

The Differential Diagnosis of Supraventricular Tachycardia Using Clinical and Electrocardiographic Features

M P Maglana,*^{MD}, R M L Kam,**^{FAMS, MRCP (UK), M Med (S'pore)}, W S Teo,***^{FAMS, M Med (S'pore), FRCP (Edin)}

Abstract

Introduction: Noninvasive determination of the mechanism of supraventricular tachycardia (SVT) is useful in order to decide on the appropriate mode of therapy. The aim of this study was to evaluate the usefulness of the clinical and electrocardiographic features in diagnosing the type of SVT. **Methods:** Design—A retrospective review of case records and electrocardiograms (ECG) of patients with definitive diagnosis of the mechanism of supraventricular tachycardia (SVT) made during electrophysiological study (EPS) and catheter ablation. Setting—A tertiary referral centre for electrophysiological studies and radiofrequency catheter ablation of arrhythmias. Sample—One hundred consecutive patients with SVT who had EPS and catheter ablation at our institution. Chief Outcome—Comparison of clinical and ECG pacemeters among 3 different types of SVT, namely atrioventricular nodal reentrant tachycardia (AVNRT), atrioventricular reentrant tachycardia (AVRT) and atrial tachycardia (AT). **Results:** There were 68 atrioventricular nodal reentrant tachycardia (AVNRT), 26 atrioventricular reentrant tachycardia (AVRT) and 6 atrial tachycardia (AT). AVRT had the earliest mean age of presentation at 26.8 ± 11.9 years. Sex and age of onset of symptoms alone were, however, not valuable in diagnosing the type of SVT. P waves were more discernible in AVRT and AT than in AVNRT (69%, 67% and 44% respectively, $P = 0.071$). AVNRT had the shortest mean RP' interval (86.3 ± 47.6 msec), while AT had the longest (187 ± 80.6 msec, $P < 0.0001$). Conversely for mean P'R interval, AT had the shortest (125 ± 30 msec), AVNRT had the longest (262.7 ± 73.7 msec, $P = 0.001$). AVNRT had the smallest mean RP':P'R ratio (0.6 ± 0.9), while AT had the largest (2.2 ± 0.6 , $P = 0.001$). The presence of pseudo r' in V₁ and pseudo s' in II/III/aVF was diagnostic of AVNRT with a specificity of 90% and 100%, respectively, and positive predictive value of 97% and 100%, respectively. **Conclusion:** Pseudo s' in II/III/aVF is highly predictive of AVNRT. Measurement of RP' and PR' interval and ratio are also useful in determining the SVT mechanism.

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Key words: Ablation, Electrocardiogram, Supraventricular tachycardia

Introduction

Noninvasive evaluation of the mechanism of the arrhythmia is important in the management of supraventricular tachycardia (SVT). It guides one in the choice of therapy. Furthermore, with the widespread acceptance of radiofrequency catheter ablation as the primary treatment of most SVT because of its safety and efficacy, assessment of the origin of the SVT before the invasive procedure is necessary.¹ It helps the operators plan the procedure, thereby minimising procedural and fluoroscopy exposure time and avoiding inadvertent mechanical trauma to the pathways.

Clinical and electrocardiographic features of patients with SVT have been reported.²⁻¹³ Most patients with atrioventricular reentrant tachycardia (AVRT) have earlier onset of symptoms than those with atrioventricular reentrant

tachycardia (AVNRT) or AT.²⁻⁴ The relationship between the P waves and the QRS complex has been extensively studied. The presence of a P wave that is separate from the QRS complex is highly predictive of AVRT and AT, with the RP':P'R ratio usually <1 in AVRT and >1 in AT.⁵

In AVNRT, the P wave is more commonly buried within the QRS complex, sometimes distorting it, hence a P wave may not be seen, or a pseudo r' in V₁ or pseudo s' in II/III/aVF may be apparent.⁶⁻⁸ Analysis of the ST segments and T waves during SVT could also be used in determining the tachycardia mechanism and localising the pathway. The presence of ST segment depression >2 mm or T wave inversion or both which are absent during sinus rhythm suggests AVRT.¹⁰

Some studies have shown that the presence of QRS alternans during the tachycardia is indicative of AVRT,^{5,7,11}

* Fellow of the ASEAN Federation of Cardiology

** Consultant Cardiologist

*** Senior Consultant Cardiologist

Director of Electrophysiology and Pacemakers

Department of Cardiology

National Heart Centre

Address for Reprints: Dr Teo Wee Siong, Department of Cardiology, National Heart Centre, Mistri Wing, 17 Third Hospital Avenue, Singapore 168752.

although others have shown that this is more rate related.^{6,10} So far, only one study has systematically looked into the combined use of clinical and electrocardiographic parameters in determining the mechanism of the arrhythmia.⁴ In this study, the repolarisation changes were not included, and the RP' relationship was not quantitatively assessed. This study was undertaken in order to determine the clinical and electrocardiographic features of patients with SVT without preexcitation during sinus rhythm which would predict the mechanism and origin of the tachycardia. Specifically this study also assessed the diagnostic value of sex, age of onset, presence of P waves, P and QRS relationship, presence of pseudo r' in V1 or pseudo s' in II/III/aVF, ST segment depression, T wave inversion and QRS alternans in SVT.

Materials and Methods

Our study sample consisted of 100 consecutive patients with SVT who had electrophysiological study (EPS) and radiofrequency catheter ablation done at our institution who met the following inclusion criteria:

- 1) narrow QRS complex (<120 msec) tachycardia,
- 2) 1:1 AV conduction during the tachycardia,
- 3) no preexcitation during sinus rhythm,
- 4) mechanism and location confirmed during electrophysiological study,

- 5) only one mechanism of the arrhythmia,
- 6) successful radiofrequency catheter ablation of the SVT, and
- 7) clearly taken electrocardiograms (ECG) during sinus rhythm and SVT.

Sex and age of onset of symptoms were noted. The 12-lead ECG tracings using 25-mm paper speed during SVT and sinus rhythm were analysed independently by two observers who had no knowledge of the type of SVT. A third observer was called upon by the research coordinator to settle conflicting observations by the two observers. The ECG were carefully analysed for the following variables:

- 1) discernibility of P waves,
- 2) RP' interval (beginning of QRS complex to that of the P waves,
- 3) P'R interval (beginning of P wave to that of the next QRS complex,
- 4) RP':P'R ratio,
- 5) pseudo r' in V₁,
- 6) pseudo s' in II/III/aVF,
- 7) ST segment depression ≥ 2 mm in V₄₋₆ which should be horizontal or downsloping and persist ≥ 80 msec after the J point,
- 8) T wave inversion in II/III/aVF, and
- 9) QRS alternans (beat to beat oscillation of the QRS complex of ≥ 1 mm in at least one lead).

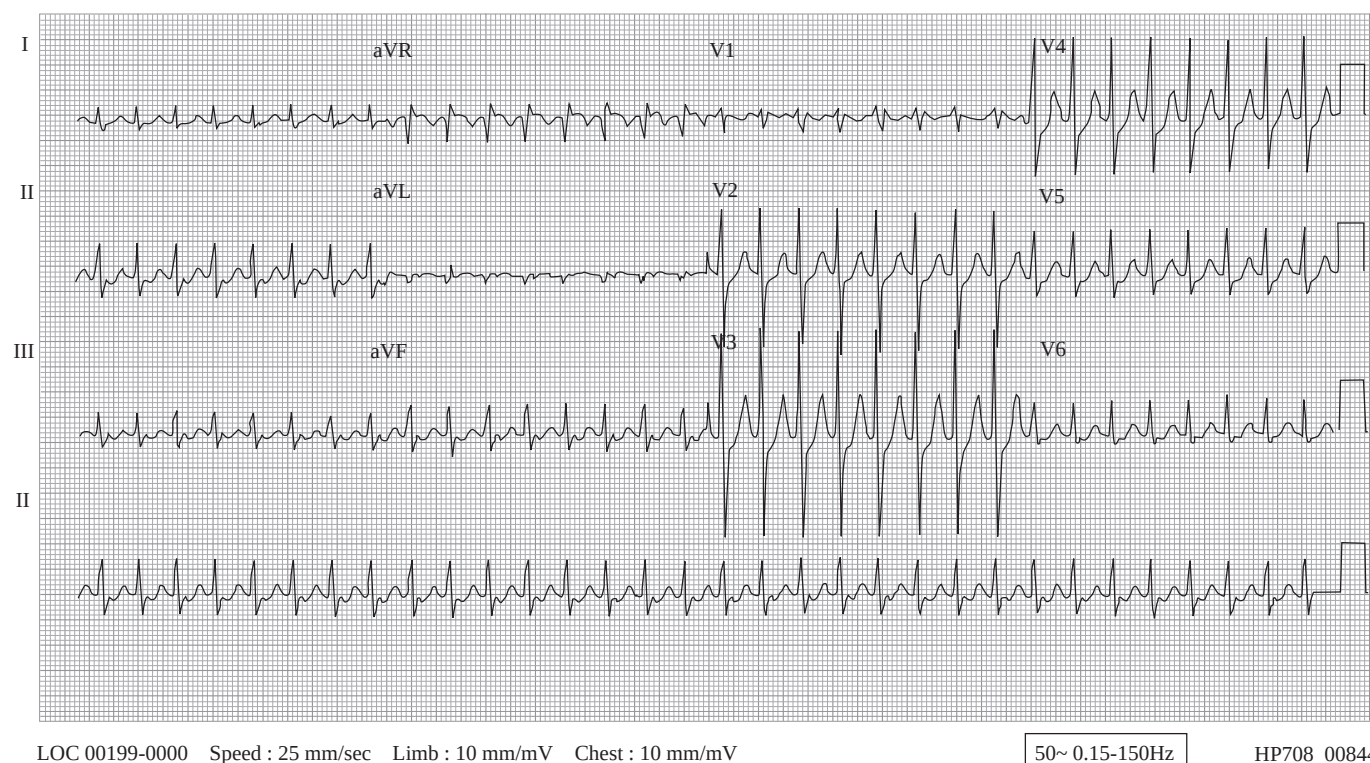


Fig. 1. 12-lead electrocardiogram of AVNRT.

The last five variables should only be apparent during SVT but absent during sinus rhythm. The actual mechanism of the SVT was determined during EPS and the definitions are as follows:

- 1) Atrioventricular nodal reentrant tachycardia (AVNRT)—a reentrant SVT utilising dual atrioventricular nodal pathways. These include antegrade conduction down the slow pathway and retrograde conduction up the fast pathway (typical AVNRT) (Fig. 1) or antegrade conduction down the fast pathway and retrograde conduction up the slow pathway (atypical AVNRT).
- 2) Atrioventricular reentrant tachycardia (AVRT)—a reentrant SVT utilising the atrioventricular node as its antegrade limb and an accessory pathway as its retrograde limb (Fig. 2).
- 3) Atrial tachycardia—a type of SVT that originates from the atrium. The mechanism could be increased automaticity, triggered activity or reentry within the atrial tissue (Fig. 3).

Statistical Analysis

Continuous variables were expressed as mean values $\pm$ standard deviation. Differences between the 3 groups were analysed by one way analysis of variance (ANOVA) for continuous variable and chi square test for categorical variables. A *P* value of <0.05 was considered significant.

TABLE I: SEX DISTRIBUTION OF SUPRAVENTRICULAR TACHYCARDIA

Type of SVT	No.	Sex		Ratio (M:F)
		Male	Female	
AVNRT	68	25 (37%)	43 (63%)	0.6
AVRT	26	14 (54%)	12 (46%)	1.2
AT	6	3 (50%)	3 (50%)	1.0
Total	100	42	58	

P = 0.298

AT: atrial tachycardia; AVNRT: atrioventricular nodal reentry tachycardia; AVRT: atrioventricular reentry tachycardia; SVT: supraventricular tachycardia

Results

Patient Characteristics

There were 100 eligible patients and three types of SVT identified: AVNRT (68), AVRT (26) and AT (6). SVT secondary to AVNRT were more common in females (63%) than in males (37%), but this was not statistically significant, whereas AVRT had similar sex distribution (54% males, 46% females) and AT had equal sex distribution (Table I). The mean age of presentation in AVRT (26.8 ± 11.9 years) was earlier than AVNRT (37.1 ± 16.5 years) and AT (36.0 ± 21.4 years) (Table II).

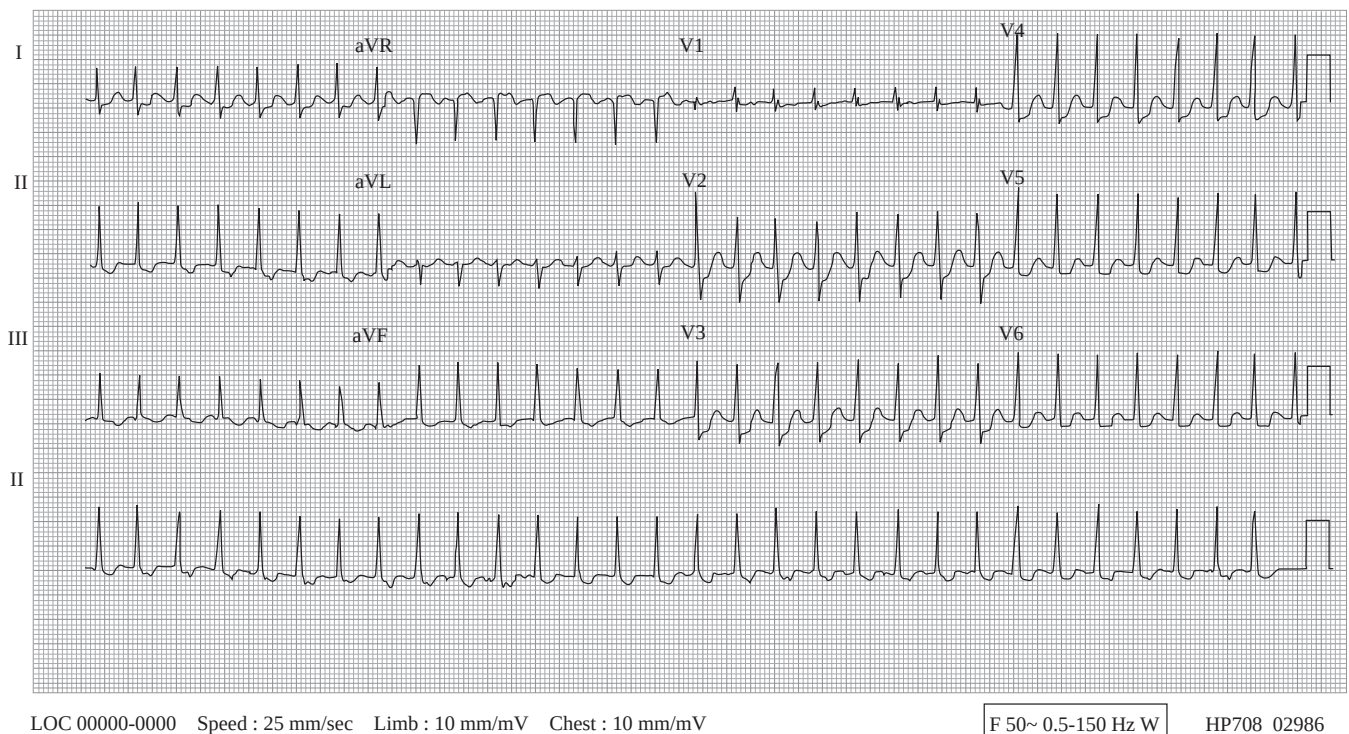


Fig. 2. 12-lead electrocardiogram of AVRT.

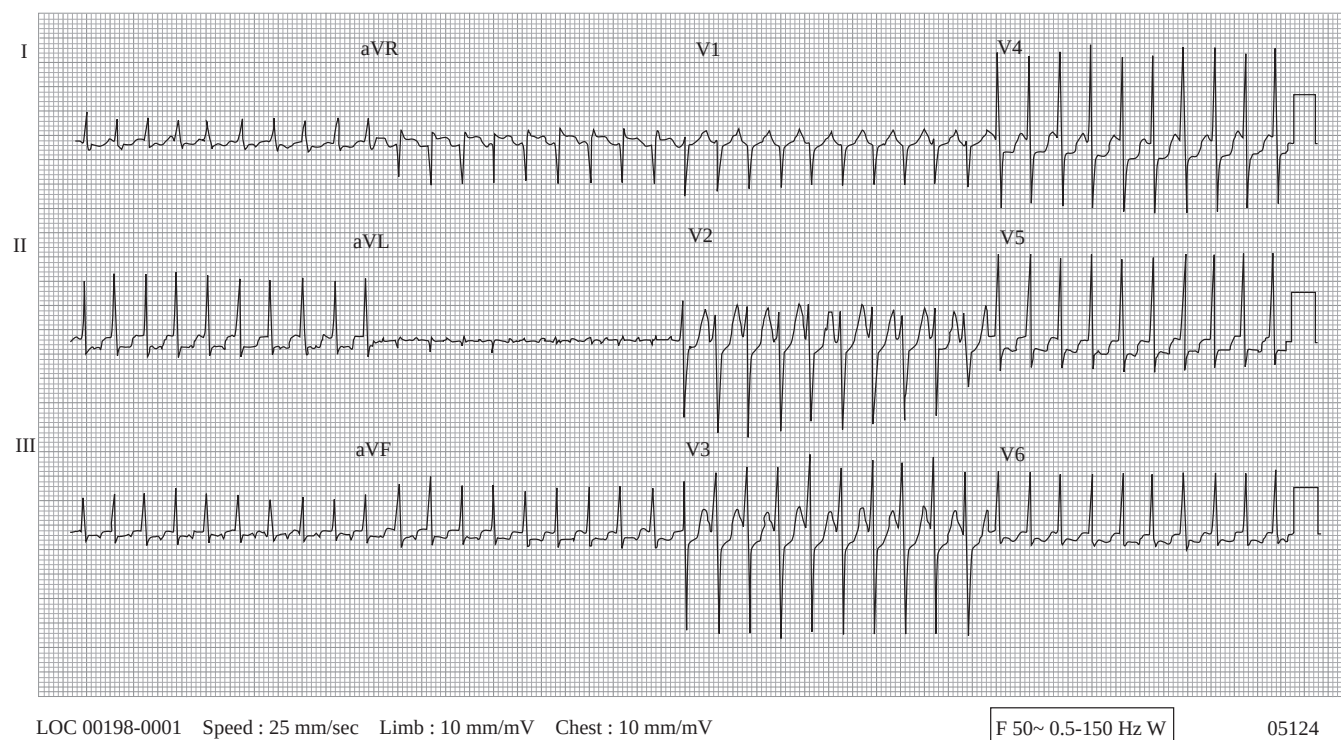


Fig. 3. 12-lead electrocardiogram of AT.

TABLE II: AGE OF PRESENTATION OF SUPRAVENTRICULAR TACHYCARDIA

Type of SVT	Age of presentation Mean $\pm$ SD (years)
AVNRT	37.1 $\pm$ 16.5
AVRT	26.8 $\pm$ 11.9
AT	36.0 $\pm$ 21.4

$P = 0.019$

AT: atrial tachycardia; AVNRT: atrioventricular nodal reentry tachycardia; AVRT: atrioventricular reentry tachycardia; SVT: supraventricular tachycardia

Electrocardiographic Findings (Table III)

The P waves were more discernible in AVRT (69%) and AT (67%) than in AVNRT (44%), but the difference was not statistically significant ($P = 0.071$). If the P wave was discernible, the RP' and P'R intervals as well as the RP':P'R ratio were significantly different between the 3 groups. The mean RP' interval was shortest (86.3 ± 47.6 msec) in AVNRT, longest in AT (187.5 ± 80.6 msec) and intermediate in AVRT (142.2 ± 35.2 msec). Conversely, mean P'R interval was shortest in AT (125 ± 30 msec),

TABLE III: ELECTROCARDIOGRAPHIC CHARACTERISTICS BY MECHANISM OF SUPRAVENTRICULAR TACHYCARDIA

ECG characteristics	AVNRT (n = 68)	AVRT (n = 26)	AT (n = 6)	P value
Discernible P	30 (44%)	18 (69%)	4 (67%)	0.071
Mean RP' interval (ms)	86.3 $\pm$ 47.6	142.2 $\pm$ 35.2	187.5 $\pm$ 80.6	0.000
Mean P'R interval (ms)	262.7 $\pm$ 73.7	242.2 $\pm$ 40.01	125.0 $\pm$ 30	0.001
Mean RP':P'R ratio	0.6 $\pm$ 0.9	0.7 $\pm$ 0.2	2.2 $\pm$ 0.6	0.001
Pseudo r' V ₁	15 (22%)	1 (3.8%)	0	—
Pseudo s' II/III/aVF	12 (18%)	0	0	—
ST $\downarrow$ V ₄ – V ₆	14 (20%)	1 (4%)	2 (33%)	0.84
T inversion II/III/aVF	16 (24%)	4 (15%)	1 (17%)	0.662
QRS alternans	5 (7.5%)	3 (11%)	0	—

AT: atrial tachycardia; AVNRT: atrioventricular nodal reentry tachycardia; AVRT: atrioventricular reentry tachycardia; ECG: electrocardiogram

longest in AVNRT (262.7 ± 73.7 msec), followed closely by AVRT (242.2 ± 40.1 msec). Consequently, the mean RP':P'R ratio was smallest in AVNRT followed by AVRT and AT (0.6 ± 0.9 , 0.7 ± 0.2 and 2.2 ± 0.6 , respectively).

For patients without discernible P waves, the presence of pseudo r' in V_1 and pseudo s' in II/III/aVF were more common in AVNRT (20% and 18%, respectively). These 2 variables were not present in AT. Only 1 AVRT had pseudo r' in V_1 . Pseudo r' in V_1 had a specificity of 90% and positive predictive value of 97%, while the pseudo s' in II/III/aVF had a specificity of and positive predictive value of 100% for AVNRT.

The presence of ST segment depression, T wave inversion and QRS alternans were not significantly different among the 3 types of SVT.

Discussion

This study is similar to previous studies with regards to the sex distribution and age of presentation of the three types of SVT.^{2,4} AVNRT was more common in females, and the age of presentation was almost a decade later than AVRT. Patients with AT had equal sex distribution and the age of presentation was also almost a decade later than AVRT. However in this study, there was no male preponderance in AVRT.

Of the electrocardiographic variables, only the RP' and P'R intervals, RP':P'R ratio and the presence of pseudo r' in V_1 and pseudo s' in II/III/aVF were found to be significantly different. Patients with AT had very long RP' interval and a short P'R interval, while the opposite was true of AVNRT. It had the shortest RP' interval and longest P'R interval. As for AVRT, its RP' interval was intermediate whereas its P'R interval closely followed that of AVNRT. The presence of pseudo r' in V_1 and pseudo s' in II/III/aVF was not sensitive but highly specific for AVNRT. Although P waves were more discernible in AVRT and AT and less on AVNRT and QRS alternans were more common in AVRT, the difference was not statistically significant.

Limitations of the Study

In this study, only 6 patients had AT, limiting the statistical analysis of type of SVT. This reflects the low incidence of this type of arrhythmia. Also, AVNRT was not classified into typical and atypical type, as there was only 1 eligible patient who had atypical AVNRT.

Conclusion

The clinical and electrocardiographic features are valuable in the assessment of the mechanism of the arrhythmia in patients with SVT. In the analysis of the ECG during

tachycardia, when P waves are present, measurement of the RP' and P'R interval as well RP':P'R ratio is valuable in diagnosing the type of arrhythmia. Patients with short RP' interval and long P'R interval most likely have AVNRT or AVRT, whereas patients with long RP' interval and short P'R interval most likely have AT. When distinct P waves are absent, pseudo r' in V_1 or pseudo s' in II/III/aVF is virtually diagnostic of AVNRT.

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