Wide QRS Complex Tachycardia

Reappraisal of a Common Clinical Problem

Masood Akhtar, MD; Mohammad Shenasa, MD, PhD; Mohammad Jazayeri, MD; Jose Caceres, MD; and Patrick J. Tchou, MD

Background and Purpose: Despite available criteria, diagnosis of the mechanisms of wide complex tachycardia is often incorrect. We aimed in this study to identify reasons for misdiagnoses and the value and limitations of clinical and surface electrocardiographic criteria.

Data Identification: The analyzed data of 150 consecutive patients with wide QRS tachycardia from this study and a literature search of key papers in English since 1960 on clinical and surface electrocardiographic criteria form the basis of this report. The final correct diagnosis was made with intracardiac electrograms.

Data Extraction and Analysis: Among the 150 patients, 122 had ventricular tachycardia, 21 had supraventricular tachycardia with aberrant conduction, and 7 had accessory pathway conduction. Only 39 of 122 patients with ventricular tachycardia were correctly diagnosed initially. In others, the diagnoses were supraventricular tachycardia with aberrant conduction (43 of 122) or simply a wide QRS tachycardia (40 of 122). Misdiagnosis in patients with aberrant or accessory pathway conduction was also common. Standard electrocardiographic criteria for ventricular tachycardia had unacceptable sensitivity, poor specificity, or both. Collectively such criteria allowed a correct diagnosis of ventricular tachycardia in 92% of cases. Diagnosis of ventricular tachycardia was also suggested by its association with structural heart disease. Criteria suggestive of ventricular tachycardia included atrioventricular dissociation, positive QRS concordance, axis less than −90 deg to ± 180 deg, combination of left bundle branch block and right axis, QRS duration of greater than 140 ms with right bundle branch block and greater than 160 ms with left bundle branch block and, a different QRS during tachycardia compared to baseline preexisting bundle branch block.

Conclusions: Ventricular tachycardia is the commonest underlying mechanism for wide QRS tachycardia. A correct diagnosis can usually be made from clinical and surface electrocardiographic criteria.

Annals of Internal Medicine. 1988;**109**:905-912.

From the University of Wisconsin and the Sinai Samaritan Medical Center, Milwaukee, Wisconsin; and the Centre de Recherche, Hôpital du Sacre-Coeur, Montreal, Quebec.

Wide QRS tachycardia is a common clinical problem that may be due to various supraventricular and ventricular mechanisms. However, despite the availability of clinical and electrocardiographic criteria, the underlying mechanism is often not diagnosed correctly (1-12). Nonetheless it is highly desirable to distinguish supraventricular tachycardia, which generally carries a good prognosis, from ventricular tachycardia, which can be life threatening if not managed properly. Because effective and often curative therapies can now be offered to patients with life-threatening tachycardias, incorrect diagnosis of ventricular tachycardia is unfortunate.

We have encountered a relatively high incidence of misdiagnosis regarding the underlying mechanism of wide QRS tachycardia. We therefore prospectively analyzed clinical and 12-lead electrocardiographic data in 150 consecutive, nonselected patients presenting at our referral centers with a wide QRS tachycardia. We report our findings from a large series of consecutive patients that provide new insights into the magnitude of the problem, the main reasons for the misdiagnoses and, various clinical and electrocardiographic clues that could improve the probability of making a correct diagnosis.

Materials and Methods

Patients

One hundred and fifty consecutive patients who presented with regular wide QRS complex tachycardias on a 12-lead electrocardiogram were referred to either of the two centers: Sinai Samaritan Medical Center, Milwaukee, Wisconsin or Centre de recherche, Hôpital Du Sacre-Coeur, Montreal, Quebec. In all cases the final diagnosis of a specific mechanism was made using the invasive electrophysiologic studies with His bundle electrogram recordings (9). The only two criteria for inclusion into this study were the availability of a 12-lead electrocardiogram done during the wide QRS tachycardia and final diagnosis using intracardiac electrocardiographic recording techniques.

Data regarding the clinical characteristics of these patients were obtained by direct questioning and review of medical records. The various parameters that were analyzed are outlined.

Clinical Variables

Duration of recurrent symptoms before the present hospitalization was assessed by history and electrocardiographic documentation. When doubt existed concerning the exact period of time that the patient had been experiencing the same tachycardia, no data were entered. Patients presenting immediately after the first episode were listed as having a total duration of symptoms less than or equal to 7 days. In other cases the appropriate number of days were calculated from the available information.

The presence of structural heart disease was determined from history and objective evidence from either noninvasive or invasive diagnostic techniques. These techniques included two-dimensional echocardiograms, radionuclide cardiac imaging techniques (that is, thallium stress testing, rest or exercise-multigated equilibrium acquisition, or both), and sometimes cardiac catheterization. Myocardial biopsies were not routinely done. Assigned categories of structural abnormalities included atherosclerotic heart disease, primary myocardial disease, and valvular heart disease. The rare patients with hypertension or congenital heart disease were categorized as "other." The existence of a previous myocardial infarction was assessed with either diagnostic Q waves in the resting 12-lead electrocardiogram or by a history of acute myocardial infarction in association with cardiac enzyme changes.

Left ventricular ejection fractions were available for most patients from either cardiac catheterizations or radionuclide studies, and in some instances only from the echocardiograms. When reliable data could not be gathered, no values for left ventricular ejection fraction were entered. In many young patients with normal ventricular size and motion, the left ventricular ejection fractions were reported as normal but actual numerical values were not provided. In these patients, values greater than or equal to 55% were entered.

It was often difficult to obtain reliable information regarding previous administration of cardio-active drugs because at times even the patients were unsure if they had been taking the prescribed medication. However, the information the provided was tabulated with particular attention to the use of antiarrhythmic medications administered for the immediate control of arrhythmia.

Electrocardiographic Parameters

A wide complex tachycardia was defined as one showing a QRS duration of greater than or equal to 120 ms on a 12-lead electrocardiogram. The QRS morphology was assigned to represent a right bundle branch block pattern when V1 showed a predominantly positive QRS complex and was labeled a left bundle branch block pattern when V1 showed a predominantly negative complex. The axis orientation was divided into four categories: normal axis, from −30 deg to +90 deg; left axis, less than −30 deg to −90 deg; extreme left, or right superior, less than −90 deg to ± 180 deg; and right axis, greater than +90 deg to +179 deg. The QRS duration and presence of a bundle branch block or fascicular block were also recorded from the baseline electrocardiogram when the conduction was over the normal pathway. When the ventricular activation during the baseline electrocardiogram showed preexcitation, the presence of preexisting bundle branch block could not be determined.

Specific QRS morphologies (monophasic, biphasic, or triphasic appearance) were analyzed in leads V1, V6, and AVR in association with right and left bundle branch block patterns (3, 5).

The terms "negative QRS" or "positive QRS" concordance were used to describe QRS complexes with predominately negative or positive deflections respectively in all precordial leads (3). In patients with left bundle branch block morphology tachycardia, the presence of S-wave slurring and QRS onset to S-wave nadir duration in lead V_1 was specifically analyzed because these criteria have been reported to distinguish ventricular tachycardia from supraventricular tachycardia with aberrant conduction (12).

Atrioventricular dissociation was diagnosed when a P wave could be clearly identified at least in one lead and was independent of the ventricular activity. Ventriculoatrial block was diagnosed if the number of QRS complexes exceeded the number of P waves but there was a P-QRS relationship.

Data Analysis

Descriptive data are presented as means plus and minus standard deviation. Comparisons of continuous variables between groups were performed by analysis of variance as well as with Student *t*-tests. The observed frequencies of particular variables were compared among various groups by chi-square analysis.

Results

Of the 150 consecutive patients presenting with wide QRS tachycardia, 122 had ventricular tachycardia as the underlying mechanism and 21 had supraventricular tachycardia with aberrant conduction. In the latter group, 6 of 21 patients had a preexisting bundle branch block whereas the remaining 15 showed aberrant conduction due to functional bundle branch block. In 7 patients broad QRS complexes resulted from conduction over an accessory pathway during supraventricular tachycardia.

Patients presenting with ventricular tachycardia were, on the average, older; those with accessory pathway conduction were the youngest (Table 1). However, the overlap of age ranges indicates that the patient's age alone may not be indicative of a particular diagnosis.

Structural heart disease was considerably commoner in patients with ventricular tachycardia (112 of 122, 92%) compared with patients with aberrant conduction (6 of 21) and accessory pathway conduction, none of whom had any detectable organic heart disease (Table 1). Seventy-one percent (87 of 122) of the patients with ventricular tachycardia had electrocardiographic documentation of an old myocardial infarction. In addition, 13 of 122 (11%) patients gave a history of myocardial infarction but lacked electrocardiographic confirmation of transmural damage. In contrast only 2 of 21 patients who had aberrant conduction and none of the patients with accessory pathway conduction had a previous myocardial infarction.

Left ventricular ejection fraction values were available in 89 of 122 patients with ventricular tachycardia and had a mean value 33.3% ± 13.6% (Table 1). The mean left ventricular ejection fraction was 52.8% ± 13.4% in 18 of 21 patients with aberrant conduction and more than 55% in all of the patients with accessory pathway conduction. Of the 122 patients with ventricular tachycardia, 10 showed no evidence of structural heart disease.

Duration of Symptoms before Presentation

Information about the duration of symptoms was available for 111 of the 122 patients with ventricular tachycardia. On the average, the arrhythmia existed for 201 ± 396 days before hospitalization (range, 1 to 2400 days). However, in most of these patients (57 of 111), the total duration was less than or equal to 14 days. On the other hand, a few patients (6 of 111) had a history of wide QRS tachycardia that exceeded 3 years. The mean duration of symptoms in patients with aberrant conduction was 1025 ± 1165 days

Table 1. *Clinical Findings in 150 Patients with Wide QRS Tachycardia**

	Ventricular Tachycardia (n = 122)	Aberrant Conduction (n = 21)	Accessory Pathway Conduction (n = 7)
Mean age (range), *yr*	60 ± 12 (22-81)	48 ± 21† (8-83)	34 ± 18† (16-73)
Men/women, *n/n*	102/20	15/6	5/2
Patients, *n*			
With structural heart disease	112	6	0
With history of myocardial infarction	87	2	0
Left ventricular ejection fraction (%)	33 ± 14	53 ± 13†	> 55†

* Where appropriate, data are mean ± SD.
† P < 0.001 compared to ventricular tachycardia.

(range, 7 to 5000) in 20 of 21 patients for whom these data could be gathered. Eleven of the twenty had a history of tachycardia of more than 3 years. In patients with accessory pathway conduction the mean duration was 2074 ± 1929 days (range, 360 to 5000) and 4 of 7 had the arrhythmia for more than 3 years before the current evaluation. When we used a history of tachycardia of over 3 years as a cutoff point, the differences between aberrant conduction and accessory pathway conduction compared with ventricular tachycardia population were highly significant ($P < 0.001$). No difference was apparent between patients with aberrant conduction and those with accessory pathway conduction.

Initial Diagnosis and Therapy

We studied the documentation concerning the diagnosis and therapy carried out by the physician who first managed the patient (usually in a primary care or emergency room setting). When the physician did not clearly indicate the diagnosis in the record, we inferred a specific diagnosis from the initial therapy instituted. Among patients with ventricular tachycardia, a correct diagnosis was made in 39 (32%). In 43 (35%) patients, supraventricular tachycardia with aberrant conduction was diagnosed and in the remaining 40 (33%), wide QRS complex tachycardia (33%) was diagnosed. An incorrect diagnosis of ventricular tachycardia was made in 6 of 21 patients with aberrant conduction and 3 of 7 with accessory pathway conduction. The remaining patients with aberrant conduction (15 of 21) were correctly diagnosed but only 1 of the remaining 4 patients with accessory pathway conduction was appropriately labeled. The 3 other patients were diagnosed as having aberrant conduction.

Thirty-five of the patients with ventricular tachycardia received intravenous verapamil. The ventricular tachycardia stopped in only 1 patient; in the remainder the tachycardia continued and immediate hemodynamic deterioration was noted, prompting DC cardioversion (10, 11). Five patients with aberrant and 3 patients with accessory pathway conduction received verapamil; a hemodynamic deterioration was noted among the latter group as well. Before therapeutic intervention all patients in this study were conscious and most were hemodynamically stable.

Value of 12-Lead Electrocardiogram during Tachycardia

We assessed the value of commonly used surface electrocardiographic criteria. The data dealing with individual criteria are presented below (1-8, 12).

Atrioventricular Dissociation

The most reliable criterion was atrioventricular dissociation, which gave correct electrocardiographic diagnosis of ventricular tachycardia in all 29 (24%) patients, who exhibited atrioventricular dissociation on surface electrocardiogram (Table 2). Atrioventricular dissociation was present in 67 (55%) patients but could only be detected with intracardiac electrograms in 38 of 67. In another 24 (20%) patients, varying degrees of ventriculoatrial block were noted. However, the diagnosis of ventriculoatrial block (from surface electrocardiogram) could be made in one third of these patients when they had a 2:1 block and when the ventriculoatrial was sufficiently long such that the P was located outside the QRS complex. One-to-one ventriculoatrial conduction was present in 31 (25%) of the patients with ventricular tachycardia. None of the patients with aberrant conduction or accessory pathway conduction showed atrioventricular dissociation.

QRS Duration

On the average QRS duration was longer in ventricular tachycardia than in supraventricular tachycardia with aberrant conduction ($P < 0.001$) (Table 3). These findings agree with those reported by Wellens and associates (5, 8). Interestingly, however, 18 (15%) of the patients with ventricular tachycardia had a QRS less than or equal to 140 ms. On the other

Table 2. *Atrioventricular Relationship in 122 Patients with Ventricular Tachycardia*

Finding	Number of Patients (Percent)
Atrioventricular dissociation (surface electrocardiogram)	29 (24)
Atrioventricular dissociation (intracardiac electrogram)	67 (55)
Ventriculoatrial block	24 (20)
1:1 ventriculoatrial conduction	31 (25)

Table 3. *QRS Duration and Cycle Length in 150 Patients with Wide QRS Tachycardia**

	Ventricular Tachycardia (n = 122)	Aberrant Conduction (n = 21)	Accessory Pathway Conduction (n = 7)
Mean QRS duration (range), *ms*	169 ± 29 (120-300)	138 ± 14† (120-160)	156 ± 24‡ (120-200)
Mean cycle length (range), *ms*	350 ± 64 (205-560)	331 ± 80 (220-470)	321 ± 77 (200-400)

* Where appropriate, data are mean ± SD.
† $P < 0.001$ compared with ventricular tachycardia.
‡ P not significant compared with ventricular tachycardia.

hand, in 5 of 10 patients with aberrant conduction with a left bundle branch block, the QRS duration was greater than or equal to 150 ms. In the remaining 5 patients with left bundle branch block and in 10 of 11 patients with right bundle branch block aberrancy, the QRS was less than or equal to 140 ms. Only one person with accessory pathway conduction had a QRS complex less than or equal to 140 ms and this patient had anterograde ventricular activation via a Mahaim connection. The remaining 6 patients with accessory pathway conduction had a QRS duration of more than 140 ms and ventricular depolarization that occurred over a Kent bundle (7).

The diagnostic accuracy of a criterion using QRS duration of more than 140 ms with a right bundle branch block and more than 160 ms with a left bundle branch block is excellent. In all 18 patients with a left bundle branch block pattern with a QRS of more than 160 ms, the diagnosis was ventricular tachycardia. Similarly, in patients with a QRS of more than 140 ms and a right bundle branch block, 64 of 67 had ventricular tachycardia. Only 1 patient with aberrant conduction and 2 patients with left free wall accessory pathway conduction had QRS duration of more than 140 ms in association with a right bundle branch block appearance.

Cycle Length of Tachycardia

Although the mean cycle length was shorter in accessory pathway conduction and aberrant conduction when compared with ventricular tachycardia, there was a significant overlap (Table 3). Cycle length alone was of little value in arriving at a correct diagnosis.

Specific QRS Configuration

1. Right bundle branch block as compared with left bundle branch block appearance of QRS (Table 4).

In patients with ventricular tachycardia, a right bundle branch block was seen in 70 of 122 (57%) whereas there was a left bundle branch block appearance in the remaining 52 patients. Among patients with ventricular tachycardia and no structural heart disease, 7 of 10 displayed a left bundle branch block type of QRS. A right bundle branch block was only slightly commoner in supraventricular tachycardia with aberrant conduction (11 of 21 compared with 10 of 21, respectively). In patients with supraventricular tachycardia with accessory pathway conduction, 4 of 7 patients showed a right bundle branch block and the remaining patients had a left bundle branch block pattern.

2. Positive compared with negative QRS concordance (Table 4) (3). Only patients with ventricular tachycardia showed a positive concordance, observed in 15 of 122 (12%) patients. A negative QRS concordance was seen in 12 of 122 (10%) patients with ventricular tachycardia and in 3 of 10 patients who had an aberrant conduction with a left bundle branch block.

3. Monophasic, biphasic, and triphasic QRS complexes.

The incidence of these morphologic appearances in leads V1, V6, and AVR is shown in Table 5(5). When the QRS morphology had a right bundle branch block appearance, a triphasic complex was seen in lead V1 among 9 of 70 (13%) patients with ventricular tachycardia and 7 of 11 patients with aberrant conduction.

Table 4. *QRS Morphologic Findings and Axis Orientation in 150 Patients with Wide QRS Tachycardia*

	Ventricular Tachycardia	Aberrant Conduction	Accessory Pathway Conduction
	←	*n*	→
QRS morphologic findings			
Bundle branch block			
Right	70	11	4
Left	52	10	3
Concordance			
Positive	15	0	0
Negative	12	3	0
QRS axis orientation, *degrees*			
−30 to +90	19	9	2
> +90 to +179	30	4	2
< −30 to −90	44	8	3
< −90 to ±180	29	0	0

Table 5. *Bundle Branch Block Patterns in 150 Patients with Wide QRS Tachycardia*

QRS Morphology	Ventricular Tachycardia			Aberrant Conduction			Accessory Pathway Conduction		
	V1	V6	AVR	V1	V6	AVR	V1	V6	AVR
Right bundle branch block*									
Monophasic	40	37	47	3	1	1	4	0	1
Biphasic	21	26	16	1	0	1	0	3	1
Triphasic	9	7	7	7	10	9	0	1	2
Left bundle branch block†									
Monophasic	26	31	34	7	9	8	3	3	3
Biphasic	18	19	17	3	1	2	0	0	0
Triphasic	8	2	1	0	0	0	0	0	0

* Patients with ventricular tachycardia = 70; aberrant conduction = 11; accessory pathway conduction = 4.
† Patients with ventricular tachycardia = 52; aberrant conduction = 10; accessory pathway conduction = 3.

Monophasic and biphasic complexes in V1 were commoner in the patients with ventricular tachycardia (61 of 70) and accessory pathway conduction (4 of 4) than aberrant conduction (4 of 11).

With a left bundle branch block, a monophasic or biphasic complex is expected in leads V_1 and V_6 during aberrant conduction, which occurred in all 10 instances. Monophasic or biphasic QRS morphology, or both, also predominated in ventricular tachycardia and accessory pathway conduction. QRS complexes showing triphasic appearances with a left bundle branch block pattern were only seen in ventricular tachycardia.

Among the patients with wide complex tachycardia having a left bundle branch block appearance, a slurred S wave or QRS onset, or both, to a nadir of the S wave greater than or equal to 70 ms in V1 was seen in 46 of 52 (88%) patients with ventricular tachycardia and in only 1 of 10 patients with aberrant conduction (12). Two of three patients with accessory pathway conduction and a left bundle branch block pattern also showed findings of prolonged and slurred S wave in V1.

QRS Axis

The distribution of axes shown in Table 4 shows that although the left axis deviation is more frequent in ventricular tachycardia (44 of 122), right axis deviation is not uncommon (30 of 122). Even a normal axis orientation may occur in some patients (19 of 122) during ventricular tachycardia. Unless the axis orientation is between less than −90 deg and ±180 deg, ventricular tachycardia cannot be reliably distinguished from aberrant conduction or accessory pathway conduction. When the QRS axis was examined in the context of accompanying QRS pattern some interesting findings emerged. A combination of left bundle branch block and right axis deviation was only seen in ventricular tachycardia (9 patients) whereas aberrant conduction with a left bundle branch block was associated with either a normal or left axis deviation. In 9 of 10 patients with ventricular tachycardia and no structural heart disease, the QRS showed a normal or right axis in association with left bundle branch block appearance in 7, and right bundle branch block in 2. The remaining patient had a right bundle branch block and extreme left axis. No combination of right bundle branch block with any axis orientation was helpful in distinguishing ventricular tachycardia from supraventricular tachycardia with either aberrant conduction or accessory pathway conduction in this series.

When all of the frequently used criteria (atrioventricular dissociation, QRS duration of more than 140 ms, left axis deviation, and specific QRS patterns) were considered collectively, a correct diagnosis of ventricular tachycardia could not be made in 10 of 122 (8%) patients with ventricular tachycardia. Similarly 3 of 21 (14%) patients with supraventricular tachycardia and aberrant conduction would have been incorrectly labeled as having ventricular tachycardia, using the above criteria.

Value of the Baseline 12-Lead Electrocardiogram

The presence of a preexisting bundle branch block was extremely valuable in distinguishing ventricular tachycardia from aberrant conduction (6). Six of the twenty-one patients with supraventricular tachycardia with aberrant conduction had a preexisting bundle branch block (right bundle branch block in 3 and left bundle branch block in 3) and in all, the QRS morphology during "wide QRS" tachycardia was identical to the baseline electrocardiogram. On the other hand, in all 15 patients with ventricular tachycardia who had a preexisting bundle branch block (right bundle branch block in 7 and left bundle branch block in 3) the QRS morphology during ventricular tachycardia was clearly different when compared with the baseline electrocardiogram. In patients with accessory pathway conduction the presence of preexisting bundle branch block could not be ascertained for obvious reasons.

Resting 12-lead electrocardiograms were also indirectly helpful in diagnosing the underlying structural heart disease. In 89 patients there was electrocardiographic evidence of previous transmural myocardial infarction and in 87 of 89 (98%) patients, the wide QRS was due to ventricular tachycardia.

Discussion

Our results indicate that in a referral population misdiagnosis regarding the exact nature of wide QRS tachycardia is common. There seems to be a tendency to diagnose patients who have ventricular tachycardia as having supraventricular tachycardia with aberrant conduction as often as diagnosing them correctly (35% compared with 32%). Ventricular tachycardia in aberrant conduction cases was diagnosed incorrectly less frequently (29%). Because ventricular tachycardia is the underlying arrhythmia in most patients, it is misdiagnosed as supraventricular tachycardia far more frequently when compared with aberrant conduction diagnosed as ventricular tachycardia (39 compared with 6 patients). This trend is clearly undesirable because ventricular tachycardia patients harbor a potentially lethal substrate and misdiagnosis and consequent mismanagement could result in death. As we have shown, even acute therapy based on improper diagnosis in these patients resulted in immediate hemodynamic collapse.

Although our purpose is not to extrapolate that a similar incidence of misdiagnosis exists at the primary care level, this issue is worth examining because it has serious implications for patient care. One can argue, for example, that cases presented here do not reflect the problem at the primary care level since difficult patients are more likely to be referred to arrhythmia centers. This fact alone could explain the initial misdiagnosis (and hence failure due to incorrect treatment), as well as the relatively high incidence of ventricular tachycardia in this population. Although this type of critique is often raised it is rarely based on objective data and it can be answered in the following manner.

In 57 patients with ventricular tachycardia, the total duration of treatment was less than 2 weeks, and in most of these instances the efficacy of antiarrhythmic agents prescribed was not known before referral. On the other hand, most patients with supraventricular tachycardia showing aberrant conduction or accessory pathway conduction had a long history of tachycardia and hence several drug failures were often documented. It would seem, therefore, that failed antiarrhythmic therapy (although it could be a reason) does not account for the frequent misdiagnoses of ventricular tachycardia in this patient population.

Consideration of some other factors suggests reasons that could actually inflate the incidence of supraventricular tachycardia with aberrant conduction in the referral population. First, patients with wide complex supraventricular tachycardia are more likely to be referred than patients with narrow complex supraventricular tachycardia, unless the latter are medically refractory. Second, because of more favorable prognoses in terms of mortality, patients with supraventricular tachycardia may have a longer history of tachycardia and therefore a greater chance of being seen eventually at an arrhythmia center. Third, a recent report indicated that house officers, internists, and general practitioners (compared to cardiologists) are more likely to be influenced by a patient's hemodynamic status when diagnosing ventricular tachycardia as compared to supraventricular tachycardia (13). In a hemodynamically stable population presenting with wide QRS tachycardia, therefore, misdiagnosis of ventricular tachycardia may in fact be even commoner at a primary care level. There seems to be no sound basis for the critique that the incidence of ventricular tachycardia compared to supraventricular tachycardia as the mechanism of wide QRS tachycardia at primary care level is dramatically lower than in this series. It is reasonable to conclude that ventricular tachycardia is the commonest cause of wide QRS tachycardia. It would be safer to err in labeling supraventricular tachycardia with aberrant conduction as ventricular tachycardia, rather than the reverse.

The exact reasons for the misdiagnosis of ventricular tachycardia despite availability of several electrocardiographic criteria are unclear but some explanations can be offered. One reason for frequent diagnosis of supraventricular tachycardia with aberrant conduction may be the ill-founded perception that aberrant conduction is as common as ventricular tachycardia. This finding was clearly not seen in this study and in fact, has never been seen in any population of consecutive patients presenting with a wide QRS tachycardia. Although functional aberrant conduction is commonly induced in the laboratory, it may not persist long enough for a patient to present with a wide QRS tachycardia due to this mechanism. Studies by Wellens and colleagues (5, 8) reporting a large number of patients with supraventricular tachycardia showing aberrant conduction were not done in consecutive patients. Although a similar number of patients with supraventricular tachycardia and ventricular tachycardia were reported for comparison, a high incidence of supraventricular tachycardia with aberrant conduction was not implied. In many of these patients, the recorded 12-lead electrocardiograms were of induced tachycardias. It is also unclear if their cases had 12-lead electrocardiograms done at the initial presentation.

Another explanation may be that most patients presenting with wide QRS tachycardia in whom a 12-lead electrocardiogram is obtained are conscious and hemodynamically stable. These factors could lead to the incorrect diagnosis of supraventricular tachycardia; this possibility has also been emphasized by other investigators (10, 11, 13). It is important to realize, however, that patients with hemodynamically stable ventricular tachycardia in whom a 12-lead electrocardiogram can be obtained would ordinarily be those included in a series like this one. Such patients constitute a highly selected population and therefore, hemodynamic stability is unlikely to provide any clue to the underlying mechanism of wide complex tachycardia. Patients with ventricular tachycardia associated with hemodynamic collapse would generally present with cardiac arrest and would not be likely to have 12-lead electrocardiograms of their tachycardias at initial presentation.

Despite hemodynamic stability, an atmosphere of urgency exists that may motivate the attending physician to intervene quickly rather than thoroughly analyze the 12-lead electrocardiogram. Although having a 12-lead electrocardiogram available is highly desirable for proper diagnosis and future reference, an immediate diagnosis of ventricular tachycardia can be made readily from the history alone. The presence of structural heart disease in association with wide QRS tachycardia suggested ventricular tachycardia in 95% of our patients (112 of 118). Similarly, a history of previous myocardial infarction was associated with a high incidence of ventricular tachycardia as the mechanism of wide QRS tachycardia (87 of 89, 98%) (11). Regardless of history, however, because 122 of 150 (81%) patients in this series had ventricular tachycardia, it should be the initial diagnosis until it can be proved otherwise. Realization of its high incidence alone will help prevent both acute- and longer-term mismanagement.

Value of the 12-Lead Electrocardiogram

Review of the 12-lead electrocardiogram in these cases confirmed the usefulness of several of the existing criteria and helped to establish some new ones (1-8). Using frequently applied criteria (atrioventricular dissociation, QRS duration > 140 ms, left axis deviation, and specific QRS morphologies), a correct diagnosis could not be made in 10 (8%) of the patients with ventricular tachycardia and 3 of the patients with aberrant conduction. Other criteria (ventriculoatrial block, QRS duration > 140 ms with a right bundle branch block and > 160 ms with a left bundle branch block, positive QRS concordance, extreme left axis deviation, and different QRS patterns in patients with preexisting bundle branch block) were more reliable. Because an accurate diagnosis of ventricular tachycardia is essential for determining a prognosis and can be done in almost all patients with intracardiac electrophysiologic studies, such studies should be considered whenever there is doubt (7, 9, 11). The data presented here and in many of the previous reports are based on the 12-lead electrocardiogram; the diagnostic accuracy from a rhythm strip alone will be lower. The value of individual electrocardiographic criteria in light of the present data is discussed below.

Atrioventricular Dissociation

Although atrioventricular dissociation is a very reliable criterion, it is clearly somewhat impractical because it could only be recognized in one fourth of the patients. Even when ventriculoatrial block is also present, the sensitivity does not improve significantly.

QRS Duration

The duration of QRS complex can be of practical value but unless it is analyzed in the context of right bundle branch block as compared to left bundle branch block pattern, it can be misleading. A QRS complex of more than 140 ms in association with supraventricular tachycardia with aberrant conduction showing left bundle branch block is the rule rather than exception, particularly when the left bundle branch block is preexisting. Furthermore, ventricular tachycardia can occur with a QRS less than 140 ms long. Unless a QRS duration of less than 140 ms with a right bundle branch block pattern or less than 160 ms with a left bundle branch block morphology is observed, aberrant conduction should not be diagnosed. A QRS duration of more than 160 ms is highly suggestive of ventricular tachycardia regardless of bundle branch block morphology with one caveat. Many patients with wide QRS tachycardia may be on class 1a or 1c agents or amiodarone and a significant QRS prolongation may occur as a result of these drugs. In this series two patients with the widest QRS complexes (280 and 300 ms, respectively) who had ventricular tachycardia were on class 1c agents.

Specific QRS Morphology

Although the monophasic and biphasic QRS complexes with a right bundle branch block were commoner in ventricular tachycardia compared to aberrant conduction (Table 5), and a triphasic complex was commoner in supraventricular tachycardia, these morphologic characteristics were the weakest for accurate diagnosis. The usefulness of these criteria must be evaluated in the context of prevalence of these tachycardias in the population under study. For example, if wide QRS tachycardia is due to ventricular tachycardia in most patients, then a triphasic QRS in V1 with a right bundle branch block appearance will more frequently cause an incorrect diagnosis of supraventricular tachycardia with aberrant conduction in patients with ventricular tachycardia (9 patients) and a correct diagnosis of supraventricular tachycardia will be made less often (7 patients). This problem would occur despite the fact that the triphasic QRS in V1 with a right bundle branch block is far more frequent in supraventricular tachycardia with aberrant conduction (7 of 11) compared with ventricular tachycardia (9 of 70). Prevalence of an underlying mechanism is critical to defining the usefulness of a given criterion. In the case of ventricular tachycardia compared to supraventricular tachycardia with aberrant conduction or accessory pathway conduction this determination has seldom been made.

In this study, the analysis of V_1 for S-wave slurring and duration of QRS onset to S-wave nadir greater than or equal to 70 ms was generally but not always diagnostic of ventricular tachycardia with a left bundle branch block pattern.

QRS Axis

From the distribution of normal, left, and right axis in the three populations, a correct diagnosis on the basis of axis alone in the three ranges is not likely (Table 4). An axis ranging from less than -90 deg to ± 180 deg seems more diagnostic of ventricular tachycardia. A combination of a right axis with left bundle branch block morphology was diagnostic of ventricular tachycardia. On the other hand, association of a right bundle branch block configuration with any axis orientation was not helpful for distinguishing among the three groups.

Baseline Electrocardiogram

The presence of a preexisting bundle branch block was quite useful, allowing a correct diagnosis of ventricular tachycardia or aberrant conduction in all patients. However, its value was limited because a preexisting bundle branch block was seen in only 15 of 122 (12%) patients with ventricular tachycardia and 6 of 21 patients with aberrant conduction. A baseline electrocardiogram was of significant value even when no preexisting bundle branch block was present because the presence of an old myocardial infarction itself almost always suggested the diagnosis of ventricular tachycardia.

Conclusions

As a result of this study the main points regarding patients presenting with a wide QRS tachycardia can be summarized as follows:

1. In wide QRS complex tachycardia, ventricular tachycardia makes up an overwhelming majority of cases in our referral populations.

2. The diagnosis of ventricular tachycardia is suggested by its frequent association with structural heart disease (positive predictive value 95%; 95% CI, 91.1% to 98.9%) and previous electrocardiographically documented myocardial infarction (positive predictive value 98%; 95% CI, 95.1% to 100%). In the absence of structural heart disease, ventricular tachycardia may still be the cause of wide QRS tachycardia in 10 of 32 of the cases.

3. Misdiagnosis of ventricular tachycardia in this referral population (and possibly at primary care level) is alarming, leading to inappropriate immediate care and potentially to long-term mismanagement. The use of intravenous verapamil should be discouraged in treating any patient with wide QRS tachycardia.

4. A correct diagnosis of ventricular tachycardia can be made in most but not all patients from the surface electrocardiogram when the reported electrocardiographic criteria are collectively applied. Individual electrocardiographic criteria have an unacceptable rate of reliability due either to poor sensitivity (atrioventricular dissociation), specificity (QRS duration > 140 ms, QRS configuration), or both (left axis deviation).

5. Highly reliable criteria for the diagnosis of ventricular tachycardia are atrioventricular dissociation and ventriculoatrial block; QRS duration more than 140 ms with a right bundle branch block and more than 160 ms with a left bundle branch block pattern; positive QRS concordance; extreme left axis deviation, that is, less than -90 deg to ± 180 deg; a combination of left bundle branch block and right axis deviation; and a different QRS pattern during tachycardia compared to a baseline electrocardiogram in patients with preexisting bundle branch block.

Requests for Reprints: Masood Akhtar, MD, Sinai Samaritan Medical Center, 950 North 12 Street, Milwaukee, WI 53201.

Current Author Addresses: Drs. Akhtar, Jazayeri, and Tchou: Sinai Samaritan Medical Center, 950 North 12 Street, Milwaukee, WI 53201.
Dr. Shenasa: Clinical EP Lab, Centre de Recherche, Hôpital du Sacre-Coeur, 5400 Quest, Boulevard Gouin, Montreal, Quebec H4J 1C5 Canada.
Dr. Caceres: Section of Cardiology, East Carolina University School of Medicine, Greenville, NC 27858-4354.

References

1. **Pick A, Langendorf R.** Differentiation of supraventricular and ventricular tachycardia. *Prog Cardiovasc Dis.* 1960;**2**:391-407.
2. **Wilson WS, Judge RD, Siegel JK.** A simple diagnostic sign in ventricular tachycardia. *N Engl J Med.* 1964;**270**:446-8.
3. **Marriott HJ.** Differential diagnosis of supraventricular and ventricular tachycardia. *Geriatrics.* 1970;**25**:91-101.
4. **Slama R, Motte G, Coumel P, Waynberger M, Sikorav H.** Les tachycardies junctionelles avec aberration ventriculaires et bloc complete retrograde (pseudo-tachycardie ventriculaire). *Arch Mal Coeur.* 1971;**64**:691-700.
5. **Wellens HJ, Bar FW, Lie KI.** The value of the electrocardiogram in the differential diagnosis of a tachycardia with a widened QRS complex. *Am J Med.* 1978;**64**:27-33.
6. **Dongas J, Lehmann MH, Mahmud R, Denker S, Soni J, Akhtar M.** Value of preexisting bundle branch block in the electrocardiographic differentiation of supraventricular from ventricular origin of wide QRS tachycardia. *Am J Cardiol.* 1985;**55**:717-21.
7. **Akhtar M.** Electrophysiologic basis for wide QRS complex tachycardia. *PACE.* 1983;**6**:81-98.
8. **Wellens HJ, Bar FW, Vanagt EJ, Brugada P.** Medical treatment of ventricular tachycardia: considerations in the selection of patients for surgical treatment. *Am J Cardiol.* 1982;**49**:186-93.
9. **Akhtar M.** Invasive cardiac electrophysiologic studies: an introduction. In: Parmley WW, Chatterjee K, eds. *Cardiology.* v 1. Philadelphia: J.B. Lippincott Company; 1988:**64**:1-17.
10. **Stewart RB, Bardy GH, Greene HL.** Wide complex tachycardia: misdiagnosis and outcome after emergent therapy. *Ann Intern Med.* 1986;**104**:766-71.
11. **Tchou P, Young P, Mahmud R, Denker S, Jazayeri M, Akhtar M.** Useful clinical criteria for the diagnosis of ventricular tachycardia. *Am J Med.* 1988;**84**:53-6.
12. **Kindwall KE, Brown J, Josephson ME.** Electrocardiographic criteria for ventricular tachycardia in wide complex left bundle branch block morphology tachycardias. *Am J Cardiol.* 1988;**6**:1279-83.
13. **Morady F, Baerman JM, DiCarlo LA Jr, DeButleir M, Krol RB, Wahr DW.** A prevalent misconception regarding wide-complex tachycardias. *JAMA.* 1985;**254**:2790-2.