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The ventricular tachycardia score: a novel approach to electrocardiographic diagnosis of ventricular tachycardia

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Aims Electrocardiographic diagnosis of wide QRS complex tachycardia (WCT) continues to be challenging as none one of the available methods is specific for ventricular tachycardia (VT) diagnosis. We aimed to construct a method for WCT differentiation based on a scoring system, in which ECGs are graded according to the number of VT-specific features. This novel method was validated and compared with Brugada algorithm and other methods.

Methods and results A total of 786 WCTs (512 VTs) from 587 consecutive patients with a proven diagnosis were analysed by two blinded observers. The VT score method was based on seven ECG features: initial R wave in V1, initial $r > 40$ ms in V1/V2, notched S in V1, initial R in aVR, lead II R wave peak time ≥ 50 ms, no RS in V1-V6, and atrioventricular dissociation. Atrioventricular dissociation was assigned two points, and each of the other features was assigned one point. The overall accuracy of VT score ≥ 1 for VT diagnosis (83%) was higher than that of the aVR (72%, $P = 0.001$) and Brugada (81%) algorithms. Ventricular tachycardia score ≥ 3 was present in 66% of VTs and was more specific (99.6%) than any other algorithm/criterion for VT diagnosis. Ventricular tachycardia score ≥ 4 was present in 33% of VTs and was 100% specific for VT.

Conclusion The new ECG-based method provides a certain diagnosis of VT in the majority of patients with VT, identifies unequivocal ECGs, and has superior overall diagnostic accuracy to other ECG methods.

Keywords Wide QRS complex tachycardia • Ventricular tachycardia • Brugada algorithm • Electrocardiography

Introduction

Electrocardiographic diagnosis of wide QRS complex tachycardia (WCT) continues to attract clinical and research attention, as evidenced by the regular formulation of new criteria and algorithms for WCT and multiple review articles over the past years.[1–11] None of these algorithms/criteria, however, is capable of accurate differentiation of ventricular tachycardia (VT) and supraventricular tachycardia (SVT), since these algorithms/criteria are based on statistical correlations between tachycardia type and QRS morphology, which overlap substantially. Several independent studies have found that various ECG-based methods, including the Brugada and Vereckei-aVR algorithms, have specificities of 40–80% and accuracies of ~75%.[2,3,6,7,12–19] Thus, these methods can result in diagnostic mistakes in one in every four patients, with potentially serious clinical consequences. A similar diagnostic accuracy of ~75% would be achieved effortlessly by considering every WCT to be a VT, because only 25–30% of WCTs are SVTs. Therefore, the clinical usefulness of these elaborate ECG-based methods seems questionable.

We believe that to diagnose VT with a high degree of confidence using standard ECG, the 'algorithmic paradigm' of 0/1 types of answers cannot be used, since it is based on the false assumption that every ECG in a patient with WCT contains sufficient information to determine whether the patient has VT or SVT. In contrast to the

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What's new?

- The VT score—a novel method for diagnosing ventricular tachycardia based on a scoring system, in which ECGs are graded according to the number of VT-specific features, was developed and validated.
- The proposed grading approach to VT diagnosis provides information on the 'strength' of diagnosis, with high VT scores yielding a near certain diagnosis and low VT scores identifying unequivocal/non-diagnostic ECGs.
- The current study investigated the largest cohort to date of patients with wide QRS complex tachycardia, providing probably the most accurate assessment of diagnostic properties of various ECG-based algorithms and criteria for VT diagnosis.

algorithmic approach, grading ECGs according to the number of VT-specific features may allow to reject ECGs with inconclusive morphology and provide a definitive diagnosis of VT in the remaining cases. Our goal was to construct, validate, and compare such a novel method of WCT diagnosis based on a scoring system.

Methods

We analysed 786 ECGs from 587 patients with WCT, where WCT was defined as a rhythm of 100–250 b.p.m. with a QRS duration ≥120 ms. ECGs with significant irregularity suggestive of atrial fibrillation or paced rhythms were excluded. Significant irregularity was considered to be present when on visual inspection the rhythm was deemed irregular on the basis of the presence of several different RR intervals with differences of >40 ms. Tracings with occasional RR irregularities (due, for example, to a captured beat) or RR interval alternans were not excluded. Ventricular tachycardia was defined as a tachycardia that was maintained without the need for structures above the His bundle. All ECGs were obtained from unselected, consecutive patients at three university-based medical centres, two in Poland and one in Japan. All ECGs were standard 12-lead recordings, registered at a paper speed of 25 mm/s and with standard amplification (1 cm/mV) and analysed by a general cardiologist and a cardiac electrophysiologist, both of whom were blinded to clinical data and the previously established WCT diagnosis. A definitive WCT diagnosis was based on the results of electrophysiology, on intracardiac electrograms from an implanted cardiac device, or subsequent ECGs that yielded a definitive diagnosis [e.g. re-appearance of P or F waves due to sinus rhythm slowing or to changed atrioventricular (AV) conduction ratio].

Table 1 Diagnostic performance of various ECG parameters considered for the VT score system and assessed in the initial cohort of 102 WCTs

Parameter	Accuracy	Sensitivity	Specificity	LR (+)	LR (−)	*k*
Initial R wave in aVR	55.9% (45.7–65.7)	34.3% (23.2–46.9)	97.1% (85.1–99.9)	12.01 (1.69–85.29)	0.68 (0.56–0.81)	1.00
No RS complex in V1–V6	41.2% (31.5–51.4)	11.9% (5.3–22.2)	97.1% (85.1–99.9)	4.18 (0.54–32.08)	0.91 (0.82– 1.01)	0.88
RWPT[a] in lead II ≥ 50 ms	72.5% (62.8–0.81)	65.7% (53.1–76.8)	85.7% (69.7–95.2)	4.60 (2.01–10.54)	0.40 (0.28–0.57)	0.80
Initial *r* > 40 ms in V1 or V2	52.9% (42.8–62.9)	31.3% (20.6–43.8)	94.3% (80.8–99.3)	5.485 (1.364–22.057)	0.73 (0.61–0.87)	0.94
Initial R wave in V1	53.9% (43.8–63.8)	34.3% (23.2–46.9)	91.4% (76.9–98.2)	4.005 (1.292–12.417)	0.72 (0.59–0.88)	1.00
S wave notch in V1/V2	42.2% (32.4–52.3)	11.9% (5.3–22.2)	100% (90–100)	41.910 (0.083–21 135.66)	0.88 (0.81–0.97)	0.86
AV dissociation	66.7% (56.6–75.7)	50.7% (38.2–63.2)	97.1% (85.1–99.9)	17.761 (2.537–124.353)	0.51 (0.39–0.65)	0.87
Precordial concordance	42.2% (32.4–52.3)	11.9% (5.3–22.2)	100% (90.0–100)	41.91 (0.08–21 135.6)	0.88 (0.81–0.97)	0.69
qR or QS in V3[b]	43.1% (33.4–0.53)	13.4% (6.3–24.0)	100% (90.0–100)	47.15 (0.09–23 675.9)	0.87 (0.79–0.96)	1.00
Vi/Vt ratio in aVR ≤ 1[c]	62.7% (52.6–72.1)	64.2% (51.5–75.5)	60.0% (42.1–76.1)	1.60 (1.03–2.50)	0.60 (0.39–0.91)	0.48
Right superior axis (−90° to ±180°)	44.1% (34.3–54.3)	22.4% (13.1–34.2)	85.7% (69.7–95.2)	1.57 (0.62–3.96)	0.91 (0.75–1.09)	0.94
RS interval in V1–V6 > 100 ms	61.8% (51.6–71.2)	56.7% (44.0–68.8)	71.4% (53.7–85.4)	1.98 (1.13–3.49)	0.61 (0.43–0.86)	0.84
S wave notch in aVR	40.2% (30.6–50.4)	10.4% (4.3–20.3)	97.1% (85.1–99.9)	3.66 (0.47–28.55)	0.92 (0.83–1.02)	0.94
Initial r or q wave >40 ms in aVR	44.1% (34.3–54.3)	19.4% (10.8–30.9)	91.4% (76.9–98.2)	2.26 (0.69–7.4)	0.88 (0.75–1.03)	0.96
QRS > 200 ms	47.1% (37.1–57.2)	26.9% (16.8–39.1)	85.7% (69.7–95.2)	1.88 (0.76–4.64)	0.85 (0.70–1.04)	0.77
S wave nadir ≥80 ms in V1/V2	53.9% (43.8–63.8)	40.3% (28.5–53.0)	80.0% (63.1–91.6)	2.01 (0.98–4.16)	0.75 (0.58–0.96)	0.81
VT score = 1	86.3% (78.0–92.3)	97.0% (89.6–99.6)	65.7% (47.8–80.9)	2.83 (1.78–4.48)	0.045 (0.01–0.18)	0.92
VT score = 2	87.3% (79.2–93.0)	83.6% (72.5–91.5)	94.3% (80.8–99.3)	14.63 (3.79–56.42)	0.17 (0.10–0.30)	0.92
VT score ≥3	74.5% (64.9–82.6)	61.2% (48.5–72.9)	100% (90.0–100)	214.79 (0.44–105 000.1)	0.39 (0.29–0.53)	0.90

Values in parentheses represent confidence intervals (%).
LR, likelihood ratio; LR (+) and LR (−) are for diagnosis of VT.
[a]RWPT denotes R wave peak time.
[b]Only when V1 has different morphology than V3.
[c]Vi denotes initial velocity and Vt terminal velocity of ventricular activation.

Ventricular tachycardia score development and validation

The VT score system aimed at providing an unquestionable diagnosis of VT when possible. It was based on the assumption that no single QRS morphological feature can lead directly to a diagnosis of VT, as none of the morphological features is pathognomonic for VT, and mistakes in assessment can occur.

To develop the VT score system and to select the applicable criteria, we used 102 consecutive ECGs. Of several promising differentiating criteria assessed (see *Table 1*), we preferred those easy to measure and with a high specificity and high positive likelihood ratio (LR) for VT diagnosis. Various combinations of these criteria were tested in the initial cohort, the goals being to maximize sensitivity while having no false-positive results (100% specificity). The remaining 684 ECGs were used to validate the VT score.

Comparison of ventricular tachycardia score with other ECG-based methods

Each ECG was analysed using the VT score approach, as well as three alternative methods: the Brugada and Vereckei-aVR algorithms and the Pava criterion [R wave peak time (RWPT) in lead II].[4,6,9]

Statistics

Continuous variables were presented as means and standard deviations. Categorical variables were presented as counts and percentages. The performance of binary decision rules was described using the following measures [with 95% confidence interval (CI)]: diagnostic accuracy, sensitivity, specificity, positive predictive value, negative predictive value, LR of a positive test (LR+), and LR of a negative test (LR−). The performance of the 'VT score' in discriminating between VT and SVT was assessed using the receiver operating characteristic (ROC) curve and area under the ROC curve. The kappa coefficient was used to evaluate inter-rater agreement. More than one ECG was used for analysis in some patients; however, this was done only when the subsequent ECGs were morphologically distinct. Each such ECG was analysed as an independent WCT tracing, as would be the case in a 'real life' scenario. Statistical analysis was performed using BDTcomparator and code written in 'R' 3.0.[20] *P*-values <0.05 were considered statistically significant.

Results

Patient demographic and clinical characteristics are summarized in *Table 2*.

Wide QRS complex tachycardia diagnosis

A definitive WCT diagnosis was based on electrophysiology in 669 patients, intracardiac electrogram recordings from devices implanted into 57 patients, and consecutive ECG data in 60 patients. The 786 WCT tracings comprised 512 VTs and 274 SVTs. Both ventricular and SVT subtypes are specified in *Table 2*.

Ventricular tachycardia score development

Table 1 shows the diagnostic performance of various criteria tested in the 'construction' cohort. The VT score system was finally based on seven selected ECG features that resulted in a high positive LR and high specificity for VT diagnosis, while maintaining adequate sensitivity. The VT score system enabled correct diagnosis in the majority of VT patients, yielding no false-positive results for VT score ≥ 3 (*Table 1*).

The seven selected criteria were:

Initial R wave in V1. The QRS complex in V1 must start with a dominant R wave, including a monophasic R (*Figure 1*, *A1*–*A6*), RS when R ≥ S (*Figure 1*, *A7*–*A9*) and Rsr′. All monophasic R wave varieties with a notch are included, except for those with the notch on the ascending limb of the R wave when the notch's nadir is in the lower half of the R wave, as this is a variant of supraventricular rsR′ morphology (*Figure 2*, *A2*–*A5*). This criterion was introduced by Sandler and Marriott.[1]

Initial r > 40 ms in V1 or V2. This criterion should be assessed only in predominantly negative QRS complexes. It is usually fulfilled when an rS complex in V1 has a 'fat' initial 'r' (*Figure 1*, *B1*–*B3*). However, it also encompasses other morphologies: RS with 'r' of relatively high amplitude (*Figure 1*, *B4*), as long as R is <S, rSr′, rS with notched 'r' (*Figure 1*, *B5*–*B6*, in V2) and rS with *r* > 40 ms present only in V2 (*Figure 1*, *B4*, *B5*, and *B8*). This criterion was introduced by Swanick *et al.*,[8] and later corroborated by Kindwall *et al.*[10]

Notched S in V1. Although this notch is usually in the middle of the descending limb of the S wave (*Figure 1*, *C1*–*C3*), it can also be near the nadir (*Figure 1*, *C4*–*C7*) or just after the beginning of the S wave (*Figure 1*, *C8* and *C9*). We defined 'notch' as any change in direction, from descending to ascending, no matter how many milliseconds it lasts. This criterion was introduced by Kindwall *et al.*[10]

Table 2 Patient clinical characteristics, including tachycardia subtypes

	***n* = 587**
Age (year); mean ± SD	55.3 (± 19.8)
Female/male (*n*)	177/410
Left ventricular ejection fraction; mean ± SD	46.1% (± 18.4%)
Pre-existing bundle branch block, *n* (%)	169 (28.8%)
Use of class I or III antiarrhythmic drugs, *n* (%)	74 (12.6%)
History	
Coronary heart disease, *n* (%)	221 (37.6%)
Cardiomyopathy, *n* (%)	99 (16.9%)
No structural heart disease, *n* (%)	267 (45.5%)
VT types (*n* = 512)	
Idiopathic RV/LV outflow tract	26
Idiopathic LV fascicular	30
Idiopathic other	2
Myocardial scar/fibrosis related [a]	454
SVT types (*n* = 274)	
AVNRT	73
o-AVRT, *n* (%)	65
Pre-excited (a-AVRT, AFL, Mahaim)	38
Atrial flutter	55
Atrial tachycardia	25
Other	18

[a]Two bundle branch re-entrant VTs were included.

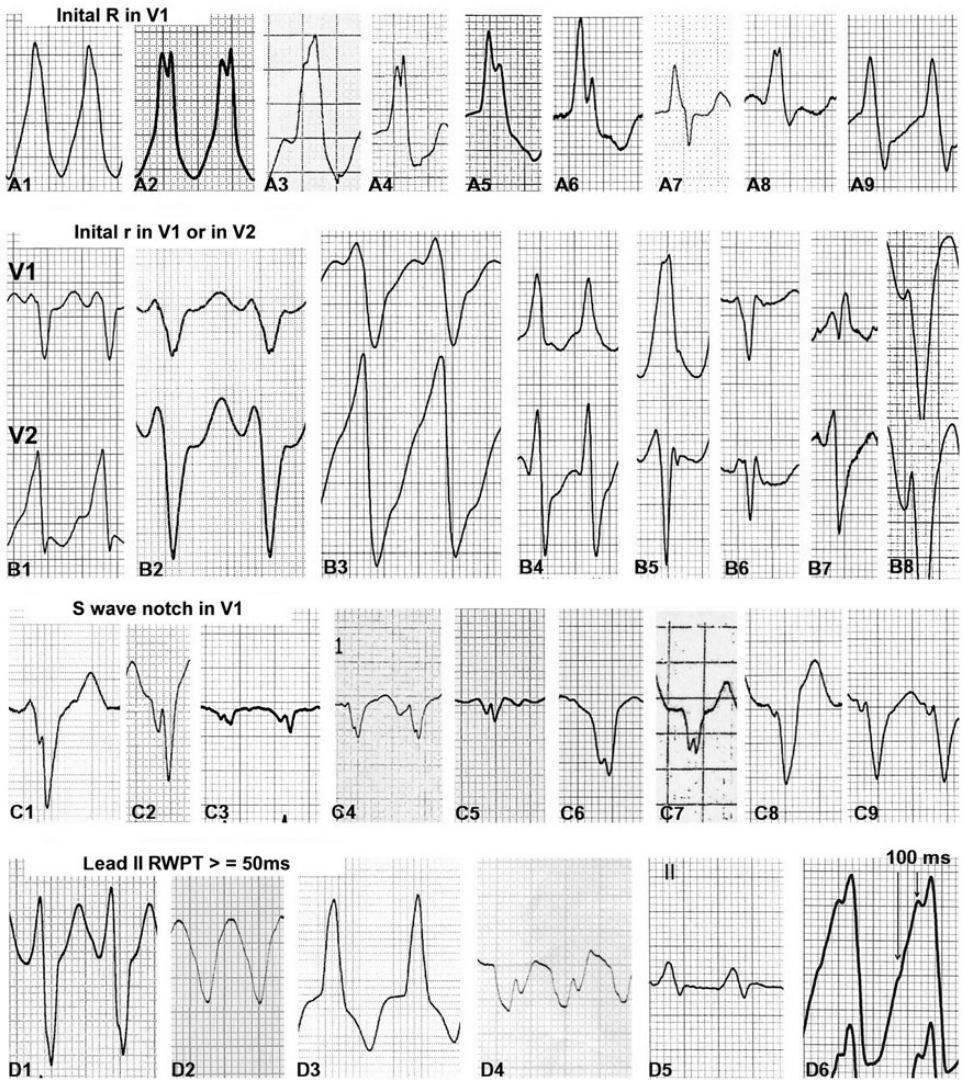

Figure 1 Ventricular tachycardia score criteria; representative QRS morphologies. For panel descriptions see the text.

Initial R wave in aVR. The QRS complex in aVR has to start with a large R wave, including a monophasic R (with or without a notch), RS with R ≥ S and Rsr′. This criterion is identical to the 'Initial R in V1' criterion,[1] but is assessed in a different lead; this criterion was introduced by Vereckei *et al.*[5]

Lead II RWPT ≥ 50 ms. The RWPT represents the interval from the beginning of the QRS to the first visible change in direction of the initial polarity, from ascending to descending or *vice versa*; i.e. to R wave peak or S wave nadir or any notch on the descending limb of the S wave or the ascending limb of the R wave (*Figure 1*). It usually appears as a monophasic R or rS with a slowly increasing ascending limb of the R/r wave (*Figure 1*, *D1* and *D3*, *D5*, *D6*) or an S wave with a slowly decreasing descending limb (*Figure 1*, *D2*, *D4*). Supraventricular lead II morphologies with short RWPT are presented in *Figure 2*. This criterion was introduced by Pava *et al.*[4]

Lack of RS complex in leads V1–V6. This criterion is fulfilled when only QS, R, qR, Qr, rSR′, Rsr′, or other QRS configurations are present from V1 to V6, but RS/rS/Rs complex is completely absent. This criterion was introduced by Brugada *et al.*[9]

Atrioventricular dissociation. Atrioventricular dissociation during WCT is considered present when there is any indication that fast ventricular activity (QRS complexes) is not a result of atrial depolarization. Complete or partial AV dissociation can reveal itself via a plethora of ECG phenomena: clearly visible p waves at a rate slower than QRS complexes, retrograde conduction different from 1:1, usually 2:1 or 3:2, fusion or capture beats or even a few random suspicious humps or irregularities in ST-T complex or changes in ST-T morphology, that, in an artefact-free WCT ECG, almost always are *bona fide* P waves, especially when present simultaneously in more than one lead. Due to its very high specificity, this criterion was the only one assigned 2 VT score points.

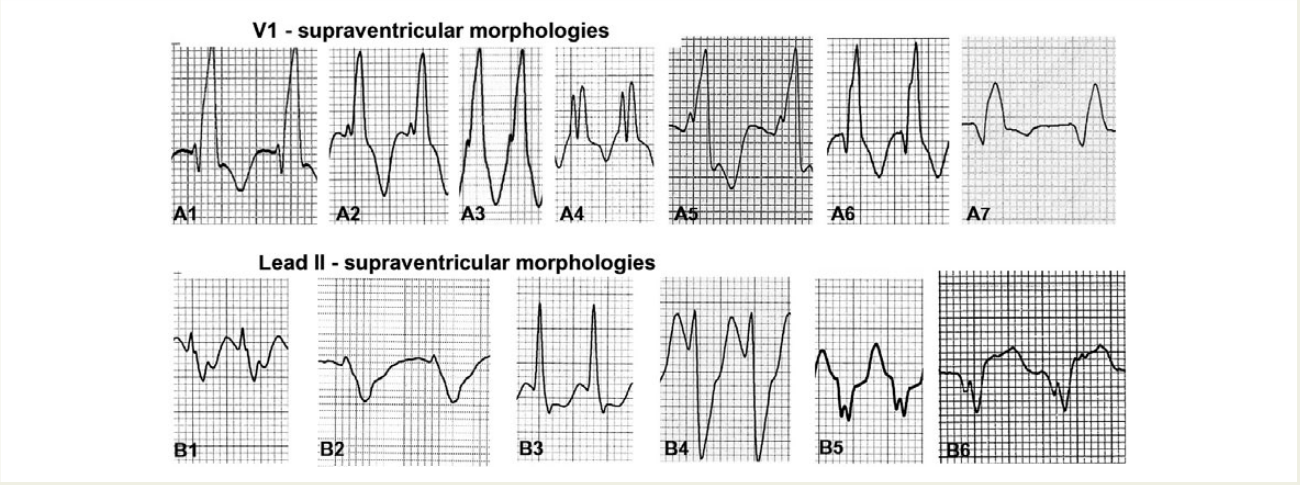

Figure 2 Examples of QRS morphologies in leads V1 and II that do not fulfil the criteria of VT score morphologies. (*A1*) Classic rsR′ pattern of right bundle branch block. (*A2*–*A5*) Notch on the ascending limb of the R wave with the notch's nadir in the lower part of the R wave. (*A6* and –*A7*) qR pattern. (*B1*–*B4*) Short RWPT (R-wave peak time): from the beginning of the QRS to the r or R wave peak there is <50 ms. (*B5* and *B6*) Short interval from the beginning of the QRS to the S wave notch.

Table 3 Diagnostic performance of the VT score, as assessed in the validation cohort of 684 WCTs

Parameter	Accuracy	Specificity	Sensitivity	LR (+)	LR (−)	κ
VT score ≥1	82.7% (79.7–85.5)	63.2% (56.7–69.3)	93.3% (90.5–95.4)	2.53 (2.14–3.0)	0.11 (0.07–0.15)	0.92
VT score ≥2	80.6% (77.4–83.5)	88.3% (83.5–92.1)	76.4% (72.2–80.3)	6.52 (4.59–9.27)	0.27 (0.22–0.32)	0.90
VT score ≥3	71.8% (68.2–75.1)	99.6% (97.7–100)	56.9% (52.1–61.5)	135.9 (19.2–962.3)	0.43 (0.39–0.48)	0.89
VT score ≥4	56.1% (52.3–59.9)	100% (98.5–100)	32.6% (28.2–37.2)	779.1 (1.584–∞)	0.67 (0.63–0.72)	0.81

κ, measure of inter-observer agreement; LR, likelihood ratio; WCT, wide QRS complex tachycardia; VT, ventricular tachycardia.

A cut-off score of three points was chosen for a definitive diagnosis of VT, as no patient with SVT from the initial group had ≥3 VT points. Scores of 0–2 were considered indicative of an indecisive morphology, and, therefore of a non-diagnostic ECG.

Ventricular tachycardia score validation

The 684 WCT ECGs used to validate the VT score consisted of 445 VTs and 239 SVTs. The diagnostic performance of the VT score system is shown in *Table 3*.

Using a cut-off of three or more points, 254 ECGs were considered diagnostic for VT; of these, 253 (99.6%) were bona fide VTs and only 1 was SVT. This single misclassified ECG was one of the antidromic AVRTs. Therefore, 57% of VTs had sufficient VT-like features to enable the VT score to provide an unquestionable diagnosis of VT. Atrio-ventricular dissociation was found to have sensitivity of 42.2% and specificity of 97.1% for VT diagnosis.

Although we consider VT score ≥3 as diagnostic, a score of 2 may be indicative of likely VT, since patients with this score are 3.5-fold more likely to be diagnosed with VT. In contrast, a score of 0 may be indicative of likely SVT, since patients with this score are 5.4-fold more likely to be diagnosed with SVT. Thus, only a score of 1 represents a true grey zone, with almost equal probability of VT and SVT. *Table 4* shows the distribution of ECGs diagnosed with VT and SVT as a function of VT score.

Table 4 Distribution of VT scores in the entire studied population (n = 786)

Diagnosis	VT score					
	0	1	2	3	4	≥5
SVT, *n*	174	70	29	1	0	0
VT, *n*	32	84	102	127	97	70
Percentage of VT in this VT score category	15.5	54.5	77.9	99.2	100	100

$P < 0.001$ (for trend).
VT, ventricular tachycardia; SVT, supraventricular tachycardia.

Interestingly, the use of the VT scoring system as an algorithm, i.e. to reach a diagnosis for every ECG, results in superior overall accuracy compared with previous ECG-based methods (*Table 5*). As shown by ROC analysis, a cut-off of ≥1 point for a diagnosis of VT and 0 points for a diagnosis of SVT (*Figure 3*) should be used.

Table 5 Comparison of VT scores with other ECG-based methods ($n = 786$)

	VT score ≥1	Brugada algorithm	aVR algorithm	Lead II RWPT	P^a	P^b
Accuracy	83.1% (80.3–85.6)	80.4% (77.5–83.1)	73.4% (70.2–76.5)	70.1% (66.8–73.3)	0.05	<0.001
Sensitivity	93.6% (91.1–95.5)	91.0% (88.2–93.4)	79.9% (76.2–83.3)	62.0% (57.6–66.2)	0.09	<0.001
Specificity	63.4% (57.4–69.1)	60.4% (54.4–66.3)	61.2% (55.1–67.0)	85.3% (80.6–89.3)	0.34	0.61
LR (+)	2.554 (2.18–2.99)	2.30 (1.98–2.67)	2.06 (1.76–2.40)	4.23 (3.15–5.68)	0.15	0.03
LR (−)	0.102 (0.07–0.14)	0.15 (0.11–0.20)	0.33 (0.27–0.40)	0.44 (0.39–0.50)	0.04	<0.001
κ	0.92	0.86	0.64	0.87	–	–

VT, ventricular tachycardia; RWPT, R wave peak time; κ, measure of inter-observer agreement.
[a]VT score ≥1 vs. Brugada algorithm.
[b]VT score ≥1 vs. aVR algorithm.

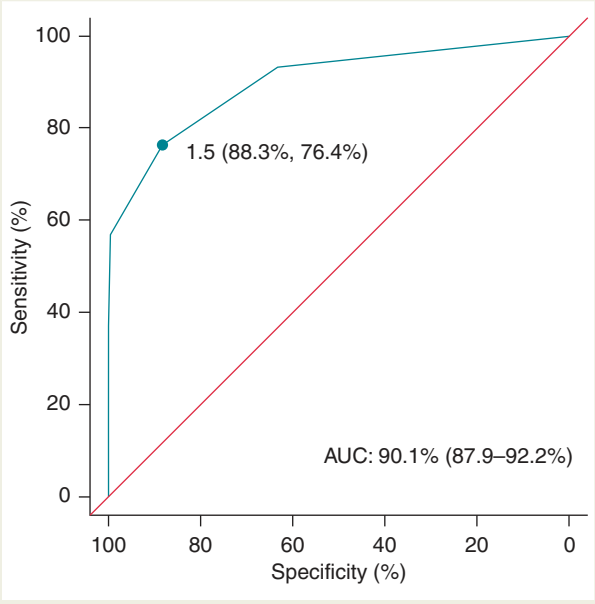

Figure 3 Receiver operating characteristic curve for VT score. AUC, area under the curve.

Discussion

The major finding of the current study is that, in contrast to SVTs, most VTs give rise to several VT-specific features on ECGs. Since a higher number of these features reflected an increased probability of VT, we devised a grading approach to VT diagnosis. In contrast to existing algorithms, the VT score provides an almost error-free diagnosis of VT when ECGs are truly diagnostic (VT score ≥3) and identifies unequivocal or moderately diagnostic ECGs (VT score of 0–2). We believe that such an approach is clinically superior, since the identification of a non-diagnostic ECG can lead to the use of other diagnostic modalities, including electrophysiology, echocardiography, clinical history, previous and subsequent ECGs, physical examination, and adenosine challenge. When the VT score indicates that the ECG is diagnostic, there is no need for further tests. In contrast, the Brugada and Vereckei-aVR algorithms and the Pava method were found to be moderately diagnostic, misclassifying ∼25% of ECGs. These methods therefore seem to be unsuitable for acute management of tachycardia, as well as for long-term clinical decision-making.

The VT score is intentionally a super-specific rather than a sensitive VT diagnostic method. This approach was taken because a 100% sensitive method, advocated in the emergency setting, is readily available (all WCTs should be treated as VTs), while a very specific diagnostic method was lacking. Therefore, we aimed to develop a method characterized by high diagnostic specificity that could prevent VT overdiagnosis, as such misdiagnosis can result in serious clinical consequences, including unnecessary defibrillator implantation, inappropriate shocks, unnecessary resynchronization pacemaker upgrades, and unnecessary long-term amiodarone therapy.

Importantly, VT score could well differentiate pre-excited tachycardias, considered electrocardiographically indistinguishable from VTs, from actual VTs. Indeed, of 38 ECGs showing pre-excited tachycardias, only 1 was misclassified as VT, with all others having ≤2 VT-like features. This compares well with other methods (e.g. Brugada and aVR algorithms) that rely either on second line algorithms—designed for differentiation between VT and pre-excited tachycardias,[21] or on categorizing misdiagnosis (pre-excited SVT diagnosed to be VT) as a correct diagnosis.[22]

Determining the VT score is simple as most of the criteria are well known, and the order of assessment of the seven features is irrelevant. A VT score of 3–4 is sufficient, making it unnecessary to assess remaining VT score criteria. In addition to using a strict cut-off of ≥3 VT points, VT score can be used more elastically as different scores reflect increasing likelihood of VT/SVT diagnosis (see *Table 4*). Moreover, although it was not our goal, the VT score can be used as an algorithm, to achieve diagnosis in every case, with a score of 0 being diagnostic of SVT and score of 1 or more being diagnostic for VT. In other words, each criterion is one step of the algorithm: if any of the seven features is present, VT is diagnosed; if none is present, SVT is diagnosed. When so used, this method still showed greater accuracy than other algorithms, as well as being easier to use due to avoidance of cumbersome steps or difficult to ascertain features (e.g. Vi/Vt). However, we believe that the best approach is to assess all seven VT score criteria, identify certain VTs (VT score of 3–8), and then use the above algorithmic approach only for the grey zone ECGs (VT score of 0–2), bearing in mind that in these

cases VT/SVT diagnosis on the basis of ECG alone is not error-free. High specificity of AV dissociation for VT diagnosis should also be remembered.

Limitations

The VT score method was constructed and validated on the basis of a general non-selected cohort of patients/ECGs, it might therefore have different diagnostic properties when applied to some specific sub-populations or cohorts with higher percentage of a particular tachycardia subtypes (e.g. bundle branch re-entrant VT—known to be difficult to differentiate from SVT).

Our method was compared with the two popular ECG methods, we did not compare it with the Wellens *et al.*,[7] Griffith *et al.*,[2] Lau and Ng,[3] Steurer *et al.*,[22] or other methods.

Summary

This study, involving the largest cohort to date of patients with WCT, resulted in the development and validation of a novel method for diagnosing VT based on a scoring system, called the VT score. This method compares favourably to other methods in terms of overall diagnostic accuracy. Moreover, the very high specificity of the method at higher scores means that it is capable of providing near certain diagnosis of VT when higher scores are reached, which occurs in the majority of cases of VT.

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