Value of Age and Sex in Differential Diagnosis of Supraventricular Tachycardia

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ABSTRACT

Introduction: Many algorithms have been proposed for the differential diagnosis of supraventricular tachycardia (SVT). However, the effect of these algorithms on different sex and age groups has not been investigated. Our aim in this study is to observe the distribution of known electrocardiography (ECG) parameters in different age and sex groups.

Patients and Methods: The ECG parameters (during tachycardia) of 114 patients diagnosed with atrioventricular nodal re-entrant tachycardia (AVNRT) or atrioventricular re-entrant tachycardia (AVRT) by electrophysiology or radiofrequency ablation were evaluated retrospectively.

Results: For women, pseudo r'-waves in V1 and in aVR were significant in the AVNRT group ($p< 0.05$), whereas the QRS alternans was significant in the AVRT group ($p< 0.05$). In the AVNRT group, the ST depression in the right precordial leads was found to be significant in individuals aged < 60 years; the up-sloping ST depression was found to be a significant parameter for individuals aged > 60 years in the same group ($p< 0.05$). The mean ST depression amplitude was higher in the AVRT patients aged > 60 years than individuals aged < 60 years in the same group ($p< 0.05$).

Conclusion: In this study, it was shown that known ECG parameters differ according to age and gender. It was also demonstrated that age and gender may be included in the SVT differential diagnosis and algorithms.

Key Words: Atrioventricular nodal re-entrant tachycardia; atrioventricular reciprocating tachycardia; differential diagnosis; electrocardiography

Supraventriküler Taşikardilerin Ayırıcı Tanısında Yaş ve Cinsiyetin Önemi

ÖZET

Giriş: Supraventriküler taşikardilerin ayırıcı tanısı için birçok algoritma önerilmiştir. Bununla birlikte, bu algoritmaların farklı cinsiyet ve yaş grupları üzerindeki etkisi araştırılmamıştır. Amacımız, bilinen elektrokardiyografi (EKG) parametrelerinin farklı yaş ve cinsiyet gruplarındaki dağılımını gözlemlemektir.

Hastalar ve Yöntem: Retrospektif olarak, taşikardi esnasında EKG'si olan ve elektrofizyoloji çalışması (EPS) veya radyofrekans ablasyonu (RF) ile atriyoventriküler nodal reentrant taşikardi (AVNRT) veya atriyoventriküler reentrant taşikardi (AVRT) tanısı alan 114 hastanın EKG parametreleri incelenmiştir.

Bulgular: Kadınlar için V1 ve aVR'de yalancı r'-dalgaları AVNRT grubunda daha anlamlıydı ($p< 0.05$); QRS alternansı AVRT grubunda anlamlıydı ($p< 0.05$). AVNRT grubunda 60 yaşın altındaki bireylerde sağ prekordiyalde ST depresyonu anlamlı görüldü; aynı gruptaki 60 yaşın üzerindeki bireyler için, yukarı eğimli ST depresyonu anlamlı bir parametre olarak saptandı ($p< 0.05$). Altmış yaş üstündeki AVRT hastalarında ortalama ST depresyon amplitüdünün ortalaması, 60 yaş altındakilere göre daha yüksekti ($p< 0.05$).

Sonuç: Bu çalışmada bilinen EKG parametrelerinin yaşa ve cinsiyete göre farklılık gösterdiği gösterilmiştir. SVT ayırıcı tanı ve algoritmalarında yaş ve cinsiyetin yer alabileceği ortaya koyulmuştur.

Anahtar Kelimeler: Atriyoventriküler nodal re-entran taşikardi; atriyoventriküler resiprokal taşikardi; ayırıcı tanı; elektrokardiyografi

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INTRODUCTION

Atrioventricular nodal re-entrant tachycardia (AVNRT) and atrioventricular re-entrant tachycardia (AVRT) are the most common types of supraventricular tachycardia[1,2]. It is clinically important that the mechanism underlying supraventricular tachycardia (SVT) can be estimated and evaluated non-invasively using electrocardiography (ECG) during tachycardia. In this respect, the ablation technique can be planned during the treatment of the disease. In addition, the preliminary diagnosis obtained by ECG shortens the duration of radiation and reduces possible complications.

ECG parameters and criteria in the SVT diagnosis have been searched for in many previous studies, and many relevant algorithms have been proposed[1,3-8].

The purpose of this study is to re-evaluate the well-known ECG parameters in the SVT diagnosis and investigate the effect of age and gender in the differential diagnosis of AVNRT and AVRT.

PATIENTS and METHODS

Patient Selection

We retrospectively reviewed ECGs of patients aged 18-100 years admitted to our clinic between 2010 and 2014 with the SVT diagnosis and diagnosed with AVRT or AVNRT by the electrophysiology study (EPS) and radiofrequency ablation (RF). Patients with poor-quality ECGs, unclear diagnosis, and any narrow QRS supraventricular tachycardias other than AVRT or AVNRT (atrial tachycardia, atrial flutter, atrial fibrillation, junctional tachycardia, etc.) were excluded from the study. The study protocol was reviewed and approved by the Local Ethics Committee of the university where the study was conducted.

Electrocardiographic Parameters

The following 16 parameters were examined in this study: pseudo r'- wave in V1, pseudo r'-wave in aVR, notch in aVL, QRS alternans, visible P wave, ST depression > 2 mm, pseudo s'-wave in inferior leads, RP intervals > 100 ms, ST depression in lateral leads, ST depression in right precordial leads, down-slope ST depression, horizontal ST depression, up-slope ST depression, maximum ST depression amplitude (mm), ST elevation in aVR, and ST elevation amplitude in aVR (mm) (Figure 1,2).

Also, 40 ECGs were randomly selected for two different researchers, whose observations were statistically tested within the group and between the groups (intra-observer and inter-observer). The two researchers were unaware of the ablation results.

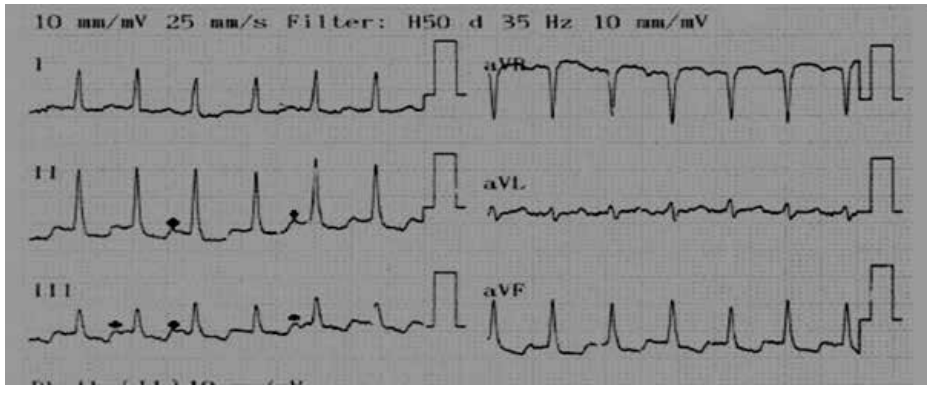

Figure 1. Points designate the apparent P wave and are measured as RP intervals > 100 ms.

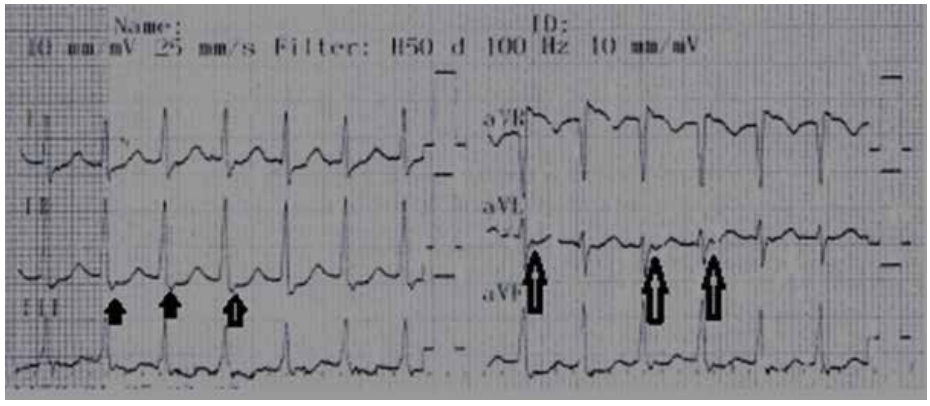

Figure 2. Small arrows indicate the pseudo s'-wave in inferior leads, and large arrows indicate notches in aVL.

All ECGs of this study were recorded at a speed of 25 mm/sec and an amplitude of 10 mm/mV.

EPS Procedure and Ablation

Routine EPS was performed in patients with documented narrow QRS tachycardia. Firstly, catheters were placed through the right and left femoral veins (RV, CS, His, RA), and then the basic diagnostic EPS procedure was performed. After the basal conduction intervals, sinus and AV node functions were normal, and VA conduction was found to be nodal and decremental by atrial pacing. When AVNRT was induced by programmed atrial stimulation, radiofrequency ablation was performed from the appropriate site with a 4 mm-tip ablation catheter. For AVRT, the earliest atrial activation site was determined by ventricular stimulation after the basic diagnostic EPS procedure. Trans-septal or retrograde aortic pathway ablation was performed depending on the location of the accessory pathway.

Statistical Analysis

Descriptive statistics of variables was reported as the frequency/percentage or as the mean ± standard deviation. Continuous and discrete variables were tested for normality using the Kolmogorov–Smirnov test. Student's t-test was used for group comparisons with normal distributions, and the Mann–Whitney U test was used for non-normal distributions. To determine the relationship between categorical variables, the Monte Carlo corrected chi-squared analysis was used. For determining the intra-observer and inter-observer consistency of two different researchers, Kohens' kappa test was used. The Type I error level was taken as 5%, and a p-value < 0.05 was accepted as statistically significant. All analysis was performed on statistical package software (SPSS ver. 20.0; SPSS Inc. Chicago, Illinois, USA).

RESULTS

Comparison of ECG Parameters

There was a total of 114 patients, of who 89 were diagnosed with AVNRT (62 women, 27 men; mean age, 46.27 ± 16.22 years) and 25 diagnosed with AVRT (14 female, 11 male; mean age, 47.36 ± 16.22 years) were included in the study. Pseudo r'-wave in V1 (sensitivity, 50.56%; specificity, 72%; p= 0.046) was determined as the defining ECG parameter for AVNRT. Having the RP intervals > 100 ms (sensitivity, 53.85%; specificity, 96%; p< 0.001), and ST depression in the right precordials (sensitivity, 64%; specificity, 61%; p= 0.022), and down-slope ST depression (sensitivity, 88%; specificity, 71%; p< 0.001) were designated as defining ECG parameters for AVRT (Table 1,2).

Parameters with Respect to Gender

When both the tachycardia groups were divided with respect to gender, the pseudo r'-wave in V1 and pseudo r'-wave in aVR (p= 0.033 and p= 0.036, respectively) were more frequent in women with AVNRT; the QRS alternans (p= 0.015) was more common in women with AVRT (Table 3).

Table 1. Univariate analysis of electrocardiographic parameters between atrioventricular node re-entrant tachycardia (AVNRT) and atrioventricular reciprocating tachycardia (AVRT)

	AVNRT (n= 89)	AVRT (n= 25)	p
Pseudo r'-wave in V1	45 (50.6%)	7 (28.0%)	0.046
RP intervals > 100 ms	2 (2.2%)	7 (28.0%)	< 0.001
ST depression in right precordial (V2, V3)	34 (38.2%)	16 (64.0%)	0.022
Down-slope ST depression	25 (28.1%)	22 (88.0%)	< 0.001
Maximum ST depression amplitude (mm)	1.184 ± 0.74	1.696 ± 0.87	0.004

Table 2. Sensitivity, specificity, positive predictive value and negative predictive value of selected criteria

	Pseudo r'-wave in V1 (AVNRT)	RP intervals of > 100 (AVRT)	ST depression in right precordial (AVRT)	Down-slope ST depression (AVRT)
Sensitivity	50.56%	53.85%	64.00%	88.00%
Specificity	72.00%	96.55%	61.80%	71.91%
Positive predictive value	86.54%	77.78%	32.00%	46.81%
Negative predictive value	29.03%	90.32%	85.94%	95.52%

Table 3. Distribution of ECG parameters according to gender

AVNRT	Women (n= 62)	Men (n= 27)	p
Pseudo r'-wave in V1	36 (58.1%)	9 (33.3%)	**0.033**
Pseudo r'-wave in aVR	23 (37.1%)	4 (14.8%)	**0.036**
AVRT	**Women (n= 14)**	**Men (n= 11)**	**p**
QRS alternans	6 (42.9%)	0 (0.0%)	**0.015**

Table 4. Distribution of ECG parameters according to age

AVNRT	< 60 of age (n= 69)	≥ 60 of age (n= 20)	p
Right precordial ST depression (V2, V3)	30 (43.5%)	4 (20.0%)	**0.044**
Up-slope ST depression	46 (66.7%)	18 (90.0%)	**0.042**
AVRT	**< 60 of age (n= 69)**	**≥ 60 of age (n= 20)**	**p**
Maximum ST depression amplitude (mm)	1.489 ± 0.73	2.350 ± 1.03	**0.033**

Parameters with Respect to Age

When both tachycardia groups were divided into two groups aged < 60 years and > 60 years, while right precordial ST depression was a significant ECG parameter for the group aged < 60 years with AVNRT (p= 0.044), the up-slope ST depression was significant for the group aged > 60 years with AVNRT (p = 0.042). For the AVRT group, the mean of maximum ST depression amplitude was higher in the group aged > 60 years (2.350 ± 1.03 mm; p= 0.033) (Table 4).

Intra-observer and Inter-observer Consistency Values

In our study, the intra-observer consistency values were found to be nearly perfect, whereas the inter-observer consistency value, kappa, average was 0.3, and the overall consistency percentage of the parameters was 70% (Table 5).

DISCUSSION

According to our observations in this study, we would like to say that the differential diagnosis of supraventricular tachycardia may require consideration differences in gender and age.

In a study including 256 patients, it was emphasised that being female and aged > 60 years were independent predictors of AVNRT with classical ECG criteria[9]. In addition, we observed pseudo r'-waves in V1, which is one of the classical ECG parameters of AVNRT, more often in women. Therefore, we think that gender can be included in the differential diagnosis algorithm. In addition, we have never observed the QRS alternans (a parameter used in the differential diagnosis for AVRT) in male patients. Therefore, we can think that the absence of QRS alternans in male patients would not exclude AVRT. In men, it may be necessary to search for different ECG parameters when making a differential diagnosis.

Gender-related ECG changes in humans and other animal species were reviewed, and as a conclusion, sex hormones were held accountable for longer QT intervals in females[10]. But to the best of our knowledge, there have been no previous studies to examine the physiologic mechanism of the ST-T changes during tachycardia episodes according to gender. It can be due to several mechanisms such as hormones, ventricular mass, different repolarisation patterns and even lead placements[11]. We think that ST-T changes are more frequent in the elderly population due to ischaemic changes that may occur with age. But in our study, we were not aware of the ischaemic status of elderly patients, and also no diagnostic tests were performed to exclude ischaemic heart disease.

In a study, the hypothesis on a relation existing between the P-wave location and tachycardia mechanism was tested. Moreover, the question whether gender and the age limit of 65 years make a difference to this relation was investigated[12]. In this study, P waves were divided into three categories: invisible P waves, pseudo r'/s'-waves, and visible P waves. In patients with AVNRT, there was no difference detected in pseudo r'/s'-waves between gender groups, whereas in our study, pseudo r'-waves in V1 were found to occur significantly more likely in women than men with AVNRT. In both studies, P wave did not differ in AVNRT between genders. Also, pseudo r'/s'-waves did not display a significant difference between the age groups < 65

Table 5. Intra-observer and inter-observer consistency values in ECG parameters

	Inter-observer consistency			Intra-observer consistency		
	%	Cohen's Kappa	p_{Kappa}	%	Cohen's Kappa	p_{Kappa}
Pseudo r'-wave in V1	87.5	0.751	**< 0.001**	95	0.875	**< 0.001**
Pseudo r'-wave in aVR	62.5	0.211	0.182	95	0.893	**< 0.001**
Notch in aVL	65.0	0.041	0.648	100	1.000	**< 0.001**
QRS alternans	70.0	0.091	0.402	95	0.881	**< 0.001**
Visible P wave	60.0	0.045	0.747	100	1.000	**< 0.001**
ST depression > 2 mm	85.0	0.483	**0.002**	100	1.000	**< 0.001**
Pseudo s'-wave in inferior leads	60.0	0.149	0.343	97.5	0.947	**< 0.001**
RP intervals > 100 ms	62.5	0.249	**0.037**	100	1.000	**< 0.001**
ST depression in inferior leads	72.5	0.382	**0.009**	97.5	0.935	**< 0.001**
ST depression in lateral leads (I, aVL, V5, V6)	82.5	0.391	**0.002**	97.5	0.925	**< 0.001**
ST depression right precordial (V2, V3)	75.0	0.472	**0.002**	95	0.900	**< 0.001**
Down-slope ST depression	60.0	0.200	0.144	95	0.898	**< 0.001**
Horizontal ST depression	62.5	0.282	**0.048**	95	0.900	**< 0.001**
Up-slope ST depression	70.0	0.400	**0.008**	100	1.000	**< 0.001**
ST elevation in aVR	82.5	0.481	**0.002**	97.5	0.980	**< 0.001**
Mean ± SD	70.50 ± 9.87	0.30 ± 0.19		97.33 ± 2.20	0.94 ± 0.04	
Paired Sample t-test		**Mean ± SD**	**p**		**Mean ± SD**	**p**
Maximum ST depression amplitude (mm)		1.39 ± 071/1.13 ± 0.91	0.022		1.34 ± 0.75/1.35 ± 0.76	**0.570**
ST elevation amplitude in aVR (mm)		0.81 ± 0.71/0.82 ± 0.66	**0.930**		0.82 ± 0.67/0.83 ± 0.69	**0.392**

ECG: Electrocardiography.

years and those above that age. A similar finding was obtained in our study when the patients with AVNRT were divided into two groups as < 60 years and > 60 years. But contrary to this study, Maury and colleagues have shown that the visible P wave is a significant parameter for the group of patients aged > 65 years.

In another study conducted on a larger scale, AVNRT and AVRT were found to possess differentiating rates with respect to age and gender[13]. According to a consensus document by the European Society of Cardiology, women have the risk twice as high as men for developing AVNRT, which is similar to our study findings; but, unlike in our study, here AVRT is twice as common in men as in women[11]. This finding may be explained by the small number of patients in the AVRT group.

In a study of 203 patients with AVNRT, a broader refractory period difference was found between the fast and slow pathways of women, which may explain the high AVNRT incidence in women[14]. Another study, conducted on children, showed increased AVNRT rates in girls[15]. Also in our study, AVNRT was more common in female gender.

The findings of the classical ECG parameters in our study were not very different from those in the previous studies. In one study, which involved 110 with documented SVT, the presence of the pseudo r '-wave in V1 and the presence of the pseudo s'-wave in the inferior leads have shown a positive predictive value > 90% in the AVNRT diagnosis. As for the AVRT diagnosis, the ST segment depression and QRS alternation were found to be the highest two positive predictive values[16]. Similarly, we have also derived that the presence of the pseudo r'-wave in V1 and the presence of RP intervals > 100 ms in ECG are significant indicators in diagnosing AVNRT and AVRT, respectively. Furthermore, we have found that ST depressions may also help the clinician.

In another study, involving 101 patients, the aVL notch has put forward as a new parameter to predict AVNRT[6]. But in our study, the aVL notch was not a significant parameter for AVNRT, neither for women nor for men.

Whereas in a study that included 150 patients, the pseudo r'-wave in aVR was found to have a higher sensitivity, speci-

ficity, and positive and negative predictive values than conventional parameters[8], in our study, the pseudo r' in aVR was not a significant parameter for AVNRT, but in the AVNRT population, it was more frequent in women.

Limitations to our study include a retrospective observational design and a relatively small number of patients. This may explain the fact that the parameters used in differential diagnosis such as the pseudo r' in aVR and the notch in AVL were not detected in our study. However, since all patients diagnosed with either AVNRT or AVRT were included in the study, we derive that this study reflects on the general population. Another limitation of this study was the difference in the experience level of each ECG observer. For this reason, a good level of observer consistency is not achieved, but the intra-observer consistency was close to perfect.

CONCLUSION

In this study, we presented that the age and gender could make a difference in the SVT differential diagnosis. In our study, for AVNRT, the pseudo R'-wave in V1 and aVR, for AVRT QRS alternans, is a more frequent ECG parameter in women. For AVNRT, right precordial ST depressions are more frequent in younger patients, while up-sloping ST depressions are more frequent in the elderly. Also, elderly patients in the AVRT group have more ST depression amplitudes than younger patients. It is obvious that this difference should be evaluated in more comprehensive studies, because electrophysiological differences between men and women and young and old patients are thought to be one of the most important cornerstones in our differential diagnosis.

CONFLICT of INTEREST

The authors reported no conflict of interest related to this article.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: İC
Analysis/Interpretation: KA, İC
Data Acquisition: KA
Writting: KA, MK
Critical Revision: ME, TA
Final Approval: All of authors

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