Atrial fibrillation coexisting with ventricular tachycardia: a challenge for dual chamber defibrillators

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Atrial fibrillation is a very common arrhythmia in patients who need an implantable cardioverter-defibrillator (ICD) because of life threatening ventricular tachyarrhythmias. The prevalence of atrial fibrillation at the time of implantation has been calculated to be as high as 20% and it has been reported that during the lifespan of the ICD more than 50% of patients may develop atrial fibrillation. Atrial fibrillation may lead to inappropriate ventricular shocks, ventricular arrhythmia induction, and thromboembolism after ventricular shocks in the presence of unknown atrial fibrillation. Furthermore, data from the AVID (antiarrhythmic versus implantable defibrillators) registry showed that atrial fibrillation was an independent predictor of worse survival. In our series (151 patients), 20% of patients had atrial fibrillation before implantation and 31% suffered from the first episode during a mean (SD) follow up of 24 (19) months. In fig 1, survival free of atrial fibrillation after ICD implantation in our series may be appreciated.

Dual defibrillator features
The dual defibrillator Medtronic 7250–7276 (Medtronic, Inc, Minneapolis, USA) has been recently introduced to treat simultaneously atrial and ventricular tachycardias. Device features are the same as those available in conventional dual chamber ICD combined with automatic detection of atrial arrhythmias, atrial tachyarrhythmia prevention algorithms, automatic painless atrial antitachycardia pacing treatments, and fully automatic, patient activated, or manual atrial shock.

Dual chamber pacing
Dual chamber rate responsive pacing may prevent atrial fibrillation by improving haemodynamics. Optimisation of atrioventricular delay and the right and left ventricular filling pattern, prevention of consistent retrograde conduction, and normalisation of heart rate rise during exercise may prevent atrial overload and reduce atrial wall stretch. Furthermore, physiological pacing may prevent atrial fibrillation by eliminating bradycardia triggered tachycardias, by reducing the frequency of premature atrial complexes with fewer chances to initiate atrial fibrillation, by avoiding the short-long atrial cycle phenomenon, and by reducing the dispersion of conduction and refractoriness. These mechanisms may have a major role in patients with sinus node dysfunction. In patients with interatrial conduction delay multisite atrial pacing (dual site right atrial pacing and biatrial synchronous pacing) and interatrial septum pacing may increase such antiarrhythmic benefits.

Atrial fibrillation prevention algorithms
New overdrive pacing algorithms have been introduced to add incremental antiarrhythmic benefits to physiological pacing. The consistent atrial pacing algorithm has been designed to achieve a high percentage of atrial pacing as a means to suppress atrial fibrillation. In our own experience the algorithm allowed atrial pacing percentages greater than 95% without significant side effects. Compared with conventional DDR pacing, algorithm activation led to a critical reduction (~80%) of premature atrial complexes. Paroxysmal atrial fibrillation episodes were significantly reduced (~42%) in all patients who during DDR pacing could not reach 90% atrial pacing.

Consistent atrial pacing algorithm benefits may be implemented by activation of the atrial rate stabilisation algorithm, which prevents the short-long cycle phenomenon after premature atrial beats, and the post mode switch overdrive.
algorithm, which induces high rate atrial pacing for some minutes after the end of atrial fibrillation to prevent early recurrence of arrhythmia.

**Dual chamber detection algorithm**

Dual chamber ICD criteria for discrimination between supraventricular and ventricular tachycardias rely on the relation between atrial and ventricular events. This allows increased specificity compared with single chamber ICD criteria, without loss of sensitivity. In our own experience with the “PR logic algorithm”, implemented in the dual chamber ICD Medtronic 7271 and 7250, the analysis of 1242 tachycardia episodes from 49 patients showed a specificity of the algorithm of 90.7% with 100% sensitivity and 97.8% positive predictive value.13 As far as atrial tachyarrhythmia detection was taken into account in the dual defibrillator series,14 the positive predictive value was as high as 97.7%. Inappropriate detection as a result of atrial oversensing was observed in only two patients. The problem was solved by reducing the atrial detection sensitivity.

**Atrial antitachycardia pacing and shock treatments**

The clinical efficacy and reliability of atrial treatments available in the dual defibrillator have been shown in international clinical trials.15–16 Data from the 7250 Italian registry14 related to 863 treated atrial episodes showed that about 50% started as regular atrial tachycardia and were suitable for antitachycardia pacing. In fact, the success rate of antitachycardia pacing treatments in atrial tachycardia (burst+, ramp, and 50 Hz burst) was 71% (234 out of 330). Unexpectedly, a 50 Hz burst showed a mild but valuable effect on atrial fibrillation (74%, 74 of 308). The success rate of atrial antitachycardia pacing progressively increased as far as the device dealt with longer median atrial arrhythmia cycles, mainly when the PP interval was longer than 220 ms. Taking into account that the majority of arrhythmia episodes accelerated within a few minutes, the efficacy of antitachycardia pacing was higher when delivered earlier after the onset of tachycardia.

The effectiveness of atrial shock was as high as 100% in atrial tachycardia (eight of eight) and 80% in atrial fibrillation (86 of 108). The effectiveness of atrial shock was directly related to the ratio between the delivered shock energy and the atrial defibrillation threshold at implantation. For episodes in which this ratio was ≤ 1.5, shock efficacy was only 54%. The success rate increased to 78% when the ratio was between 1.5 and 2.5 and reached 90% for a ratio > 2.5. Patient tolerance was fairly related to the delivered energy and strongly dependent on the number of atrial shocks and on their effectiveness. No ventricular arrhythmia induction was observed after atrial antitachycardia pacing or shock delivery. Early cardioversion of atrial fibrillation may prevent atrial remodelling and may maintain sinus rhythm during long term follow up.

**Conclusions**

Considering (1) that patients with life threatening ventricular tachyarrhythmias have a high incidence of symptomatic atrial fibrillation; (2) that atrial tachyarrhythmias may lead to inappropriate ICD shock delivery and major clinical adverse events; and (3) that dual defibrillators showed very high efficacy and safety in preventing and treating such atrial tachyarrhythmias in clinical evaluation, it is our opinion that all patients who are candidates for implantation of an ICD should receive a device equipped with atrial pacing capability, atrial arrhythmia detection, and treatment by antitachycardia pacing and cardioversion. Wide application of atrial pacing algorithms and painless atrial antitachycardia pacing treatments should be encouraged to reduce the overall burden of atrial fibrillation. Atrial shock should be used taking into account clinical presentation of atrial fibrillation episodes and patient preference. Automatic shock may be the optimal choice for poorly tolerated atrial arrhythmias, while patient activated shock may be selected for patients who prefer to have pain control. In our opinion, this strategy may be cost effective by improving patient quality of life and reducing hospitalisations.