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Association Between the Left Atrial and Left Atrial Appendages Systole Strain Rate in Patients with Atrial Fibrillation

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Background: The aim of this research was to explore the association between the left atrial (LA) and left atrial appendages (LAA) systole strain rate (SSR) in patients with atrial fibrillation (AF), and to provide evidence to aid in the assessment of disease progression.

Material/Methods: A total of 180 patients with AF were selected for the study (130 patients with paroxysmal AF (Par AF) and 50 patients with persistence AF (PerAF).In addition, 60 healthy individuals were selected as a control group. The total and side wall SSRs were calculated.

Results: The total SSR in the control group was higher than in the ParAF and PerAF groups (2.87±0.45 *vs.* 2.15±0.56 *vs.* 1.92±0.62 and 6.24±1.61 *vs.* 4.45±1.42 *vs.* 3.66±1.55). The total SSR of LAA was correlated with that of LA in the AF patient groups and the control group; the correlation coefficients were 0.720, 0.563, and 0.421. However, the ratio of total SSR of LAA to that of LA was not significant statistically different among the three groups (2.24±0.41 vs. 2.35±0.58 *vs.* 2.03±0.56). The posterior wall had the lowest SSRs in the control group and ParAF group.

Conclusions: The SSRs of AF patients were lower than that of healthy individuals, and the degree was associated with disease progression. The SSR was different in different side walls, and gradually shorten with disease progression.

MeSH Keywords: Atrial Appendage • Atrial Fibrillation • Atrial Function, Left

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Background

Atrial fibrillation (AF) is one of the common arrhythmia presentations observed in the clinic, its incidence rate increases with age, and it brings a huge threat to a patient life, safety, and quality of life [1,2]. As a simple and viable indicator of AF, the heart blood flow parameter is an important tool to evaluate the function of the left atrial (LA) [3]. In addition, strain and strain rate indexes can be used to evaluate myocardial deformation at presentation, which can reflect the overall myocardial functional state [4–6]. In this study, we utilized easily operated, noninvasive, and highly accurate echocardiogram and transesophageal echocardiography (TEE) to visualize the heart and left atrial appendages (LAA). Based on results from ultrasonography, the association between LA and LAA systole strain rate (SSR) in AF patients was analyzed, which may provide a basis for future clinical research.

Material and Methods

Study objects

One hundred and eighty AF patients treated at our hospital from January 2013 to December 2015 were randomly enrolled in this study. Inclusion criteria included: (1) complied with the criteria for the diagnosis of AF; (2) underwent transthoracic echocardiography (TTE) and esophagus inspect; and (3) signed informed consent. Exclusion criteria included: (1) LA thrombosis; (2) congenital heart disease; (3) hypertensive heart disease; and (4) dysfunctions in left ventricular. In addition, 60 healthy patients with matching gender and age were randomly selected as the control group. This study received permission from and was supervised by the Medical Ethics Committee. The clinical data of the 180 AF patients and 60 control patients are shown in Table 1.

Methods

Patients received imaging evaluation by TTE and TEE. The images of the cardiac cycle were collected via TTE results; the acquisition sections were four-chamber view and two-chamber view. Six hours before the esophagus inspect, patient fasting was needed. Patients were anesthetized before inspection. The preferred inserting depth of the probe to show the heart bottom section was about 35–40 cm; which allowed dynamic cardiac cycle measurement. The images were analyzed with QLAB software.

Observational index

The LA inner diameter (LAID), left ventricular ejection fraction (LVEF), SSR of LA and LAA, and strain rate of each side wall were observed and calculated.

Statistical methods

Statistical calculations were established using SPSS 19.0 software. Measurement data were presented as x±s. The differences between two groups were compared using *t*-tests and the differences among three groups were compared using ANOVA tests. Enumeration data were compared using χ^2 tests. Pearson method was used in correlation analysis. A value of $p<0.05$ was considered statistically significant.

Results

Comparison of LAID, LVEF, and SSR among the three groups

There were no significant differences in LAID or LVEF among the three groups ($p>0.05$). SSRs in LA and LAA of the control group were higher than in the parAF and perAF groups (2.87±0.45 *vs.* 2.15±0.56 *vs.* 1.92±0.62, $p<0.05$; 6.24±1.61 *vs.* 4.45±1.42 *vs.* 3.66±1.55, $p<0.05$) (Table 2).

Correlation analysis of LA and LAA SSR among the three groups

Significant correlations were shown in LA and LAA SSRs among control, parAF, and perAF groups, the correlation coefficients were 0.720, 0.563, and 0.421 (R^2=0.513/0.194/0.178), and there were no significant differences in SSR ratios (2.24±0.41 *vs.* 2.35±0.58 *vs.* 2.03±0.56) (Table 3).

Table 1. Clinical data of 180 AF patients and 60 control cases.

Group	AF (n=180)	Control (n=60)	χ^2/t	P
Gender (Male/Female)	116/64	36/24	0.191	0.662
Average age (year)	51.42±5.22	51.27±5.53	0.190	0.850
AF type (case)				
ParAF	130	–	–	–
PerAF	50	–	–	–

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Table 2. Comparison of LAID, LVEF and SSR among three groups (x±s).

Group	parAF (n=130)	perAF (n=50)	Control (n=60)	*F* value
LAID (mm)	33.25±4.13	36.73±7.09	27.71±5.28	1.21
LVEF (%)	63.74±6.23	61.89±7.96	65.37±7.02	1.37
LA SSR	2.15±0.56	1.92±0.62	2.87±0.45	11.56*
LAA SSR	4.45±1.42	3.66±1.55	6.24±1.61	6.02*

Comparison among three groups, * P<0.05.

Table 3. Correlation of LA and LAA SSR among three groups.

Group	parAF (n=130)	perAF (n=50)	Control (n=60)	*F* value
LAA SSR/LA SSR	2.35±0.58	2.03±0.56	2.24±0.41	0.81
Correlation coefficient	0.563*	0.421*	0.720*	–
R^2	0.194	0.178	0.513	

* P<0.05.

Table 4. Comparison of SSR in side wall and segment among three groups.

Group	parAF (n=130)	perAF (n=50)	Control (n=60)	*F* value
LA				
Atrial septum	2.02±0.52	1.85±0.41	2.50±0.46	11.07*
Left atrial wall	2.21±0.66	1.86±0.56	3.42±0.91	30.19*
Front wall	2.45±1.04	1.81±0.88	3.17±1.09	9.67*
Posterior wall	1.88±0.64	1.77±0.49	2.41±0.42	7.32*
LAA				
Medial wall	4.51±1.41	3.46±0.94	6.31±0.78	19.54*
Lateral wall	4.50±1.60	3.68±0.96	6.31±1.12	30.26*

* P<0.05.

Comparison of SSR in side walls and segments among the three groups

The results of side wall evaluation showed that values of LA posterior walls in the control group and the parAF group were the lowest; however, there were no significant differences compared to the perAF group. There were significant differences in each side wall SSR among the three groups (p<0.05) (Table 4).

Discussion

AF is one type of progressively developing cardiovascular disease. In light of world population aging phenomenon, the threat of AF associated diseases to the health of elder people is increasing. In cardiovascular diseases, AF is one of the most common arrhythmias. The clinical symptoms of AF include chest discomfort and flustered feeling. AF increases the risk and incidence of stroke and heart failure, which brings huge physical, mental, and economic burdens to patients. In recent years, with its rising incident rate, AF has become a research hot topic among cardiovascular diseases; its corresponding therapy method is also the focus of study for clinicians [7,8].

When AF occurs, LA loses the function to pump blood, the heart rate turbulence disrupts the heart chambers collaborative activities, resulting in damage to the heart normal functions, resulting in decreased patient activity and quality of life. When thrombus is induced by AF, the incidence of embolic diseases is progressively increased, which brings increased threats to a patient's life and safety. Clinical studies have shown that the key links between initiation and development of AF were the damage of

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LA functions and reconstitutions of LA structure, which were also the determinant factors for consideration for the therapeutic effect of treatments for AF. LAA is the special accessory structure of LA, and LAA is the most common place where the LA thrombus occurs. The damage incidence of LAA function is directly proportional to the incident rate of embolic diseases in AF patients [9], and the mechanical function of LAA is closely related to the therapeutic effect of treatments for AF [10]. In the ventricular systole, the active relaxation activities and stiffness of LA will affect the volume of circulating heart blood flow from the pulmonary vein to the LA [11]. The functions of LA and LAA associate with the therapeutic effect of treatments for AF, therefore, the accurate evaluation of LA and LAA possesses significant meanings to estimate the AF illness state, including helping clinical doctors make accurate judgment, formulate effective therapeutic plans and evaluate the therapeutic effect.

LA is responsible for three major functions in heart movements. One function is the storage function, which means the storage of the circulating heart blood in the left atrium from the pulmonary vein during the left ventricular systolic stage. In the early stage, LA active relaxation is responsible, whereas in the late stage, the basement activity of left ventricular contraction is responsible. This process is also influenced by the compliance of LA. The second function is the vessel function; this means that in the early diastole phase of LA, depending on the active relaxation of LA, the LA blood flow enters into the left ventricle via the opening of the mitral valve. The third function is the booster pump function, which occurs in the late phase of left ventricle diastole. Depending on the LA contraction ability, the LA blood flow is propelled into the left ventricle by the active contraction pressure of LA, and this process is also influenced by the compliance of the left ventricle. SSR reflects myocardial functions through the deformation degree and rate of myocardium, and is a relatively new indicator used to evaluate myocardial deformation activities. On the basis of this theory of function, myocardial functions can be directly reflected by myocardial deformation activities, and the myocardial lesion severity can also be measured. A large number of studies have verified the high value of using SSR to evaluate left ventricular functions, and some studies have also reported the effectiveness of SSR to evaluate LA functions [12]. When AF happens, the active contraction ability and booster pump function of LA are lost. As a function of storage, the deformation ability is gradually impaired, and the deformation degree and rate are all decreased [13–16].

Conclusions

In this study, we found that the SSRs of LA and LAA in AF patients were lower than that of healthy people, with the lowest value in the posterior wall, and with deterioration of the AF-related illness, the differences were gradually diminished. Thus, for AF patients, the LA SSR is an important referential value not only to estimate LAA functions and AF-related illness state, but also to predict prognosis.

Conflict of interest

None.

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