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Research Article

Echocardiographic Evaluation of Left Atrial and Left Atrial Appendage Function in Atrial Fibrillation

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Abstract
This was an observational cross sectional study of 100 Patients at R.G Kar Medical College and Hospital, Kolkata. With diagnosis of Atrial Fibrillation between March 2018 to August 2019. Patients who fulfil the inclusion and exclusion criteria were enrolled for the study after getting written informed consent. Echocardiographic evaluation of function of Left atrium and left atrial appendage in atrial fibrillation shows impairment. Echocardiographic assessment of various parameters of left atrial and left atrial appendage function showed significant difference between various types of atrial fibrillation. Left atrial dimensions, volume indices, left atrial appendage velocity, pulse doppler and tissue doppler are easy to perform and useful in predicting left atrial function in atrial fibrillation.
Keywords: *left atrial function, atrial fibrillation.*

Introduction

Atrial fibrillation is the most common of the serious cardiac arrhythmias and is associated with increased morbidity and mortality in the community. Prospective data from the large population-based studies have established a relationship between M-mode anteroposterior LA diameter and the risk of developing AF.[6,7]

In the Framingham study, a 5-mm incremental increase in anteroposterior LA diameter was associated with a 39% increased risk for subsequent development of AF[6]. In the Cardiovascular Health Study, subjects in sinus rhythm with an anteroposterior LA diameter >5.0 cm had approximately four times the risk of developing AF during the subsequent period of surveillance.[7]

More recently, LA volume has been shown to predict AF in patients with cardiomyopathy[3,4] and first-diagnosed nonvalvular AF in a random sample of elderly Olmsted County residents who had undergone investigation with a clinically indicated echocardiogram.[1,2]

The relationship between LA volume and LA dimension was nonlinear 65, and it has been confirmed that LA volume represented a superior measure over LA diameter for predicting outcomes including AF[1,3,5] and provided prognostic information that was incremental to clinical risk factors.[1]

Echocardiographic measures of LA diameter, volume and mechanical function were associated with AF progression. The left atrial appendage is the most frequent site of thrombus formation due to

stagnation of blood flow. Additionally, LAA segmental anatomy, which is most commonly seen, increases the likelihood of thrombi[8-11]. Di Baise et al. demonstrated that non-chicken wing LAA morphology may precipitate thrombus formation.[12]

Left atrial appendage blood flow velocity is another echocardiographic parameter in assessment of LAA function. It is recorded even in patients with AF, but only reduced blood flow below 25 cm/s may be associated with thrombus formation.[13,14,15] In contrast, in patients in sinus rhythm blood flow velocity in the LAA is much higher than in those with AF.[15,16,17]

Direct imaging shows various types of morphologically altered blood such as spontaneous echocardiographic contrast or echogenic blood, sludge or organized thrombus.[10,13,14,18] Visualization of morphologically less organized clots in the LAA is challenging, therefore all possible parameters should be taken into account when differentiating blood clots. Providencia et al. provided a review of various studies in this area.[15]

Aims and Objectives

To study the patients presenting with atrial fibrillation for clinical profile, left atrial anatomy and function and left atrial appendage with Specific objectives:

- Clinical status in the form of stroke, heart failure in patients with atrial fibrillation
- Left atrial function in predicting risk of atrial fibrillation, guiding therapeutic strategies predicting outcomes in patients of atrial fibrillation
- Evaluation of left atrial appendage anatomy and status by transthoracic and transesophageal echocardiography in patients with atrial fibrillation.

Inclusion Criteria

Patients will be eligible for enrollment if patient is diagnosed with atrial fibrillation or ECG changes showing atrial fibrillation (paroxysmal, persistent, longstanding or permanent).

Exclusion Criteria

-Patients with NYHA class III or IV heart failure
-Patient in Cardiogenic shock
-Patient not willing.
-TEE Contraindications

Absolute contraindications for TEE- Perforated viscus, Esophageal stricture, Esophageal tumor, Esophageal perforation, laceration, Esophageal diverticulum, Active upper GI bleed.

Relative contraindications for TEE- History of radiation to neck and mediastinum, History of GI surgery, Recent upper GI bleed, Barrett's esophagus, History of dysphagia, Restriction of neck mobility (severe cervical arthritis, atlantoaxial joint disease), Symptomatic hiatal hernia, Esophageal varices, Coagulopathy, thrombocytopenia, Active esophagitis, Active peptic ulcer disease.

Methods

Consecutive patients admitted to Dept. of Cardiology, R.G Kar Medical College, Kolkata from March 2018 to August 2019 with Atrial Fibrillation were recruited for the study and cases selected from them according to the study design. Assessment of Left Atrial function was done by following methods:

All two dimensional, M-mode and conventional Doppler echocardiographic measurements were performed according to guidelines of American Society of Echocardiography. All measurements were repeated thrice and mean values were taken. For assessment of LA function the following parameters were used:

1. Volumetric assessment of left atrial function
   a) Leftatrial diameter
   b) Left atrial area and volume
   c) Left atrial phasic volumes
2. Left atrial function assessment by doppler echocardiography
   a) Transmitral and pulmonary venous flow velocities
   b) Left atrial ejection force and kinetic energy
3. Tissue Doppler imaging of left atrial function.

Observations

100 patients of atrial fibrillation in R.G. Kar medical college from March 2018 to August 2019 were studies with following parameters.

Section 1: Background characteristics of the study subjects.

Most of the study subjects population were of 51-70 years of age (91%). Mean age was 60.2(±8.2) years.7% subjects were from below 50 years age group and 2% were from above 70 years age group.

62 % of patients were male while 38% of patients were female in study group.

80 % of patients were hindu while 20% of patients were muslim in study group.

Section 2: Risk factors of the study subjects

Prevalence of heart failure (61%) and stroke/ TIA (14%) was high in patients with AF.

Association of other comorbidities like CAD, CKD, DM, HTN is also significant i.e.22%,14%,30% and 65% respectively [in comparison to average Indian population 4% (NCME),6% (variable), 7%(ICMR), 17%(ICMR) respectively]. 51 % of subjects gave history of tobacco consumption in some form. 34% study subjects were suffering from obesity.

44% of study subjects presented with complaints of palpitation.

Section 3: Types of Atrial fibrillation and associated structural heart disease in the study subjects.

Among 100 study subjects, 46% subjects were having permanent AF, 30% had paroxysmal and 24% had persistent AF.

Almost all (82%) but 18% of patients had pulmonary arterial hypertension and mean PAH among the individuals who had PAH was 30.6±11.5mm Hg.

54 % (majority) had chicken wing configuration of left atrial appendage followed by cactus 25% and windsock 20% only 1 patient had cauliflower shape.

16% of all study subjects had regional wall motion abnormality. Anterior wall hypokinesia was most commonly seen in study group (50%) among all patients presenting with regional wall motion abnormality followed by inferior wall hypokinesia (37.5%), inferolateral wall hypokinesia was seen in 6.3% and global hypokinesia was seen in 6.3%.

31% of AF patients had associated structural heart disease other than regional wall motion abnormality. Most commonly seen is mitral stenosis (29%) out of all patients with structural heart disease, mixed valvular heart disease in 54%, severe MR in 9.7%, asymmetric septal hypertrophy in 6.5%.

Only 12 % of subjects with AF had thrombus. LA thrombus (33.3%) was most common followed by left atrial appendage (25%) and then combined (16.7%); spontaneous echo contrast seen in 16.7% and sludge in 1 patient (8.3%).

Section 4: Types of Atrial fibrillation and left atrial indices in these subtypes and relationship within these indices.

Mean value of DT in paroxysmal AF is 187.93 msec, in persistent AF is 140.79 msec and permanent AF is 154.9 msec. Mean value of IVRT in paroxysmal AF is 91.2 msec, in persistent AF is 86 msec and permanent AF is 86.15 msec. Mean value of LA diameter in paroxysmal AF is 37.56 mm, in persistent AF is 37.33 mm and permanent AF is 38.43 mm. Mean value of Ejection Fraction in paroxysmal AF is 60 %, in persistent AF is 56.45% and permanent AF is 58.3%.

Mean value of E velocity in paroxysmal AF is 84.56 m/s, in persistent AF is 90.79 m/s and permanent AF is 96.6 m/s. Its value increases in persistent AF and further increases in permanent AF as compared to paroxysmal atrial fibrillation.

E' velocity (mean values) in paroxysmal, persistent and permanent AF are 7.83, 7.81 and 6.33 cm/ sec respectively.

E/E' values are 11.6 and 12.08 in paroxysmal and persistent AF respectively while in permanent AF its value is higher i.e. 16.8.

A' values in paroxysmal, persistent and permanent AF are 7.46, 7.2 and 6.38 cm/s respectively.

Left atrial appendage emptying velocity values in paroxysmal, persistent and permanent AF are 85.8, 86.7 and 78.82 cm/s respectively.

As CHADS 2 score increases E/E' value is increasing (score of 2- 13.3, score 3-16.48, score 4-6 -17.8).As CHADS 2 score increases LA minimum volume is increasing (score 2- 42.33 ml, score 3-48.91, score 4-6 -57ml).As CHADS 2 score increases Left atrial emptying fraction value is decreasing (score2 -36.79%, score3 - 34.26%, score4-6 – 28.5%).

More patients were visualized with thrombus/spontaneous echo contrast on echocardiography in permanent atrial fibrillation than persistent or paroxysmal atrial fibrillation.

71.42% of stroke / TIA happened to be in permanent AF group and 14.28% in each persistent and paroxysmal AF. Also it can be seen that coronary artery disease was more prevalent in paroxysmal atrial fibrillation (45.45%) while it was 27.27% in persistent and permanent AF group each.

Mean values of left atrial minimum volume were 34.6 ml and 38.1 ml in paroxysmal and persistent atrial fibrillation while it was higher i.e. 51.7 ml in permanent atrial fibrillation.

Left atrial expanding index (mean values) in paroxysmal AF was 71.6% while in persistent and permanent AF were 55 and 49.7% respectively. Left atrial emptying fraction (mean values) were 41.3%, 35.2% and 32.8% in paroxysmal, persistent and permanent atrial fibrillation respectively.

From paroxysmal to persistent to permanent type of atrial fibrillation; left atrial minimum volume mean values increased while values of left atrial expanding index and left atrial emptying fraction decreased.

Among 24 patients with CHADS2 score 3, 15 patients (62%) were having permanent Atrial Fibrillation. Both patients having CHADS2 score of 4 belongs to permanent Atrial Fibrillation.

Among 46 patients having permanent Atrial Fibrillation, 32 patients (66.66%) were having CHADS2 score ≥ 2. Among 30 patients having permanent Atrial Fibrillation, 20 patients (69.56%) were having CHADS2 score ≥ 2. Among 24 patients having permanent Atrial Fibrillation, 14 patients (58.33%) were having CHADS2 score ≥ 2. So, in our study CHADS2 score was higher in permanent Atrial Fibrillation population than other two.

Majority (54) of AF patients were having chickenwing type of left atrial appendage followed by cactus (25) and then windsock (20) and only one patient was having cauliflower shape.

Occurence of stroke / TIA in various types of atrial fibrillation patients also distribution of thrombus in these patients was shown. Both occured more commonly in chicken wing type of left atrial appendage, but chicken wing type of left atrial appendage is most common so relation between shape and stroke/thrombus further confirmed. Proportion of stroke/TIA was higher among the individuals who had LAA shape other than the chicken wing pattern compared to patients who had LAA shape of Chicken wing (15.2% vs 13.0%). But the distribution was not found to be statistically significant (p=.746). Proportion of thrombus formation was higher among the individuals who had LAA shape other than the chicken wing pattern compared to patients who had LAA shape of Chicken wing (13% vs 11.1%). But the distribution was not found to be statistically significant (p=.767)

Mean LAA emptying velocity was less among the individuals having thrombus compared to non-thrombus group. The difference was found to be statistically significant; p=.00 (p<.05).

Proportion of the individuals having stroke/TIA was higher among the individuals who had thrombus compared to them who did not have it (100.0% vs 2.3%). The distribution was found to be statistically significant (p=.000).

There was fair degree negative correlation between LAA emptying time and E/E'. (Pearson correlation coefficient between ±0.25 and ±.5).

There was fair degree of positive correlation between LAA emptying time and E'. (Pearson correlation coefficient between ±0.25 and ±.5).

Conclusions

The prognosis after development of atrial fibrillation is bad. It worsens heart failure, increases chances of stroke/TIA. Atrial fibrillation in itself further deteriorates left atrial function further

decreasing cardiac output and decompensating patient further.

The traditional use of echocardiography to assess left atrial dysfunction has limitations because of the left atrial shape and its phasic variations.

For past two decades several parameters have evolved to assess the left atrium and left atrial appendage function by echocardiography, in this study I have tried to correlate the
echocardiographically assessed left atrium and left atrial appendage function with atrial fibrillation.

With newer advances in echocardiography we can see parameters which can predict or detect left atrial dysfunction in early stages to prevent further deterioration and even prevention of developing atrial fibrillation by treat in underlying structural heart disease promptly. We can also monitor left atrial function pre and post atrial fibrillation ablation.

Average age of study group was 60 years.

Prevalence of hypertension, T2DM, coronary artery disease and chronic kidney disease was higher in study group as compared to average Indian population. Proportion of population suffering from obesity was higher in study group and also nicotine consumption.

Pulmonary arterial hypertension was present in most of study subjects with mean value of pulmonary artery pressure was 30mmHg.some of subjects had associated regional wall motion abnormality among them half population had anterior wall hypokinesia.

Most common structural heart disease associated in our study group was valvular heart disease with majority presented with mixed valvular heart disease followed by mitral stenosis.

We included three types of atrial fibrillation in our study group most common was permanent atrial fibrillation among them.

By transesophageal echocardiography we studied left atrial appendage morphology in study population and found out chicken wing morphology was most common followed by cactus and windsock in almost similar proportion while cauliflower rarely.

A' and E' velocity values decreased from paroxysmal through persistent to permanent atrial fibrillation while E/E' values increased in similar trend.

From paroxysmal to persistent to permanent type of atrial fibrillation; left atrial minimum volume mean values increased while values of left atrial expanding index and left atrial emptying fraction decreased.

Higher CHADS2 score was present in permanent AF in our study groups. We found out direct relation of CHADS2 score with E/E' and Left atrial minimum volume and inverse relationship with left atrial emptying fraction.

More patients were visualized with thrombus/spontaneous echo contrast on echocardiography and stroke /TIA in permanent atrial fibrillation than persistent or paroxysmal atrial fibrillation.

Stroke /TIA more commonly seen in patients visualized with thrombus on echocardiography. Mean left atrial appendage emptying velocity was lower in study subjects with thrombus visualized on echocardiography. Stroke /TIA/thrombus on echo more commonly found in non chicken wing group of left atrial appendage.

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