | <0.0001 |
| LAEF (%) | 24.55 ± 5.65 | 47.81 ± 5.25 | <0.0001 |
| LASV (ml) | 14.59 ± 1.69 | 18.69 ± 2.49 | <0.0001 |
| LVEF (%) | 56.47 ± 1.32 | 66.48 ± 3.87 | <0.0001 |
| LVOT VTI (ml) | 21.09 ± 1.25 | 21.31 ± 1.87 | 0.6029 |
| LAVI (ml) | 36.57 ± 9.48 | 25.17 ± 1.21 | <0.0001 |
| LAFI | 16.48 ± 6.69 | 46.51 ± 6.39 | <0.0001 |

(LA diameter – left trial diameter, LAESV - left atrial end systolic volume, LAESVI - left atrial end systolic volume index, LAEDV - left atrial end diastolic volume, LAEF - left atrial emptying fraction, LASV - left atrial stroke volume, LVEF - left ventricular ejection fraction, LVOT VTI - left ventricular outflow tract velocity time integral, LAVI – left atrial volume index, LAFI – left atrial function index)

Table 3 shows that the ECHO- Left Atrial Dimensions / Volumes levels of patients having diastolic dysfunction reflected significantly higher LA diameter mm, LA ESV ml, LA ESVI ml/m2, LAEDV, LAVI ml and lower LAEF %, LASV ml, LVEF %, and LAFI values compared to control patients

Table 4: LAFI and LAVI vs diastolic grades

| | LAVI (ml/$m^2$) | LAFI (%) |
|---|---|---|
| DD Grade I | 29.41 ± 2.47 | 23.39 ± 2.61 |
| DD Grade II | 34.85 ± 0.89 | 13.09 ± 2.03 |
| DD Grade III | 52.15 ± 4.13 | 8.63 ± 0.51 |
| Control | 25.25 ± 1.23 | 46.52 ± 6.49 |
| P - value | <0.0001 | <0.0001 |

Table 4 reflects that LAVI levels of the patients significantly increase as the level of DD grading increases and LAFI levels of the patients significantly decrease as the level of DD grading increases

**DISUSSION**

The concept of LAFI was first proposed by Thomas et al (5). LAFI calculation involves LA structure, LA function and LV function. LA emptying fraction (LAEF) reflects LA function, Left atrial end systolic volume index (LAESVI) reflects LA structure and LVOT VTI reflects LV function.

In our study, we observed that as diastolic dysfunction grade increases LAFI decreases. It indicates with increase in diastolic grade, LA dysfunction also worsens. Many studies on LAFI had shown that it can be a predictor of rehospitalisation, atrial fibrillation and stroke.

In HF with preserved EF, LA function is a important predictor of rehospitalisation after adjustment of confounding factors (6). In patients with HF with preserved EF and CAD, patients with low LAFI had increased rehospitalisation over a median follow up of 7.9 years (7).

In HF with reduced EF, Atrial fibrillation was common in patients with low LAFI compared to patients with high LAFI (8).

CAD patients with low LAFI had three times more risk of ischemic stroke or TIA even without any prior atrial fibrillation (9).

All these data shows that LAFI is not just a marker of left atrial dysfunction but also prognosticates future adverse cardiac events like hospitalization, stroke and atrial fibrillation.

A limitation of the present study was that we did not incorporate an atrial strain analysis which is a non-volumetric measure of atrial function. If we have compared LAFI with atrial strain data, our study would have been more comprehensive. Another limitation is that in clinical setting, we have no direct ultrasound software to calculate LAFI. So LAFI need to be calculated indirectly through formulas which needs more measurements and additional time.

Conclusion

Traditional parameters to evaluate left atrial function have their own advantages and limitations. LAFI is rhythm independent and evaluates left atrial function, left atrial remodeling and left ventricular diastolic function. Calculation of LAFI needs patience, technical feasibility and additional time during routine echo evaluation but its clinical significance in prognostication has opened a new direction and worth exploring

Conflict of interest

Authors have no conflict of interest

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