Pacemaker programming and troubleshooting

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PACEMAKER PROGRAMMING

In order that pacemaker patients derive greatest benefit from their therapy, appropriate device programming and follow-up are essential to (1) ensure patient safety, (2) provide physiologic pacing, and (3) maximize device longevity. The person performing device programming should be aware of the patient’s clinical profile (indication for pacing, daily activity, comorbidities, medication, special needs, etc.) in addition to the technical aspects of the device (electrical parameters, diagnostic features, specific algorithms, etc.). The patient and the device should be treated as an entity, and programming should be tailored to the patient’s needs. In a recent multicenter registry from the Netherlands, 14% of pacemakers were left in their factory settings at 6 months’ follow-up, and this proportion is probably higher in many countries. In a large study conducted mainly in Europe, only 41% of pacemakers had programming that was considered to provide physiologic pacing. For instance, unnecessary right ventricular (RV) pacing was not avoided in 38% of patients without atrioventricular (AV) block, despite compelling evidence to do so. Modern premium pacemakers often have automatic programming recommendations based upon different patient profiles, which may be useful for relatively inexperienced personnel. Also algorithms that automatically adjust parameters such as pacing output, sensitivity, or rate response reduce the need for reprogramming.

Many specific programming features and pacing indications are described in detail in other chapters of this book. General programming recommendations are overviewed in the following section.

PACING MODE

Recommendations for pacing mode selection according to device indication and patient profile have been made, both by the US/Canadian (HRS/ACCF) and the European (ESC) cardiological societies. The recommendations are very similar, and a summary of the pacing modes from the 2013 ESC guidelines is shown in Figure 37-1.

**DDDR**

This mode is adapted to patients in sinus rhythm, with either sinus node dysfunction and/or AV block, in order to maintain AV synchrony. Care should be taken to ensure physiologic pacing by managing AV delays (see programming of AV delays later in this chapter).

**DDIR**

This nontracking mode is most often used during automatic Mode Switch due to atrial tachyarrhythmias, in order to avoid rapid ventricular pacing. AV synchrony is lost when AV block occurs with atrial sensed events; however, it is maintained with atrial pacing. The DDDR mode with a long paced AV delay (there is no programmed sensed AV delay) may be considered in patients with sinus node dysfunction who have intrinsic AV conduction if the device does not have specialized algorithms to avoid ventricular pacing, and in order to avoid issues such as endless loop tachycardia (see later section of this chapter), which may occur with tracking modes when a long AV interval is programmed.

**ADI(R)**

This pacing mode, in conjunction with a switch to the DDDR mode, constitutes the basis of several algorithms designed to reduce RV pacing (see Chapter 13). These algorithms are designated by different names: AAIR(R)/DDDR(R) or Managed Ventricular Pacing by Medtronic (Minneapolis, MN), AAIR(R) with VVI backup or RHYTHMIQ by Boston Scientific (Marlborough, MA), AAI Safe R by Sorin (Milan, Italy), and ADI(R)/DDDR(R) mode by Biotronik (Berlin, Germany). The device functions in an ADI(R) mode until blocked P waves occur repeatedly, resulting in a switch to a DDDR mode for a specified duration, followed by an AV conduction check (Fig. 37-2). Algorithms from different companies have slight differences but all allow pauses with long-short sequences to occur. Although they reduce ventricular pacing effectively, it may be better to avoid this algorithm in (1) patients with permanent complete AV block (in whom they are ineffective), (2) patients with symptomatic first degree AV block (Fig. 37-3), (3) pacemaker-dependent patients who do not tolerate slow rates (as dizzy spells may occur during the conduction search tests), and (4) cases with a long QT interval or history of torsades de pointes. Even though these algorithms are safe and well-tolerated by the great majority of patients, there has been concern for ventricular proarrhythmia of the long-short pacing sequences.

**VDD**

Systems with single-pass leads incorporating a floating atrial bipolar are rarely implanted today due to issues with atrial undersensing. Atrial sensing amplitudes of less than 0.5 mV were found in 19.1% of VDD pacemakers compared with 1.6% of DDD pacemakers (P < 0.001) at long-term follow-up, albeit without any significant clinical impact. This mode may be programmed in a dual-chamber device in which the atrial lead has lost capture but maintains adequate atrial sensing.

**VDIR**

This nontracking mode is usually programmed only during atrial tachyarrhythmia Mode Switch episodes.

**AAIR(R)**

Single-chamber atrial pacemakers are very seldom implanted nowadays, especially since the results of the randomized DANPACE trial, which showed a higher incidence of paroxysmal atrial fibrillation and a two-fold increased risk of pacemaker reoperation in patients with sick sinus syndrome randomized to the AAIR versus DDDR pacing. It should only be considered in patients with intact AV or

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