

VALIDATION OF DIAGNOSTIC ACCURACY OF LEADS AVR AND V1 IN ATRIOVENTRICULAR NODAL REENTRANT TACHYCARDIA (AVNRT)

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ABSTRACT

Objective: To evaluate specificity, sensitivity and diagnostic accuracy of r' deflection at the end of the QRS complex in leads aVR and V1 of ECG for diagnosis of AVNRT

Study Design: Descriptive cross sectional study.

Place and Duration of Study: This study was conducted at AFIC/NIHD Rawalpindi from Nov 2014 to Jan 2015.

Material and Methods: Sixty two patients presenting to AFIC/NIHD for catheter ablation from November 2014 to January 2015 were enrolled in the study. The ECGs were evaluated for r' deflection in leads V1, AVR and pseudo S wave in the inferior leads prior to performing an electrophysiology study. The diagnosis was confirmed by cardiac electrophysiology study.

Results: The AVNRT was correctly diagnosed in 88.5% of cases. For AVNRT diagnosis, r' deflection in AVR (sensitivity 90.1%, specificity 100%), r' deflection in V1 (sensitivity 90.1%, specificity 100%) and pseudo S wave (sensitivity 86.6%, specificity 100%) predicted AVNRT in 93%, 91% and 85% of cases, respectively. Therefore the presence of r' deflection in V1 and aVR leads; and pseudo S wave in the inferior leads were found to be reliable predictors of AVNRT.

Conclusion: The standard ECG criterion of pseudo r' deflection and pseudo S wave is an accurate method of diagnosing AVNRT.

Keywords: Atrioventricular nodal reentrant tachycardia (AVNRT), supraventricular tachycardia, QRS complex.

INTRODUCTION

The most common type of regular paroxysmal supraventricular tachycardia encountered in humans is AVNRT¹. It has been observed that even continuous administration of antiarrhythmic drugs may be ineffective in up to 70% of patients to prevent acute episodes of AVNRT². Effective discrimination between the various underlying mechanism of paroxysmal supraventricular tachycardia pre-procedure will help in reducing procedure duration, fluoroscopy time and complications. Several studies have been done in the past to explore the diagnostic utility of electrocardiography to distinguish between the various tachycardia mechanisms³⁻⁸.

A prospective study has been conducted at the Armed Forces Institute of Cardiology with an objective to assess the value of r' deflection at the end of the QRS complex in aVR and V1

leads; and also to evaluate the specificity, sensitivity and accuracy of this criterion to predict AVNRT as the underlying mechanism of paroxysmal supraventricular tachycardia.

MATERIALS AND METHODS

Sixty two consecutive patients coming to AFIC for radio frequency ablation of paroxysmal supraventricular tachycardia between the months of November 2014 to January 2015 have been prospectively enrolled in this study. Patients of both genders and all age groups were considered. Informed consent was obtained for each patient. The methodology of this study has been approved by the Institutional Review Board of AFIC/NIHD for administrative and ethical issues.

Patients who remained undiagnosed after EPS or were suffering from structural heart disease, atrial tachycardia, bundle branch block in sinus rhythm or during tachycardia and/or manifested pre-excitation were excluded from this study.

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A 12 lead ECG was obtained for each patient during sinus rhythm and during tachycardia at a paper speed of 25 mm/s, gain setting of 10 mm/mV, and filter setting of 0.5 and 1000 Hz. The ECGs were evaluated prior to EPS by two separate observers who were blinded to patient information (Fig-1). The observers were then asked to specify the most likely mechanism of paroxysmal supraventricular tachycardia from each ECG; and the disagreement was resolved by consensus.

ECG Evaluation

All of the ECGs were evaluated according to the following formula⁹:

- a) **r' deflection in lead V1:** Presence of a positive deflection at the end of the QRS complex in lead V1 and the absence of this deflection during sinus rhythm
- b) **r' deflection in lead aVR:** Presence of a r' deflection at the end of the QRS complex in lead aVR and the its absence during sinus rhythm.
- c) **Pseudo S wave in the inferior leads:** Presence of a negative deflection at the end of the QRS in II, III and aVF leads during tachycardia and the absence of this sign during sinus rhythm.
- d) **Visible P-wave:** Deflection in the ST-segment interpreted as a retrograde P-wave in at least one of the 12 leads.

Electrophysiology study

The patients underwent electrophysiology study in the post absorptive state and all antiarrhythmics were discontinued for at least five half-lives before the study. Two standard 6F quadripolar catheters were placed under fluoroscopy guidance via the right femoral vein in the right ventricular apex and at the bundle of His. One 7F quadripolar catheter placed in the right atrium, which was subsequently used as an ablation catheter. Another 7F quadripolar catheter was positioned in the coronary sinus via the left subclavian vein.

Programmed atrial and ventricular stimulation was performed. Twelve lead surface ECG and bipolar filtered electrocardiograms (50 – 100 Hz) and unipolar

unfiltered electrocardiograms were recorded (49.1 – 60.5 Hz). The exact mechanism of tachycardia was determined by electrophysiological study including; induction and termination of tachycardia by atrial or ventricular extra-stimuli, presence of dual AV nodal physiology, parahisian pacing, retrograde conduction properties during ventricular

Table-1: Demographic, Electro-cardiographic and RF-ablation characteristics of patients (n = 70).

Charactristics	AVNRT
Patients (%)	98%
Gender	
Males (%)	60.6%
Females (%)	39.4%
Age (years)	44±14 years
Weight (kg)	70±11 kg
Height (cm)	166±7 cm
Diabetic (%)	5%
Hypertensive (%)	18%
LVEF	
Normal (>50%)	96%
Slightly reduced (41-50%)	4%
SVT heart rate (mean ± SD)	195±15 bpm
r' deflection in V1 n(%)	55 (88.7%)
r' deflection in aVR n(%)	55 (88.7%)
Pseudo s wave in II, III, aVF (%)	53 (85.5%)
EPS-RFA procedure duration in mins (mean ± SD)	88±20 mins
Fluoroscopy time in mins (mean ± SD)	17±7 mins
Number of energy applications	5.85 ± 5

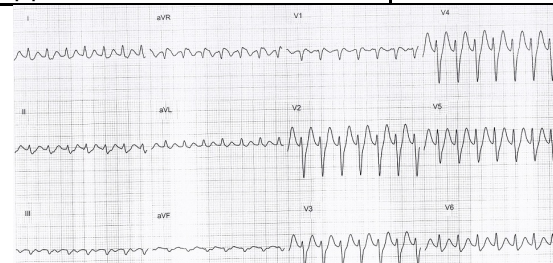


Figure-1: Twelve-lead ECG recording during spontaneous AVNRT showing r' deflection in aVR and V1; and pseudo S in I, II and aVF leads.

paced and advancement of the atrial

electrogram after ventricular extra-stimulus delivered during His refractoriness¹⁰⁻¹². A successful radiofrequency catheter ablation procedure further confirmed the underlying tachycardia mechanism.

Statistical analysis

The data were entered in IBM SPSS Statistics software (version 19). Continuous data were expressed as median and mean along with standard deviation values. Proportions were expressed as percentages with confidence

Table-2 summarizes the specificity, sensitivity, positive predictive value and negative predictive value of present ECG criterion. For AVNRT diagnosis, r' deflection in AVR (sensitivity 90.1%, specificity 100%), r' deflection in V1 (sensitivity 90.1%, specificity 100%) and pseudo S wave (sensitivity 86.6%, specificity 100%) predicted AVNRT 93%, 91% and 85% of cases, respectively.

Mean time consumed in electrophysiology study and RF ablation of AVNRT was 88 ± 20

Table-2: Sensitivity, specificity, positive predictive value and negative predictive value of present ECG criterion in AVNRT.

	Sensitivity (%)	Specificity (%)	Positive predictive value (%)
AVNRT			
R' deflection in V1	90.1%	100%	100%
R' deflection in aVR	90.1%	100%	100%
Pseudo S wave in II, III, aVF	86.8%	100%	100%

intervals of 95%. Different groups were compared with either chi-square test or a non-parametric Fisher's exact test. Similarly groups of continuous variables were compared by using student's t-test or a non-parametric Wilcoxon - Mann - Whitney test. The inter - observer agreement is calculated by the kappa - statistic, Sensitivity, specificity, and predictive values were calculated in the usual manner and a *p*-value of 0.05 is considered significant.

RESULTS

Out of sixty two patients, there were 37 (59.7%) males and 25 (40.3%) females. The age range was 16 – 77 years; mean age was 44.26 ± 14.85 years, mean age for females was 42.4 ± 11.2 years and for males was 45.5 ± 16.9 years. The demographic and electrocardiographic characteristics are summarized in table-1.

The average inter - observer agreement ratio was 95.05% with kappa index of $\kappa = 0.7$, indicating good strength of agreement. The strength of agreement between two pairs ranged from moderate ($\kappa = 0.5$) to excellent ($\kappa = 0.9$).

Electrophysiology study and RF ablation confirmed the diagnosis of AVNRT in 61 cases. Of the 61 cases we correctly diagnosed 54 cases on the basis of ECG criteria which equals 88.5% correct diagnosis.

minutes while total fluoroscopy time was 17 ± 7 minutes.

DISCUSSION

The most common forms of tachycardia are either AVNRT or AVRT, representing 90% of paroxysmal supraventricular tachycardias¹. Various studies have reported to assess "The standard criterion" for diagnosis of AVNRT¹⁻⁶ and some new electrocardiographic algorithms have been proposed^{8,9}. Despite the evolution of novel algorithms, the standard ECG algorithm stands out in its simplicity and accuracy to diagnose AVNRT. The present study supports the standard ECG criterion and shows that; (i) r' deflection in lead aVR (ii) r' deflection in lead V1 (iii) pseudo S wave in lead II, III and aVF are strong predictors of diagnosing AVNRT.

This is an on-going type of study and only preliminary results are being shared at the present time. Results of this study are very similar to many other studies where it has been concluded that r' deflection in lead aVR and V1 and pseudo S wave in inferior leads is certainly the most significant predictor of AVNRT^{1-6,13-15,16}.

Torrecilla et al conducted a similar study on 470 patients and derived a reliable logistic regression model to predict the major mechanisms of paroxysmal supraventricular

tachycardias. Torrecilla's proposed model correctly assigned the tachycardia type in 82% of the cases and the author concluded that r' deflection in lead V1 and aVR is the most reliable measure for predicting atrioventricular nodal reentrant tachycardia¹⁶.

A study conducted in similar manner by Toro et al shows a sensitivity of 60% and specificity of 88.5% for r' deflection in lead V1 and aVR for diagnosing atrioventricular nodal reentrant tachycardia⁸.

After conducting a study on one hundred and fifty patients, Haghjoo et al reported that pseudo-r' in aVR had a higher sensitivity, specificity, and predictive values compared with the conventional criteria of the pseudo-r' in V1 and pseudo S wave in inferior leads⁹.

CONCLUSION

The standard ECG criterion of pseudo r' deflection and pseudo S wave is an accurate method of diagnosing AVNRT.

Conflict of Interest

This study has no conflict of interest to declare by any author.

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