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ORIGINAL ARTICLE

A Comparison of Right Ventricular Non-apical Defibrillator Lead Position with Traditional Right Ventricular Apical Position: A Single Centre Experience

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Background Implantable cardioverter defibrillator (ICD) leads have traditionally been placed at the right ventricular apex (RVA). An important minority of patients with an ICD may develop a future requirement for bradycardia support. Pacing from the RVA may be detrimental, promoting heart failure and mortality. Increasingly non-apical right ventricular (RVNA) lead positions have been suggested as an alternative pacing site.

Methods A retrospective review of 512 patients who received an ICD at our institution between 1999 and 2011 was conducted. A comparison of lead performance characteristics was performed between RVNA sites and those at RVA. Data were collated from chart review and the pacing database.

Results The mean follow-up period in the RVNA cohort was 40.4 ± 25.9 months and in the RVA cohort it was 38 ± 31.8 months (p = 0.43). The RVNA cohort consisted of 144 leads and 368 leads in the RVA cohort. The groups had similar baseline clinical characteristics. No significant difference was detected in the proportion of patients receiving an appropriate ICD defibrillation (RVNA 10.4% vs. RVA 16.8%; p = 0.07), inappropriate defibrillation (RVNA 7.6% vs. RVA 7.6%; p = 0.99) or an unsuccessful defibrillation (RVNA 0% vs. RVA 1.7%; p = 0.12). There was also no significant difference in the proportion of patients receiving successful anti-tachycardia pacing (ATP) (RVNA 13.2% vs. RVA 17.4%; p = 0.49) or failed ATP (RVNA 2.7% vs. RVA 4.1%; p = 0.25). There was no significant difference in lead impedance (p = 0.99), sensing (p = 0.59) and pacing threshold (p = 0.34).

Conclusion In this large retrospective study, RVNA ICD lead had similar stability and therapy efficacy compared to the traditional RVA position. This potentially has important implications for the suitability of RVNA as an alternative site for ICD leads.

Keywords Right ventricular pacing • Right ventricular non-apical pacing • Implantable cardioverter defibrillator • Defibrillation • Anti-tachycardia pacing

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Introduction

Implantable cardioverter defibrillators (ICDs) have demonstrated mortality benefits in both primary and secondary prevention of sudden cardiac death [1,2]. Traditionally leads have been positioned in the right ventricular apex (RVA), a location thought to provide the best defibrillation threshold and lead stability [3,4]. In some cases ventricular pacing may be required over time. Pacing from this location has been associated with adverse left ventricular remodelling [5], increased incidence of atrial fibrillation, congestive cardiac failure [6,7] and an increase in mortality [7]. The DAVID study demonstrated a worse outcome in those patients paced frequently at the RVA in whom baseline left ventricular function was significantly reduced [7], a factor common to the majority of patients receiving an ICD.

Alternative site pacing has been proposed to potentially avoid the deleterious structural and haemodynamic effects on left ventricular function. A number of sites have been investigated including the right ventricular outflow tract (RVOT) and the mid or low septum. It is believed that septal pacing may provide a more physiological activation of the left ventricle [8]. Overall these studies have shown a variable effect on left ventricular function although a recent meta-analysis has suggested a beneficial effect with non-apical pacing [9]. There are currently two large multicentre international studies underway which may provide additional confirmation as to whether non-apical pacing protects left ventricular systolic function [10]. Over time many patients with ICDs may require pacing due to a combination of disease progression, the effect of adjunctive drug therapy and the development of sinus and atrioventricular node disease. Previous studies have demonstrated that ICD leads placed in the RVNA have similar defibrillation thresholds [11–13] and long-term stability and performance as leads placed in the RV apex [13,14].

Accordingly, we performed a retrospective review over a 12-year period between 1999 and 2011 in patients receiving an ICD for primary and secondary prevention at our institution to demonstrate similar efficacy of delivered ICD therapy and lead performance between the two different lead positions (RVA vs. RVNA).

Methods

A retrospective analysis, between 1999 and 2011 was conducted at the Princess Alexandra Hospital in Brisbane, Australia, of 512 consecutive patients with an ICD implanted for primary and secondary prevention indications in accordance with recognised guidelines [15]. ICD generators and defibrillator/pacing leads from Guidant (Boston Scientific Inc., Natick, MA, USA), Medtronic (Medtronic Inc., Minneapolis, MN, USA) and St Jude Medical (St. Jude Medical Inc., St Paul, MN, USA) were employed. Data were collected from review of the medical records and a local pacing database (Paceart, Medtronic Inc, Minneapolis MN, USA). The study was performed in accordance with the ethical standards of the Princess Alexandra Hospital, Brisbane, Australia.

The ICD lead was placed either in the RVNA or the RVA as determined by operator preference at the time of implant. Standard venous access techniques were used. Active fixation leads were used in all cases. ICD positioned in the RVNA were placed using fluoroscopy with the lead deemed to be in a satisfactory position if the tip was pointing superiorly approximately to the left shoulder position in the antero-posterior (AP) view. No attempt was made to define the final lead position as either septal or anterior in the right ventricle. Defibrillation testing was performed in all patients with 10 joule safety margin.

Post implant the device was interrogated the following morning and a chest X-ray (AP and lateral views) was performed. Wound review occurred at one week and device interrogation at four to six weeks and subsequently at six-monthly intervals. The interval check was shortened to three months as the device reached elective replacement intervals. Patients were instructed to return immediately for device interrogation should they experience a therapy.

Successful arrhythmia termination was defined as either ATP or an intra-cardiac shock terminated the arrhythmia. A shock was deemed inappropriate if the intra-cardiac electrograms (IEGMs) either confirmed an atrial arrhythmia or fibrillation [16,17] or, in the case of single ventricular lead system, where the ventricular rate was deemed irregular and there was no associated presyncope or syncope documented in the charts. ICD shocks and anti-tachycardia pacing was recorded and classified as appropriate or inappropriate by the electrophysiologist performing follow-up.

The following data were collected: patient demographics, left ventricular function by standard transthoracic 2D echocardiography, New York Heart Association (NYHA) functional class, medication, device indication, diabetes mellitus and the presence of an ischaemic or non-ischaemic cardiomyopathy.

Lead performance was measured by a change in pacing impedance of more than 30% from baseline. A change in pacing impedance of more than 30% has previously been demonstrated in pacemaker leads as having 90% specificity and 36% sensitivity for the detection of lead failure [18]. A similar parameter was arbitrarily set for lead sensing. An increase in pacing threshold more than three times from initial threshold or greater than 3 mV was defined as unstable. The baseline impedance, sensing and pacing threshold were taken at the first post-implant interrogation which occurred within four weeks post-implant.

Statistics

Data are presented as mean value ± standard deviation unless otherwise stated. Data analysis was performed using standard statistical software (SPSS, version 2.03, Chicago, Illinois). Comparison of within group continuous normally