# Left ventricular ejection fraction to left atrial volume index ratio as a new predictor of left atrial appendage thrombus formation in patients with atrial fibrillation

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**Abstract: Background:** A recent study demonstrated that in patients with nonvalvular atrial fibrillation (AF), a ratio of left ventricular ejection fraction (LVEF) to the left atrial volume index (LAVI) of, 1.5 has 100% sensitivity fordetecting left atrialappendage (LAA) thrombus. We sought to apply this ratio in valvular and nonvalvular AF who attending Echocardiography Unit, Cardiology Department, Bab El She'ryia University Hospital. **Introduction:** Although. So small, it is so important! LAA is a separate structure from LA with unique developmental, anatomical, and physiological properties. LAA is one of the most important structures of heart during AF because it is the major site for thrombus formation. TEE is the method of choice for evaluating both anatomy and function of LAA and in particular for detection of the thrombus. However, TEE is uncomfortable for the patients and carries its own risks. So, many upgraded methods & efforts done in the past & still in recent era to present an alternative noninvasive method in steed of TEE in detection of LAA thrombus. **Aim of the work:** Detecting the presence or absence of LAA thrombus using 2D transthoracic echocardiographyby a simple, rapid and non-invasive method. In addition, to add a new point in prediction of those who are at high risk of thrombo-embolic complications of AF and subsequently need long-life anticoagulants. **Material and methods:** a prospective study done over a period of one year that included 66 AF patients indicatedfor TEE examination. Patients were subjected to informed verbal consent, full history taking with special emphasis on history of hypertension, diabetes mellitus, and history of thromboembolic complications &history of any contraindication for TEE examination. All patients were assessed clinically with full Cardiological examination & resting 12 leads ECG was done to all. As well as the CHADS2VAS2C score for every patient with nonvalvular AF was calculated. Conventional 2D TTE was done. LVEF to LAVI ratio through TTE has been measured. 2D TEE targeting the LAA was done. Data was collected & coded using Microsoft Office Excel Worksheet while statistical analysis was performed using statistical package for social sciences (SPSS) version 23.0 for windows. **Results**: Out of 66 AF patients, 38 females & 28 males ranged between 20 & 66 years with mean age ± SD was(49.06 ± 12.09) years. There was total agreement between this 2D TTE simple approach & TEE in detection of LAA thrombus. There was significant reduction in LA and LAA parameters measured by 2D TTE in relation to TEE. We noticed reasonable correlations between LAA thrombus formation & impaired LV systolic function, decrease LAA flow measurements & increase LA diameter. In addition, we observed the effect of AF on LAA dimensions, which made it larger than usual. **Conclusion:** Low LVEF to LAVI ratio has a comparable accuracy to trans esophageal approach. The addition of long-life anticoagulant is mandatory to whom suffering from AF, if LVEF to LAVI ratio is ≤1.4 regardless the CHA2DS2-VASc score. The safest type of AF is that due to thyrotoxicosis. Weight loss has a precious role in decreasing the formation of LAA thrombus. The shorter the patient, the more incident of LAA thrombus formation. CAD extended farther to be one of the significant risk factor. The atrial flutter has the same impact as well as the atrial fibrillation. The rate control is preferred to rhythm control. LAA thrombus as well as incidence of AF is directly proportionate to increased patient age. **Recommendations:** Therefore, the usage of LVEF to LAVI ratio, as a comfortable & safe method before cardioversion instead of semi invasive maneuver (TEE) which routinely used. Usage of this ratio as a bedside screening test in all AF patients, directing the management and helping decision-making. Finally, the LVEF to LAVI ratio adds more patients to those at high risk of stroke whom requiring long-life anticoagulant, regardless the CHA2DS2-VASc score to guard against thrombo-embolic complications of AF.

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## 1. Introduction

Atrial fibrillation is rapidly becoming the ‘‘low back pain’’ of Cardiology. It becomes more common with age, cardiac disease, and certain systemic diseases such as thyrotoxicosis. Hypertension, which affects one third of population-two thirds of those over 65 years old-is a harbinger of atrial fibrillation. It is frequent in postsurgical patients and can be precipitated by hyper- or hypovolemia. Sometimes it is the first manifestation of unrecognized underlying cardiac diseases such as mitral stenosis and atrial septal defect. Unfortunately, it is sometimes discovered only after a stroke in which it plays a causal role. Almost all areas of Cardiologyare touched by atrial fibrillation[1]**.** Atrial fibrillation is the most commonly sustained arrhythmia in man. While it affects millions of people around the globe already, its incidence will reach epidemic proportions as people live longer and doctors become even more successful in treating other cardiovascular diseases. Until recently, atrial fibrillation did not receive the attention it deserved, in part because we did not have much of a therapeutic armamentarium that could be brought to bear[2]. The thromboembolic risk for AF is now well appreciated, and its prevention is one of the prime goals of therapy, especially in patients in whom achieving sinus rhythm is difficult or not possible[3]. Although. So small, it is so important! It is briefly a left atrial appendage (LAA). In the past, LAA has been considered a relatively insignificant redundant portion of no anatomical or physiological function[4]. Actually, The LAA has unique developmental, anatomical, and physiological properties. These properties render it ideal to act as a reservoir in conditions of volume overload, and to affect the adaptive responses necessary for the reduction of circulating blood volume. It is the major site of thrombus formation in non-valvular atrial fibrillation (AF) and to a lesser extent in mitral valve (MV) disease[5]. It is well established that trans-oesophageal echocardiography (TEE) is the method of choice for evaluating both anatomy and function of LAA and in particular for detecting the presence of thrombi. In contrast, in the vast majority of patients conventional transthoracic echocardiography (TTE) does not result in images of sufficient quality to explore LAA[6]. Nevertheless, efforts were, still and will be done to present a comfortable & noninvasive method (instead of TEE) providing a good quality image of LAA. In 1999, Omran et al., compared the accuracy of TTE for detection of LAA thrombi with that of TEE and proved that if transthoracic echogenicity of patients is optimal, the new generation transthoracic echocardiographic system used is able to detect or exclude LAA thrombi with a high degree of confidence. TEE examination may therefore be limited to cases of suboptimal imaging or where there is a clinical concern despite negative transthoracic results[7]. Not only efforts limited to LAA morphological concern, it also extended to its functional assessment by Doppler as N. Fukuda et al., 2003 validated TTE measurements of LAA flow velocity comparing them with TEE measurements[8]. In fact, transthoracic echocardiography (TTE) can be helpful in the management of AF by identifying pathological conditions that may predispose to AF, and identifying conditions that may increase the risk of thromboembolism[9]. One of these conditions is low LVEF to LAVI ratio, which can diagnose LAA thrombus if it is ≤1.4.

## 2. Methods

### Patient population

A prospective study done over a period of one year on a sample of 66 AF patients indicated for TEE examination e.g. before cardioversion, referred to Echocardiography Unit, Cardiology department, Bab El She’ryia University Hospital from October 2015 to October 2016.

### Echocardiographic and clinical data collection

All patients were subjected to the following: Informed verbal consent, full history taking with special emphasis on history of hypertension, diabetes mellitus, and history of thromboembolic complications & history of any contraindication for TEE examination. All patients were assessed.

### Statistical analysis

Data was collected, revised, organized, tabulated & coded using Microsoft Office Excel Worksheet while statistical analysis was performed using statistical package for social sciences (SPSS) version 23.0 for windows. Both were used for graphical presentation. In descriptive analysis, data were expressed as mean ± standard deviation (SD) for continuous variables normally distributed & median if they skewed distributed. Incidence as percentage (%) was for categorical variables. While in inferential analysis we used the following: *Kappavalue (K)* for calculating degree of agreement.

Clinically with full cardiological examination & resting 12 leads ECG was done to all. As well as the CHADS2VAS2C score for every patient with nonvalvular AF was calculated. Conventional 2D TTE was done and the average values of the following data were obtained:

- LVIDd, LVIDs, EF % (Modified Simpson’s method& m-mode), LA diameter.
- Mitral Valve pathology (MS or MR) if present is assessed.
- LA volumes are measured; maximum LA volume (before mitral valve opening), preatrial contraction volume (at the onset of P wave on the

ECG and minimal LA volume (at mitral valve closure).

• LAA data: presence or absence of thrombus, LAA flow measurements, maximum and minimum areas. LVEF to LAVI ratio through TTE has been measured to predict presence or absence of LAA thrombus. Its main role was to rule-out LAA thrombus. 2D TEE targeting the LAA was done as a reference in presence or absence of thrombus & SEC. We obtained from it the following data: LAA emptying and filling velocities, maximum and minimum areas of LA and LAA.

*Student's t-test* (two-tailed), *Chi-square* ($\chi 2$), one–way *ANOVA* and *Fisher's exact* (if required) tests were used for comparison between variables. P value <0.05 is considered statistically significant, while P < 0.01 is considered highly statistically significant result. *Pearson correlation coefficient (r)* was used as a measure of the strength of correlation between two variables. *Spearman's rank* correlation was performed if skewed variables. Cut–off value of the ratio for the presence of the thrombus and corresponding specificity and specificity were calculated using the *Receiver operator characteristic (ROC)* curve. The level of significance was acceptedif the P value < 0.05.

## 3. Results

Table 1. Demographic and clinical characteristics of the studied sample.

| Variables | No. (N = 66) | % |
|---|---|---|
| Group | | |
| Valvular | 24 | 36.4 |
| Non – valvular | 42 | 63.6 |
| Preserved function | 19 | 28.8 |
| Reduced function | 14 | 21.2 |
| Thyrotoxicosis | 9 | 13.6 |
| Gender | | |
| Male | 28 | 42.4 |
| Female | 38 | 57.6 |
| Thrombus | | |
| Absent | 53 | 80.3 |
| Present | 13 | 19.7 |

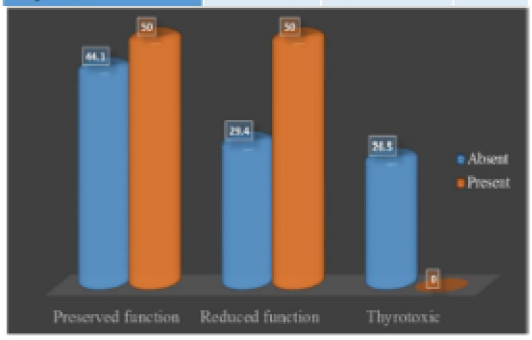
We identified 66 patients who met the inclusion and exclusion criteria. The electrophysiological procedures that prompted the TEE were cardioversion in 53 (80.3). The median time interval between the TTE and TEE in the sample studied was 2 days, and 75% of subjects had both studies with in the same session. The baseline characteristics of patients with

Table 2. Comparison of demographic and clinical data among the studied sample according to the clinical group.

| Variables | Group | M ± SD | p |
|---|---|---|---|
| Age | Valvular | 43.33 ± 8.52 | 0.003 |
| | Non-valvular | 52.33 ± 12.69 | |
| Height | Valvular | 166.38 ± 6.03 | 0.488 |
| | Non-valvular | 167.48 ± 6.25 | |
| Weight | Valvular | 80.00 ± 12.37 | 0.101 |
| | Non-valvular | 84.93 ± 11.13 | |
| BMI | Valvular | 28.91 ± 4.20 | 0.189 |
| | Non-valvular | 30.37 ± 4.35 | |
| BSA | Valvular | 1.90 ± 0.16 | 0.104 |
| | Non-valvular | 1.96 ± 0.12 | |
| SBP | Valvular | 120.00 ± 14.45 | < 0.001 |
| | Non-valvular | 135.48 ± 16.56 | |
| DBP | Valvular | 71.67 ± 9.17 | 0.027 |
| | Non-valvular | 78.45 ± 12.90 | |
| Pulse | Valvular | 85.46 ± 13.51 | 0.121 |
| | Non-valvular | 92.67 ± 20.01 | |

Table 3 and Figure 1 show comparison of thrombus among the studied sample according to the clinical non – valvular subgroup after exlusion of valvular group.

| Non – valvular subgroups | Thrombus | | P |
|---|---|---|---|
| | Absent (N = 34) | Present (N = 8) | |
| Preserved function | 15 (44.1%) | 4 (50.0%) | 0.400 |
| Reduced function | 10 (29.4%) | 4 (50.0%) | |
| Thyrotoxic | 9 (26.5%) | 0 (0.0%) | |




It vs. without LAA thrombus are detailed in Tables 1 and 2. Most notably, thrombus is present in 19.7 % of the studied sample. Female patients represent the higher proportion. The average age of the patients in the studied sample was 49.06 ± 12.09. While the average BMI was 29.84 ± 4.32 and the average BSA

Table 4. Comparison of demographic and clinical data among the studied sample according to presence or absence of thrombus by TEE irrespective of clinical group.

| Variables | Thrombus | M ± SD | p |
|---|---|---|---|
| Age | No | 47.74 ± 11.58 | 0.042 |
| | Yes | 54.46 ± 13.09 | |
| Height | No | 167.15 ± 5.80 | 0.843 |
| | Yes | 166.77 ± 7.66 | |
| Weight | No | 83.38 ± 12.16 | 0.739 |
| | Yes | 82.15 ± 10.25 | |
| BMI | No | 29.87 ± 4.27 | 0.911 |
| | Yes | 29.72 ± 4.71 | |
| BSA | No | 1.94 ± 0.14 | 0.774 |
| | Yes | 1.93 ± 0.14 | |
| SBP | No | 129.43 ± 16.80 | 0.699 |
| | Yes | 131.54 ± 20.35 | |
| DBP | No | 76.13 ± 12.51 | 0.843 |
| | Yes | 75.38 ± 10.50 | |
| Pulse | No | 89.42 ± 17.96 | 0.573 |
| | Yes | 92.62 ± 19.43 | |

Table 5. Comparison of some Trans – Thoracic Echocardiographic parameters among the studied sample according to presence or absence of thrombus by TEE irrespective of clinical group. It was 1.94 ± 0.14.

| Variables | Group | M ± SD | p |
|---|---|---|---|
| LAD | Valvular | 5.30 ± 1.07 | 0.836 |
| | Non-valvular | 5.05 ± 5.86 | |
| Aortic root | Valvular | 4.15 ± 6.16 | 0.827 |
| | Non-valvular | 3.88 ± 3.84 | |
| LVEDD | Valvular | 5.12 ± 0.79 | 0.831 |
| | Non-valvular | 5.09 ± 0.55 | |
| LVESD | Valvular | 3.76 ± 0.96 | 0.479 |
| | Non-valvular | 3.62 ± 0.65 | |
| FS % | Valvular | 29.63 ± 9.33 | 0.614 |
| | Non-valvular | 30.74 ± 8.20 | |
| EF (M mode) | Valvular | 55.90 ± 13.51 | 0.780 |
| | Non-valvular | 56.85 ± 13.19 | |
| EF (Simpsons) | Valvular | 53.77 ± 12.98 | 0.870 |
| | Non-valvular | 54.28 ± 11.87 | |
| LAA (A4C) | Valvular | 37.71 ± 16.07 | < 0.001 |
| | Non-valvular | 20.81 ± 5.66 | |
| LAA (A2C) | Valvular | 40.85 ± 16.21 | < 0.001 |
| | Non-valvular | 24.89 ± 8.04 | |
| LAVI | Valvular | 89.93 ± 55.87 | < 0.001 |
| | Non-valvular | 42.27 ± 36.36 | |

There is no statistical significant difference between the absence or the presence of the LAA thrombus in AF with preserved and reduced EF. In addition this non-significant difference is also presented in AF due thyrotoxicosis, see table 3 and figure 1. Demographic and clinical data among the studied sample according to presence or absence of thrombus by TEE irrespective of clinical group are shown in table 4. Some Transthoracic Echocardiographic parameters among the studied sample according to the clinical group are collected in table 5. Some Trans – Thoracic Echocardiographic parameters among the studied sample according to presence or absence of thrombus by TEE irrespective of clinical group are collected in table 6. Some Trans – Esophageal Echocardiographic parameters among the studied sample according to presence or absence of thrombus by TEE irrespective of clinical group are shown in table 7. Low CHA2DS2VASc scores has no distinctive role in prediction of LAA thrombus, table 8 and figure 2. The predictors for presence of LAA thrombus among non-valvular subgroup are shown in table 9, Impaired LVEF (OR, 1.7; 95% CI, 0.13 – 0.79), increased LAVI (OR, 1.05; 95% CI, 0.21 – 2.12), impaired emptying and flow velocities in the LAA were significantly associated with an increased likelihood of exhibiting thrombus formation. While the predictors for presence of LAA thrombus among valvular subgroup as clarified in the table 10, there is no specific predictor of thrombus formation among this group. Even, increased LAVI not considered as a predictor of LAA thrombus among valvular group. The ROC curve analysis demonstrates that the LVEF/LAVI ratio has an excellent discriminatory capacity in predicting LAA thrombus with an AUC of 0.73of the studies sample with sensitivity of 92.31% and specificity of 69.81%. The cutoff point is 1.4. See table 11 and figure 3.

Table 6. Comparison of some Trans – Thoracic Echocardiographic parameters among the studied sample according to the clinical group.

| Variables | Thrombus | M ± SD | P |
|---|---|---|---|
| LAD | No | 5.27 ± 5.24 | 0.664 |
| | Yes | 4.63 ± 0.63 | |
| Aortic root | No | 4.15 ± 5.31 | 0.556 |
| | Yes | 3.27 ± 0.57 | |
| LVEDD | No | 5.09 ± 0.68 | 0.918 |
| | Yes | 5.12 ± 0.48 | |
| LVESD | No | 3.63 ± 0.81 | 0.349 |
| | Yes | 3.85 ± 0.57 | |
| FS% | No | 39.08 ± 9.03 | 0.032 |
| | Yes | 24.32 ± 5.71 | |
| EF (M mode) | No | 57.56 ± 13.99 | 0.043 |
| | Yes | 52.18 ± 8.50 | |
| EF (Simpsons) | No | 55.10 ± 12.78 | 0.034 |
| | Yes | 49.98 ± 8.61 | |
| LAA (A4C) | No | 23.83 ± 14.54 | 0.034 |
| | Yes | 37.46 ± 7.21 | |
| LAA (A2C) | No | 27.48 ± 15.22 | 0.005 |
| | Yes | 41.54 ± 6.68 | |
| LAVI | No | 54.21 ± 15.99 | 0.007 |
| | Yes | 71.92 ± 13.98 | |

Table 7. Comparison of some Trans – Esophageal Echocardiographic parameters among the studied sample according to presence or absence of thrombus by TEE irrespective of clinical group.

| Variables | Thrombus | M ± SD | p |
|---|---|---|---|
| LAV | No | 99.69 ± 10.19 | 0.009 |
| | Yes | 111.23 ± 7.29 | |
| Flow velocity LAA | No | 40.55 ± 19.62 | < 0.001 |
| | Yes | 18.77 ± 11.02 | |
| CHA2DS2VASc | No | 1.50 ± 0.93 | 0.003 |
| | Yes | 2.25 ± 1.98 | |
| Ratio | No | 3.40 ± 7.97 | 0.042 |
| | Yes | 1.08 ± 0.45 | |

Table 8 and figure 2 show association between presence or absence of thrombus by TEE and CHA2DS2VASc score among non–valvular subgroup.

| $CHA_2DS_2$-VASc score | Thrombus | | P |
|---|---|---|---|
| | Absent (N = 34) | Present (N = 8) | |
| 0 | 5 (14.7%) | 2 (25.0%) | 0.006 |
| 1 | 12 (35.3%) | 2 (25.0%) | |
| 2 | 12 (35.3%) | 0 (0.0%) | |
| 3 | 5 (14.7%) | 1 (12.5%) | |
| 4 | 0 (0.0%) | 2 (25.0%) | |
| 5 | 0 (0.0%) | 1 (12.5%) | |

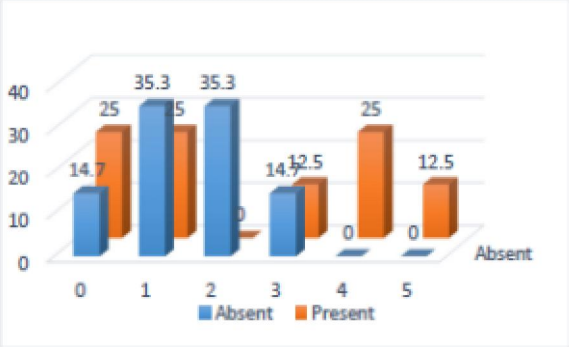



Table 9. Predictors for presence of LAA thrombus among non-valvular subgroup.

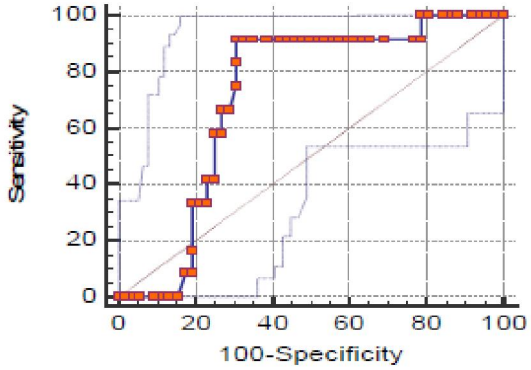
| Predictors | OR (95 % CI) | p |
|---|---|---|
| Age | 1.12 (1.03 – 1.15) | 0.729 |
| EF (Simpsons) | 2.03 (0.13 – 0.79) | 0.009 |
| LAVI | 3.01 (0.21 – 2.12) | 0.034 |
| Flow velocity LAA | 1.09 (1.12 – 2.03) | 0.078 |
| $CHA_2DS_2$-VASc score | 2.37 (0.81 – 1.09) | 0.501 |
| Ratio | 1.93 (1.14 – 2.01) | 0.003 |

Table 10. Predictors for presence of LAA thrombus among valvular subgroup.

| Predictors | OR (95 % CI) | p |
|---|---|---|
| Age | 1.19 (0.01 – 0.97) | 0.197 |
| EF (Simpsons) | 1.59 (3.09 – 3.48) | 0.824 |
| LAVI | 2.71 (2.43 – 2.87) | 0.41 |
| Flow velocity LAA | 1.13 (0.07 – 1.10) | 0.291 |
| $CHA_2DS_2$-VASc score | 1.07 (2.01 – 2.13) | 0.541 |
| Ratio | 1.37 (1.05 – 1.76) | 0.462 |

Table 11 and Figure 3 show the ROC curve with its two arms the sensitivity and the specificity of the studied sample. The cutoff point of the ratio in relation to thrombus presence.

| Cutoff point | ≤ 1.4 |
|---|---|
| AUC | 0.730 |
| Sensitivity | 92.31 % |
| Specificity | 69.81 % |
| Positive predictive value | 42.9 % |
| Negative predictive value | 97.4 % |




**4. Discussion**

Practically, we aimed from this study to present an accepted simple method for prediction of LAA thrombus as a surrogate to that using the invasive TEE. Transthoracic approach is not only noninvasive method but it is also available, safe & cost effective.

Therefore, we enrolled 66 patients had atrial fibrillation and were indicated for TEE in order for cardioversion at Bab El- She'ryia University Hospital between October 2015 and October 2016. They were 38 females (57.6%) and 28 patients were males (42.4%). Mean age ± SD was (49.06 ± 12.09) years. Ninety one percent of patients (60) were AF and 9 %( 6 patients) had atrial flutter. Only 4(6%) patients had history of thromboembolic complication. Thrombus was predicted in 13 patients (19.7%) by this simple 2D transthoracic approach, which is confirmed by TEE. Significant SEC (Grade 2 & 3) was found in 5 patients (7%) by transthoracic approach but 6 patients (9%) by TEE showed SEC. Fifty-three patients (80.3%) had free LAA by TEE who previously predicted by this 2D

TTE simple approach. An interesting aspect of our study is that LAA thrombus formation could be predicted in all patients by this simple TTE approach even if it is not found at the current moments. In addition, we could not ignore recent improvements in echocardiographic technology such as frame rate, gain, focus & harmonic imaging that enables us to visualize LAA thrombus by TTE very well. Our study reported that transthoracic approach has a comparable accuracy to transesophgeal approach, which used as a reference in presence of LAA thrombus. Therefore, we would present a comfortable and safe method i.e. LVEF to LAVI ratio before cardioversion instead of semi invasive maneuver (TEE) which routinely used. It would be a suitable option for elders, severely ill patients & surely for those refuse TEE. We would also propose it might not be necessary to perform TEE for further exploration. This prospective randomized study demonstrates that the LVEF/LAVI ratio has an excellent discriminatory capacity in predicting LAA thrombus with an AUC of 0.73, which is nearly similar to the originally reported 0.88 value[9]. Please keep in mind this ratio has no rule in valvular AF and it is only applied in nonvalvular type (see below). We reporting ratio of ≤1.4 has a 92.3% sensitivity and a 97.4% NPV in detecting LAA thrombus with specificity and PPV of 69.8% and 42.9%, respectively in nonvalvular AF. One of the most important aspect of our study is even if thrombi have not been seen by TEE at the time of investigation, follow up studies viewed thrombus formation according to the ratio. Thrombi were detected after 2 weeks of initial TEE study in those their LVEF to LAVI ratio ≤ 1.4. This 2D TTE simple ratio is not only limited to detection of LAA thrombus; but also has extended predictive value of its formation and guard against stroke. We noticed reasonable positive correlation between LA diameter & LAA thrombus formation (r = 0.50). Cut off value of LA diameter (4.63 ± 0.63 cm anteroposterior diameter in parasternal long axis view) had around 100 % sensitivity & 70% specificity to identify LAA thrombus. Our findings give rise to several testable hypotheses with potential implications for clinical decision-making. In patients with AF and CHA2DS2-VASc scores ≤1, a normal LVEF and a normal LA volume index appears to identify a group of patients at very low risk for stroke. At the lowest end of the spectrum of risk, the frequency of LAA thrombus in patients in our study with CHA2DS2-VASc scores of zero 1.7% approximates the minimum reported incidence of stroke after cardioversion in anticoagulated patients, which is 1.9%[10]. However, according to this our prospective study if the LVEF to LAVI ratio ≤1.4, the CHA2DS2-VASc score has no distinctive value in the prediction of LAA thrombus, despite it is a strong suggestive scale of stroke. There was no direct relationship between CHA2DS2-VASc score and the presence or absence of LAA thrombus. As shown in results 50% of patients with LAA thrombus have CHA2DS2-VASc score ≤1. However, high CHA2DS2-VASc score e.g.≥ 3 is a good predictor of LAA thrombus (p value is 0.006), which is in line with NRAF[11]. Follow up of patients who have suggestive ratio of thrombus formation (≤1.4) with low CHAD2DS2-VASc score ≤1 (despite they have not LAA thrombi at the current moment of diagnosis), revealed thrombus formation in the LAA after variable periods (varying between 2 weeks and 1 month). This was an indication for long-life anticoagulant especially in non-valvular AF with a history of coronary artery disease i.e. ischemic AF. According to our study, any patient with low EF to LAVI ratio - the cutoff point is ≤1.4 – should receive long life anticoagulant irrespective to CHAD2DS2-VASc score (p value < 0.001). Since they have high potentiality for thrombus formation. Our study adds an important reason prefer the rate control to rhythm control. AS with low LVEF to LAVI ratio ≤1.4, which increase the potentiality of LAA thrombus formation, the need for continued anticoagulation therapy is mandatory. The formation of LAA thrombus in patients with valvular AF e.g. mitral stenosis and mitral prosthesis still a mystery. It may be due to changed LA geometry. In addition, homeostasis that occur in LA and LAA. We assume that thrombus formation in valvular AF undergo the law of Virchow, and AF by itself has no direct role in thrombus formation. We enrolled 24 patients (36.4%) with AF and valvular heart disease.

Thirteen (54.2%) had mitral stenosis with different degrees, 6 (25%) had sever mitral regurgitation, 4 (16.7) had prosthetic mitral valve and one (4.1%) patient had mitral valve ring. All of them had no direct risk factor for stroke e.g. mean age was 43±8, no HTN, no DM and so on. The mean LVEF was 53.7±12. The LAVI was 89.9±55.8 that was much bigger. The LVEF to LAVI ratio was ranging from 0.3 to 1.2. However, only 5 patients (20.8%) had LAA thrombus, 3 of them (60%) had therapeutic INR. So, we fully agree about prescription of anticoagulation in patients with valvular heart disease as soon as they develop AF. We conduct that increased body mass index (BMI) above 29.2 is highly associated with increased incidence of atrial fibrillation occurrence, recurrence and resistance to cardioversion as well as LAA thrombus among non-valvular AF patients. Although, the p value is not significant (p value is 0.189). One of the important variable in LVEF to LAVI ratio is the body weight, which affect directly the primarily of the ratio and indirectly the incidence of LAA thrombus formation. Therefore, weight loss and life style modification is strongly recommended

and recently it already one of the treatment lines recommended by the guidelines. We observed that thyrotoxic AF is the safest type of AF. All patients whatsoever the LVEF to LAVI ratio having free LAA by TEE (p value 0.004). However, the small size of the sample still the main obstacle. Therefore, the decision to treat these patients with short- or long-term anticoagulation should be made on an individual basis, taking into consideration other risk factors and the expert opinion. The LVEF to LAVI has no distinctive predictive role in thyrotoxic AF as. is the case in valvular AF. Anticoagulation for patients who have atrial flutter should be handled just as it would for patients who have AF. Any patient, who had atrial flutter and low LVEF to LAVI ratio i.e.≤1.4, should receive anticoagulant. The average age among the studied sample according to presence of thrombus by TEE irrespective of clinical group is 54.4±13 while in those with no thrombus is 47.7±11 (p value is 0.042). However, despite it is a good predictor of LAA in both valvular and non-valvular types of AF, the p value of the age is not significant (p value 0.197 and 0.729 respectively). The average height among the studied sample according to presence of thrombus by TEE irrespective of clinical group is 167±5.1. We noticed that AF patients are with short stature moreover, those with LAA thrombus are shorter. The main indicator of them according to our study e.g. LVEF to LAVI ratio is impaired both LV systolic and diastolic functions. Neither LAV nor LAVI are associated. Nevertheless, the P value is not significant (P value 0.84). We noticed that patients with ACS who developed AF due to ischemia but no other risk factors for AF and stroke e.g. old age, diabetes and hypertension, the AF lasted for long times and was more resistant to cardioversion. Moreover, follow up of those patients revealed LAA thrombus within short periods. The limited number of these patients preclude the results. The fact that LVEF/LAVI is highly predictive of LAA thrombus is not particularly surprising. It is physiologically plausible that impaired LVEF and the consequent elevation in the LV filling pressure lead to LA enlargement and blood stasis that result in LAA thrombus formation[12].

## Conclusion

Low LVEF to LAVI ratio has a comparable accuracy to trans esophageal approach, which used as a reference in detection of LAA thrombus. The addition of long-life anticoagulant is mandatory to whom suffering from AF, if LVEF to LAVI ratio is ≤1.4 regardless the CHA2DS2-VASc score. With LVEF to LAVI ratio ≤1.4, the CHA2DS2-VASc score has no distinctive value in prediction of LAA thrombus, despite it is a strong suggestive scale of stroke. This LVEF to LAVI ratio could not applied in valvular AF. The safest type of AF is that due to thyrotoxicosis. Weight loss has a precious role in decreasing the formation of LAA thrombus. The shorter the patient, the more incident of LAA thrombus formation. CAD extended farther to be one of the significant risk factor. The atrial flutter has the same impact as well as the atrial fibrillation. The rate control is preferred to rhythm control. LAA thrombus as well as incidence of AF is directly proportionate to increased patient age.

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