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ORIGINAL ARTICLE

A South Australian Registry of Biphasic Cardioversions of Atrial Arrhythmias: Efficacy and Predictors of Success

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Background Restoration of sinus rhythm by biphasic cardioversion is an established strategy for patients in atrial arrhythmias. This study aimed to investigate the real-life practice of cardioversions throughout a local hospital to determine frequency and predictors of success and use of high energy (> 200 joules).

Methods Prospective analysis of consecutive biphasic cardioversions from 2009-2013. Patient demographics, medical history and cardioversion data were collected.

Results 484 cardioversions from 379 patients were included in the final analysis. The majority (73%) of cardioversions were immediately successful after a single shock; overall success was 88% (1-5 shocks). Exploratory analyses revealed that single-shock success was significantly associated with lighter weight (OR 1.19, 95% CI 1.0-1.4, $p<0.05$). If a second shock was required, energy escalation was significantly associated with success (OR 3.11, 95% CI 1.43-6.77, $p<0.05$). Increasing weight was the strongest predictor of receiving high energy (10 kg increase OR 1.43, 95% CI 1.13-1.81, $p<0.05$).

Conclusions This prospective analysis reflects the real-life heterogeneous practice of biphasic cardioversions of atrial arrhythmias throughout a local hospital. These findings highlight the importance of first shock energy selection with careful consideration of patient weight. We emphasise the recommendation to escalate energy, highlighting the need for high-energy defibrillators in 'hard-to-cardiovert' patients.

Keywords Atrial fibrillation • Atrial flutter • Tachyarrhythmia • Cardioversion • Body Weight • Treatment efficacy

Introduction

Biphasic cardioversion is a well-established rhythm-control strategy for patients in atrial arrhythmias. A successful cardioversion performed with the least amount of shocks and energy is preferable in reducing the duration and complications of the procedure. There are current recommendations to guide therapy with regards to cardioversion energy selection and pad position [1–5]. However, evidence is limited, particularly in a real-life setting, to determine predictors of success that could increase efficacy of therapy.

There is increasing evidence that high-energy defibrillators capable of escalating to 360 joules (J) are advantageous in

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clinical practice. High-energy shocks using a biphasic truncated exponential waveform have been required to successfully cardiovert patients in atrial fibrillation who failed cardioversion with an energy-limited (200 joule maximum) rectilinear biphasic waveform [6,7]. Body weight and associated high impedance are important factors that may necessitate the use of higher energies [4]. Thus far only one study has suggested titration of therapy for atrial fibrillation patients depending on their weight [8]; data for patients in atrial flutter and tachycardia are lacking.

Many of the studies investigating biphasic cardioversions of atrial arrhythmias have either described cardioversions performed in a single location, or in patients with similar presentations of arrhythmia. To date, no studies have described the practice of cardioversions throughout a general hospital setting in all its complexity. Therefore, this study will provide the first description of real-world cardioversions performed throughout a single hospital centre. Outcomes such as cardioversion efficacy, predictors of efficacy, frequency and predictors of high-energy cardioversions will be described.

Methods

This prospective analysis investigated all electrical cardioversions of atrial fibrillation, flutter and tachycardia in a single hospital setting from 2009-2013. Electrical cardioversions of ventricular tachycardias were excluded from the study.

Data Collection

The details of each cardioversion conducted in the cardiology unit were recorded prospectively. Relevant variables such as patient age, weight, defibrillator type, pad position, energy selection, and outcome was documented and stored in the patient's medical file. The hospital's database was then cross-checked for all electrical cardioversions using discharge coding. The data from the report form as well as other relevant information was collected and missing information was sourced from the patient notes. In cases of cardioversion outside the cardiology unit, cardioversion information was recorded from the patient notes. Patient height could not be accurately and consistently obtained from the notes. A successful single shock or multi-shock cardioversion was defined as the maintenance of sinus rhythm at discharge as documented in patient files. The local ethics committee deemed that ethical review was not required because the methodology of this study was solely observational.

Devices

Biphasic devices used in the hospital included Zoll M Series and ZollPropaq MD (Zoll Medical Corporation, Massachusetts, USA), RB waveforms, both limited to 200J. Medtronic's Physio-Control Lifepak 20e (Physio-control Inc., Washington, USA), BTE waveform, capable of escalating to 360J was only available for cardioversions within the cardiology department.

Statistical Analysis

Continuous variables are presented as median and interquartile range (IQR), and discrete variables as frequency and percentage. Univariate predictors of outcome variables were determined using generalised estimating equations (GEE) analysis with an independence working correlation structure. Baseline variables with a p-value <0.25 and sufficient clinical rationale for selection were entered into exploratory multivariate GEE for analysis of predictors of first shock success and high-energy use. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated and a probability value of <0.05 was considered statistically significant. A power calculation was not performed because this was an exploratory observational study only. All statistical analyses were performed using SPSS Statistics 18, Release Version 18.0.3 (SPSS Inc., 2010, Chicago).

Results

Between 2009 and 2013 a total of 561 cardioversions were identified using hospital discharge coding. Seventy-seven cardioversions were excluded from analysis on the basis of inadequate information, incorrect coding, or cardioversions of ventricular arrhythmias. In total, 484 consecutive records of cardioversions of atrial arrhythmias were obtained from 379 individual patients (Table 1).

Cardioversions for an initial rhythm of atrial fibrillation comprised 76% records compared to 24% for atrial flutter and atrial tachycardia (Table 2). Medtronic devices were documented for 252 (52%) cardioversions and 225 (46%) records did not have the defibrillator type documented, thus device-specific analyses were not performed.

Table 1 Patient Characteristics (n=379).

	%, median [interquartile range]
Age	65 [56–73]
Male gender	68%
Weight (kg) (n=362)	91 [80–106]
Previous cardioversion (n=321)	19%
> 1 episode during 2009-2013	19%
Hypertension	63%
Permanent pacemaker / automatic internal cardiac defibrillator (n=221)	5%
Ablation (n=221)	5%
Ischaemic heart disease (n=220)	28%
Heart failure (n=220)	23%
Mitral regurgitation (n=220)	5%
Valve disease (n=220)	6%
Diabetes	25%
Asthma / chronic obstructive airway disease (n=378)	30%
Obstructive sleep apnoea (n=221)	18%