EDITORIAL

Discrimination of ventricular tachycardia from supraventricular tachycardia in implantable cardioverter defibrillators by automated electrogram morphology analysis: can leads finally replace the electrophysiologist?

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This editorial refers to 'Morphology discrimination in implantable cardioverter-defibrillators: consistency of template match percentage during atrial tachyarrhythmias at different heart rates' by D.A.M.J. Theuns et al., on page 1060 (Volume 10 number 9, September 2008)

Inappropriate device discharges for misclassified supraventricular tachycardia (SVT) may be considered as unavoidable burden within the safety philosophy of implantable cardioverter-defibrillator (ICD) therapy. At least, this seems to be the painful lesson that patients and their caring doctors had to learn during the past decade with ever increasing rates of device implantation for secondary and primary prevention. During this recent period, almost all studies that first hand showed significant survival benefits by the ICD also reported rates of up to 52% of all shock therapies in 10–22% of patients to be inappropriately delivered for SVT, as retrospectively assessed from the stored electrograms.1–3

For a long time, only standard programming features, such as 'rate stability' and 'sudden onset', were available to address this clinical problem. In the late 1990s, dual-chamber ICDs received market approval, and the integrated information from an atrial lead for SVT detection significantly improved the suppression of inappropriate electrotherapy.4 In clinical practice, this was specifically relevant in patients with recurrent slow ventricular tachycardias (VTs) with the need of programming very long detection intervals resulting in a more than three-fold increase of the SVT burden.5 However, overall benefits of dual-chamber vs. single-chamber ICD implantation remain a matter of controversial debate.

Moreover, the dominant arrhythmia inappropriately treated with shocks is fast-conducted atrial fibrillation or flutter, both frequently coexisting arrhythmias in heart failure patients. Unfortunately, in these types of tachycardia, dual-chamber algorithms often loose specificity for SVT discrimination. For instance, in a recent trial comparing adjunctive drug therapy in patients fitted with an appropriately programmed dual-chamber ICD, the incidence of inappropriate shock therapy was 15.4% per year on β-blocker medication alone, compared with 9.4% on sotalol and was further reduced to 3.3% by a combination of amiodarone plus β-blockers during 1 year of follow-up.6 Hence, unless all patients will receive amiodarone from the time of ICD implant onward, there is an urgent need for technological improvement to lower this disturbing and potentially dangerous complication of ICD therapy.

From the technical perspective, it seems a promising concept to analyse the specific electrogram morphology for discrimination of SVT from VT. The advanced computing capability of current ICD microprocessors allows to perform beat-to-beat comparisons of a baseline 'template' acquired during normal (mostly sinus) rhythm with the QRS complex acquired during a rapid rhythm above the detection rate. If the 'match' is within a prespecified range, the rhythm is classified as from supraventricular origin and therapy is with-hold.

Such algorithms have first been studied in single-chamber devices, where therapy for VT was appropriately withheld in >75% of tachycardia episodes. However, further increase of the specificity for SVT could only be achieved at the cost of lowering the sensitivity for true VT and thereby putting the patient at risk of untreated true ventricular arrhythmias.7

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The study population is reflecting the current indications for primary and secondary prophylaxis, and 22% of patients had a history of atrial arrhythmias. The mean follow-up of 34 months covers the time period of most first inappropriate therapy and furthermore allows for the observation of long-term changes that may influence the algorithm performance in the specific heart failure population. As the main finding, there is a consistent high template match during VT, which is independent of the ventricular cycle length within a broad range between 599 and 299 ms. This reassures implanting doctors to activate the algorithm in patients with all types of previously documented or clinically expected tachycardias. Moreover, since most studies on morphology discrimination are limited to single centre observations, it is assuring that the present study independently confirms previous data with regard to calculated sensitivity and specificity of the combined activation of VT discriminators.

A typical feature of studies investigating ICD therapy events is the clustered occurrence of shocks or antitachycardia overdrive pacing in a minority of patients. In the present paper, for example, a total of 1029 electrogram stored episodes in 47 of 88 study patients (53%) were analysed. As evident from the graphic depiction, however, the individual number ranged up to 100 episodes per patient, so that potentially very few patients may have contributed the majority of episodes. In most ICD studies, the general estimating equation method for statistical correction of such non-normal distributed multiple longitudinal events is used for correction, but critical discussion with regard to calculated sensitivity and specificity of the combined activation of VT discriminators.

It should be kept in mind that isolated morphology discrimination, even using the most recently modified technique and with repetitive automatic update of baseline templates, yielded low sensitivity and specificity values of 70.2 and 89.4%, respectively. It remains to be determined if serial testing of morphology matches during atrial pacing—as was meticulously done in the present study—is able to further improve the yet unsatisfying performance of this technique. In clinical practice, morphology discriminatory algorithms in most devices are therefore activated in combination with other enhancement criteria, such as onset, stability, or dual-chamber detection algorithms.

There are several eminent explanations for the limited performance of template comparisons in current ICDs: first, bundle branch block often occurs with higher heart rates compared with the normal heart beat, progressive heart disease or drug effects are well known to change the surface electrogram over time; in addition, alterations of body posture may change the vector in relation to the sensing lead and local activation patterns of different VT origins may result in considerable overlap of VT and SVT morphologies in some patients. For unexperienced doctors it remains a challenge to identify true VT from broad QRS SVT on the surface electrogram. Fortunately, an ICD with a single lead or two leads from atrium and the right ventricle is still not able to replace the expertise of an electrophysiologist.

In conclusion, all our efforts to further reduce unwanted ICD therapy should be made. Individual clinical determination of the intervention rate cut-off values and the deactivation of time-out counters are essential prerequisite. The work by Theuns et al. contributes in our common guidance of doctors in optimized programming of the available devices and clarifies the further ways we still have to go.

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