Recurrent failure of internal defibrillation despite the addition of a subcutaneous array

Benedict M Wiles, Paul R Roberts, Arthur M Yue

University Hospital Southampton NHS Foundation Trust, Southampton, UK

Abstract

A gentleman with idiopathic dilated cardiomyopathy and severe left ventricular systolic dysfunction presented with high defibrillation threshold (DFT) after implantation of a dual coil implantable cardioverter defibrillator (ICD). Despite the addition of a subcutaneous array he subsequently presented with failed shock therapies. Resistance to internal defibrillation was postulated and an alternative strategy adopted; namely a subcutaneous ICD. DFT testing of the subcutaneous ICD was successful on two occasions at maximum output, but a defibrillation safety margin could not be demonstrated. We therefore present a highly challenging case of high DFT, where despite multiple defibrillator configurations a degree of uncertainty persists.

Case

We present a 60 year old gentleman with idiopathic dilated cardiomyopathy, severe left ventricular systolic dysfunction (EF 0.25), permanent atrial fibrillation and normal QRS duration (120ms). A primary prevention implantable cardioverter defibrillator (ICD) was inserted (model DVMB2D4, Medtronic Inc., MN, USA) with a dual coil right ventricular lead (model 6947M, Medtronic Inc., MN, USA). Normal lead parameters were achieved. Defibrillation threshold (DFT) testing was undertaken with successful induction of ventricular fibrillation (VF) but repeated failure of shock therapy. In total six internal therapies were delivered including maximum output (35J) shocks from two different shock vectors with two different right ventricular (RV) lead positions. Fortunately VF was consistently terminated with external defibrillation.

Device revision was undertaken with implantation of a subcutaneous array (model 6996SQ, Medtronic Inc., MN, USA) and high voltage splitter adaptor (model 5019, Medtronic Inc., MN, USA). DFT testing was repeated. Induced VF persisted after both 25J and 35J shocks delivered RV to array, but was terminated by a 25J shock (10J safety margin) delivered RV to can and array. The device was therefore programmed to deliver 35J shocks in this configuration and the patient discharged.

Eighteen months later the patient presented with VF. Device interrogation revealed that nine appropriate shocks had been delivered, with failure of defibrillation on eight occasions. During resuscitation an automated external defibrillator had been successful in converting VF to atrial fibrillation on the single occasion it was used. A full neurological recovery ensued and no reversible precipitant for VF was identified. All measured lead parameters remained within the normal range.

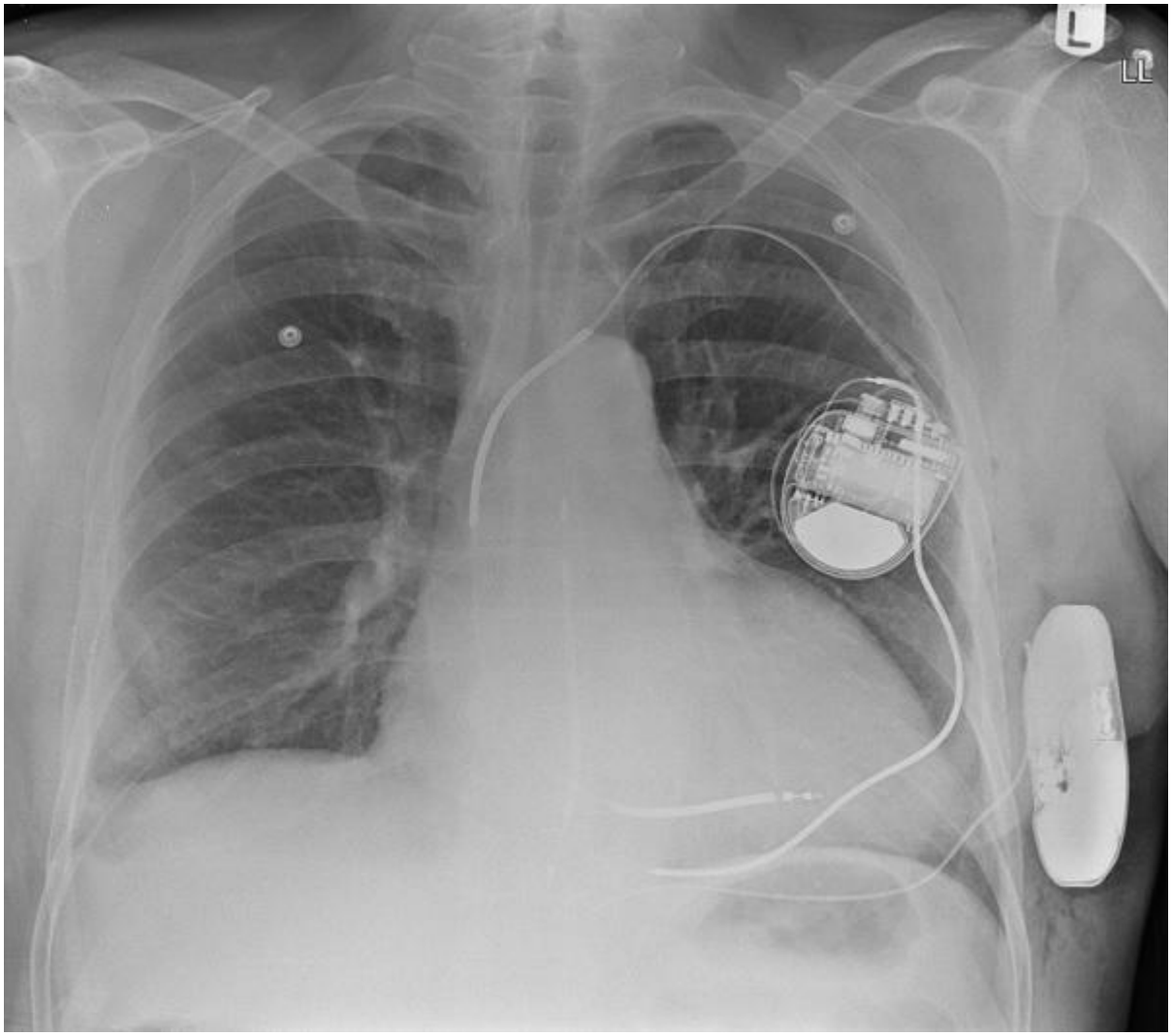
Ongoing management of this patient presented a significant challenge. High DFTs occur in around 2.3% of patients undergoing ICD implantation.[1] However the addition of a subcutaneous array has been demonstrated to reliably correct this problem in the majority of cases and failure of shock therapy despite the addition of a subcutaneous array is rarely encountered.[1] Sotalol therapy was commenced, and increased to a total dose of 160mg daily, due to its favourable impact on lowering DFT. However we did not feel this modification alone would adequately reduce the DFT or justify the risks of further testing, given the relatively small decrease in DFT associated with sotalol therapy[2] Consideration was given to introducing an azygos vein coil, as this has previously been demonstrated to reduce DFT in combination with a subcutaneous array.[3] However we felt that an entirely different strategy was required.

It was noted that despite apparent resistance to internal defibrillation, high voltage external defibrillation had always been successful. We postulated therefore that a subcutaneous ICD (S-ICD), capable of delivering higher energy therapies from a subcutaneous location akin to that obtained by external defibrillator pads, would provide the most reliable long term reduction in sudden cardiac death. An S-ICD (device model A209, lead model 3401; Boston Scientific Limited, MA, USA) was therefore implanted. DFT testing was undertaken with two VF inductions. Repeated success at maximum output (80J) was achieved however we were unable to demonstrate a defibrillation safety margin as a 65J shock failed to terminate VF.

There is a probabilistic mechanism to DFT testing due to the unpredictable interplay of several variables (myocardial depolarisation, myocardial ischaemia, autonomic tone, electrolyte concentration).[4] Success or failure at a given energy threshold does not guarantee future performance, although repeated success at a given energy threshold does increase the probability of future success. Failure of defibrillation threshold testing in the subcutaneous ICD is also rare. In the combined IDE and EFFORTLESS registries only one case of DFT failure was observed, whereby maximum output testing failed to reliably terminate VF.[5] The efficacy of an S-ICD system which has successfully treated VF with maximum output therapy on two occasions, but failed at 65J is currently unknown. Further DFT testing in this gentleman would not be without significant risk and clinical failure of his transvenous system had already been demonstrated.

The implanted S-ICD was therefore programmed to deliver maximum output shocks, whilst the transvenous system retained but with therapies deactivated. [Figure] Twenty four months since S-ICD implantation our patient has experienced no further ventricular dysrhythmias to challenge his new device configuration.

Figure: PA chest radiograph demonstrating the transvenous ICD, subcutaneous array and subcutaneous ICD in situ.



Conflict of interest:

Dr Benedict Wiles receives a Fellowship grant from Boston Scientific. Dr Paul R Roberts receives consultancy and advisory board payments from both Medtronic and Boston Scientific. Dr Arthur Yue has no conflicts of interest to declare.

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