STUDY OF EPICARDIAL ADIPOSE TISSUE, ECHOCARDIOGRAPHIC PARAMETERS AMONG ATRIAL FIBRILLATION PATIENTS

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ABSTRACT

Background: AF is the most common sustained arrhythmia managed in clinical practice and it is associated with an increased risk of mortality, stroke and peripheral embolism. Epicardial adipose tissue (Epicardial fat depots) is a small but very biologically active ectopic fat depot that surrounds the heart. Being a simple echo-finding, we can measure it using two-dimensional echocardiography. Epidemiological Studies have linked its thickness to Atrial Fibrillation.

Aim of the study: To investigate the potential association between epicardial adipose tissue (EAT) and Left atrial size and AF.

Subject and Methods: This observational study was carried out in Cardiology and emergency departments in Zagazig University and Al-Ahhar teaching hospitals, includes 42 patients were divided into 3 groups: 16 had paroxysmal AF, 5 patients had permanent AF, and 21 had sinus rhythm, as a control group. All subjects were subjected to complete history taking, full physical examination, and for diagnostic tools (laboratory, electrocardiographic, and echocardiographic assessment).

Results: There was a statistically significant difference between the sinus and AF paroxysmal group (p<0.001) and AF permanent group (p=0.011). The AF paroxysmal group had more epicardial adipose tissue than AF permanent group (mean difference= .08200, p<0.001). Regarding LA diameter and volume, the left atrial diameter and volume were more increased in AF patients than non-AF patients. There was no statistically significant difference between the studied groups regarding their IVS, while There was a statistically significant difference between the studied groups regarding their LVESD. Also, the level of C-reactive protein was significantly increased in AF.

Conclusions: EAT was increased in Patients with AF and was associated with increasing the size and volume of the left atrium, which could be used in predicting AF. The level of C-reactive protein was significantly increased in AF patients in our study, which could be used in predicting AF. However, the small number of included patients required taking the result with more caution, and further studies with a larger sample are needed.

Keywords: Atrial Fibrilation, Echocardiography, epicardial adipose tissue, Echocardiographic parameters.

I. INTRODUCTION

Nowadays, Atrial fibrillation is the most common arrhythmia managed in clinical practice and it is associated with an increased risk of mortality, stroke and peripheral embolism (1).

Atrial fibrillation (AF) is commonly associated with overweight and obesity. Overweight populations have higher incidence, prevalence, severity, and progression of AF compared with their normal weight counterparts. Stable weight loss decreases AF burden and AF recurrence following treatment (1).
Among the novel mechanisms involved in the pathophysiology of AF substrate, increasing evidence exists for the arrhythmogenic impact of local epicardial fat depots on the human atria (2). Epidemiological Studies have linked Epicardial Adipose Tissue (EAT) Thickness to Atrial Fibrillation (AF) (3).

Epicardial adipose tissue (EAT) is a small but very biologically active ectopic fat depot that surrounds the heart. Given its rapid metabolism, thermogenic capacity, unique transcriptome, secretory profile, and simply measurability, epicardial fat has drawn increasing attention among researchers attempting to elucidate its putative role in health and cardiovascular diseases (4).

Epicardial Adipose Tissue (EAT) is a simple echo-finding that can be measured and detected using two-dimensional echocardiography. EAT is supposed to have a role in the metabolic activity of the heart due to its anatomic and functional proximity to the myocardium (5).

We aimed in this study to investigate the potential association between epicardial adipose tissue (EAT) and left atrial size and AF.

II. STUDY DESIGN AND PARTICIPANTS

This was an observational study was carried out in Cardiology and emergency departments in Zagazig University and Al-Ahrar teaching hospitals. The study group consisted of 42 subjects, divided into AF patients that includes 21 patients, and the control group consisted of 21 patients who were on sinus rhythm. The AF patients were divided into two subgroups 16 patients of paroxysmal and 5 patients of permanent AF, according to the patterns described in the recent guidelines

The paroxysmal AF patients who had AF episodes that were self-terminating within 48 h, or up to 7 days, or were medically or electrically cardioverted within 7 days. Also, the permanent AF patients whom AF was accepted by the patient or physician and no rhythm control were enrolled in the study.

All patients who had with moderate and severe valvular disease, severe heart failure NYHA class III–IV, hepatic or renal failure, with recent infection, surgery, or acute coronary syndrome and with malignancy or autoimmune diseases were excluded from the study.

All patients were subjected to:

- Full history taking, clinical evaluation, imaging diagnostic examination (Electrocardiographic, and Echocardiographic assessment) for all patients, laboratory investigations: levels of total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, triglycerides, glucose, Thyroid profile, Kidney and Liver function tests, high-sensitivity C-reactive protein (hs-CRP)

Electrocardiography

The 12-lead ECG was performed at rest in the supine position to determine Atrial Fibrillation from sinus rhythm.

- AF: shows lack of discrete P waves Fibrillatory waves are present at a rate of 350-600 beats/min, and vary in amplitude, morphology, and intervals.

- Ventricular response shows no repetitive pattern, "irregularly irregular".

Transthoracic Echocardiography

Echocardiography is the most accessible and affordable imaging modality to assess epicardial fat. A transthoracic echocardiogram was performed, using a PHILIPS HD7 machine and Vivid 8 with a probe S4. LA diameter, LA volume, left ventricular diameter, and ejection fraction measurements were performed according to the current guidelines.

The thickness of EAT was measured on the right ventricular free wall of the two-dimensional parasternal long-axis view at end systole. We preferred the area above the right ventricle as this has the thickest EAT layer. In addition, the parasternal long-axis view allows optimal beam orientation and more accurate measurement. The anterior echo-lucent space between the linear echo-dense visceral pericardium and the right ventricular epicardium was considered to be EAT (Figure 1).
Fig (1): Echocardiographic assessment of epicardial fat thickness in AF patient measured in PLA at end systole (its value=0.4 cm).

Statistical analysis

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 25.0) software for analysis. According to the type of data, qualitative data were represented as number and percentage, quantitative continuous data were represented as mean ± SD or median (Range).

The following tests were used to test differences for significance; difference and association of qualitative variables was assessed by Chi square test ($X^2$) or Fisher’s exact test while differences between quantitative independent groups by t test. $P$ value was set at <0.05 for significant results & <0.001 for high significant result. Analysis of variance (ANOVA) test was used to test the statistical significance for difference in the values of the means of more than two groups for each numeric parameter.

III. RESULTS

- Demographic findings

In the paroxysmal AF subgroup, the mean age of 47.8±14 years and the mean BMI 23.63±2.778. While in the permanent AF subgroup, the mean age 45.6±7 years and the mean BMI of 22.8±1.304. In the sinus subgroup, the mean age of 47±13.5 years. and the mean BMI of 22.57±1.599

Most of the included patients were males. paroxysmal AF group had 62.5% were males with 10 patients none were smokers. While of the patients who had permanent AF, 4 patients (80%) were males, and 2 patients (40%) were smokers. In spite of the patients who had sinus rhythm, 12 patients (57.1%) were males, and 3 patients (14.29%) were smokers.

In paroxysmal AF group, only 2 patients (12.5%) were hypertensive and diabetic and only 1 patient (6.25%) had dyslipidemia while of the patients who had permanent AF, only 1 patient (20%) was hypertensive and non were diabetic nor had dyslipidemia. Of the patients who had sinus rhythm, 3 patients (14.3%) were hypertensive, 2 patients (9.5%) were diabetic, and 2 patients (9.5%) had dyslipidemia. (Figure 2, a,b,c).

Of the patients who had paroxysmal AF, none were on beta-blockers therapy and 3 patients (18.75%) were on warfarin therapy. While of the patients who had permanent AF, 1 patient (20%) was on beta-blockers and warfarin therapy. Of the patients who had sinus rhythm, none were on beta-blockers or warfarin therapy.
There was no statistically significant difference between the studied groups regarding age (p=0.946), BMI (p=0.325), gender (p=0.638), hypertension (p=0.916), DM (p=0.708), dyslipidemia (p=0.747), smoking (p=0.05), and warfarin treatment (p=0.109).

There was no statistically significant difference Among the three studied groups regarding their EF (p=0.907) (Table 1).

- **ECG and Echo parameters findings**

Regarding Epicardial Adipose Tissue distribution among the studied groups, there was a statistically significant difference between the sinus and AF paroxysmal group (p<0.001) and AF permanent group (p=0.011). The AF paroxysmal group had more epicardial adipose tissue than AF permanent group (mean difference= .08200, p<0.001).

Regarding left atrial (LA) diameter distribution among the studied groups there was a statistically significant difference between the sinus and AF paroxysmal group (p<0.001) and AF permanent group (p<0.001). There was no statistically significant difference between AF paroxysmal and AF permanent groups (p=0.442).

Regarding left atrial (LA) volume, there was a statistically significant difference between the sinus and AF paroxysmal group (p<0.001) and AF permanent group (p<0.001), while there was no statistically significant difference between AF paroxysmal and AF permanent groups (p=0.349).

Regarding Interventricular septum (IVS), In the paroxysmal AF subgroup, the mean IVS is 8.313±1.25, the mean RV is 22.375±3.81, and the LVEDD mean is 45.25±3.786. While in the permanent AF subgroup, the IVS mean is 8.2±0.837, the mean RV is 20±4, and mean LVEDD is 46 mean LVEDD is 46.19±5.278. There was no statistically significant difference between the studied groups regarding their IVS (p=0.949), RV (p=0.508), and LVEDD (p=0.796).

In the paroxysmal AF subgroup, the LVESD mean is 34.625±5.303. While in the permanent AF subgroup, the LVESD mean is 38.4±1.673. In the sinus subgroup, the LVESD mean is 30.667±5.073. There was a statistically significant difference between the studied groups regarding their LVESD (p=0.005). There was a statistically significant difference between the sinus and AF permanent groups (p=0.009). There was no statistically significant difference between the sinus and AF paroxysmal groups or between AF paroxysmal and AF permanent groups (p= 0.052 and 0.304) (Table 2,3).

- **Laboratory findings**

Of the patients who had paroxysmal AF, 8 patients (50%) had Abnormal CRP status while of the patients who had permanent AF, 2 patients (40%) had Abnormal CRP status. Of the patients who had sinus rhythm, none had Abnormal CRP status.

In the paroxysmal AF subgroup, the INR mean is 1.426±0.792, with a mean Na level of 138.3±3.825, and a mean K level of 4.244±0.352. While in the permanent AF subgroup, the INR mean is 1.342±0.765, with a mean Na of 140.2±3.271, and a mean K of 3.92±0.377. In the sinus subgroup, the mean INR was 1±0, with a mean Na of 139.33±3.454, and with a mean K of 3.895±0.43.

There was no statistically significant difference between the studied groups regarding their INR (p=0.066), and Na (p=0.522). There was a statistically significant difference between the studied groups regarding their CRP status (p=0.001) and K level (p=0.033). The AF paroxysmal group had more K level than the sinus and AF permanent groups. There was a statistically significant difference between the sinus group and AF paroxysmal group (p= 0.030), while there was no statistically significant difference between the AF permanent and Sinus group (p=0.991), or AF paroxysmal (p=0.260). (Table 4).

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**Table 1.** Demographic data distribution among studied groups.

<table>
<thead>
<tr>
<th>Age</th>
<th>Sinus (n= 21)</th>
<th>AF paroxysmal (n= 16)</th>
<th>AF permanent (n= 5)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean, SD</td>
<td>47</td>
<td>13.491</td>
<td>47.8</td>
<td>14.015</td>
</tr>
<tr>
<td>Median, IQR</td>
<td>45</td>
<td>17</td>
<td>51</td>
<td>17.5</td>
</tr>
</tbody>
</table>

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### Table 2. ECG and Echo parameters among studied groups.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sinus (n= 21)</th>
<th>AF paroxysmal (n= 16)</th>
<th>AF permanent (n= 5)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Epicardial Adipose Tissue (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean, SD</td>
<td>0.342</td>
<td>0.019</td>
<td>0.46</td>
<td>0.03</td>
</tr>
<tr>
<td>Median, IQR</td>
<td>0.34</td>
<td>0.04</td>
<td>0.46</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Left Atrial Diameter (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean, SD</td>
<td>3.381</td>
<td>0.244</td>
<td>4.063</td>
<td>0.186</td>
</tr>
<tr>
<td>Median, IQR</td>
<td>3.4</td>
<td>0.4</td>
<td>4</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Ejection fraction %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean, SD</td>
<td>62.286</td>
<td>2.918</td>
<td>62.125</td>
<td>3.538</td>
</tr>
<tr>
<td>Median, IQR</td>
<td>62</td>
<td>4</td>
<td>62.5</td>
<td>4.5</td>
</tr>
<tr>
<td><strong>Left Atrial volume (ml/m2)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean, SD</td>
<td>26.19</td>
<td>2.874</td>
<td>36.25</td>
<td>2.817</td>
</tr>
<tr>
<td>Median, IQR</td>
<td>26</td>
<td>4</td>
<td>37</td>
<td>2.25</td>
</tr>
<tr>
<td><strong>Interventricular septum (IVS)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean, SD</td>
<td>8.19</td>
<td>1.167</td>
<td>8.313</td>
<td>1.25</td>
</tr>
<tr>
<td>Median, IQR</td>
<td>8</td>
<td>2</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td><strong>Right ventricle (RV)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean, SD</td>
<td>21.524</td>
<td>4.191</td>
<td>22.375</td>
<td>3.81</td>
</tr>
<tr>
<td>Median, IQR</td>
<td>22</td>
<td>8</td>
<td>23</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>Left ventricular End Diastolic Diameter (LVEDD)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean, SD</td>
<td>46.19</td>
<td>5.278</td>
<td>45.25</td>
<td>3.786</td>
</tr>
<tr>
<td>Median, IQR</td>
<td>44</td>
<td>8</td>
<td>45</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>Left ventricular End Systolic Diameter (LVESD)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean, SD</td>
<td>30.667</td>
<td>5.073</td>
<td>34.625</td>
<td>5.303</td>
</tr>
<tr>
<td>Median, IQR</td>
<td>30</td>
<td>6</td>
<td>38</td>
<td>8</td>
</tr>
</tbody>
</table>

### Table 3. Post Hoc Tests Multiple Comparisons, Tukey HSD, on the ECG and Echo parameters among studied groups

<table>
<thead>
<tr>
<th>(I) Rhythm</th>
<th>(J) Rhythm</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>5% Confidence Interval</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I) Rhythm</td>
<td>(J) Rhythm</td>
<td>Mean Difference (I-J)</td>
<td>Std. Error</td>
<td>Sig.</td>
<td>5% Confidence Interval</td>
<td>95% Confidence Interval</td>
</tr>
<tr>
<td>Sinus</td>
<td>AF paroxysmal</td>
<td>-.11810*</td>
<td>.00788</td>
<td>.000</td>
<td>-1.373</td>
<td>-.0989</td>
</tr>
<tr>
<td>AF paroxysmal</td>
<td>Sinus</td>
<td>.11810*</td>
<td>.00788</td>
<td>.000</td>
<td>.0989</td>
<td>.1373</td>
</tr>
<tr>
<td>AF paroxysmal</td>
<td>AF permanent</td>
<td>.03610*</td>
<td>.01182</td>
<td>.011</td>
<td>-.0649</td>
<td>-.0073</td>
</tr>
<tr>
<td>AF paroxysmal</td>
<td>AF permanent</td>
<td>.03610*</td>
<td>.01182</td>
<td>.011</td>
<td>.0073</td>
<td>.0649</td>
</tr>
<tr>
<td>AF paroxysmal</td>
<td>AF paroxysmal</td>
<td>-.08200*</td>
<td>.01217</td>
<td>.000</td>
<td>-.1116</td>
<td>-.0524</td>
</tr>
</tbody>
</table>

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Table 4. Laboratory findings among studied groups.

<table>
<thead>
<tr>
<th></th>
<th>Sinus (n= 21)</th>
<th>AF paroxysmal (n= 16)</th>
<th>AF permanent (n= 5)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INR</strong></td>
<td>Mean, SD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Median, IQR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP status</td>
<td>Normal</td>
<td>21</td>
<td>100</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>Abnormal</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>Mean, SD</td>
<td>139.33</td>
<td>3.454</td>
<td>.522</td>
</tr>
<tr>
<td></td>
<td>Median, IQR</td>
<td>139</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>Mean, SD</td>
<td>3.895</td>
<td>0.43</td>
<td>.033</td>
</tr>
<tr>
<td></td>
<td>Median, IQR</td>
<td>3.7</td>
<td>0.4</td>
<td></td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.
Figure 2. Dyslipidemia distribution among the studied groups.

Figure 3. Epicardial Adipose Tissue distribution among the studied groups

Figure 4. Left Atrial Diameter distribution among the studied groups
IV. DISCUSSION

Although epicardial adipose tissue (EAT) consists a small percentage of total body fat, it is more associated with atrial fibrillation (AF) than thoracic or visceral fat (6).

This can be explained as the EAT is in direct contact with surroundings without separation by any connective tissue. It can also induce fibrosis in the atrial myocardium by secreting inflammatory substances, which eventually results in AF (7).

Additionally, it has many ganglion plexuses that have a role in the beginning and preservation of AF (8).

Therefore, we investigated the association between EAT and AF in permanent and paroxysmal AF patients and normal sinus rhythm subjects and other factors associated with increased EAT.

In our study, we observed no significant difference in baseline demographics between all three comparator groups except in using beta-blockers, which was significantly increased in patients with permanent AF. Regarding patients’ characteristics as gender, age, BMI, and smoking, our study included younger patients with mean age 47.8, 45.6, and 47 years in paroxysmal AF patient, permanent AF patients, and normal sinus rhythm patients, respectively than other published studies in the literature with ages higher than 50 years old (9, 10, 11, 12).

Most of the patients were males, which also resembled the published studies (9, 10, 11, 12).

Regarding Body mass index, our patients had normal Body mass index values less than 25 Kg/m2 as in only Hasebe et al. (11), however, the most of published studies’ patients were overweight with Body mass index between 25 and 30 Kg/m2 (9, 10, 12).

Moreover, in our study, no patient was a smoker in paroxysmal AF patients, only two patients (40%) were smokers in permanent AF, and three (14.29%) in control normal sinus patients; however, the incidence of smoking was higher in Hasebe et al. and reached 52% in AF patients, and 46% in control patients (11), and it was lower in Nakamori et al.; 9% in AF patients and 6% in control patients (12).

In the presence of comorbidities, the majority of our patients did not have hypertension, diabetes mellitus, or dyslipidemia. However, near half of the patients in related studies had hypertension (9, 10, 11, 12) and dyslipidemia (10; 11; 12); however, the percentage of diabetic patients was very close to our study percentage (9, 10, 11, 12).

Regarding medications, no patient was on beta-blocker medication in our study except one (20%) in the permanent AF group, and warfarin was used by three (18.75%) in the paroxysmal AF group and one (20%) in the permanent AF group. However, the incidence of beta-blockers administration was higher in Nakamori et al., 55% in AF patients, and 40% in the control group (12).
While the included patients in other related studies were taking medications as angiotensin-converting enzyme inhibitor drugs (11,12), statins (11,12), calcium channel blockers (12), and diuretics (12).

The level of C-reactive protein was significantly increased in AF patients in our study as some studies observed an association between C-reactive protein and AF (13, 14) as it is considered as an inflammation biomarker and a left atrium biopsy taking in AF patients revealed inflammatory cells (15).

Regarding ECG and Echo parameters: we used Echocardiography to assess the EAT, size of left atrial, two ventricles size, Ejection fraction, end-systolic and diastolic volumes in the left ventricle, intraventricular septum size, and pulsed wave in all three groups as normal sinus rhythm group which contained 21 patients (50% of the total sample), paroxysmal AF group with 16 patients (38.1% of the sample), and permanent AF group with 5 patients (11.9% of the sample).

The methods of EAT assessment were different between published studies. For example, Hasebe et al. assessed the EAT by multi-detector computed tomography in 50 patients with AF and 50 normal sinus control patients, and 50 patients with coronary artery syndrome (11).

Also, Al Chekakie et al. used computed tomography. However, they used Echocardiography too for accurate measurement, and it included 126 paroxysmal AF patients, 71 persistent AF patients, and 76 normal sinus rhythm patients (9).

While Batal et al. used a three-dimensional computed tomography angiogram to assess patients, and it included 60 paroxysmal AF patients, 36 persistent AF patients, and 73 non-AF control patients (10).

Nakamori et al. used cardiovascular magnetic resonance and included 53 AF patients and 52 non-AF control patients (12).

The EAT was significantly more increased in paroxysmal and permanent AF patients than sinus rhythm patients, which was the same in Al Chekakie et al. (9). However, in our study, the EAT was more increased in paroxysmal AF patients than permanent AF patients which is in contrary with Al Chekakie et al. and Batal et al. as the EAT was more increased in permanent AF patients this could be explained by the small number of permanent AF patients in our study (9,10).

Additionally, Batal et al. showed that the EAT, especially only the peri-atrial fat between the left atrium and esophagus, was significantly increased in AF patients and was significantly associated with AF even after adjusting the confounders (10). which was explained as the esophagus is very near to the ostia of pulmonary veins (16) which have the role in initiating AF (17) and secreting inflammatory substance from periatral fat in this area activates the focus in pulmonary veins ostia (10).

The left atrial size could predict the presence of AF (18). Besides, its diameter and volume were more increased in AF patients than non-AF patients, especially permanent AF patients whose left atrial diameter increased more than paroxysmal AF patients (9). which supported our results.

The stretching of the left atrial wall as a result of left atrial enlargement altered the refractory period, which could be related to AF (19). Moreover, a significant relationship was found between EAT and left atrial enlargement (20, 21).

Also, Al Chekakie et al (9). measured left atrial diameter and volume by Echocardiography and left atrial volume by Computed tomography, and it found that EAT associated with the left atrial diameter in all methods, which matched our results of association of both left atrial volume and diameter and EAT even in multivariate analyses.

V. CONCLUSION

EAT was increased in Patients with AF and was associated with increasing the size and volume of the left atrium, which could be used in predicting AF. The level of C-reactive protein was significantly increased in AF patients in our study, which could be used in predicting AF. However, the small number of included patients required taking the result with more caution, and further studies with a larger sample are needed.
LIMITATION
Our study’s main limitation was using a small sample of AF patients, especially in the permanent AF group. Also, measuring total EAT without more details about its anatomical site, however, a meta-analysis showed that AF was significantly associated with both totals EAT and left atrial epicardial adipose tissue (22). Besides, using the two-dimensional Echocardiography did not measure the true volume of left atrial and more radiological methods as computed tomography (23).

REFERENCES