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Research Article

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Predictors of Left Atrial Thrombus and Short-Term Recurrence of Arrhythmia in Patients Undergoing Electrical Cardioversion for Atrial Fibrillation, a Single-Centre Experience

Callan Gavaghan*

The Gold Coast University Hospital, Hospital Boulevard Southport 4215, Australia.

***Corresponding author**
Callan Gavaghan, The Gold Coast University Hospital, Hospital Boulevard, G2-16/154 Musgrave Avenue Southport QLD, 4215 Australia, Tel: +61431665288; E-mail: cbgavaghan@hotmail.com

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Abstract

Background: *Systemic thromboembolism is a serious complication of electrical cardioversion. Even in the absence of such complications there exists a significant rate of arrhythmia recurrence post cardioversion.*

Aims: *The aim of this study was to identify factors that may aid clinicians in identifying those patients at increased risk of atrial thrombus formation and short-term arrhythmia recurrence.*

Methods: *One-hundred and twelve patients were retrospectively identified across a 2.5 year period as having undergone electrical cardioversion at the Gold Coast University Hospital for atrial fibrillation or atrial flutter. Demographic, clinical and echocardiogram data was analysed to identify potential predictors of thrombus, unsuccessful cardioversion and arrhythmia recurrence.*

Results: *Cardioversion was successful in 87.6% of patients. Cardioversion was more successful initially in males ($p<0.01$) and those with reduced atrial volume ($p<0.01$) and higher left ventricular ejection fraction ($p<0.01$).*

Arrhythmia recurrence within 3 months occurred in 57.7% of patients. Recurrence was more likely in those with congestive heart failure ($p<0.05$) and a longer pre-cardioversion duration of arrhythmia ($p<0.05$).

Spontaneous echo contrast was observed in 3 (2.6%) of patients, whilst left atrial thrombus was observed in 7 (6.2%) of patients. Potential predictors of thrombus were congestive heart failure ($p<0.05$) and increased left atrial volume ($p<0.01$).

Conclusions: *This retrospective study identified a number of factors that may useful in the clinical setting in predicting cardioversion success, both initially and short-term, in addition to predicting thrombus formation.*

Keywords: Cardioversion, Thrombus, Atrial fibrillation, TOE, Echo.

Introduction

Atrial fibrillation (AF) is the most commonly identified arrhythmia in clinical practice and it is associated with significant morbidity and mortality [1]. Up to 15% of all ischaemic strokes can be attributed to underlying AF [2]. Direct-current cardioversion (DCCV) is a procedure that is performed with the goal of improving cardiovascular function and preventing thromboembolism [3]. However, there exists a significant risk of systemic thromboembolism, in up to 7% of patients, post DCCV [4-7]. This risk is reduced, but not removed entirely, by anticoagulating patients for approximately 3-4 weeks prior to DCCV [5-8]. Historically this was achieved using Warfarin, but newer oral anticoagulants, in particular Rivaroxaban, are now often used for this purpose [9]. Studies have suggested that despite adequate anticoagulation left atrial thrombus (LAT) and spontaneous echo contrast (SEC) may persist in 2-12% of patients [10-13].

Trans-oesophageal echocardiography (TOE) is routinely used prior to DCCV to exclude the presence of LAT, left atrial appendage thrombus (LAAT), sludge and SEC [14]. The ability to detect these factors is significant as they are all associated with an increased risk of embolic stroke post DCCV [15]. Studies such as the ACUTE trial, have suggested that TOE-guided cardioversion may be as effective as conventional anticoagulation in preventing embolic events post DCCV [16].

The risk of ischaemic stroke in AF ranges widely depending on the use of anticoagulation, co morbid conditions and previous stroke history [17,18]. The CHADS2 and CHA2DS2-VASc scores are simple scoring systems that can be used to categorise a patient's risk of an ischaemic event secondary to atrial fibrillation. Recent

studies have demonstrated that there may be a role for this scoring system in predicting the presence of spontaneous echo contrast (SEC) or thrombus on a pre-DCCV TOE [19,20].

Kleemann, *et al*. noted, however, that the CHA2DS2-VASc score does not incorporate echocardiographic findings and have attempted to use these measurements as a tool for assessing the risk of embolic events post cardioversion. Recent studies have published findings indicating that there may be several clinical and echocardiographic factors associated with the presence of thrombus, such as increased left atrial diameter, heart failure, duration of AF, and reduced left ventricular ejection fraction (LVEF) [12,21-23].

In addition to considering the risks of DCCV for AF, it is worth noting the success rates and clinical benefit achieved using this procedure. Documented long-term success rates post DCCV, where success is defined as maintaining a sinus rhythm, vary from 34-60%. Several studies have attempted to identify potential predictors of successful DCCV, such as the absence of congestive heart failure, short duration of AF prior, or lower left atrial volume. Identifying these potential predictive factors is of clinical importance as they may be used to guide a physician's decision making in the management of patients in AF [24-31].

This present study will build on current knowledge by focusing on data collected from patients undergoing elective DCCV for AF or atrial flutter (AFL) over a 2.5-year period within a single centre. We will be assessing the data to identify the patient variables that are predictive of thrombus. We will also be discussing the factors that are predictive of cardioversion success, both initially and at follow-up. Further clarifying these factors may of use in dictating the appropriateness of performing DCCV for AF and AFL in certain patient populations.

Material and methods

Patient Population

We retrospectively identified 112 consecutive patients (75% male) as having attended for TOE-guided DCCV for AF or AFL at the Gold Coast University Hospital, and its predecessor the Gold Coast Hospital, between January 2013 and July 2015. In total 107 TOE-guided DCCVs were performed during this period. Three patients did not undergo DCCV due to persistent LAT on TOE and a further 2 patients self-reverted after having their DCCV postponed due to LAT seen on initial TOE.

Data Collection

A database of all patients who were booked for TOE-guided DCCV was compiled and medical records and imaging databases were retrospectively reviewed. There was a particular focus on obtaining data relevant to predicting LAAT/SEC and DCCV success, in addition to collecting information regarding procedural and post-procedural complications. Demographic data, patient co-morbidities, transthoracic echocardiogram (TTE) and TOE parameters, data pertaining to previous DCCV and success of DCCV were collated. The CHA2DS2-VASc score was calculated for each patient based on data pertaining to presence of heart failure, hypertension, patient age, diabetes, sex, previous stroke and vascular disease. Maintenance of sinus rhythm post DCCV was assessed via outpatient notes and correlated with follow-up ECGs in the medical record. Without continuous cardiac monitoring it would be difficult to rule out the return of paroxysmal AF post DCCV. It was assumed in this study that if a patient remained asymptomatic post DCCV, and had sinus rhythm at followup, that they had not reverted to AF.

Post-procedural complications such as thromboembolism were also noted by assessing medical records.

Definitions

Cardioversion success was defined as an immediate return to sinus rhythm after DCCV. Long-term cardioversion success was defined as maintenance of sinus rhythm more than 3 months after DCCV. Failed cardioversion refers to patients who either did not revert to sinus rhythm at any time or those who returned to AF or AFL within several minutes of DCCV. LAAT and LAT were defined, as per Wazni *et al*. and Grewal *et al*., as a circumscribed and uniformly dense mass, distinct from the left atrium and left atrial appendage endocardium, that is present in more than 1 imaging plane [32,33]. SEC was defined as smoke-like echoes with a clear swirling pattern. In this study the findings of SEC, LAAT or LAT are summated under the term 'thrombus'. Excess alcohol consumption was defined as the consumption of more than 2 standard drinks per day, in keeping with Australian NHMRC guidelines [34].

Echocardiography

All echocardiographic examinations were performed at GCH or GCUH. All patients had a TOE examination assessing for presence of thrombus prior to DCCV. Ninety-percent (n=100) of patients also had a TTE in the 4 weeks prior to DCCV. Measurements of ejection fraction and atrial volume were noted at that time.

Procedure Description

All patients received a minimum of 3 weeks anticoagulation pre-TOE with warfarin, apixaban or rivaroxaban. Patients were generally sedated with propofol and midazolam by an attending anaesthetist. Pre-DCCV TOE was then performed. If no thrombus was present on TOE then the treating team would proceed with DCCV. The amount of electricity used for cardioversion was variable depending upon patient body habitus and attending cardiologist decision. The maximum amount of electricity applied in a single shock was 200J bi-phasic and the minimum was 50J bi-phasic. If cardioversion was not achieved on the first shock then up to 2 further shocks were applied. The procedure was abandoned if cardioversion was not achieved after 3 shocks.

Statistics

Data was analysed using the SPSS (SPSS Inc., Chicago USA) and MedCalc (Mariakerke, Belgium) software. The Student's t-test was used to calculate p-values for continuous variables with a normal distribution and Mann-Whitney U-test was used for continuous variables outside the normal distribution. For categorical variables either the Fisher's exact test or the Chi-square test was applied. Receiver operating characteristic (ROC) curves were then used to demonstrate the sensitivities and specificities of variables predictive of thrombus or cardioversion success.

Results

In the current study, 112 patients undergoing TOE DCCV were included as study participants. As (**Table 1)** reveals, the majority (50.0%) of the study population were between the ages of 61 and 75. The mean age of the study sample was 63 ± 25 years. Of the total subjects, 75% were males and 25% were females. Following

TOE, 8.9 % of patients were identified as having thrombus in the left atrium. Of the patients in this study, 13 (11%) had AFL, whilst the remainder had AF. The mean BMI of the study sample was 30.51 ± 14 Kg/m^2. It was observed that 71.3% of study subjects were either overweight or obese (BMI ≥ 25). The mean CHA2DS2-VASc score was found to be 1.92 ± 2.8.

Table 1: Clinical and Demographic Profile

Parameter		Value (%)
Age	<46	9 (8.1)
	46-60	30 (26.8)
	61-75	56 (50)
	>76	17 (15.2)
Gender	Male	84 (75)
	Female	28 (25)
BMI† (kg/m^2)		
<18.5 (Underweight)		0 (0)
18.5-24.9 (Healthy Weight)		14 (12.5)
25-29.9 (Over Weight)		38 (33.9)
30-34.9 (Obesity)		24 (21.4)
35-39.9 (Obesity)		10 (8.9)
≥40 (Extreme Obesity)		8 (7.1)
LAAT/LAT‡		5 (4.5)
SEC§		5 (4.5)
Atrial Fibrillation		99 (88.4)
Atrial Flutter		13 (11.6)
CHF¶		21 (18.8)
Hypertension		46 (41.1)
Diabetes		10 (8.9)
Prior History of Stroke or TIA††		7 (6.3)
Valvular Heart Disease		54 (48.2)
Excess Alcohol Consumption		9 (8)

†BMI-Body Mass Index Kg/m^2, ‡LAAT/LAT-Left Atrial Appendage Thrombus/Left Atrial Thrombus, §SEC-Spontaneous Echo Contrast, ¶CHF-Congestive Heart Failure ††TIA-Transient Ischemic Attack

Reversion to sinus rhythm post-DCCV was observed in 94 (87.6%) patients and it was unsuccessful in 13 (12.4%) patients. The potential predictors of successful cardioversion are included in **(Table 2)**. Following comparison of these two groups, it was found that unsuccessful cardioversion was significantly more likely amongst females (61.5%, p < 0.01) and those patients with higher Left Atrial Volume-Biplane (LAV-BP) (p<0.01) and lower Left Ventricular Ejection Fraction-Biplane (LVEF-BP) (p<0.01).

Cardioversion was more successful amongst those with previous history of cardioversion (27.7%, p<0.05).

Table 2: Predictors of Successful Cardioversion

Parameter	Successful Cardioversion (n=94)	Unsuccessful Cardioversion (n=13)	P-value
Age (Years)	63.9±12.0	59.8 ±15.9	0.27[a]
Female	18 (19.9)	8 (61.5)	0.04[b]
BMI† (kg/m^2)	29.9 ± 5.9	34.9 ±12.03	0.15[c]
Duration of AF/AFL‡ (weeks)	75.7 ± 122	77.1 ±70.3	0.78[c]
Previous History of cardio version	26 (27.7)	0 (0)	0.03[d]
Hypertension	41 (43.6)	4 (30.8)	0.62[b]
Diabetes	10 (10.6)	0 (0)	0.60[d]
CHF§	16 (17.1)	2 (15.4)	0.96[d]
Valvular Heart Disease	46 (46.1)	5 (38.5)	0.74b
Vascular Diseases	19 (20.4)	2 (15.4)	0.87[d]
Excess Alcohol Consumption	8 (8.5)	1 (7.7)	0.98[d]
Atrial Flutter	13 (13.8)	0 (0)	0.35[d]
Previous History of Stroke	5 (5.3)	2 (15.4)	0.68[d]
CHADS2VASc	1.9 ± 1.4	2.0 ± 1.6	0.90[c]
Left Atrial Volume-Indexed (mL/m^2)	37.8 ± 20.0	43.6 ± 15.3	0.10[c]
Left Atrial Volume-Biplane (mL/m^2)	61.9 ± 17.7	88.7 ± 29.3	0.001[a]
LVEF-Biplane (%)	60.0 ± 9.7	50.5 ± 12.0	0.007[a]

(%), mean ± standard deviation
†BMI-Body Mass Index Kg/m^2, ‡Atrial Fibrillation/Atrial Flutter, §CHF-Congestive Heart Failure, ¶LVEF- Left Ventricular Ejection Fraction
a = Unpaired t Test
b = Pearson Chi Square Test
c = Mann Whitney Test
d = Fischer Exact Test

Following echocardiography SEC was observed in 3 (2.7%) of patients and LAT or LAAT was observed in 7 (6.3%) of patients, while 102 (91.0%) patients did not show any evidence of atrial thrombus/SEC. Initial cardioversion was abandoned in all patients with SEC or LAAT/LAT until a delayed repeat TOE concluded these findings were no long present. **(Table 3)** shows the potential predictors of thrombus formation. The rate of congestive heart failure (CHF) was significantly higher amongst those patients who demonstrated thrombus (p<0.05). LAV-Indexed and LAV-BP were significantly higher amongst patients with atrial thrombus (p = 0.01 and p<0.001 respectively).

Table 3: Predictors of Thrombus

Parameter	Thrombus/ SEC Present (n = 10)	Thrombus/ SEC Absent (n = 102)	P-Value
Age (Years)	66.7 ± 13.0	63.0 ± 12.3	0.36[a]
Female	3 (30.0)	25 (24.5)	0.70[d]
BMI† (Kg/ m^2)	28.4 ±5.3	30.8 ± 7.1	0.39[c]
Duration of AF‡ (weeks)	38.5 ± 70.3	75.3 ± 118.0	0.96[c]
Previous History of Cardioversion	1 (10)	35 (22.2)	0.16[d]
Number of Shocks to Cardiovert	1 ± 0	1.4 ± 0.7	0.84c
CHF§	5 (50.0)	16 (15.7)	0.02[b]
Valvular Heart Disease	5 (50.0)	49 (48.0)	0.51[b]
Vascular Diseases	0 (0)	21 (20.8)	0.11[d]
Excess Alcohol Consumption	0 (0)	9 (8.8)	0.41[d]
Atrial Flutter	1 (10.0)	12 (11.8)	0.67[d]
Previous History of Stroke	0 (0)	7 (6.9)	0.50[d]
CHADS2VASc	2.1 ± 1.3	1.9 ± 1.5	0.60[c]
Left Atrial Volume-Indexed (mL/m^2)	56.5 ± 12.3	41.9 ± 15.6	0.01[c]
Left Atrial Volume-Biplane (mL/m^2)	104 ± 18.8	52.0 ± 12.2	<0.001[a]
LVEF-Biplane (%)	45.4 ± 10.5	52.0 ± 12.2	0.11[a]

(%), mean ± standard deviation
†BMI-Body Mass Index Kg/m^2, ‡Atrial Fibrillation/Atrial Flutter, §CHF-Congestive Heart Failure, ††LVEF-Left Ventricular Ejection Fraction
a = Unpaired t Test
b= Pearson Chi Square Test
c = Mann Whitney Test
d = Fischer Exact Test

It was observed that 56 (57.7%) patients had recurrence of arrhythmia within 3 months following successful initial cardioversion. Those with AFL and CHF were significantly less likely ($p<0.05$) to have a recurrence of arrhythmia. The duration of AF was also found to be significantly longer in those with recurrence of arrhythmia ($p<0.05$). The analysis of potential predictors of arrhythmia recurrence is shown in **(Table 4)**.

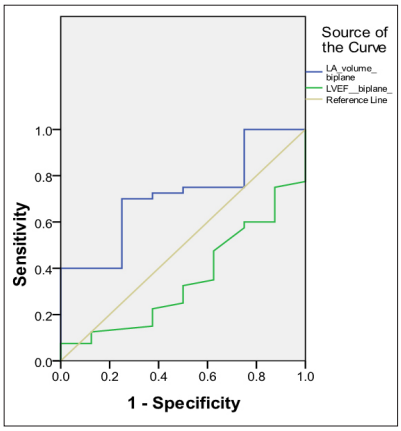
Table 4: Predictors of Post Cardioversion recurrence of Arrhythmia

Parameter	Recurrence of Arrhythmia (n = 56)	Non-recurrence of Arrhythmia (n =41)	P-Value
Age (Years)	62.9 ± 12.3	64.2 ± 13.7	0.62[a]
Female	15 (26.8)	9 (22.0)	0.98[b]
BMI† (Kg/ m^2)	31.0 ± 7.6	30.6 ± 6.7	0.79[c]
Duration of AF‡ (weeks)	74 ± 99.7	59.4 ±113.2	0.02[c]
Previous History of Cardioversion	14 (25)	8 (19.5)	0.69[b]
Number of shocks to Cardiovert	1.4 ± 0.7	1.3 ± 0.6	0.72[c]
CHF§	6 (10.7)	12 (29.3)	0.03[b]
Valvular Heart Disease	27 (46.3)	19 (46.3)	0.83[b]
Vascular Diseases	10 (17.9)	10 (24.4)	0.59[b]
Excess Alcohol Consumption	8 (14.3)	1 (2.4)	0.07[d]
Atrial Flutter	2 (3.6)	9 (22.0)	0.007[d]
Previous History of Stroke	5 (8.9)	1 (2.4)	0.39[d]
CHADS2VASc	1.8 ± 1.4	2.2 ± 1.7	0.34[c]
Left Atrial Volume-Index (mL/m^2)	43.0 ± 16.3	43.3 ± 16.9	0.85[c]
Left Atrial Volume-Biplane (mL/m^2)	86.0 ± 31.0	86.6 ± 29.1	0.91[a]
LVEF-Biplane (%)	53.0 ± 12.2	49.7 ± 12.6	0.19[a]

(%), mean ± standard deviation
†BMI-Body Mass Index Kg/m^2, ‡Atrial Fibrillation/Atrial Flutter, §CHF-Congestive Heart Failure, ¶LVEF- Left Ventricular Ejection Fraction
a = Unpaired t Test
b= Pearson Chi Square Test
c = Mann Whitney Test
d = Fischer Exact Test

When LAV-BP and LEVF-BP. two predictors of initial successful cardio version, were compared in an ROC curve **(Figure 1)**, the area under the curve for LAV-BP and LVEF-BP was 0.716 ± 0.18 and 0.352 ± 0.20 respectively.

Figure 1: ROC curve showing LAV†-Biplane and LVEF‡-Biplane as predictor of Initial Successful Cardioversion

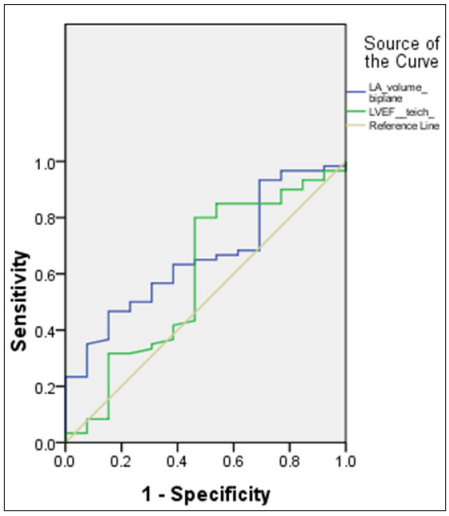


	LAV-Biplane	LVEF-Biplane
Area under Curve	0.716	0.352
Standard Error	0.090	0.098
Level of Significance	0.056	0.189
95% Confidence Interval	0.539-0.892	0.160-0.534

†LAV-Left Atrial Volume, ‡LVEF-Left Ventricular Ejection Fraction

An ROC curve showing LA-BP and LVEF as predictors of atrial thrombus/SEC was performed **(Figure 2)**. This revealed an area under the curve of 0.662 ± 0.14 and 0.592 ± 0.18 for LA-BP and LVEF respectively.

Figure 2: ROC curve showing LA†-Biplane and LVEF‡ as predictors of atrial thrombus



	LA Volume- BP	LVEF
Area under Curve	0.662	0.592
Standard Error	0.077	0.097
Level of Significance	0.068	0.303
95% Confidence Interval	0.512-0.812	0.402-0.782

†LAV-Left Atrial Volume, ‡LVEF-Left Ventricular Ejection Fraction

Procedural Complications

Procedural complications arising from DCCV were generally rare. Four patients experienced an episode of hypotension post procedure, but no acute medical intervention was required for this. One elderly patient died from a stroke 4 months post DCCV. No thrombus was noted at the time of DCCV and the patient had remained in sinus rhythm at 2 months post DCCV. A second patient, who had an unsuccessful DCCV, was noted to have a TIA 3 month's post procedure.

Discussion

This study of TOE DCCV performed in 112 patients, from a single tertiary hospital in Australia, demonstrates immediate and short-term success similar to published studies on this subject. Cardioversion resulted in an initial return to sinus rhythm in 87.6% of patients in this study, while the published immediate success rate ranges from 82-94.5% [25,27,35,36]. Amongst those with an initially successful cardioversion, sinus rhythm was maintained after 3 months in 57.7% of patients. In comparison, two studies with follow-up at only 1 month post DCCV reported success rates of 49% and 62.5% [26,31].

Unsuccessful initial cardioversion was significantly more likely ($p<0.05$) in females, those having their first DCCV, and in patients with higher LAV-BP and decreased LVEF-BP. In the reviewed literature, patient sex generally had little significance on the success of cardioversion and some findings were contradictory. Kuppahally *et al*. found that cardioversion was more successful in females, whereas Akdemir *et al*. noted the opposite. Adjusting for patient co-morbidities may result in a lessening of this association, as it did in the former study [31,37].

As in this study, reduced biplane LAV was also noted to be a predictor of cardioversion success in several previous studies [28,31]. Interestingly, there was less correlation between indexed LAV than for biplane LAV ($p=0.1$ vs. $p<0.001$). This is in keeping with the trend towards BMI being higher in those with unsuccessful cardioversion ($p=0.15$), where indexing a patient's LAV to their surface area would largely negate this effect. Likewise a previous study has shown DCCV to be initially more successful in those with a lower BMI [38]. The area under the curve (AUC) when using LAV-BP to predict cardioversion success was 0.716. This result indicates that LAV-BP can be used in a clinical setting to predict initial cardioversion success with a fair level of accuracy. This information may be of use when considering whether to proceed with DCCV in certain patient populations.

It is a noteworthy finding that LVEF was significantly ($p>0.007$) higher in those patients who had successful cardioversion. In similar studies LVEF has not been significantly associated with DCCV success [28,39]. When LVEF-BP was plotted on a ROC curve, however, the AUC was 0.352, indicating that LVEF-BP is not a reliable test for predicting DCCV success.

Those patients undergoing their first DCCV were significantly more likely ($p>0.05$) to be unsuccessful in cardioverting. This finding is likely due to selection bias, as all patients undergoing a repeat DCCV in this study had undergone an initially successful DCCV in the past.

The variables associated with reduced recurrence of arrhythmia three months post DCCV were the presence of heart failure, AFL and shorter duration of arrhythmia pre-DCCV ($p<0.05$). A similar finding regarding AFL and the reduced incidence of arrhythmia recurrence post DCCV has been indicated by a previous study [40]. Conversely, CHF has in the past been associated with an increased likelihood of arrhythmia recurrence [30]. A limitation of this study was that the severity and management of the CHF was not noted, which limits the interpretation of this result [30].

Previous studies have also found that a longer duration of AF prior to DCCV is associated with a higher incidence of arrhythmia recurrence [41,42]. Indeed, in this current study those with AF duration >24 weeks pre-DCCV had a failure rate at 3 months post-DCCV more than double those with AF duration <24 weeks (55.5%

vs. 20.5%). Interestingly, the duration of AF was not significant in predicting the success of the initial cardioversion, despite previous studies indicating an association [30,42].

There was a trend towards excess alcohol consumption being more common amongst those with arrhythmia recurrence than in those who remained in sinus rhythm (p=0.07). This association has also been documented by previous studies and is in keeping with alcohol being a precipitant in the initial development of AF [37,43].

The prevalence of LA thrombus in this study was 6.3%, while the prevalence of SEC was 2.7%. The published incidence for either of these findings on TOE ranges widely from 8.2%-57% [15,21,22,23]. There are a number of possible explanations for this, such as different protocols for anticoagulation pre-TOE, accuracy of ultrasound equipment and inter-observer variability in detecting and defining thrombus.

The three variables identified as being predictors for the presence of clot were CHF, increased LA volume-indexed and increased LA volume-BP. LA volume and LA diameter have both been identified as potential predictors of clot formation in previous studies [12,23]. LA enlargement (LAE) may occur either as a consequence of AF or, alternatively, it may promote the development of AF, such as in the setting of mitral valve disease [44,45]. Both AF and LAE contribute to abnormal blood stasis and place such patients at significant risk of thromoboembolic disease, therefore it is logical that LAE be positively associated with the presence of clot [45].

The increased incidence of clot in those patients with CHF was in keeping with the finding that LVEF was generally lower in those with clot on TOE. CHF has been identified by previous studies as an independent risk factor for clot formation [46,47].

Despite CHF being predictive for thrombus, the CHA2DS2-VASc scores were not significantly different between those with clots and those without. It is notable however, that all patients with a thrombus also had a CHA2DS2-VASc score of ≥1. There has been contention historically as to the usefulness of CHADS2 and CHA2DS2-VASc in excluding the presence of thrombus. While some studies have found a CHADS2 score of 0 to exclude thrombus, others have demonstrated that thrombus may persist despite low scores [21,48-50]. Although an increase in the CHA2DS2-VASc score may be associated with an increased likelihood of thrombus in certain populations, it does not directly incorporate other factors, such as LAE, that are predictive of thrombus.

Limitation

The limitations of this study are primarily those inherent to most retrospective studies. This study relies on medical records and procedural documents to obtain data. A prospective study would be preferable in ensuring completeness of pre-procedural and follow-up information. For instance, although all patients in this study had received anticoagulation pre-TOE, it is difficult to determine retrospectively whether this medication was properly administered and adhered to. To ensure accuracy in this study the TTE ideally would have been performed at the time of TOE-cardioversion. Unfortunately this was often performed around 2-4 weeks prior, which has implications on the data if any significant changes to cardiac function occurred during this time. Echocardiographic data was not re-analysed de novo by independent cardiologists so the presence of thrombus may be affected by the expertise of the cardiologist who initially reported the images. The authors chose not to utilise multivariate analysis in light of this method having a low level of power for a sample of this size. In a larger sample a multivariate analysis would be useful to discern if any of the independent variables are in fact co-dependant.

Conclusions

This single-centre, retrospective study, has identified a number of patient factors associated with reduced rates of DCCV success, both initially and within 3 months. Practitioners who take these factors into account may be better able to predict patient outcomes post procedure, which will aid in deciding whether DCCV is appropriate for certain populations. The predictors of thrombus formation discussed in this study may be used to categorize patients at high risk of thromboembolism, ensuring that anti-coagulation regimes are adhered to and that TOE is performed pre-DCCV.

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