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Original Article

Short-term success and recurrence of supraventricular arrhythmias after electrical cardioversion

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Abstract

Objectives: Electrical cardioversion is a common treatment for terminating supraventricular arrhythmias, particularly atrial fibrillation. However, factors related to immediate success and subsequent arrhythmia recurrence remain unclear in some populations. This study assessed the immediate success rate of electrical cardioversion and the recurrence rate among patients who initially responded.

Methods: This analytical cross-sectional study was conducted at Afshar Hospital in Yazd, Iran, from 2014 to 2019. A consecutive sample of 75 adults with supraventricular arrhythmias (atrial fibrillation, atrial flutter, or atrial tachycardia) who underwent electrical cardioversion was included. Patients with prior CABG, pregnancy, or incomplete records were excluded. Data were collected using a structured checklist covering demographics, clinical history (cardiac disease, valvular disease, diabetes, hypertension, smoking), and procedural outcomes (immediate success, number of attempts, recurrence). Analyses were performed in SPSS v 26.

Results: Among 75 patients (60% male; mean age 52 ± 15 years), atrial fibrillation was the most common arrhythmia (44%). Electrical cardioversion restored sinus rhythm immediately in 68 patients (90%). Immediate success was not significantly associated with baseline comorbidities (cardiac disease, valvular disease, diabetes, hypertension, or smoking), left ventricular ejection fraction, or arrhythmia subtype (all $p > 0.05$). During follow-up, recurrence occurred in 23 of 68 patients with immediate success (33.8%) and was not significantly related to comorbidities, LVEF, or arrhythmia type (all $p > 0.05$). However, recurrence differed significantly by immediate procedural outcome ($p = 0.001$).

Conclusions: Electrical cardioversion achieved a high immediate success rate in supraventricular arrhythmias, and successful cardioversion was associated with a substantially lower recurrence rate. Comorbid conditions did not significantly influence immediate procedural success in this cohort.

Keywords: Electrical cardioversion, Atrial arrhythmias, Procedural success, Arrhythmia recurrence, Afshar Hospital

Introduction

Supraventricular arrhythmias continue to impose a considerable burden on healthcare systems worldwide, not only because of their high prevalence but also due to their association with substantial morbidity and mortality. Among these arrhythmias, atrial fibrillation (AF) stands out as the most common sustained form. Its prevalence has been rising

steadily due to population aging and the growing incidence of cardiovascular risk factors such as hypertension, diabetes, and structural heart disease. Recent projections suggest that more than 12 million individuals in the United States alone will be living with AF by 2030, reflecting the scale of this public health challenge{Kornej, 2020 #1}(1, 2). Recent clinical guidelines categorize atrial fibrillation (AF) into four types: paroxysmal, persistent, long-standing persistent, and permanent. Persistent AF is an episode lasting longer than seven days or requiring medical intervention, such as medication or electrical therapy, to restore normal rhythm. Other supraventricular arrhythmias, including atrial flutter (AFL) and atrial tachycardia (AT), may present with symptoms like palpitations, shortness of breath, and fatigue. These conditions are also associated with an increased risk of stroke and heart failure. Direct current cardioversion (DCCV) is a critical treatment option for restoring sinus rhythm in patients experiencing symptomatic atrial arrhythmias, especially when medication for rhythm control is ineffective or not well-tolerated. The procedure involves delivering a synchronized electrical shock to produce global myocardial depolarization, allowing the sinoatrial node to regain control of the heart rhythmOver the years, many clinical, electrocardiographic, and echocardiographic variables have been studied as potential predictors of both immediate procedural success and long-term maintenance of sinus rhythm. However, the existing literature is heterogeneous, and findings are not consistently reliable across different studies. While some research emphasizes the duration of arrhythmia before cardioversion as a significant factor in determining long-term rhythm stability, others have not identified any single reliable predictor. Recently, researchers have also focused on electrocardiographic markers and advanced signal-processing techniques as potential tools to enhance patient selection and improve the prediction of cardioversion outcomes. Despite the frequent use of electrical cardioversion (ECV), there is limited evidence detailing its outcomes in specific regional or institutional contexts. Such localized data are crucial for understanding real-world practice patterns, optimizing patient selection, and informing resource allocation. With this in mind, the present study aims to evaluate the outcomes of ECV among patients with atrial arrhythmias treated at Afshar Hospital in Yazd, Iran. Specifically, we seek to determine the immediate.

Materials and Methods

Study Design and Setting

This analytical cross‐sectional study was carried out at Afshar Hospital, a major tertiary care center in Yazd, Iran. The study lasted five years, from March 2015 to March 2020. The researchers obtained all data retrospectively from existing medical records. The study protocol was reviewed and approved by the Institutional Ethics Committee of the Islamic Azad University, Yazd Branch (Ethics Code: IR.IAU.KHUISF.REC.1399.253).

Study Population and Sampling

The study population comprised all adult patients (aged 18 years or older) who underwent electrical cardioversion for supraventricular arrhythmias, specifically atrial fibrillation, atrial flutter, or atrial tachycardia, at Afshar Hospital in Yazd, Iran. Using a census sampling approach, all eligible patients with complete and accessible medical records were included, resulting in an initial identification of 80 patients. The exclusion criteria consisted of incomplete documentation, missing pre-procedure or post-procedure ECGs, and arrhythmias that fell outside the predefined categories. Consequently, the final analytical sample included 75 patients.

Inclusion and Exclusion Criteria

Patients were eligible for inclusion if they were 18 years of age or older, had a confirmed diagnosis of supraventricular arrhythmia, specifically atrial fibrillation (AF), atrial flutter (AFL), or atrial tachycardia (AT), and had undergone at least one session of electrical cardioversion. Documented electrocardiographic findings in the medical record were the basis for the diagnosis of arrhythmia. Patients were excluded if they had a history of coronary artery bypass grafting (CABG), were pregnant at the time of the procedure, or had incomplete medical records that did not allow extraction of the required clinical or procedural data.

Data Collection Tool and Procedure

Data were collected retrospectively from patients' medical records using a structured checklist developed by the principal investigator.

The checklist included two main components:
• Demographic and Clinical Characteristics: This section captured age, sex, history of cardiac disease (including coronary artery disease and cardiomyopathy), history of valvular heart disease, presence of diabetes mellitus, presence of hypertension, and smoking status.
• Cardioversion and Outcome Data: This section documented the type of arrhythmia (AF, AFL, atypical AFL, AT, LAT, or combined AF/AT), the patient's left ventricular ejection fraction (LVEF) as reported on echocardiography, the number of cardioversion attempts, the immediate success of the procedure (defined as restoration of sinus rhythm within minutes of the electrical shock), and the occurrence of arrhythmia recurrence after a successful cardioversion.

Statistical Analysis
All statistical analyses were conducted using SPSS (version 26.0; SPSS Inc., Chicago, IL, USA). Descriptive statistics summarized the demographic and clinical characteristics of the study population. Categorical variables, including sex, history of cardiac or valvular disease, presence of diabetes or hypertension, smoking status, type of arrhythmia, immediate success of cardioversion, and recurrence, were reported as frequencies and percentages. Age, the only continuous variable in the dataset, was summarized as mean ± standard deviation (SD). Pearson's chi-square test was used to examine associations among categorical variables. Specifically, the test evaluated the relationship between immediate cardioversion success (dependent variable) and several independent variables, including history of cardiac disease, history of valvular disease, diabetes, hypertension, smoking status, LVEF category (<35%, 36–49%, >50%), and type of arrhythmia. The same approach was used to assess the association between arrhythmia recurrence and these clinical variables, as well as its relationship with immediate success. All statistical tests were two-tailed, and a p-value less than 0.05 was considered statistically significant. The findings are presented in tabular form and supported by narrative descriptions in the Results section.

Ethical Considerations
The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Because the research relied solely on a retrospective review of medical records, the institutional ethics committee waived the requirement for informed consent. All patient information was handled confidentially, and data were used exclusively for research and statistical purposes. The research team ensured careful, transparent, and accurate reporting throughout the study.

Results
The study included 75 patients with atrial arrhythmias who underwent electrical cardioversion at Afshar Hospital in Yazd. As summarized in Table 1, 45 patients (60%) were male and 30 (40%) were female. A history of cardiac disease was documented in 40 patients (53.3%), while 35 (46.7%) had no prior cardiac diagnosis. Valvular heart disease was present in 23 patients (30.7%), whereas 52 (69.3%) had no evidence of valvular involvement. Hypertension was identified in 20 patients (26.7%), and 55 (73.3%) were normotensive. Diabetes mellitus was reported in 13 patients (17.3%), with 62 (82.7%) having no history of diabetes. Most individuals in the cohort were nonsmokers; only 4 patients (5.3%) reported a history of smoking, while 71 (94.7%) denied tobacco use. With respect to the index arrhythmia, atrial fibrillation (AF) was the most common presentation, observed in 33 patients (44%). Atrial tachycardia (AT) accounted for 20 cases (26.7%), and typical atrial flutter (AFL) was identified in 14 patients (18.7%). Less frequent arrhythmia types included left atrial tachycardia (LAT) in 4 patients (5.3%) and atypical AFL in 3 patients (4%). A combined pattern of AF and AT was documented in only one patient (1.3%). Overall, the study population demonstrated a moderate burden of cardiovascular comorbidities, with AF representing the predominant atrial arrhythmia at presentation Table 1.

Table 1. Baseline clinical characteristics and distribution of atrial arrhythmia types among patients undergoing electrical cardioversion

Variable	Category	Frequency	Percentage	Variable	Category	Frequency	Percentage
Sex	Male	45	60	Arrhythmia Type	Atrial Fibrillation (AF)	33	44
	Female	30	40		Atrial Flutter (AFL)	14	18.7
History of Cardiac Disease	Yes	40	53.3		Atypical AFL	3	4
	No	35	46.7		Atrial Tachycardia (AT)	20	26.7
History of Valvular Disease	Yes	23	30.7		Left Atrial Tachycardia (LAT)	4	5.3
	No	52	69.3		AF and AT	1	1.3
Diabetes Mellitus	Yes	13	17.3	Smoking History	Yes	4	5.3
	No	62	82.7		No	71	94.7
Hypertension	Yes	20	26.7				
	No	55	73.3				

Values are reported as frequency (n) and percentage (%). All categories reflect the information documented in patients' medical records during the study period.

As shown in Table 2, none of the baseline comorbidities were statistically significantly associated with the immediate success of electrical cardioversion. Among patients who achieved immediate restoration of sinus rhythm, 51.5% (n = 35) had a history of heart disease, compared with 71.4% (n = 5) in the non-success group (p = 0.314). Similar patterns were observed for other comorbidities: the proportions of patients with valvular heart disease (30.9% vs. 28.6%, p = 0.635), diabetes mellitus (17.6% vs. 14.3%, p = 0.823), hypertension (26.5% vs. 28.6%, p = 0.905), and a history of smoking (4.4% vs. 14.3%, p = 0.268) were comparable between the two groups. Left ventricular systolic function also showed no meaningful differences between patients with and without immediate success (p = 0.635). In the immediate-success group, 33.8% had an LVEF <35%, 27.9% had an LVEF of 36–49%, and 38.2% had an LVEF >50%. These proportions were similar in the non-success group, where 42.9%, 28.6%, and 28.6% of patients fell into the respective LVEF categories. A comparable pattern was observed for arrhythmia type (p = 0.798). Among patients with immediate success, atrial fibrillation, atrial flutter, and atrial tachycardia accounted for 44.1%, 23.5%, and 32.4% of cases, respectively. In contrast, the non-success group showed distributions of 42.9%, 14.3%, and 42.9% for the same arrhythmia types. Taken together, these findings indicate that in this cohort, immediate cardioversion success did not appear to be strongly influenced by baseline comorbidities, left ventricular ejection fraction, or the specific subtype of atrial arrhythmia Table 2.

Table 2. Association of baseline comorbidities, left ventricular ejection fraction, and atrial arrhythmia type with the immediate success of electrical cardioversion

Variable	Category	Immediate Success Yes (%) (n)	Immediate Success No (%) (n)	P-value
History of Heart Disease	Yes	51.5% (35)	71.4% (5)	0.314
	No	48.5% (33)	28.6% (2)	
History of Valvular Disease	Yes	30.9% (21)	28.6% (2)	0.635
	No	69.1% (47)	71.4% (5)	
History of Diabetes	Yes	17.6% (12)	14.3% (1)	0.823
	No	82.4% (56)	85.7% (6)	
History of Hypertension	Yes	26.5% (18)	28.6% (2)	0.905
	No	73.5% (50)	71.4% (5)	
History of Smoking	Yes	4.4% (3)	14.3% (1)	0.268
	No	95.6% (65)	85.7% (6)	
LVEF	<35%	23 (33.8%)	3 (42.9%)	0.635
	36–49%	19 (27.9%)	2 (28.6%)	
	>50%	26 (38.2%)	2 (28.6%)	
Type of Arrhythmia	AF	30 (44.1%)	3 (42.9%)	0.798
	AFL	16 (23.5%)	1 (14.3%)	
	AT	22 (32.4%)	3 (42.9%)	

Values are presented as n (%). Comparisons between the immediate-success and non-success groups were performed using chi-square or Fisher's exact tests, as appropriate. All statistical tests were two-tailed.

As shown in Table 3, arrhythmia recurrence during follow-up was identified in 23 of 68 patients (33.8%), while the remaining 45 patients (66.2%) remained free of recurrent atrial arrhythmias. Overall, there were no meaningful differences in major cardiovascular comorbidities between patients with and without recurrence. A history of cardiac disease was documented in 55.6% of patients without recurrence and 43.5% of those with recurrence (p = 0.346). Likewise, valvular heart disease was present in 33.3% of patients without recurrence and 26.1% of those with recurrence (p = 0.541). The proportions of patients with diabetes mellitus (15.6% vs. 21.7%; p = 0.527), hypertension (26.7% vs. 26.1%; p = 0.959), and a history of smoking (6.7% vs. 0%; p = 0.205) were also similar across groups. Left ventricular ejection fraction (LVEF) demonstrated a non-significant trend toward lower systolic function among patients with recurrence. Nearly half of the recurrence group (47.8%) had an LVEF <35%, compared with 26.7% of those without recurrence. In contrast, preserved systolic function (LVEF >50%) was observed in 30.4% of patients with recurrence and 42.2% of those without recurrence (p = 0.218). The distribution of atrial arrhythmia types was also comparable between groups (p = 0.731). Among patients without recurrence, atrial fibrillation, atrial flutter, and atrial tachycardia accounted for 42.2%, 22.2%, and 35.6% of cases, respectively. The corresponding proportions in the recurrence group were 47.8%, 26.1%, and 26.1%. In contrast to the other variables, the immediate procedural outcome showed a clear and statistically significant association with recurrence. All recurrence events occurred among patients who initially achieved successful cardioversion, whereas no recurrences were observed in those without immediate success p = 0.001; Table 3.

Table 3. Association of baseline comorbidities, left ventricular ejection fraction, arrhythmia type, and immediate cardioversion success with atrial arrhythmia recurrence

Variable	Category	Arrhythmia Recurrence No n (%)	Arrhythmia Recurrence Yes n (%)	P-Value
Cardiac Disease	Yes	25 (55.6%)	10 (43.5%)	0.346
	No	20 (44.4%)	13 (56.5%)	
Valvular Disease	Yes	15 (33.3%)	6 (26.1%)	0.541
	No	30 (66.7%)	17 (73.9%)	
Diabetes Mellitus	Yes	7 (15.6%)	5 (21.7%)	0.527
	No	38 (84.4%)	18 (78.3%)	
Hypertension	Yes	12 (26.7%)	6 (26.1%)	0.959
	No	33 (73.3%)	17 (73.9%)	
Smoking History	Yes	3 (6.7%)	0 (0.0%)	0.205
	No	42 (93.3%)	23 (100.0%)	
LVEF	<35%	12 (26.7%)	11 (47.8%)	0.218
	36–49%	14 (31.1%)	5 (21.7%)	
	>50%	19 (42.2%)	7 (30.4%)	

Values are presented as n (%). Comparisons between patients with and without arrhythmia recurrence were performed using chi-square or Fisher's exact tests, as appropriate. All statistical tests were two tailed.

Discussion

Guideline-based analyses also confirm that ECV remains a reliable first-line rhythm-control this study presents a comprehensive analysis of outcomes of electrical cardioversion (ECV) for supraventricular arrhythmias in a cohort of 75 patients at Afshar Hospital in Yazd, Iran. The findings show that ECV is highly effective for immediate restoration of sinus rhythm, with a success rate of 90%. This strong acute efficacy aligns with contemporary international studies reporting immediate success rates of 80–95% among patients with AF and AFL undergoing ECV (3, 9). Recent guideline-based analyses also confirm that ECV remains a reliable first-line rhythm-control strategy in symptomatic patients (10, 11). One of the most important findings of our study is the lack of association between immediate procedural success and a wide range of patient-specific factors. Demographic variables (age, sex), common comorbidities (cardiac disease, valvular disease, diabetes, hypertension), behavioral factors (smoking), arrhythmia type (AF, AFL, AT), and baseline cardiac function (LVEF) did not significantly influence acute success. Similar findings have been reported in recent studies, which show that traditional clinical variables have limited predictive value for immediate ECV success, whereas procedural factors such as pad placement, shock energy, and waveform characteristics may play a more prominent role (12, 13). These findings suggest that the acute response to ECV is influenced more by the electrophysiological state of the atria at the time of shock delivery than by chronic comorbidities (14). However, the study also underscores a critical limitation of ECV: its inability to ensure long- term freedom from arrhythmia. Our data showed a recurrence rate of 33.8% among patients who initially achieved sinus rhythm, consistent with recent reports describing recurrence rates of 30–60% within the first year after cardioversion (15, 16). The significant association between immediate success and recurrence reflects that patients who fail to convert have no opportunity for documented relapse. Among those who do convert, however, recurrence remains common, highlighting that immediate success is necessary but not sufficient for long-term rhythm control (10). Our analysis of predictors of recurrence among successfully treated patients yielded negative results. We found no significant association between recurrence and any of the examined clinical variables, including comorbidities, LVEF, or arrhythmia type. This is consistent with recent systematic reviews showing

that commonly measured clinical and echocardiographic parameters often fail to reliably predict long-term maintenance of sinus rhythm after cardioversion (17). These findings support the concept that recurrence is multifactorial, potentially influenced by factors not captured in our retrospective dataset, such as atrial fibrosis, arrhythmia duration, inflammatory markers, and post-procedural antiarrhythmic therapy (18). The demographic finding that males constituted a larger proportion (60%) of the patient population is consistent with contemporary epidemiological data showing a higher prevalence of AF and related arrhythmias in men (19). The predominance of AF (44%) as the most common arrhythmia in our cohort also aligns with global evidence identifying AF as the most prevalent sustained arrhythmia worldwide (20). The study has several limitations. Its retrospective cross-sectional design limits the ability to determine the precise timing and burden of recurrence and may underestimate asymptomatic events. The sample size, although adequate for primary outcomes, may have been underpowered to detect subtle associations, particularly for less common variables such as smoking. Additionally, important predictors of recurrence—such as arrhythmia duration, left atrial size, atrial fibrosis, and antiarrhythmic drug use—were not available in our dataset. These factors have been increasingly recognized as important contributors to long-term rhythm outcomes in recent literature. In conclusion, while ECV remains an effective tool for acute rhythm control, its long-term success is limited by substantial recurrence rates. Baseline clinical characteristics, LVEF, and arrhythmia subtype did not reliably predict either immediate success or recurrence in our cohort. Future research should prioritize prospective, longitudinal studies incorporating advanced imaging, biomarkers, and standardized pharmacological management to improve prediction models and enhance long-term rhythm control.

Conclusion

Electrocardioversion is a highly effective procedure for the immediate restoration of sinus rhythm in patients with supraventricular arrhythmias, regardless of underlying comorbidities or arrhythmia type. Nonetheless, a considerable proportion of patients who achieve initial success experience recurrence, underscoring the importance of effective long-term management strategies. Thus, electrocardioversion should be considered a primary therapeutic option for symptomatic patients, but it must be accompanied by a comprehensive follow-up plan to reduce the risk of relapse.

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Authors' Contributions

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Conflicts of Interest

The authors declare that they have no conflicts of interest related to this study.

Ethical Statement

The study protocol was reviewed and approved by the Institutional Ethics Committee of the Islamic Azad University, Yazd Branch (Ethics Code: IR.IAU.KHUISF.REC.1399.253).

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