Important Parameters for Implantable Cardioverter Defibrillator Selection

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KEYWORDS

• ICD • Implantable cardioverter defibrillator • Single-chamber • Dual-chamber • DF-1 • DF-4

KEY POINTS

- Several important parameters relating to device characteristics, patient attributes, and comorbidities should be considered when selecting the appropriate implantable cardioverter defibrillator (ICD) for each patient.
- Single-chamber ICDs are appropriate for most primary and secondary prevention patients without a pacing indication.
- The need for atrial or A-V sequential pacing is the only well-established indication for dual-chamber ICD implantation.

INTRODUCTION

The efficacy of implantable cardioverter defibrillators (ICDs) in reducing the risk of sudden cardiac death (SCD) has been well established by several clinical trials in both patients with previous ventricular tachycardia (VT) and fibrillation (VF) (secondary prevention)[1] and those at higher risk of developing such arrhythmias (primary prevention).[2–5]

However, there are several important parameters that should be considered when selecting the appropriate ICD for each patient. This review aims to examine some of these issues. Other articles in this issue will specifically address the issues surrounding the choice between transvenous and subcutaneous ICDs (S-ICD), and between single- and dual-coil leads.

SINGLE- VERSUS DUAL-CHAMBER IMPLANTABLE CARDIOVERTER DEFIBRILLATOR

The single-chamber ICD has a single lead in the right ventricle (RV). The dual-chamber ICD has a lead in the right atrium in addition to the lead in the RV. These devices are able to deliver antitachycardia pacing (ATP) as well as a high-energy electrical shock for the treatment of VT and VF. In addition, ICDs can also deliver pacing to treat bradycardia if needed. Most of the randomized controlled trials that established the efficacy of ICDs for primary and secondary prevention of SCD used single-chamber ICDs.[6]

In addition to atrial or A-V sequential pacing capability, the dual-chamber ICD has the additional potential advantages of providing enhanced

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arrhythmia discrimination, monitoring for atrial arrhythmias, and delivering atrial ATP to treat such arrhythmias. There also are potential drawbacks to dual-chamber ICDs, including increased device-related complications, increased RV pacing, and increased cost.

Arrhythmia Discrimination

Because ICDs determine the need to deliver therapy (ATP and/or shocks) largely by the rate or cycle length of the tachycardia, a single-chamber ICD can have difficulty differentiating between VT and supraventricular tachycardia (SVT) based solely on rate. During ventricular arrhythmias (VA), the ventricular rate is often faster than the atrial rate, whereas, during some SVTs, the atrial rate is faster than the ventricular rate. Therefore, because the ICD is able to sense the atrial electrogram, 1 potential advantage of the dual-chamber ICD over the single-chamber device is enhanced arrhythmia discrimination (beyond the available single-chamber rhythm discriminators) and a reduction in inappropriate shocks.

Several randomized controlled trials have sought to determine if dual-chamber ICDs improve arrhythmia discrimination. Several trials that included predominantly a secondary prevention population conducted in the 1990s to early 2000s did not demonstrate a difference in the number of SVTs misclassified as VT, inappropriate ICD therapies, or in mortality and arrhythmogenic morbidity.[7–9] Limitations of these trials include relatively small sample sizes (each with N $\leq$100) and noncontemporary device programming.

Subsequent studies in predominantly secondary prevention patients without a pacing indication suggested some benefits of dual-chamber ICDs. The Detect Supraventricular Tachycardia Study randomly assigned 400 participants who received a dual-chamber ICD (75% secondary prevention) to a single- or dual-chamber detection algorithm. This study used more contemporary rhythm discrimination algorithms, including morphologic criteria. However, the investigators used a VT detection rate no faster than 150 bpm, which is very low compared with current practice. This study demonstrated significant reduction in the number of SVT episodes inappropriately classified as VT in the dual-chamber arm (30.9%) compared with the single-chamber detection arm (39.5%) with an odds ratio (OR) of inappropriate detection of 0.53 (P = .03). The odds of inappropriate therapy delivery (ATP or shock) were also decreased by 46% (P = .02).[10] However, no difference in the number of arrhythmia-related hospitalizations or additional clinic visits was seen.

The Dual chamber and Atrial Tachyarrhythmias Adverse events Study (DATAS) trial randomized 334 participants with an ICD indication (88% secondary prevention) to dual-chamber ICDs, single-chamber ICDs, or dual-chamber ICDs programmed as a single-chamber ICD. This study showed 33% lower composite score rate of clinically significant adverse events (all-cause mortality, invasive intervention due to cardiovascular causes, hospitalizations >24 hours for cardiovascular causes, 2 or more episodes of inappropriate shocks, and sustained symptomatic atrial tachyarrhythmias lasting >48 hours) in the dual-chamber ICD group.[11] This study is limited by nonstandardized device programming and the use of combined outcome.

The 2 most recent studies focused on primary prevention patients and reported conflicting results. The Optimal Anti-Tachycardia Therapy in Implantable Cardioverter-Defibrillator Patients Without Pacing Indications (OPTION) trial randomized 453 participants with an ICD indication (75% primary prevention) who received a dual-chamber ICD to dual-chamber or single-chamber device programming. The devices in both groups were programmed with lower VT detection rate of 170/min. The single-chamber programming group used onset, stability, and long cycle search discrimination criteria (but no morphologic criteria), whereas the dual-chamber group used a proprietary dual-chamber rhythm discrimination algorithm that included ventricular rate stability, rate-onset analysis, atrioventricular association analysis, long cycle search, and determination of the chamber of origin in the case of 1:1 tachycardia. Of note, the investigators did not specify the duration that was required to diagnose an arrhythmia episode. This study demonstrated a significantly longer time to first inappropriate shock in the dual-chamber ICD group compared with the single-chamber ICD group. At the end of 27-month study period, 10 patients in the dual-chamber setting group (4.3%) and 23 patients in the single-chamber setting group (10.3%) received at least 1 inappropriate shock (P = .015). Based on these results, the number of patients needed to treat with a dual-chamber ICD to prevent 1 patient from experiencing an inappropriate shock was 17.[12] The rate of death or cardiovascular hospitalization remained similar in both groups in this study.

The Reduction And Prevention of Tachyarrhythmias and Shocks Using Reduced Ventricular Pacing with Atrial Algorithms Study (the RAPTURE Study) randomized 100 participants receiving primary prevention ICD to dual-chamber or single-chamber devices. The devices in both groups