ORIGINAL ARTICLE

New insights into the clinical signs of supraventricular tachycardia: The “sign of lace-tying”

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Background: Supraventricular tachycardias (SVT) are a common arrhythmia therefore an accurate diagnosis is of clinical importance. Although an ECG performed during tachycardia greatly aids diagnosis, patient history and predisposing factors also improve diagnostic accuracy.

Methods: This prospective study included 100 consecutive patients undergoing electrophysiological study for SVT with the aim to reassess their clinical characteristics and describe frequent predisposing factors, such as the “sign of lace-tying” that to our knowledge has not previously been reported. Each patient completed an extensive questionnaire (70 questions) during their hospital stay.

Results: Our series comprised: 67% of patients with atrioventricular nodal reentrant tachycardia (AVNRT); 24% with an accessory pathway; and 9% presented atrial tachycardia. Half of the population were male and 29% of the cohort presented hypertension. Syncope during tachycardia appeared in 15% of patients, dizziness in 52% and thoracic pain in 59%. We encountered a predisposing risk factor for SVT in 53% of cases; with 32% exhibiting an anteflexion of the trunk termed the “sign of lace-tying.” Data also showed that younger patients tended to present AVRT and regular pounding in the neck appeared only in patients with AVNRT.

Conclusions: Overall, our study has highlighted the importance of considering clinical signs and patient characteristics both before and during SVT for the precise diagnosis of paroxysmal SVT. Furthermore, 32% of patients presented the “sign of lace-tying” or body position change before SVT, implying a diagnosis of SVT.

KEYWORDS

anamnesis, sign of lace-tying, supraventricular tachycardia, syncope

1 | INTRODUCTION

The three main forms of supraventricular tachycardias (SVT): (1) atrioventricular nodal reentrant tachycardia (AVNRT); (2) atrioventricular reentrant tachycardia (AVRT) due to an accessory pathway and (3) atrial tachycardia (A.Tach.) have been well described over the past 25 years regarding both their electrophysiological properties and successful treatment with radiofrequency. Curiously, however, their clinical

characteristics, predisposing factors, symptoms during tachycardia and mode of arrest have not been thoroughly studied in the literature despite their importance to clinicians. Therefore, the aim of our prospective study was to reassess the complete clinical characteristics of SVT.

2 | METHODS

This prospective study included 100 consecutive patients admitted to the CHU UCL Namur university hospital between January 2015 and

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The current analysis received no grants from any funding agency.

February 2016 for radiofrequency ablation of supraventricular tachycardia (SVT).

Demographic and medical data were obtained for all patients. In addition, an extensive questionnaire (70 items) was fulfilled for every patient during their stay in hospital. All anamneses were performed by the same staff member to avoid subjective interpretation. Particular attention was paid to predisposing factors and symptoms during tachycardia. Age at onset of first episode of tachycardia, duration, time of day and frequency of episodes, and mode of arrest were also noted.

For all patients, a precise diagnosis of tachycardia mechanism was obtained from invasive electrophysiological study. For further sub-analysis, the group of patients was divided into three categories according to the mechanism of SVT: atrioventricular nodal reentrant tachycardia (AVNRT), atrioventricular reentrant tachycardia (AVRT) and atrial tachycardia (A.Tach.).

Each patient gave their informed consent and approval for collecting data about patients for this study was obtained from the ethical committee of the institution (ref. 101/2015).

Following statistical analysis results are expressed as mean $\pm$ SD. The comparison between variables was performed with the Kruskal-Wallis test and the chi-square test for the comparison of proportion. A $p < 0.05$ was considered statistically significant.

3 | RESULTS

The patient cohort included 100 patients with a mean age of 46.8 ± 19.2 years and a male: female ratio of 1:1. Table 1 shows the demographic and clinical characteristics of patients. As for other series, the mean age at diagnosis of SVT was lower for AVRT than for AVNRT (Bottoni et al., 2003). The mean age during treatment for SVT was 51 ± 18 years for AVNRT, 34 ± 20 years for AVRT and 52 ± 13 years for A.Tach. ($p = 0.02$). However, the age of first known tachycardia symptoms was indeed younger with 44 ± 20 years for AVNRT, 28 ± 20 years for AVRT and 48 ± 19 years for A.Tach. ($p < 0.005$).

Of the patient cohort, 29 patients (29%) suffered from hypertension with treatment, two from coronary heart disease, three congestive heart failure, four chronic obstructive pulmonary disease (COPD) and seven suffered from sleep apnea. We observed no statistical difference between the three arrhythmia groups.

As shown in Table 2, 53% of patients reported at least one predisposing factor for developing SVT. Among these, body position changes were the most frequent favoring factor (32%). Typically, an abrupt development of SVT would occur when a patient bowed down to tie their lace, hence the term "sign of lace-tying." Our data revealed an

	AVNRT 67 pts	AVRT 24 pts	A. Tach. 9 pts	All 100 pts
Age (years)	51 ± 18	34 ± 20	52 ± 13	47 ± 19
Sex (% of men)	43% (29/67)	63% (15/24)	67% (6/9)	50%
Age at onset of SVT (years)	44 ± 20	28 ± 20	48 ± 19	40 ± 21
Hypertension	36% (24/67)	8% (2/24)	33% (3/9)	29%
Coronary artery disease	0%	8% (2/24)	0%	2%
COPD	3% (2/67)	4% (1/24)	11% (1/9)	4%
Congestive heart failure	1% (1/67)	4% (1/24)	11% (1/9)	3%
Sleep apnea	6% (4/67)	8% (2/24)	11% (1/9)	7%

TABLE 1 Demographic and clinical characteristics

A.Tach., atrial tachycardia; AVNRT, atrioventricular nodal reentrant tachycardia; AVRT, atrioventricular reentrant tachycardia; COPD, chronic obstructive pulmonary disease.

	AVNRT 67 pts	AVRT 24 pts	A.Tach. 9 pts	All 100 pts (%)
Presence of one factor	55% (37/67)	46% (11/24)	56% (5/9)	53
Body position change/"sign of lace-tying"	36% (24/67)	29% (7/24)	11% (1/9)	32
Physical exercise	12% (8/67)	25% (6/24)	33% (3/9)	17
Emotion	24% (16/67)	25% (6/24)	22% (2/9)	24
Postprandial phase	1.5% (1/67)	4% (1/24)	0%	2
Alcohol intake	6% (4/67)	0%	11% (1/9)	5
Caffeine intake	3% (2/67)	0%	11% (1/9)	3

TABLE 2 Predisposing risk factors for SVT

A.Tach., atrial tachycardia; AVNRT, atrioventricular nodal reentrant tachycardia; AVRT, atrioventricular reentrant tachycardia.

equal presence of this factor in AVNRT (36% of patients) and AVRT groups (29% of patients).

In addition, emotional stress was the second most frequent (24%) predisposing factor; with the same proportion in AVNRT (24%) and AVRT (25%) groups. A third predisposing risk factor of exercise related to 17% of all patients, yet with a distinction between AVNRT (12%) and AVRT (25%) groups ($p = \text{NS}$).

Our data also showed the possible presence of other more anecdotal triggers such as alcohol (5%), caffeine intake (3%) and postprandial phase (2%).

As shown in Table 3, 15% of all cases reported syncope with a higher proportion in the AVRT group (20.8%) than AVNRT (14.9%) and no syncope reported in the few patients with A. Tach. ($p = \text{NS}$). In the

group of patients with syncope, 73% (11/15) presented prodromes as palpitations (8/11), dizziness (8/11) or malaise (5/11).

Almost all patients (93%) presented palpitations and a relatively high proportion (70%) exhibited dyspnea. Also 60% of cases suffered from either chest pain or chest discomfort. Interestingly, 27% of patients with AVNRT described spontaneously a regular rapid pounding in the neck, however no patients with AVRT reported this symptom ($p < 0.005$).

The duration of episodes lasted between a few minutes and a maximum of 1 hour in 68% of the patients (Table 4). Episodes longer than 1 hour occurred in 29% of the cases. The frequency of episodes varied between a few per week and a few per month for 64% of patients. For 29% of patients less than 1 episode occurred per month. Regarding

TABLE 3 Symptoms during tachycardia

	AVNRT 67 pts	AVRT 24 pts	A.Tach. 9 pts	All 100 pts
Palpitations	94% (63/67)	92% (22/24)	89% (8/9)	93%
Dyspnea	70% (47/67)	63% (15/24)	89% (8/9)	70%
Asthenia	58% (39/67)	58% (14/24)	44% (4/9)	57%
Dizziness	55% (37/67)	54% (13/24)	22% (2/9)	52%
Syncope	15% (10/67)	21% (5/24)	0%	15%
With prodrome	80% (8/10)	60% (3/5)		73% (11/15)
As palpitations	60% (6/10)	40% (2/5)		53% (8/15)
As malaises	30% (3/10)	40% (2/5)		33% (5/15)
As dizziness	50% (5/10)	60% (3/5)		53% (8/15)
Chest pain/ discomfort	60% (40/67)	58% (14/24)	56% (5/9)	59%
Unwellness	33% (22/67)	21% (5/24)	33% (3/9)	30%
Regular pounding in the neck	27% (18/67)	0%	11% (1/9)	19%
Sweating	46% (31/67)	42% (10/24)	44% (4/9)	45%

A.Tach., atrial tachycardia; AVNRT, atrioventricular nodal reentrant tachycardia; AVRT, atrioventricular reentrant tachycardia.

TABLE 4 Duration and frequency of arrhythmias

	AVNRT	AVRT	A.Tach.	All (%)
Episode duration				
<1 min	1% (1/67)	4% (1/23)	13% (1/8)	3
1–10 min	37% (25/67)	30% (7/23)	38% (3/8)	36
10 min–1 h	33% (22/67)	35% (8/23)	13% (1/8)	32
>1 h	28% (19/67)	30% (7/23)	38% (3/8)	29
Episode frequency				
≥1/day	5% (3/66)	4% (1/23)	43% (3/7)	7
1–6/week	20% (13/66)	35% (8/23)	29% (2/7)	24
1–5/month	45% (30/66)	30% (7/23)	14% (1/7)	40
<1/month	30% (20/66)	30% (7/23)	14% (1/7)	29
Time period of episode				
Day only	66% (44/67)	70% (16/23)	43% (3/7)	64
Night only	0%	0%	0%	0
Day and night	34% (23/67)	30% (7/23)	57% (4/7)	36

A.Tach., atrial tachycardia; AVNRT, atrioventricular nodal reentrant tachycardia; AVRT, atrioventricular reentrant tachycardia.

TABLE 5 Mode of arrest of SVT

	AVNRT 67 pts	AVRT 24 pts	A.Tach. 9 pts	All 100 pts (%)
Spontaneous (without change in activities)	16% (11/67)	42% (10/24)	33% (3/9)	24
Resting (no activities)	60% (40/67)	50% (12/24)	67% (6/9)	58
Valsalva maneuver	16% (11/67)	8% (2/24)	0%	13
Carotid sinus massage	7% (5/67)	8% (2/24)	0%	7
Medical intervention	48% (32/67)	29% (7/24)	44% (4/9)	43
Drink of cold water	9% (6/67)	4% (1/24)	0%	7

A.Tach., atrial tachycardia; AVNRT, atrioventricular nodal reentrant tachycardia; AVRT, atrioventricular reentrant tachycardia.

the time period of episodes, 64% of patients reported episodes during the day only, with 36% during both day and night.

Table 5 shows the different modes of arresting SVT for the different arrhythmia groups. For 58% of patients resting stopped their tachycardia. Valsalva maneuvers or carotid sinus massage arrested SVT in 13% and 7% of patients, respectively. It is important to note that the mode of arrest could have varied for the same patient from one episode to another. In addition, 43% of patients requested medical assistance (emergency services or general practitioner).

4 | DISCUSSION

Predisposing risk factors for SVT, as described in this prospective study, are useful clues to help diagnose patients with SVT, which to the best of our knowledge have not previously been fully evaluated. One such factor is body motion or the "sign of lace-tying" (32% of our study population). This factor was reported when a patient describes the beginning of a paroxysmal regular tachycardia after bending forward, therefore the only possible diagnosis is SVT. The mechanism to explain development of SVT after this trigger must be the occurrence of a supraventricular extrasystole and re-entry. However, there are few reports in the literature that have discussed this phenomenon (Falk, Tarko, & Levine, 1981; Zimetbaum & Josephson, 1998).

Our series showed exercise as a triggering factor with a difference between AVNRT (12%) and AVRT (25%) groups, indicating that AVRT could be more dependent on adrenergic tone in some patients.

We observed a similar set of symptoms and associated frequencies during tachycardia compared to other series (Bottoni et al., 2003; Wood, Drew, & Scheinman, 1997). Syncope occurred in 14.9% of patients with AVNRT and 20.8% with AVRT. In these cases, a higher proportion of patients with AVRT (40%) presented no prodrome before syncope than patients with AVNRT (20%). This may be due to a higher heart frequency during AVRT. The absence of prodrome is clearly a risk factor for injury. The percentage of syncope in our study aligns with other series (Bottoni et al., 2003; Brembilla-Perrot, Beurrier, Houriez, Claudon, & Wertheimer, 2001; Wood et al., 1997). Also in accordance with other series, nearly all patients (93%) reported palpitations. Although this seems logical it

is quite different for patients with AF, with less than 50% suffering from this symptom (Salam et al., 2014).

We observed higher frequencies of dyspnea, fatigue and chest pains or discomforts in our cohort compared with other series (Bottoni et al., 2003; Wood et al., 1997), possibly due to the prospective and extensive nature of our study.

Although 27% of patients with AVNRT described regular pounding in the neck, no patients with AVRT exhibited this symptom (0%), in agreement with S. Gürsoy et al. (Gürsoy, Steurer, Brugada, Andries, & Brugada, 1992). According to E. Gonzalez-Torrecilla et al., a correlation between regular pounding in the neck and patient age can discriminate patients with AVNRT from those with AVRT (Gonzalez-Torrecilla et al., 2009).

The mode of arresting SVT during a patient's daily life as reported in our study has not previously been evaluated in other series. Our data highlight the modest effect of the Valsalva maneuver (13%) and carotid sinus massage (7%) as well as the importance of medical intervention (43%). This last point may explain, in part, the negative impact on health related quality of life data as studied by U. Walfridsson et al. (Walfridsson, Stromberg, Janzon, & Walfridsson, 2009).

In conclusion, clinical signs and characteristics of patients both before and during SVT will enable a more precise diagnosis of paroxysmal SVT. Overall, our data has shown that AVRT patients tend to be younger and regular pounding in the neck is only associated with cases of AVNRT. Importantly, 32% of patients presented the "sign of lace-tying" or change in body position before SVT implying the diagnosis of SVT.

Some limitations of this study should be acknowledged. Firstly, all patients included in this prospective study visited a tertiary referral center which may have induced bias for this category of patients with more symptomatic arrhythmias. Secondly, we only included patients observed during hospitalization for electrophysiological study and radiofrequency treatment, therefore other patients with either less frequent or less severe symptoms could have been underrepresented. Finally, the group of patients with A.Tach. was too small to achieve statistically significant results.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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