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Original Article

Comparison of the effects of mitral regurgitation and pulmonary arterial hypertension on left atrial functions

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Abstract

Aim: The left atrium (LA) is a cardiac chamber that plays a fundamental role in successful cardiac pumping function and the mortality is more frequent in patients withLA dysfunction. Both of left cardiac pathologies such as mitral regurgitation (MR) and right cardiac pathologies such as pulmonary hypertension (PHT) may cause structural and functional alteration in LA. In the present study, we examined the effects of PHT and MR on LA functions by making use of deformation parameters.

Material and Methods: 58 patients followed up with diagnoses of MR (32) and PHT (28) and healthy subjects (28) having the demographical characteristics similar to those of patients were involved in the present study. The deteriorations of LAfunctions of patients, changes of affected parameters among the disease groups, and the clinical effects of these changes were examined.

Results: 88 patients were involved in the present study. The mean age was 38.7±4.5 years, and 34% of the participants were male. AlthoughLA functions were found to be deteriorated in both diseases when compared to the control group in univariate analysis, the difference was found only in deformation analyses (p:0.02). In MR group, LA functions were determined to be lower than both of PHT and control group. In correlation analysis, both of the diseases were found to be significantly related with LAS and LASR.

Conclusions: In the present study, we showed that both of the diseases may affect the LA functions at various levels and, when compared to conventional methods,LAS and LASR parameters can provide more accurate information about the severity of both diseases.

Keywords: Left Atrium; Mitral Regurgitation; Pulmonary Arterial Hypertension; Strain.

INTRODUCTION

Left atrium (LA) is a cardiac chamber that plays fundamental role for a healthy cardiac pumpfunction and the cardiovascular mortality is more observed among the individuals having LA dysfunction. Mitral regurgitation (MR) is the leading factor causing LA dysfunction, and the systolic and diastolic dysfunctions and the right cardiac pathologies cause LA dysfunction (1,2).

The pulmonary arterial hypertension (PHT) is a progressive disease coursing with high level of mortality. It may be idiopathic, as well as it may be seen due to other factors. It also causes both pulmonary and cardiac dysfunction. In this disease, the LA functions may be deteriorated in early period (3-5).

Although there are various studies on these diseases in literature, there is no study comparatively examining the effects on LA functions. In the present study, we aimed to investigate the deterioration in LA functions, the changes in affected parameters in disease group, and the clinical effects of these changes.

MATERIAL and METHODS

The present study was carried out on patients, who applied to our clinic between January 2017 and December 2017. The approval of ethics committee was obtained and the procedures were executed in accordance with Helsinki Declaration. The patients were divided into three groups based on the results of echocardiographic examination. The patients found to have mitral regurgitation at the end of echocardiographic evaluation were assigned to Group 1, those found to have pulmonary artery pressure >30 mmHg to Group 2, and those having normal cardiac functions to Group 3. The patients with secondary pulmonary hypertension, those that cannot be evaluated because of the bad echogenicity, the patients having mitral stenosis,

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and the patients having left ventricular dysfunction were excluded from the study.

The clinical and demographical characteristics of the patients and the medications they used were recorded before the study.

Echocardiography

All the patients were undergone echocardiographic examination in left lateral decubitus position by using Vivid 7 device.In accordance with the current ASE recommendations[3], the images for the offline analyses were recorded from all the windows in apnea periods, in length of minimum 3 cardiac cycles, and at 50-70 fps.

The records were assessed by two experienced cardiologists in accordance with current ASE recommendations and by using EchoPack soft ware. All of the patients were undergone standard echocardiographic examination including 2D (two-dimensional), PW (pulsed-wave) Doppler, color Doppler and M-mode echocardiography by using both TTE and TEE. The deformation analyses were performed by making use of the video records, which were recorded at the rate of 50-75 fps rate and in which the endocardial borders are visible. The limits were manually drawn by using pointer. Then, the device calculated the LAS and LASR parameters. The measurements were repeated after a week and the intra-observer and inter-observer variations were checked.

Statistical analysis

The numeric variables were expressed as mean value or median value, whereas the categorical variables were expressed in percentage. The normality of variables' distribution was tested using Kolmogorov Smirnov test. The signal-averaged ANOVA test or Kruskall Wallis test was used in comparing the numeric variables, whereas categorical values were compared using X^2 test.The correlation of LAS and LASR parameters with severity of disease was analyzed using Pearson's correlation test. The analyses were performed using SPSS Version 22. The statistical significance was set at $P < 0.05$.

RESULTS

In accordance with the inclusion and exclusion criteria, 56 patients were involved in the present study. The baseline demographical characteristics are summarized in Table 1 and LAS and LASR values of the study population were shown in figure 1.

Table 1. Baseline demographical and clinical characteristics of the study population

	Group-1 (N=32)	Group-2 (N=26)	Group-3 (N=30)	P Value
Age (years)	41±3.5	37±3.6	38±3.4	0.342
Sex (male, %)	37	32	35	0.245
Diabetes Mellitus, %	12.3	13.9	11	0.315
Hypertension, %	24.9	21.5	20	0.243
Dyslipidemia, %	12	11.7	11	0.704
CRF, %	1.2	1.1	1.2	0.911
WBC × 10^3mL	8.1 (5.9-10.2)	7.5 (75.2-9)	8.4 (7.1-11)	0.654
Neutrophil× 10^3mL	5.1 (3.2-6.7)	5.4 (4.1-6.5)	5.1 (4.1-6.5)	0.960
Lymphocyte × 10^3mL	2 (1.1-2.6)	2.1 (1.7-2.7)	2.3(1.8-2.7)	0.692
Hemoglobin, g/dL	14.5±1.8	14.7±1.6	14.7±1.8	0.851
Platelet, × 10^3mL	241±54	248±59	255±63	0.731
Creatinine	0.8±0.2	0.8±0.3	97.8±19.2	0.413
Glucose, mg/dl	103 (90-136)	107 (93-143)	102(93-133)	0.704
Total Cholesterol, mg/dL	180 (143-221)	176 (151-201)	190 (159-231)	0.321
LDL-Cholesterol, mg/dL	116 (110-147)	121 (105-150)	126 (100-158)	0.082
HDL-Cholesterol, mg/dL	40 (24-47)	42 (30-49)	40 (34-48)	0.856
Triglyceride, mg/dL	156 (110-222)	149 (111-228)	139 (101-198)	0.128
Na	139 (136-140)	138 (135-140)	139 (135-142)	0.631
K	4.3 (4-4.6)	4.2 (4.1-4.6)	4.1 (4.1-4.6)	0.432
Ca	9.5 (9.1-9.8)	9.2 (9-9.7)	9.3 (9-9.7)	0.189
Mg	1.8 (1.5-2.1)	1.9 (1.4-2.2)	2 (1.9-2.3)	0.851
AST	24 (20-34)	23 (19-31)	24 (19-32)	0.298
ALT	23 (17-33)	21 (16-30)	22 (16-31)	0.593
Albumin	4.1 (3.9-4.5)	4.1 (3.9-4.4)	4.2 (3.9-4.5)	0.129

Abbreviations: CRF; chronic renal failure, LDL; low density lipoprotein; HDL, ; high density

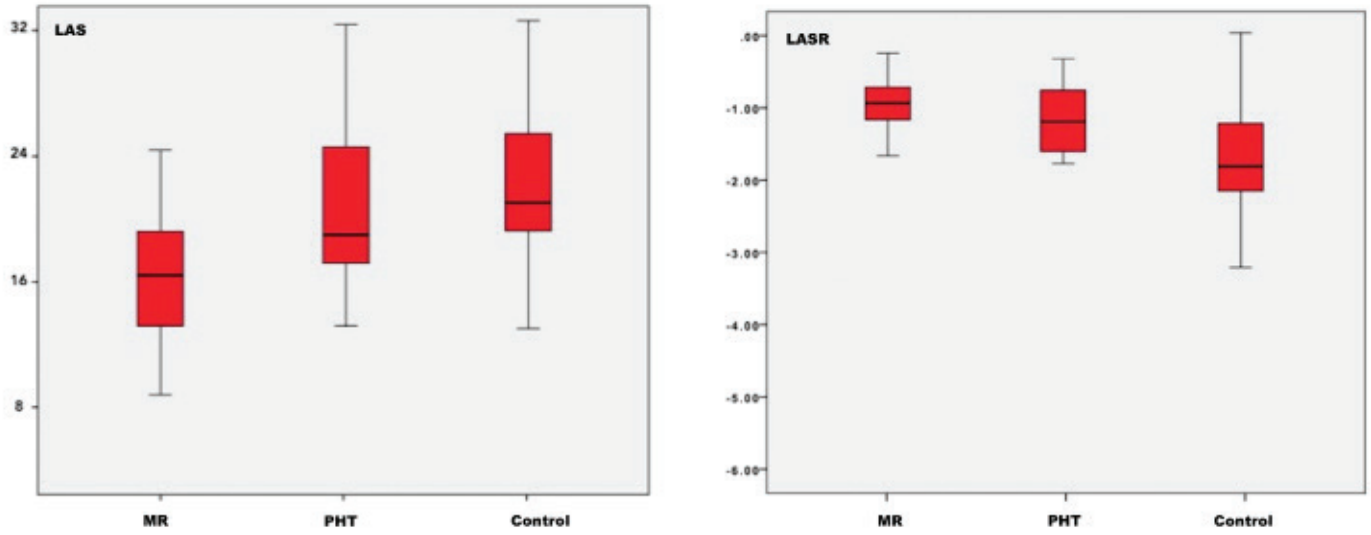

Figure 1. LAS and LASR values of the study population

Given the conventional echocardiographic characteristics of both groups, it was determined that the Doppler parameter and left ventricular systolic and diastolic diameters were significantly higher in MR group. In PHT group, the right ventricular diameters were found to be significantly higher and TAPSE was significantly lower when compared to control and MR groups. However, when compared to the control group, the difference was near the significance level (Table 2).

Table 2. Baseline echocardiographic characteristics of the study population

	Group-1 (N=32)	Group-2 (N=26)	Group-3 (N=30)	P Value
LVDD (mm)	46.8±6.0	46.1±5	46.3±4	0.43
LVSD (mm)	26.2±5.2	25.4±5.2	25.7±5.1	0.67
RVD (mm)	37.5±6.2	37.1±6.2	36.1±4.2	0.21
TAPSE (mm)	19±5.2	20.2±5.2	20.8±4.2	0.45
sPAP (mmhg)	25.1±5.2	28.6±5.2	24.6±5.5	0.78
LV-EF (%)	62.4±6.0	62.9±6.0	63.9±6.5	0.32
E velocity (m/s)	1.2±0.14	1.1±0.10	1.0±0.9	0.36
A velocity (m/s)	0.59±0.10	0.70±0.10	0.72±0.10	0.56
E' (m/s)	0.14±0.02	0.11±0.03	0.12±0.03	0.23
A' (m/s)	0.16±0.01	0.15±0.01	0.15±0.01	0.19
IVRT (ms)	86.2±13.6	89.9±11.1	85.9±10.3	0.49
IVCT (ms)	42.2±8.1	44.4±9.3	44.4±9.3	0.67
LAS (%)	19.2±5.1	22.4±5.2	24.4±5.2	0.02
LASR E (s-1)	0.9±0.2	1.10±0.2	1.40±0.2	0.043
LASR A (s-1)	1.25±0.2	1.40±0.1	1.50±0.2	0.031
LASR S (s-1)	0.82±0.2	1.10±0.1	1.20±0.2	0.041

Abbreviations: LVDD; left ventricular diastolic diameter, LVSD; left ventricular systolic diameter, RVD; right ventricular diameter, TAPSE; tricuspid annular plan systolic excursion, sPAP; systolic pulmonary artery pressure, LV-EF; left ventricular ejection fraction, RV-EF; right ventricular ejection fraction, IVRT; isovolumetric relaxation time, IVCT; isovolumetriccontraction time,LAS; left atrial strain, LASR E; Left atrial strain rate E, LASR A; Left atrial strain rate A, LASR S; Left atrial strain rate S

In speckle tracking analysis, when compared to the control group, the LA functions were found to be lower in both diseases, whereas the difference was more significant in MR group.

Given the correlation of severity of MR and PHT with the LAS values, a good and negative correlation (r=0.57) was found with MR and moderate and negative correlation was found with PHT (r=0.36).

DISCUSSION

The present study is the first, study, in which the effects of MR and PHT diseases on the LA functions were investigated. In the present study, it was showed that both diseases might affect the deterioration of LA functions but the LA dysfunction is more significant among MR patients and, when compared to the control group, the deterioration was milder in PHT group.

LA has a critical role for a healthy cardiac function under favor of its functions as conduit, pump, and reservoir. The deterioration in LA functions was related to the increased mortality. In Framingham study, LA enlargement was found to be related to the mortality. In another study, the increased LA volume was related to the development of postoperative arterial fibrillation. Finally, left atrial volume index was found to have a significant relationship with mortality (6-10).

The LA dysfunction is a common symptom among the mitral valve diseases. The left atrium subjected to chronic pressure and volume overload is exposed to both structural and morphological alteration, and consequently the dilatation develops and atrial contraction ability is gradually lost. From this aspect, following the atrial functions of these patients is of critical importance for selecting the surgical or interventional treatments (11-14). Based on the results obtained in this study, it can be seen that, when compared to the control group, the LA volume and Doppler parameters were significantly higher in both

groups. However, in subgroup analysis, this difference was not at statistical significance level even though the deterioration was more prominent in MR group. This finding is important since it suggests that LA functions may be rapidly deteriorated in early period among MR patients, and that this effect may be seen in later periods in PHT. This finding is unique when compared to the literature.

Our second finding was that, in speckle tracking echocardiographic examination, the LA functions were found to be significantly deteriorated in both groups and this deterioration was more severe in MR group. In MR, the increased volume and pressure load cause changes in LA structure and morphology, and the deformation analyses on MR patients showed that theLA dysfunction developed since the early period (13-16). This finding is in accord with the literature. However, the low level of strain in PHT group is not as prominent as in MR group, and this result is important since it indicates that LA dysfunction is at milder level. Given the results obtained from the present study, it can be stated that the LA functions of PHT patients were deteriorated and, when compared to the conventional parameters, LA strain and LASR parameters may be useful in detecting the LA dysfunction of PHT patients in earlier periods. In conclusion, when compared to the conventional methods, the deformation analysis yield better and more reliable results in determining the LA dysfunction in both patient groups.

CONCLUSION

The LA structure and function are affected from both right and left cardiac pathologies. This effect is more prominent in left cardiac pathologies such as MR, and the conventional echo and Doppler parameters may not provide the clinician with accurate findings in estimating the severity of disease or making clinical decisions regarding the LA structure and functions. From this aspect, when compared to the conventional methods, LAS and LASR parameters may provide the clinician with more useful information in right and left cardiac pathologies.

Limitations

Our study has some limitations. First, our sample size is relatively small. LAS is not routinely assessed in clinical practice. Therefore, our sensitivity and specificity values were derived from our small cohort and might not be necessarily applied to a general population. Due to local technical unavailability, we could not perform 3D echocardiography or magnetic resonance imaging.

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