ST segment depression in atrioventricular reentrant tachycardia

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Abstract

Background: ST segment deviation is common in patients with narrow QRS complex tachycardia. It mainly concerns young people in whom ischemic background is unlikely. In our work we would also like to propose another potential mechanism – the overlapping of individual components of the QRS complex. Material and methods: The study included 11 patients (7 women and 4 men) with paroxysmal narrow QRS complex tachycardia. In all patients EPS was performed and the diagnosis of atrioventricular reentrant tachycardia was established and finally successful RF ablation was done. We measured the individual components of QRS QR, RS and RJ during sinus rhythm and during tachycardia. Results: The difference RJ-QR during tachycardia correlated negatively with tachycardia cycle length T (r = -0.85, p = 0.000831). We also showed a significant difference between the amplitude of the RJ segment in tachycardia and during sinus rhythm (p = 0.005), at the same time we showed no differences between the amplitude of QR and RS. Conclusions: We showed a statistically significant difference in ST segment depression in correlation with the rate of tachycardia in patients with AVRT resulting mainly from the overlapping of individual components of the QRS complex.

Keywords: ST-segment depression · tachycardia with narrow QRS complex · AVRT

Citation


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**Introduction**

ST segment changes are mainly associated with coronary artery disease (CAD). However, in supraventricular tachycardias (SVTs) ST segment changes are common and may affect to 50-60% of patients with atrioventricular nodal reentry tachycardia (AVNRT) and atrioventricular reentrant tachycardia (AVRT) [1]. In patients with AVNRT or AVRT, the change in the ST segment on the electrocardiogram (ECG) most often takes the form of downward oblique deviation [2]. Vast majority of these patients are healthy, young people in whom cardiac ischemia is unlikely [3]. The ST segment changes during episodes of SVT has been discussed many times, but none of these studies demonstrated a clear mechanism responsible for the ST segment deviations [4-5]. In this paper, we discuss the potential explanation of ST segment changes in AVRT. We also propose another potential mechanism – the overlapping of individual components of the QRS-T complex resulting in a change in the baseline reference point and a measurement artifact in the form of ST segment depression.

**Materials and methods**

11 patients (7 women and 4 men) took part in the study, their average age was about 28 years. All patients underwent an electrophysiological study (EPS), during which the diagnosis of AVRT was made, followed by successful radiofrequency ablation of the accessory pathway was performed. Detailed demographic, clinical, and laboratory data are described in Table 1.

We assessed the ECG analogously to our earlier work on AVNRT [6-7]. Figure 1 shows how the individual components of the QRS complex were measured. Due to the best visibility of the R wave, lead V5 was used for all measurements.

The statistical analysis was performed using the computer program Statistica v. 13.3 (StatSoft Inc., Tulsa, USA). The Shapiro-Wilk W test was used to calculate normality of distribution, we used the Wilcoxon test for dependent groups for comparisons, and the Spearman’s test for correlation. The study was approved by the local Bioethical Committee at Wroclaw Medical University number KB – 213/2020.

**Results**

ECG parameters are presented in Table 2 and Figure 2. We noted a significant difference between the amplitude of the RJ segment in tachycardia and during sinus rhythm ($p = 0.005$). At the same time we found no differences between the amplitude of QR and RS.

**Abbreviations**

- AV – atrioventricular
- AVNRT – atrioventricular nodal reentry tachycardia
- AVRT – atrioventricular reentrant tachycardia
- ECG – electrocardiogram
- EPS – electrophysiological study

**Table 1. Clinical characteristics of studied patients**

<table>
<thead>
<tr>
<th>Total N = 11</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>28.06 ± 10.16</td>
</tr>
<tr>
<td>Male/female</td>
<td>4/7</td>
</tr>
<tr>
<td>Comorbidities:</td>
<td></td>
</tr>
<tr>
<td>HT</td>
<td>1 (9.1%)</td>
</tr>
<tr>
<td>DM</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>IHD</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>CKD</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Laboratory</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin (mmol/L)</td>
<td>13.57 ± 1,20</td>
</tr>
<tr>
<td>K+ (mmol/L)</td>
<td>4.21 ± 0.40</td>
</tr>
<tr>
<td>Glucose (mg/dL)</td>
<td>95.04 ± 12.3</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>0.7 ± 0.10</td>
</tr>
<tr>
<td>TSH (mU/L)</td>
<td>1.75 ± 1.20</td>
</tr>
</tbody>
</table>


**Figure 1. Individual components of the QRS complex**

QR segment – the distance between the bottom of the Q wave and the peak of the R wave, RS segment – the distance between the peak of the R wave and the bottom of the S wave, RJ segment – the segment between the peak of the R wave and the J point
We also showed a significant negative correlation between the tachycardia cycle length and the RJ-QR difference – the faster the arrhythmia, the greater the ST segment denivation (r = -0.85, p = 0.000831). During sinus rhythm, there were no significant changes in RJ-QR difference.

A graphical representation of the above-mentioned relationships is shown in Figure 3.

![QR and RJ measurements during tachycardia (left panel) and during sinus rhythm (right panel)](image)

**NSR** – normal sinus rhythm

### Table 2. The basic electrocardiographic parameters measurements in sinus rhythm and tachycardia with according differences and statistical test results

<table>
<thead>
<tr>
<th>Parameters</th>
<th>QR(mV)</th>
<th>RS(mV)</th>
<th>RJ(mV)</th>
<th>RJ – QR(mV)</th>
<th>Cycle length (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tachycardia</td>
<td>1.103 +/- 0.400</td>
<td>1.213 +/- 0.433</td>
<td>1.147 +/- 0.393</td>
<td>0.033 +/- 0.091</td>
<td>329.50 +/- 37.56</td>
</tr>
<tr>
<td>Sinus Rhythm</td>
<td>1.065 +/- 0.469</td>
<td>1.189 +/- 0.434</td>
<td>1.064 +/- 0.440</td>
<td>0.010 +/- 0.073</td>
<td>739.55 +/- 179.5</td>
</tr>
<tr>
<td>Difference</td>
<td>0.038</td>
<td>0.024</td>
<td>0.083</td>
<td>0.023</td>
<td>—</td>
</tr>
<tr>
<td>P</td>
<td>0.575</td>
<td>0.114</td>
<td>0.005</td>
<td>0.207</td>
<td>—</td>
</tr>
</tbody>
</table>

### Table 3. The correlation of RJ-QR in tachycardia and sinus rhythm with tachycardia cycle length

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Heart rate in tachycardia Spearman correlation rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>[RJ-QR] Tachycardia</td>
<td>r = -0.85, p = 0.000831*</td>
</tr>
<tr>
<td>[RJ-QR] Sinus Rhythm</td>
<td>r = -0.50, p = 0.074</td>
</tr>
</tbody>
</table>

**Discussion**

In patients with AVRT, there is a phenomenon of ST segment depression. Because this tachycardia affects mainly young people in whom ischemic etiology is unlikely, the most probable cause is a measurement artefact – the overlapping of individual components of the QRS complex and elevation of the baseline, a retrograde P wave or QRS alternans [1].

ST segment depression during SVT is well-documented in the literature [4-5]. These changes usually resolve when...
sinus rhythm is restored, although it has been reported that
ST-segment depression may persist and is not associated with
CAD-related myocardial damage [3].

Dorenkamp et al. concluded that there is no correlation
between the presence of CAD and ST segment depression in
ECG of patients with paroxysmal SVT [1]. The same percent-
age of people with ST segment depression was observed both
among patients with significant narrowing in the coronary
vessels and in patients with normal coronary angiography re-
sults.

In our study, we demonstrated a positive correlation be-
tween ST segment depression and arrhythmia rate. The short-
er the arrhythmia cycle, the greater the overlap of the T wave
of the previous QRS complex with the next QRS complex,
which causes a rise the baseline and may give the impression
of ST segment depression. We proposed a similar explanation
for the AVNRT in another article [6].

During fast AVRT, in some patients there is an QRS al-
ternans. Due to the dynamic change in the amplitude of all
components of the QRS complex (QR, RS, RJ) from beat to
beat, there is a change in the baseline, which may look like
depression of the ST segment. The QRS alternans in AVRT
has not been explained, some studies suggest intraventricular
conduction disturbances as the cause of this phenomenon [6].
In our study, unfortunately, we did not have patients with QRS
alternans during orthodromic tachycardia.

A retrograde P wave occurs during AVRT. In orthodromic
AVRT, the interval between the QRS complex and the retro-
grade P wave should be at least 70 ms, depending on the electro-
physiological properties of the accessory pathway and the
location between pathway and AV node [7]. For this reason,
the retrograde P wave is projected onto the ST segment or the
T wave. This may cause ST segment depression, which looks
like its denivelations, likewise to myocardial ischemia. Riviera
et al reached similar conclusions [8].

When considering the spatiotemporal relationships of
retrograde atrial activation during AVRT, the possible loca-
tions of accessory pathways should be considered [9]. Viewed
from the V5 lead, the left-sided accessory pathways generate
retrograde P waves that will be negative, inducing a lowering
of the J point and ST-segment in this lead. Right lateral path-
ways cause opposite changes inducing the relative elevation
of the J point and the ST segment of the electrocardiogram
in lead V5. Septal tracts induce similar changes, as activation
of the left atrium electrically prevails over activation of the
right atrium, but in this location the retrograde P wave is ex-
ceptionally short, which means that, depending on the speed
of retrograde conduction, the change in a targeted manner
may influence the J point or a fragment of the ST segment.
Posterior pathways, depending on the location, can affect the
described phenomenon in different ways. Therefore, in the
case of our results, obtained in a relatively small study group,
the relationships described do not have to be unambiguous.
A probabilistic conclusion may be that the relationship de-
scribed earlier is true, modified only by the influence of the
retrograde P wave depending on the location of the accessory
pathway [10-11].

Limitations

This is a single-center study conducted in a small group of
patients. Because AVRT is a rare arrhythmia, there are signif-
ificant difficulties in gathering a larger group of patients. None
of the patients had coronary angiography performed to com-
pletely exclude the ischemic cause of ST segment changes. In
addition, there was no exercise test performed and no pac-
ing with the arrhythmia rate during the EPS to reproduce the
baseline conditions during arrhythmia.
Conclusions

The cause of ST-T segment changes during AVRT remains unexplained. In this paper we propose a fairly simple but important explanation. The concept of ST segment change as a measurement artifact resulting from the overlapping of individual components of the QRS-T complex in AVRT has not been described in the literature so far. More research is needed to confirm this concept and to search for other potential mechanisms.

Conflicts of interest

None to report.

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Not applicable.

References


