Epicardial Adipose Tissue: A Marker of Atrial Fibrillation After Coronary Artery Bypass Graft Surgery

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Abstract

Objectives: Atrial fibrillation after coronary bypass surgery has been observed very often. In recent studies, the relationship between atrial fibrillation and epicardial adipose tissue (EAT) has been demonstrated. In our study, we aimed to investigate the relation between epicardial adipose tissue and atrial fibrillation frequency occurring after coronary artery bypass surgery.

Methods: A total of 80 patients who had undergone isolated coronary artery bypass surgery were included in the study. Preoperative transthoracic echocardiography was performed and epicardial adipose tissue thickness was measured. The incidence of postoperative atrial fibrillation were examined in patients.

Results: The epicardial adipose tissue thickness of the group with postoperative AF was significantly greater (8.9 ± 1.5 mm) (p <0.001). Also, the length of stay in hospital in the group with postoperative AF was observed longer than the other group (6.7 ± 1.9 days).

Conclusions: According to our study, EAT thickness is a risk factor for the development of AF after coronary artery bypass surgery and it has been demonstrated that it increases the length of hospital stay.

Keywords: Coronary artery bypass surgery, epicardial adipose tissue thickness, atrial fibrillation.

Introduction

In recent years, it has been demonstrated that there is a close relation between the increase of visceral adipose tissue and the occurrence of cardiovascular events (1). The epicardial adipose tissue (EAT) is the most important among adipose tissues. EAT is in a close relationship with almost all of the factors causing formation of coronary artery disease (1). Epicardial adipose tissue is located on the front surface of the heart, covers about 80% of heart’s surface, and takes place as an extension of visceral adipose tissue in the body. EAT is closely related to the morphology and function of heart (2). EAT is directly related with myocardium and secretes vasoactive substances those have cardiovascular risk. These substances are interleukin-6, angiotensin II, free fatty acids, TNF-α and several cytokines (3). This tissue, locating around the epicardial coronary arteries, is involved in the process of progression of coronary atherosclerosis through inflammation markers (4). Epicardial adipose tissue functions as a metabolically active organ. In a previous study, it has been demonstrated that inflammation markers in the serum are increased as a result of increased thickness of epicardial adipose tissue and consequently atrial fibrillation in patients appears more frequently (5).

Atrial fibrillation (AF) is one of the most common cardiac arrhythmia, and one of the most important causes of cardiac morbidity and mortality (6). As a result of studies, the incidence of atrial fibrillation after open heart surgery varies between 25 and 40% (7). Several factors that occur in the post-operative period may accelerate the formation of atrial fibrillation. They function at the cellular level by disrupting membrane stabilization. Increased levels of cellular oxidative stress increases atrial fibrillation (8). Some studies demonstrated that there is a close relationship between epicardial adipose tissue and atrial fibrillation (9-12).

In our study, we aimed to measure the correlation between epicardial adipose tissue and atrial fibrillation frequency occurring after coronary artery bypass surgery.

Materials and Methods

This study was planned as a retrospective study and made by scanning the patients’ files and the database. The sampling of this study was chosen as Canakkale Onsekiz Mart University, Clinic of...
Cardiovascular Surgery between December 2011 and February 2014. The patient’s undergone coronary bypass surgery, and had sinus rhythm preoperatively, and whose data were complete were included in the study. The patients who had undergone emergency surgery, who had preoperative rhythm problems, who had undergone combined surgical procedures, who had valvular heart disease, who used digoxin, beta-blockers and antiarrhythmic drugs preoperatively, who had medical treatment due to chronic obstructive pulmonary disease, who had myocardial infarction during and after surgery, whom intra-aortic balloon pump was implanted in the postoperative period, who received inotropic support and who had preoperative renal, hepatic or thyroid diseases were excluded from the study. Within the specified period 224 patients determined for the study. But we could reach the records of 80 patients’ echocardiography images. Then the data of 80 patients with isolated coronary bypass surgery in whom transthoracic echocardiography (TTE) was performed preoperatively by the same cardiologist and epicardial adipose tissue thickness was measured retrospectively from the records were collected.

Anesthesia and surgical protocols of all patients included in the study group were performed by standard methods. The preoperative demographic data were similar.

The patients were divided into two groups, the patients who had atrial fibrillation and who did not have atrial fibrillation postoperatively.

All of the operations were conducted in the presence of cardiopulmonary bypass (CPB). CPB was performed with cannulation of ascending aorta and right atrium (two-stage), moderate hemodilution with hematocrit value held between 22% - 25% and moderate systemic hypothermia (30 ° C.). Myocardial protection was provided with cold hyperkalemic crystalloid cardioplegia (Plegisol) and topical hypothermia. Patients were taken to intensive care unit postoperatively, and after optimal conditions for extubation had occurred, they were extubated and taken out of intensive care unit.

**Measurement of epicardial adipose tissue**

Echocardiography data of all patients were taken by scanning the device. Scanning was performed by the same cardiologist who was unaware of the clinical data. Echocardiography was performed in all patients with Vivid 7 Pro (Vingmedelectronic, GE, Horten, Norway) echocardiography device, 2 to 5 MHz probe, at the left lateral position, as standard. Measurements were recorded under simultaneous single derivation electrocardiogram recording, and by taking the average of three cardiac cycles. M-mode and Doppler measurements were performed in accordance with the recommendations of the American Association of Echocardiography (13).

Epicardial adipose tissue measurements were performed in the parasternal long axis view by measuring the layer between the echodens pericardium and echolucent space on right ventricular free wall, perpendicularly, at the end of diastole. Aortic annulus was taken as reference (14).

<table>
<thead>
<tr>
<th>Table 1. Demographic data of patients</th>
<th>Postop AF- (n=50)</th>
<th>Postop AF+ (n=30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>61.1±9.3</td>
<td>59.5±8.3</td>
<td>0.44</td>
</tr>
<tr>
<td>Male</td>
<td>39 (%78)</td>
<td>23 (%76.7)</td>
<td>0.89</td>
</tr>
<tr>
<td>BMI</td>
<td>26±4.9</td>
<td>26.2±3.8</td>
<td>0.87</td>
</tr>
<tr>
<td>Hypertension</td>
<td>24 (%48)</td>
<td>15 (%50)</td>
<td>0.86</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>26 (%52)</td>
<td>16 (%53.3)</td>
<td>0.91</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>10 (%20)</td>
<td>10 (%33.3)</td>
<td>0.18</td>
</tr>
<tr>
<td>KOAH</td>
<td>12 (%24)</td>
<td>11 (%36.7)</td>
<td>0.23</td>
</tr>
<tr>
<td>Valvulopathy</td>
<td>6 (%12)</td>
<td>5 (%16.7)</td>
<td>0.56</td>
</tr>
<tr>
<td>NYHA FC</td>
<td>1.9±0.5</td>
<td>2±0.6</td>
<td>0.42</td>
</tr>
<tr>
<td>LA diameter</td>
<td>4.2±0.4</td>
<td>4.4±0.3</td>
<td>0.08</td>
</tr>
<tr>
<td>LVEDD</td>
<td>4.5±0.3</td>
<td>4.8±0.4</td>
<td>0.06</td>
</tr>
<tr>
<td>LVESD</td>
<td>2.9±0.6</td>
<td>3.1±0.4</td>
<td>0.09</td>
</tr>
<tr>
<td>E/A</td>
<td>0.8±0.2</td>
<td>1.1±0.6</td>
<td>0.08</td>
</tr>
<tr>
<td>Preoperative EF (%)</td>
<td>56.7±8.7</td>
<td>53.4±8.8</td>
<td>0.11</td>
</tr>
<tr>
<td>Epicardial fat thickness</td>
<td>6.5±1.9</td>
<td>8.9±1.5</td>
<td>P&lt;0.00</td>
</tr>
</tbody>
</table>

| 1 |
Statistical Analysis

SPSS 15 software package was used for statistical evaluation. All measurements were assessed by Kolmogorov-Smirnov test in terms of conformity to the normal distribution. Continuous variables are presented as mean ± standard deviation or median (minimum-maximum), and categorical variables were expressed as a percentage. For comparing of groups, Student t or Mann-Whitney U test for continuous variables and chi-square test for categorical variables were used. P values <0.05 were considered significant.

Table 2. Perioperative data of patients

<table>
<thead>
<tr>
<th></th>
<th>Postop AF- (n=50)</th>
<th>Postop AF+ (n=30)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of clogged arteries</td>
<td>2.4±0.7</td>
<td>2.2±0.8</td>
<td>0.26</td>
</tr>
<tr>
<td>Number of bypass grafts</td>
<td>2.8±0.7</td>
<td>2.5±1.1</td>
<td>0.38</td>
</tr>
<tr>
<td>CPB time (min)</td>
<td>118.1±2</td>
<td>120.7±3</td>
<td>0.72</td>
</tr>
<tr>
<td>X-clamp time (min)</td>
<td>67±17.6</td>
<td>69.8±19</td>
<td>0.51</td>
</tr>
<tr>
<td>Postoperative drainage (ml)</td>
<td>660.5±2</td>
<td>620.2±2</td>
<td>0.44</td>
</tr>
<tr>
<td>Extubation time (hour)</td>
<td>22.7</td>
<td>33.3</td>
<td></td>
</tr>
<tr>
<td>ICU stay time (day)</td>
<td>1.76±0.1</td>
<td>1.73±0.1</td>
<td>0.89</td>
</tr>
<tr>
<td>Hospital stay time (day)</td>
<td>5.6±1</td>
<td>6.7±1.9</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Results

In patients who had undergone isolated coronary artery bypass surgery, patients with AF and without AF in the postoperative period were compared. Both groups were similar in terms of age, sex, body mass index (BMI), hypertension, hyperlipidemia, diabetes mellitus, functional capacity, left atrial diameter, left ventricular end diastolic diameter, left ventricular end systolic diameter, E/A and left ventricular ejection fraction. The epicardial adipose tissue thickness of the group with postoperative AF was significantly greater (8.9 ± 1.5 mm) (p <0.001) (Figure 1). According to our findings the only factor that is statistically significant between groups is EAT thickness. So we did not perform univariate/multivariate analysis.

Patients' perioperative data were analyzed. The number of diseased vessels was 2.4 ± 0.7 in the group without postoperative AF, and 2.2 ± 0.8 in the group with postoperative AF. The difference between the two groups was not statistically significant, and evaluated as similar.

The difference between the two groups in terms of number of bypassed vessels (distal anastomosis), cardiopulmonary bypass time and cross clamp time was not statistically significant. Patients in both groups were extubated in the postoperative period after staying intubated over a period of 10 hours (non-AF group 10 ± 2.7; AF group 11.6 ± 4). Patients had stayed in the intensive care unit approximately for two days, and then taken to the patients' rooms. In the group with and without AF, postoperative drainage volume was measured 845 ± 176.5 ml and 867 ± 223.2 ml, respectively, and this difference was not statistically significant. The length of stay in hospital in the group with postoperative AF was observed longer than the other group (6.7 ± 1.9 days). This difference was statistically significant (p <0.01) (Table 2).

Discussion

In our study, we investigated what factors might be influential in postoperative AF development in patients undergoing coronary artery bypass surgery. In patients with thicker EAT atrial fibrillation after coronary artery bypass surgery is seen more likely. In addition, the length of hospital stay in patients with postoperative AF was observed significantly higher. It is thought that this increase occurs due to patients' medical treatment for atrial fibrillation. As is known, the increase of visceral adipose tissue in the body is associated with several cardiovascular risk factors including particularly the metabolic syndrome. According to the systematic review and meta-analyses of Rabkin (15) data showed strong relationship between EAT and body mass index especially with waist circumference and visceral adipose tissue. Therefore, EAT, as a part of visceral adipose tissue in the body, is closely associated with risk factors necessary for the formation of metabolic syndrome. EAT is increased in patients with risk factors for metabolic syndrome (16). In our study, patients with co-morbid diseases such as hypertension, hyperlipidemia, and diabetes mellitus were present in nearly equal numbers in both groups.

In the study of Akyol et al, in patients with metabolic syndrome, as EAT thickness increases subclinical atherosclerosis, one of the cardiovascular risks is formed and it has been demonstrated that EAT...
measurement may be a simple marker to evaluate this (17). In our study, the number of clogged coronary arteries and the number of bypassed coronary arteries (distal anastomosis) did not show a statistically significant difference.

Also in many studies, it has been demonstrated that EAT is effective in determining cardiovascular side effects, and also in determining the long-term survival (18). There are many studies showing that EAT secretes various cytokines and chemokines leading to destabilization and rupture of the plaques located in the coronary arteries(19). There are many studies showing the relationship between EAT and coronary artery disease (20,21).

Increase in EAT is a risk factor for formation of coronary artery disease and the development processes and It is suggested it can provide valuable information to evaluate the prevalence and the activity of coronary artery disease. EAT was measured thicker in patients with coronary artery disease than those without coronary artery disease (22).

In many studies, more atherosclerotic intimal lesions were determined in the parts of the coronary arteries covered with EAT (the parts myocardium surrounded) than the parts not covered with EAT (22). Altun et al. demonstrated that measuring EAT is important in the early detection of atherosclerosis (24).

In addition, it was found to be directly related to the number of clogged coronary arteries (25). As epicardial adipose tissue becomes thicker, fat cells become more infiltrative into the atrium and ventricle (26). The relationship between epicardial adipose tissue thickness and the atrial fibrillation has been identified in studies conducted by CT measurement (27).

In our study, transthoracic measurements were made and it has been demonstrated that the increase in thickness of EAT in echocardiographic images is determinative for atrial fibrillation.

In addition, the electrophysiologic studies revealed that fat tissues localized in the atrial septum are associated with atrial arrhythmia and sick sinus syndrome. In the study of Shirani et al. it has been shown that adipose tissue in the interatrial septum is closely related with atrial fibrillation (28). In our study, although there was no statistically significant difference between both groups in terms of left atrium diameter, an increase in postoperative atrial fibrillation and postoperative hospital stay was observed in the group that has thicker epicardial adipose tissue. Epicardial adipose tissue modulates intrinsic autonomic nervous system, and as a result of action in this system, the probability of atrial fibrillation increases (29).

Atrial fibrillation developed in the postoperative period (AF) is often transient, but high ventricular response due to AF can cause unwanted side effects. Thus postoperative AF after coronary bypass surgery is the most common cause of morbidity (30). In our study, the duration of hospital stay was longer in the group with postoperative AF after coronary artery bypass surgery. This case is thought to arise from duration of medical treatment to return their cardiac rhythm to normal sinus rhythm.

Atrial fibrillation is one of the most common complications after open heart surgery. Postoperative atrial fibrillation develops in 25 to 40% of patients undergoing open heart surgery (31). Advanced age, chronic obstructive pulmonary disease, peripheral artery disease, discontinuation of beta-blockers, left atrial enlargement are some of the reasons for postoperative AF (32-34). In our study, patients with these diseases and conditions were excluded, thus an optimal study was planned.

**Conclusion**

In our study, we revealed that the thickness of EAT increased in patients with postoperative AF after isolated coronary artery bypass surgery, and this was statistically significant. Because preoperative measurement of the thickness of EAT is simple and non-invasive, it can provide information about the postoperative survival of patients undergoing coronary artery bypass surgery.

**References**


