Atrial septal defect (ASD) encompasses 10% of all congenital heart lesions[1] and represent the third most common congenital cardiac defect seen in adults.[2] Secundum ASD causes shunting of blood between the systemic and pulmonary circulations. Most young patients with ASD are asymptomatic during childhood and adolescence, even if the shunt volume is large.[3, 4] ASD is associated with the development of pulmonary hypertension, congestive heart failure, atrial arrhythmias, right heart volume overload and decompensation.[5–7]

ASD causes changing in cardiac hemodynamics dependent on the defect size and shunt volume.[3] In the myocardium of an atrium and ventricle continuously exposed to volume overload, stress extends to tissues in the cardiac conduction system and manifests as intra-atrial or intra-ventricular conduction delay. The aim of the study is to evaluate that ECG findings in patients with atrial septal defect can help determine the shunt rate.

Methods: This retrospective study included 74 patients with ASDs. Standard 12-lead ECG and right precordial electrocardiographic recordings (V3R, V4R, VSR, and V6R) were obtained from all patients. QT intervals were measured manually from ECG on paper prints. According to shunt ratio (Qp/Qs), the patients divided into two groups as <1.5 group 1; 1.5> Group 2.

Results: The mean ages of Group1 and Group2 were similar (p>0.05). There were no significant differences between the two groups between RA (right atrium) diameters, RV (right ventricle) diameter (p>0.05). V4RQTmax were 321.2±26.4 msec; 351.1±33.6 msec, respectively (p<0.05) and V5RQTmax were 319.2±22.6 msec; 350.1±32.3 msec, respectively, (p<0.05), which were found to be significantly different.

Conclusion: Were obtained that the right precordial leads could be used to estimate the shunt ratio of patients with secundum ASD.

Keywords: Electrocardiography; right precordial lead; secundum atrial defect
trophysiology has been well established and it is considered to be an important contributor to arrhythmogenesis in conditions with pathologically altered hemodynamics. \cite{11} Prolonged repolarization in ASD patients who typically lack significant depolarization changes may be a probable model of the effect of volume overload on repolarization. \cite{12, 13} The aim of the study is to evaluate that ECG findings in patients with atrial septal defect can help determine the shunt rate.

**Methods**

This retrospective study included 74 patients with secundum ASD diagnosed by echocardiography and catheter study in Türkiye Yüksek İhtisas Hospital. This study was carried out with the approval of the chief of clinic. All of the patients mean age had 42.05±15 581 (40 females and 34 males). All the patient information was de-identified and the study was purely descriptive and retrospective in nature with no clinical relevance for the involved patients. Exclusion criteria had pulmonary venous return anomaly, left persistent superior vena cava, primary pulmonary hypertension, chronic obstructive pulmonary disease, essential hypertension, atrial fibrillation, pacemaker, left bundle branch block and systemic disease. Additionally, the patients taking QRS prolonging medications were also excluded. ECGs had been readable with clearly defined monophasic T waves and disappearing or different U waves.

Standard 12-lead ECG and right precordial electrocardiographic recordings (V3R, V4R, V5R, and V6R) were obtained from all patients. QT intervals were measured manually from ECG on paper prints. QT interval was determined visually from the beginning of the earliest onset of the QRS complex to the end of T wave defined as the point where the tangent drawn at the steepest slope of the descending limb of the T wave intersects the isoelectric line. The longest QT distance is determined as maximum QT.

**Echocardiography**

Right ventricular (RV) dimensions were obtained from echocardiographic M-mode tracings and subsequently their Z-scores were calculated. Maximum right and left ventricular (LV) inlet dimensions at end-diastole were obtained from apical four chamber images. Shunt ratio (Qp/Qs) was calculated by two-dimensional and Doppler echocardiographic measurements. According to shunt ratio (Qp/Qs), the patients divided into two groups: <1.5 group 1; 1.5> Group 2. Both groups age, RA (right atrium), RV (right ventricle), SPAP (systolic pulmonary artery pressure and V1, V2, V3R, V4R, V5R, V6R maximum QT values were compared.

**Statistics**

Categorical (nonparametric) data were compared with Mann-Whitney U test in evaluations. Values in the same group were compared with the paired t test. Statistical data are given as mean value. P values <0.05 were considered significant.

**Results**

The mean ages of Group 1 and Group 2 were similar (p>0.05). There were no significant differences between the two groups between RA (right atrium) diameter, RV (right ventricle) diameter, V1QTmax, V2QTmax, V3RQTmax and V6RQTmax (p>0.05).

Between Group 1 and Group 2; systolic pulmonary artery pressure were 32.5±6 mmHg; 43.4±11.3 mmHg, respectively, p<0.05). V4RQTmax were 321.2±26.4 msec; 351.1±33.6 msec, respectively p<0.05 and V5RQTmax were 319.2±22.6 msec; 350.1±32.3 msec, respectively p<0.05 which were found to be significantly different (Table1).

In the ROC Curve analysis, it was observed that the V4RQTmax value was above 321 ms and determined that the shunt rate was 1, 5 and above in these patients with 76, 7% sensitivity and 58.1% specificity (r=0.634).

**Discussion**

RBBB pattern is frequently encountered in patients with atrial septal defect. RBBB pattern has been suggested to be due to RV volume load and RV hypertrophy.\cite{14} RBBB may be an electrocardiographic indicator of right ventricular pressure load.\cite{15} It was concluded that the right axis deviation seen in secundum ASD is dependent on the volume and pressure load of the right ventricle.\cite{16} Atrial arrhythmias, first degree atrioventricular block, and right ventricular hypertrophy are other electrocardiographic findings in patients with ASD.\cite{17} These findings on electrocardiography are not specific for ASD and are not sufficient to predict the disease in clinical practice.

Electrocardiographically, right precordial leads are more sensitive than standard leads in showing problems of the right ventricle.

In addition to the standard leads used in the exercise test, right lead leads were added in the thought that it would increase the sensitivity in the diagnosis of coronary artery disease. It was observed that the sensitivity of the exercise test performed in this way to detect right coronary lesions increased.\cite{18}

In our study, there was a significant correlation and positive correlation between V4RQTmax and V5RQTmax.
values with shunt ratio over 1.5 (respectively p<0.05, r=0.634; p<0.05, r=0.616). There was a significant relationship between systolic pulmonary artery pressure and shunt ratio (p<0.05). Pulmonary artery pressure was high in patients with shunt ratio above 1.5 this finding. It shows that RV pressure load increases with increasing shunt ratio in patients with ASD. Shahim W. et al informed that the prolongation of the QRS duration in the left precordial leads has been shown to be due to an increase in the pressure load rather than an increase in the volume load of the left ventricle.[19]

Our study; we could not spat a significant relationship between the shunt ratio and the change in RA and RV dimensions (p>0.05). However, we observed a significant relationship between systolic pulmonary artery pressure and RA and RV dimensions (p<0.001). These results showed that the diameter of RA and RV in patients with ASD is associated with a change in systolic pulmonary artery pressure, not shunt rate.

Conclusions

Were obtained that the right precordial leads could be used to estimate the ratio of patients with ASD. Clinician will be able to comment on shunt rate according to V4RQTmax and V5RQTmax values. In patients who are considered to have ASD as a preliminary diagnosis with symptoms and examination findings, the right lead will be useful in demonstrating the severity of the disease by electrocardiographic evaluation. Moreover, increased shunt ratio leads to increased systolic pulmonary artery pressure and systolic loading occurs in the right ventricle. This pathophysiological change might show itself in length on the right lead electrocardiography (V4R and V5R) at QT.

Table 1. Comparison of age, RA diameter, RV diameter, SPAP and V1QTmax, V2QTmax, V3RQTmax, V4RQTmax, V5RQTmax and V6RQTmax values for those with a shunt ratio below 1.5 (Group 1) and those above 1.5 (Group 2)

<table>
<thead>
<tr>
<th></th>
<th>Group1(n=14)</th>
<th>Group2(n=60)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>35.7±11</td>
<td>43.5±16.2</td>
<td>0.259</td>
</tr>
<tr>
<td>RA diameter (cm)</td>
<td>2.9±0.7</td>
<td>3.4±1.1</td>
<td>0.35</td>
</tr>
<tr>
<td>RV diameter (cm)</td>
<td>2.9±0.8</td>
<td>3.1±1.0</td>
<td>0.662</td>
</tr>
<tr>
<td>SPAP (mmHg)</td>
<td>32.5±6</td>
<td>43.4±11.3</td>
<td>0.0116</td>
</tr>
<tr>
<td>V1QTmax (msec)</td>
<td>341.1±35.4</td>
<td>357.6±31.2</td>
<td>0.276</td>
</tr>
<tr>
<td>V2QTmax (msec)</td>
<td>343.1±30.8</td>
<td>371.6±35.2</td>
<td>0.077</td>
</tr>
<tr>
<td>V3RQTmax (msec)</td>
<td>338.1±29.6</td>
<td>354.4±27</td>
<td>0.227</td>
</tr>
<tr>
<td>V4RQTmax (msec)</td>
<td>321.2±26.4</td>
<td>351.1±33.6</td>
<td>0.029</td>
</tr>
<tr>
<td>V5RQTmax (msec)</td>
<td>319.2±22.6</td>
<td>350.1±32.3</td>
<td>0.013</td>
</tr>
<tr>
<td>V6RQTmax (msec)</td>
<td>324±27</td>
<td>347.3±31.6</td>
<td>0.109</td>
</tr>
</tbody>
</table>

RA: Right atrium; RV: Right ventricle; SPAP: Systolic pulmonary artery pressure

Disclosures

Ethics Committee Approval: This study was carried out with the approval of the chief of clinic.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – A.O.; Design – A.O.; Supervision – E.S.; Materials – A.O.; Data collection &/or processing – A.O.; Analysis and/or interpretation – A.O., E.S.; Literature search – A.O.; Writing – A.O., E.S.; Critical review – E.S.

References


