Defibrillation threshold testing at implantation: can we predict the patient with a high defibrillation threshold?

Dominic A.M.J. Theuns¹* and Michael R. Gold²

¹Department of Cardiology, Erasmus MC, Rotterdam, The Netherlands; and ²Medical University of South Carolina, Charleston, SC, USA

Received 27 December 2009; accepted after revision 2 January 2010; online publish-ahead-of-print 29 January 2010

This editorial refers to ‘Does defibrillation threshold increase as left ventricular ejection fraction decreases?’ by J.E. Val-Mejias and A. Oza, on page 385.

Defibrillation threshold (DFT) testing is an integral part of implantable cardioverter-defibrillator (ICD) implantation. The primary functions of defibrillation assessment are to confirm appropriate sensing of ventricular fibrillation and to establish an adequate safety margin for defibrillation. However, recent publications question the necessity of DFT testing during implantation, quoting the effectiveness of the current generation of devices and the rate of complications associated with testing.¹–³ The recently published Canadian experience of 19,067 ICD implantations revealed eight serious testing-related complications (three deaths and five strokes), indicating an incidence of 0.042%.⁴ Accordingly, the risk of severe testing-related complications appears to be negligible.

Over the years, defibrillator and lead technology has advanced. Current ICD systems use one or two intracavitary defibrillation coils, biphasic waveforms, and active can technology. These systems provide a mean DFT of 8–10 J with the maximum output of current devices typically 35–40 J. Thus, the remaining question is: do we still encounter patients with a ‘high DFT’ with the current generation of devices? Traditionally, a DFT is considered high when the difference between the maximum output of a device and the lowest effective energy level is <10 J. In recently published literature, the lack of achieving a 100% safety margin or a DFT value >15 J is used as the definition of high DFT. The reported incidence of cases with a high DFT (<10 J safety margin) is ~6%.⁵

Patients with a high DFT pose a challenge, especially those who cannot be defibrillated with the maximum output of the implanted system. In addition, ~15% of the patients will experience an increase of at least 10 J of DFT within 2 years after device implantation,⁶ although this percentage may be lower with modern waveforms and dual-coil lead systems.⁷,⁸ Identification of patients who may have a high DFT is important to manage these patients. Many studies were performed previously with a variety of waveforms and lead systems to identify predictors of a high DFT. Hodgson et al.⁹ evaluated 34 parameters, including demographic and clinical features, as possible predictors of DFT. In this study, no clinical parameter correlated strongly with the DFT, which suggests that it is not feasible to predict which patient may have a high DFT. A review of 1139 patient records revealed that amiodarone use was associated with an increased risk for system modification due to a high DFT compared with patients not taking amiodarone (hazards ratio, 3.35; 95% confidence interval, 1.96–5.73). In the same study, lower left ventricular ejection fraction (LVEF) had a borderline predictive value for high DFT. The association between left ventricular function and failure of defibrillation was examined in the Post Implant Testing Study (PITS). As systolic function declined, there was a trend to a higher failure rate, which was not statistically significant.¹⁰ Other studies suggest that left ventricular mass or volumes are more predictive than EF to predict DFTs.¹¹,¹² However, as the clinical parameter, left ventricular mass accounted only for <5% of the variability of DFT measured.⁹

The study by Val-Mejias and Oza¹³ provides data on the association between left ventricular function and success of defibrillation. These investigators analysed data from three different multicentre, prospective, randomized studies, which enrolled a total of 230 patients. The clinical characteristics of this cohort were typical of the current population of patients receiving ICDs, although echocardiographic and body size parameters which were predictive in other studies of DFTs were not assessed. The mean DFT ranged from 7.5 J (LVEF ≥ 46%) to 8.6 J (LVEF ≤ 25%); the association between lower LVEF and higher DFT was not statistically significant. Only seven patients (3%) had a high DFT (defined as >20 J), including three patients (1%) with <10 J safety margin. All patients with high DFT had LVEF ≤ 35%. With respect to LVEF, 185 of the 192 patients...
(96%) with LVEF ≤ 35% had DFT < 20 J, and 98% of the patients with LVEF ≤ 35% had > 10 J safety margin.

In summary, the article by Val-Mejias and Oza demonstrates that changes in DFT are minimal across a broad range of LVEF. In addition, patients with depressed left ventricular function (LVEF ≤ 35%) will not necessarily have a high DFT. This once again confirms our difficulty to a priori clinically identify patients who will be difficult to defibrillate.

Conflict of interest: D.A.M.J.T. has received research grants from Biotronik, Boston Scientific, and St. Jude Medical, and is a consultant for Cameron Health. M.R.G. is a consultant to Boston Scientific and Medtronic, conducts research sponsored by Boston Scientific, Cameron Health, Medtronic, and St. Jude Medical, and receives honoraria from Boston Scientific, Biotronik, Medtronic, St. Jude and Sorin.

References