Correlation of Atrial Fibrillation with Left Atrial Volume in Patients with Mitral Stenosis. A single centre study from Pakistan

Original Article

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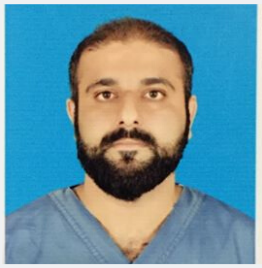

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ABSTRACT

Background: Rheumatic heart disease has a strong association with mitral valve stenosis. Atrial fibrillation is one of the most common complications of this condition and is a poor prognostic factor. Early detection and prompt management of atrial fibrillation can help to improve the quality of life and increase the life expectancy of the patients. We carried out this study to investigate the significance of left atrial volumetric changes in mitral stenosis and its correlation with atrial fibrillation.

Methodology: We audited the data of 60 patients of rheumatic heart disease who had mitral valve stenosis. The patients were randomized into atrial fibrillation (Group A) and normal sinus rhythm (Group B). We conducted this cross-sectional analytical study at Cardiology Department, Mayo Hospital, Lahore, from 1st February 2017 to 31st January 2018. We only included those patients who consented to be a part of this study and fulfilled our predefined inclusion criteria. Left atrial volume was measured by prolate ellipse method and biplane methods on echocardiography. The Data was analyzed on SPSS v20.

Results: Sixty patients were included in the study. Among the subjects, thirty-six (60%) were males, and twenty-four (40%) were females. Atrial fibrillation was noted in 43.33% of the patients of mitral valve stenosis. There was a marked difference in the mean volume of the left atrium among the two groups. We observed that the mean area of the mitral valve for Group A patients was larger than that of patients in Group B. Our study showed an inverse correlation between left atrial volume and mitral valve area among Group A patients.

Conclusion: Patients of mitral stenosis are at an increased risk of developing atrial fibrillation if the left atrial volume is increasing. All patients with mitral stenosis should have routine echocardiography & measurement of left atrial volumes, so that proper treatment can be started if the left atrial volume is increasing, to prevent atrial fibrillation.

Keywords: *Normal Sinus Rhythm, Mitral valve Stenosis, Left Atrial Volume, Atrial Fibrillation, Left Atrial Dilation.*

INTRODUCTION

Structural abnormality of the mitral valve, leading to left ventricular inward flow obstruction is called Mitral valve stenosis. Rheumatic fever is the most common cause of mitral valve stenosis.[1] Surgeons have observed during mitral valve replacement that in the majority of the patients with mitral stenosis, there is a substantiation of rheumatic heart disease.[2] About 40% of the patients with chronic rheumatic heart disease have either mitral regurgitation or mitral stenosis. Patients suffering from rheumatic mitral stenosis constitute two-thirds of total cases of mitral stenosis.[3] Atrial fibrillation is a documented complication of long-standing mitral stenosis and occurs secondary to atrial enlargement [Figure 1]. It has a herculean association with the size of the left atrium, the total duration of its pathological enlargement, and the age of the patient.[2-4] Enlarged left atrium precludes the effective emptying of the atrium into the ventricle, subsequently causing excessive pooling of blood into the left atrium and reduction of its “pump boost” function. Left atrial dilation adversely affects the slow, as well as fast conductive pathways in the walls of the atria, thus predisposing the patients to atrial fibrillation.[5] Paroxysmal or persistent atrial fibrillation can precipitate pulmonary enema in up to

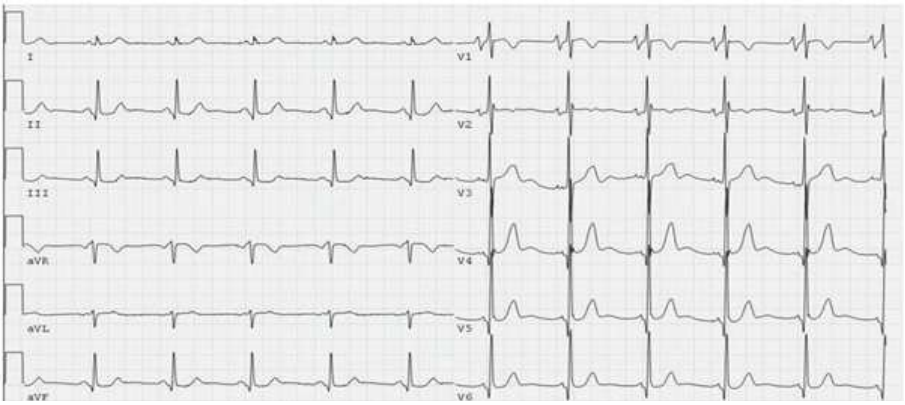

Figure 1: ECG showing Bifid P wave in Left Atrial Enlargement.

eighty percent of patients, further complicating the disease.[6] Atrial stasis, a hallmark of advanced left atrial dilation, is evident on echocardiography as spontaneous echo contrast and is generally a result of multiple factors, most significant of those being forward flow obstruction, disorganized electrical activity, and increased size of the left atrial cavity. Left atrial anteroposterior diameter was one of the first standardized echocardiographic parameters for the estimation of left atrial volume.[7] It is noteworthy that the enlargement of the left atrium is not uniform in most cases. The rate at which it enlarges varies in different planes, which leads to pathological mechanical modifications in the left atrium. Left atrial volume or its changes may not be accurately reflected by using a single linear dimension. The volume of the left atrium is a more sensitive parameter than the diameter of the left atrium, to assess any increase in left atrial dimensions.[8,9] The following study aims to determine the correlation of atrial fibrillation with left atrial volume in patients with mitral stenosis.

METHODOLOGY

We conducted this cross-sectional analytical study in the department of Cardiology Mayo hospital Lahore from February 2017 to January 2018 after ethical approval from the institutional review board of King Edward Medical University, vide letter number No.206/RC/KEMU dated 26.11.2019.

Patient Selection & Randomization

A total of Sixty patients were included in this study (thirty in each group). The patient population was estimated using a 5% level of significance, 90% power with the expected percentage of atrial fibrillation as 75%, and left atrial volume as 100%. The patients were recruited by non-probability convenient sampling following predefined inclusion & exclusion criteria, from the outpatient & inpatient departments of Mayo Hospital Lahore after obtaining informed consent. We stratified the subjects into two groups (A and B) using block randomization. Group A patients had atrial fibrillation (n=30), and Group B patients had normal sinus rhythm (n=30). Our study groups had established diagnosis of mitral stenosis with a positive history of rheumatic fever.

Inclusion Criteria

All patients who were legally adults, diagnosed cases of rheumatic mitral stenosis, belonging to both genders, were included in this study.

Exclusion Criteria

Patients with hyperthyroidism, marked left ventricular dysfunction having ejection fraction less than 35% on echocardiography, congenital heart disease, and long-standing coronary artery disease were excluded from our study.

Patient Characteristics

The patients who fulfilled our pre-defined criteria were recruited for this study. The study procedure was explained to them. Demographic information like name, age, sex, race or ethnicity, and address were noted. A detailed history and physical examination were done for all the patients. All the patients underwent baseline systemic evaluation. Routine serum chemistry, including a lipid profile, was done for all. Standard twelve lead electrocardiogram was recorded, followed by echocardiographic studies for each patient.

Estimation of Left Atrial Volume

Echocardiographic measurements, required for the estimation of left atrial volume (LAV), were taken over at least five times if the baseline rhythm was atrial fibrillation. All echocardiographic studies were performed by one diagnostic cardiac sonographer with the same echocardiographic instrument (VIVID 7) according to a standardized protocol, viz a viz “prolate ellipse method.” The measurements of left atrium were performed in four chambers, the apical view labeled as D2 and D3, and the parasternal long-axis view labeled as D1. The left atrial volume was calculated using the following formulas;.

Left Atrial Volume in ml = D1xD2xD3x0.523.

The other method employed to calculate volume was the biplane area-length method;

LA volume = 0.85xA1xA2/(L1-L2/2).

Inclusion and exclusion criteria were followed in letter and spirit to control the confounding variables and minimize bias.

RESULTS

This study included 60 patients. There were 36 male subjects (60%) and 24 (40%) female subjects. The mean age of our subjects was 37.33±10.01 years with minimum age 20 years and maximum age of 60 years, respectively [Table 1].

We noticed a significant left atrial size variation among the two groups. In our study, the mean left atrial size for Group A was 75.23±18.62, whereas for Group B, it was 42.30±12.30 [Table 2].

The mitral valve area was significantly reduced in both groups. Group A patients had a mean mitral valve area of 1.252±0.541 cm^2, whereas Group B patients had a mean mitral valve area of 0.870±0.368cm^2[Table 3].

We found a significant association between echocardiographic changes and left atrial volumes. Scans of Group A patients revealed abnormally large left atria, with volumes greater than 75 in nearly half of the subjects [Table 4]. In Group B, the left atrial volume was <45 in the majority of the subjects, and no significant left atrial enlargement was noted [Table 4]. The difference of left atrial volumes amongst the study groups was found to be statistically significant, with a p-value of < 0.001.

Echocardiographic findings showed a significant difference in mitral valve area dimensions in the 2 study groups. It is interesting to note that among the patients of Group B, the mitral valve area was <1.0 in the majority (n=27, 90%) [Table 5].

Among the Group B patients, left atrial volume and mitral valve area showed a negative moderately significant correlation (r= -0.436, p<0.001). Whereas in Group A, Left Atrial Volume, and Mitral Valve Area showed a very weak inverse correlation (r= -0.012, p=0.952) [Figure 2].

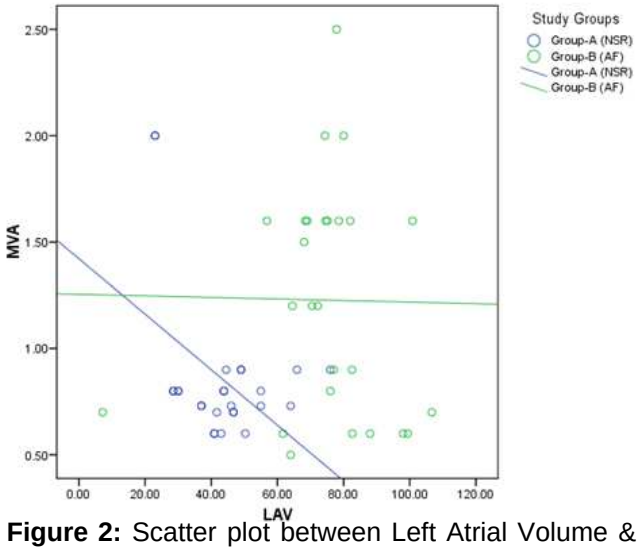

Figure 2: Scatter plot between Left Atrial Volume & Mitral Valve Area.

DISCUSSION

Rheumatic fever is a condition affecting children and the juvenile population.[10] Rheumatic heart disease is a commonly reported complication of rheumatic fever. It's typically preceded by a sore throat and, if not diagnosed in time, can lead to permanent mutilation of the mitral valve of the heart. The causative organism is a bacterium called Streptococcus pyogenes, a member of group A beta-hemolytic Streptococci family. There is pathological calcification of mitral valve due to autoimmune reaction, ultimately leading to mitral stenosis, which is irreversible and can only be corrected surgically in advanced cases.[11,12] Mitral valve stenosis hampers proper filling of the left ventricle, the end-diastolic volume is markedly reduced, leading to diminished stroke volume and failure of "pump boost" action of the heart. This starts a vicious cycle, which ultimately leads to left atrial enlargement and atrial fibrillation. Atrial fibrillation is one of the most alarming complications of advanced rheumatic heart disease and can be managed if diagnosed in time.[13] During the course of mitral stenosis, enlargement of the left atrium is considered a key element. Changes in the left atrial pressure secondary to stenosis of the mitral valve lead to the enlargement of the left atrium over time and atrial fibrillation is considered to be a secondary phenomenon.[14] The increase in left atrium tension due to an increase in pressure as a consequence of mechanical obstruction at the mitral valve leads to increased oxygen consumption by the myocardium. Myocardium dilates due to increased workload and ultimately leads to heart failure. The disarray of myocardial cells and an increase in tension of the left atrial wall results in electrophysiological and conductive changes leading to atrial fibrillation.[13,14] Due to improper filling of ventricles, the blood supply to vital organs, especially the brain, is impaired, which predisposes the patient at risk of stroke, dementia, and Alzheimer's disease. Additionally, one of the most feared complications of atrial fibrillation is heart failure, which adds to the misery of the patient.[15] The disease is prevalent in low-income communities worldwide and is a leading cause of sudden cardiac death in these communities.[16]

CONCLUSION

Rheumatic fever is prevalent in low socioeconomic

Total	**60**
Mean	37.33
SD	10.01
Min	20
Max	60

Table 1: Age wise distribution of patients

	Group A (n=30)	**Group B (n=30)**	**Total (n=60)**
Mean	75.23	42.30	56.57
SD	18.62	12.30	22.41
Min	71.9	23.01	7.19
Max	106.70	76.00	106.70

Table 2: Descriptive Statistics For Left Atrial volume

	Group A (n=30) cm^2	**Group B (n=30) cm^2**	**Total (n=60) cm^2**
Mean	1.252	0.870	1.031
SD	0.541	0.368	0.484
Min	0.50	0.60	0.50
Max	2.50	2.00	2.50

Table 3: Descriptive statistics for mitral valve area

		Electrocardiographic Findings		**Total**
		Group A (n=30)	**Group B (n=30)**	
LAV	**<45**	1(3.0%)	21(70%)	**22**
	45-55	0(0%)	10(33.33%)	**10**
	56-65	4(13.33%)	1(3.0%)	**5**
	66-75	8(26.66%)	1(3.0%)	**9**
	>75	43.33(50%)	1(3.0%)	**14**

Table 4: Association between Atrial Fibrillation & Left Atrial volumes

cm^2		Atrial Fibrillation (n=30)	(n=30)	Total
MVA	<1.0	13(42.3%)	27(90.0%)	40
	1.1-1.5	4(13.33.%)	0(0%)	4
	>1.5	13(42.33%)	3(10.0%)	16

Table 5: Association between Atrial Fibrillation (AF) & Mitral valve area (MVA)

populations. Partially treated rheumatic fever predisposes the patient to the development of mitral stenosis and atrial fibrillation. Our findings depicted a higher frequency of atrial fibrillation in mitral stenosis as well as higher left atrial volume in patients with atrial fibrillation. Our study findings may help to identify patients in sinus rhythm to screen those at risk of developing atrial fibrillation by using echocardiography. It may also aid in the management by using either antiarrhythmic medication or prophylactic anticoagulation or both for the prevention of thromboembolism.

LIMITATIONS OF CURRENT STUDY

As with any study, there are some limitations to this study as well. Echocardiography is an essential component of this study. As it is a non-invasive modality, there are intra-observer and inter-observer variations during studies because technically, it very difficult to reproduce the same images. Our study used 2-Dimensional echocardiography for all the measurements. In comparison to 3-Dimensional echocardiography and Cardiovascular magnetic resonance (CMR), 2-Dimensional echo underestimates the LA volumes due to geometric assumptions, LA foreshortening, and manual tracing errors. For future studies, we may need to use these advanced modalities to get more accurate LA measurements.

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CONFLICT OF INTEREST

The Authors declared no conflicts of interest.

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