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Case Series

What Governs Immediate or Delayed Cardioversion of Atrial Fibrillation by Direct Current Shock?

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Abstract:

Background: Aftershock delivery and dierct current DC-cardioversion of atrial fibrillation may be immediate or delayed.

Objective: To characterize the immediate or delayed reversion of atrial fibrillation.

Methods: The study was conducted at Alhassani Heart Centre from October 2018 to February 2022**.** Patients diagnosed with persistent atrial fibrillation and who reverted to sinus rhythm after DC-Cardioversion were included in this case series study. Some patients showed immediate conversion to sinus rhythm while others showed delayed conversion after shock delivery. The duration of the atrial fibrillation, the ventricular rate range before the intervention, the preceding drug therapy, patient weight, and left atrial size were measured to illuminate the factors that affect the reversion format.

Results: From a total of 86 patients with persistent atrial fibrillation treated with DC-cardioversion, 77 (89%) patients reverted into sinus rhythm and were included in the study. Fifty patients reverted immediately and 27 patients reverted late. The mean ventricular rate was higher in the immediate group 138 ± 22 compared to 75 ± 18 in the delayed group. The post-conversion appearance of atrial premature beats was more in the delayed group. The left atrial size was slightly larger in the delayed group. The role of taking a preceding drug was not significant in both groups.

Conclusion: The pattern of reversion in atrial fibrillation patients undergoing DC shock is governed by the ventricular rate before the reversion and the appearance of atrial premature complexes after DC shock.

Keywords: Atrial fibrillation; Cardioversion; DC shock; Delayed; Immediate.

Introduction:

Electrical cardioversion for atrial fibrillation (AF) by synchronized direct current (DC) shock is a common and efficient procedure to convert atrial fibrillation to normal sinus rhythm (SR)1-12. Achieving SR improves hemodynamics, especially in patients with heart failure (HF)13,14.

DC shock usually converts AF into SR immediately after the application of the shock5,11,15,16. It is not uncommon that the reconversion is delayed for a few beats before SR is achieved16.

Occasionally this delay may be long enough to make the physician decide to deliver another unnecessary DC shock.

The etiologies behind this delayed cardioversion phenomenon are not clear. Residual wavelets in the atrium may still be present after the DC shock to shortly maintain AF, but not enough to sustain it16-20.

This case series study aims to clarify what factors govern the immediate or delayed cardioversion of AF.

Patients and Methods:

Patients who received synchronized DC Shock and reverted into SR at Alhassani Cardiology February 2022, were included in the study. AF was classified as early persistent when it was sustained for > 7 days and < 3 months; late persistent if it was sustained for > 3 months and < 1 year, and chronic if the symptoms persisted for more than a year. The decision of rhythm control strategy was made for all patients with persistent AF. In the chronic AF, the strategy was chosen after discussing the pros and cons with the patient. Direct oral anticoagulant (DOAC) was started 48-72 hours before DC shock. Transthoracic echocardiography was done before DC shock to exclude LA thrombi.

The patient arrived at the hospital in a fasting state. Pre-procedural assessment of the physical status, risk evaluation, and discussion with the patient and family was done. An intravenous line is set and the patient is put in a supine position with shoulder support. Oxygen is administered via nasal cannula. The patient is connected to cardiac rhythm monitoring facilities. Ketamine 25 mg plus fentanyl 25-37 ugm are administered intravenously and a calculated dose of propofol 80-140 mg according to the weight and built of the patient aiming for heavy sedation. Synchronized DC Shock is delivered once the patient loses consciousness. This method is sufficient even if another shock is needed. The heart rhythm is recorded by the ECG monitor of the defibrillator (Cardioserv

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from GE). One ECG lead is chosen with the highest voltage R wave and clearly shows synchronization sign. The positive electrode of the defibrillator's paddle (or patch) is put at the left mid-axillary line and the negative one at the right mid infra-clavicular line. Under the satisfactory sedation state, a first DC Shock of 200 J is delivered and the rhythm is instantly observed. If the rhythm is still in AF, a second shock of 300 J is delivered. If needed, a third last dose of 300 J is given. The interval between the shocks is 2-3 minutes. The procedure was labelled as successful if SR was achieved, and a failure if the rhythm was still in AF after the third shock. The patient is labeled as immediate cardioversion if SR is achieved immediately after the shock, and as delayed cardioversion if the cardioversion is delayed after delivering the DC shock. Accordingly, the cardioverted patients are classified into one of two groups, the immediate group (IG) and the delayed group (DG). In the DG the number of beats in AF and time in seconds before restoring SR was calculated. The ventricular rate before and after the cardioversion was measured in both groups. The appearance of atrial premature complexes after cardioversion was noticed in both groups. The energy needed for the cardioversion was compared between the two groups. The time in minutes for the first response to command after reconversion was assessed as also the time until full consciousness recovery. A full neurological assessment was performed immediately after recovery of consciousness. The patient was observed at the recovery unit for 2-3 hours and discharged home 2 hours after regaining full consciousness. DOAC and oral antiarrhythmic drugs with either amiodarone or flecainide were started at a minimal dose for six months or according to the clinical status of the patient. Follow-up was done after 4 weeks and then every 3 months or with recurrence of symptoms. At the outpatient (OP) clinic, patients were assessed by clinical symptoms, ECG, and 48 hours of Holter monitoring. Echocardiography was repeated to assess LVEF and LA size.

Results:

From a total of 86 patients with persistent AF, 77 patients (89%) were converted into SR with synchronized DC shock. These 77 patients were included in this case series study. The ages of the participants ranged from 35 to 84 years. There were 36 males and 41 females. The weight of the patients ranged from 75-98 kg. The underlying structural heart diseases (SHDs) in the group were ischemic cardiomyopathy (iCMP) in 16 patients (21%), Tachycardia induced cardiomyopathy (TIC) in 11 patients (14%), Thyrotoxicosis in two patients and repaired atrial septal defect (ASD) in one patient. No structural heart disease was found in 47 patients (61%). The duration of AF based on symptoms and available previous ECGs was as follows: 1-2 months in 11 patients (14.3%), 3 months – one year in 41 patients (53.2%), and more than one year in 25 patients (32.5%). The presenting symptoms were palpitation in 62 patients (80.5%), dyspnea in 38 patients (49.4%), dizzy spells in 18 patients (23.4%), syncope in 10 patients (13%), and chest pain in 8 patients (10.4%). Many patients had more than one symptom. The anticoagulant drugs given were Rivaroxaban in 65 patients (84.4%), dabigatran in seven patients (9%), and five patients (6.5%) patients received warfarin, Table 1.

Table 1: Demographic and clinical features of the study group

Variable	Category	Number	%
Gender	Male	36	46.8
	Female	41	53.2
SHD	Yes	30	39.0
	No	47	61.0
Assessed duration of AF	1-2 months	11	14.3
	3 months – 1year	41	53.2
	> 1 year	25	32.5
Presenting symptoms	Palpatation	62	80.5
	Shortness of breath	38	49.4
	Dizziness	18	23.4
	Syncope	10	13.0
	Chest pain	8	10.4
Anticoagulant drugs	Rivaroxaban	65	84.4
	Dabigatran	7	9.0
	Warfarin	5	6.5
Total		77	100,0

Fifty patients (64.9%) were converted immediately after the DC shock (the immediate group – IG) and 27 patients (35.1%) had a delayed conversion (the delayed group – DG).

Where the comparison of the two groups in terms of a number of parameters. The mean age was higher for the Immediately converted than the delayed converted group, but statistically not significant ($p>0.05$). There were more males in the DG and more females in the IG, but they were not significantly associated. The mean weight of the cases in the two groups does not seem to be statistically significant also there are no significant differences in weight among immediate and delayed groups ($p>0.05$), on the other hand, the Pre-conversion ventricular mean, Pre-conversion AF beats and Number of beats to achieve SR

were significantly differing between immediate and delayed groups ($p<0.05$), while statistically the significant differences ($p>0.05$) were not observed for DC shock dose needed, LA size, Time for the response, Time for full recovery, SR during follow-up and Recurrence of AF. Table 2

Table 2: Distribution of the immediate and delayed conversions groups

Parameter	Category	Immediate group	Delayed group	Statistical test	*P*-value
Age (years)	Mean±SD	62±9	60±10	T-test	0.37
Gender	Male	22 (44%)	16 (59.3%)	Chi-square	0.20
	Female	28 (56%)	11 (40.7%)		
Weight (Kg)	Mean±SD	89±7.7	90±10.2	T-test	0.63
Pre-conversion ventricular mean (rate/minute)	Mean±SD	138±22	75±18	T-test	0.0001
Pre-conversion AF beats	Range	0	4 – 22		0.0001
	Mean±SD	0	13±6	T-test	
	Time (seconds)	0	3.4 - 11	T-test	0.0001
	Mean±SD	0	7.2±4		
DC shock dose needed	200J – 1st dose	38 (76%)	18 (66.7%)	Chi-square	0.44
	300J - 1st dose	11 (22%)	7 (25.9%)		
	300J – 2nd dose	1 (2%)	2 (7.4%)		
The post-conversion appearance of APCs	Yes	12 (24%)	24 (88.9%)	Chi-square	0.00001
	No	38 (76%)	3 (11.1%)		
LA size (cm)	Mean±SD	4.3±2	4.5±3	T-test	0.7
Time for response (minutes)	Range	10 - 16	7.5 - 16	T-test	0.5
	Mean±SD	13±6	12±8		
Time for full recovery (minutes)	Range	15 - 26	12 – 26	T-test	0.6
	Mean±SD	22±9	23±10		
SR during follow-up	No.(%)	32 (64%)	19 (70.4%)	Chi-square	0.57
Recurrence of AF	No. (%)	18 (36%)	8 (29.6%)	Chi-square	0.57
Number of beats to achieve SR	<5	0 (0%)	3 (11.1%)	One way ANOVA	0.00001
	5-10	0 (0%)	8 (29.6%)		
	11-15	0 (0%)	3 (11.1%)		
	16+	0 (0%)	13 (48.1%)		

The synchronized DC shock reverts the AF into sinus rhythm immediately with the appearance of few atrial premature beats after the reversion which usually disappears within a few seconds (Figuer: 1),

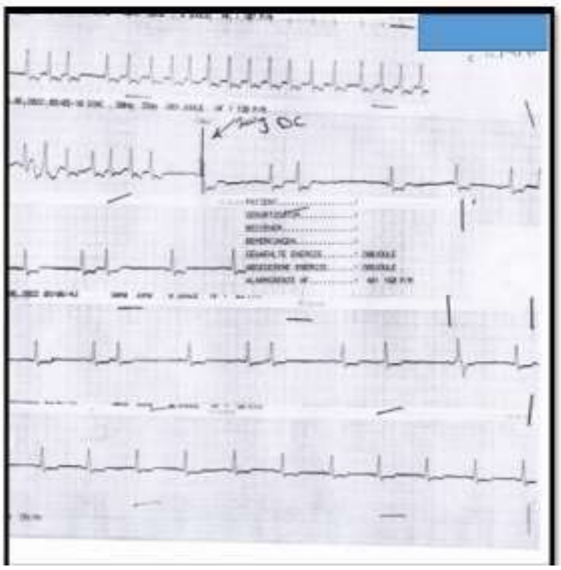

Figure 1: SDCS reverting the AF immediately into SR with frequent APC appearance

another immediate reversion of AF into sinus rhythm with no atrial premature beats appearance in figure (2).

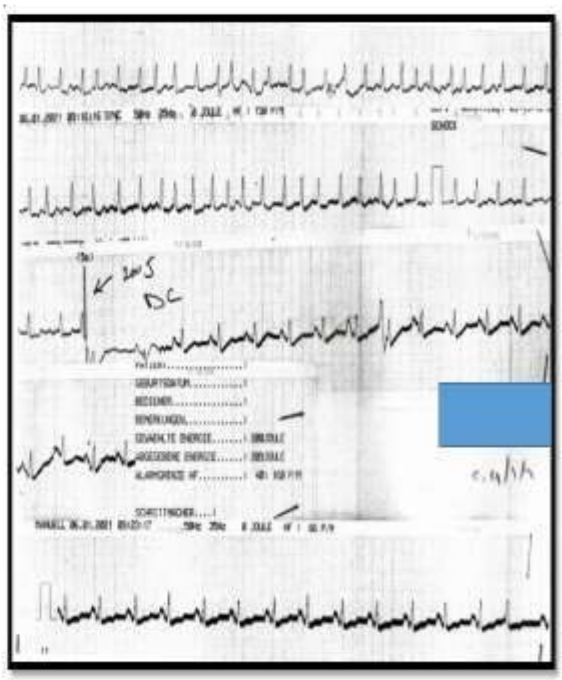

Figure 2: AF reverted immediately into SR after 200J SDCS

The delayed pattern of reversion of AF into sinus rhythm where about for 10 beats AF continued before stabilizing into sinus rhythm (figure 3),

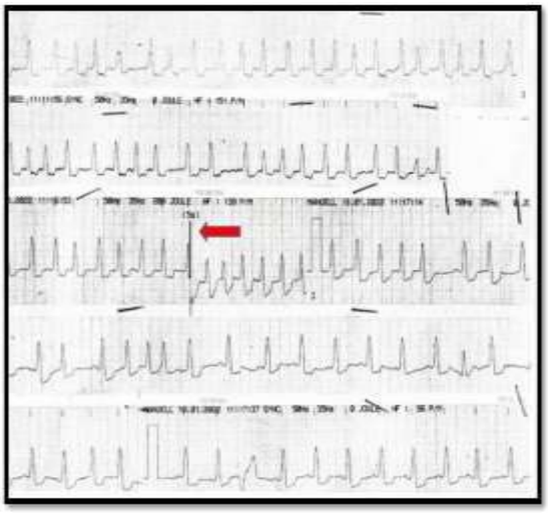

Figure 3: Delayed reversion of AF into SR by SDCS (red arrow) after 11 AF (3.6 seconds) betas with frequent APCs

while the delayed reversion pattern of AF into sinus rhythm with limited duration of AF after the DC shock before stable sinus rhythm achievement were found in some patients (fig.4),

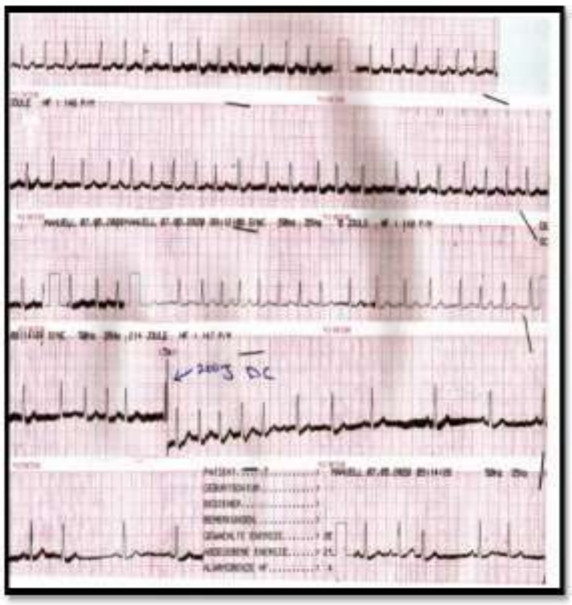

Figure 4: Delayed reversion of AF into SR by SDDCS after 7 beats (3.4 seconds) in AF

and The remarkable delayed reversion of AF into sinus rhythm after DC shock delivery where we can see AF continued for about 36 beats (11seconds) before stable sinus rhythm appearance (fig.5). In this situation in specific the physician may consider unnecessarily deliver another DC shock.

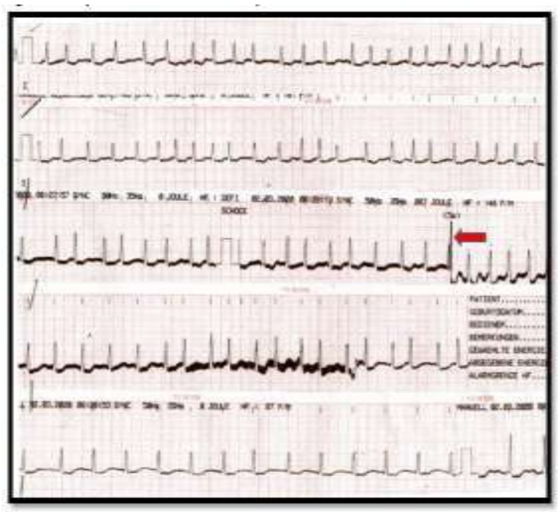

Figure 5: Delayed reversion of AF by SDCS (red arrow) after 24 AF beats (11 seconds)

Discussion:

The potential mechanism of AF is multiple micro-reentry circuits firing together in a variable time and cycle length. Cardioversion depolarizes cardiac tissues and makes them refractory. Depolarisation of all micro-reentry circuits involved in AF will lead to the termination of AF.

The termination of AF by DC shock can be immediate after shock delivery or delayed for a few beats16. Waiting for a short period before delivering a second shock is practically and clinically significant. The factors which govern these conversion patterns were looked for in this study. Wong et al16, (the only study we found in the literature discussing the delayed and the immediate reversion of AF into SR with DC shock) used coronary sinus catheters to record atrial potentials in 171 patients. They found that 54% of their AF patients converted immediately after cardioversion and 45% had a delayed pattern, compared to the current study with 65% with an immediate conversion and 35% with a late pattern and the ventricular rate was faster in the IG than the DG group. These findings are in contradiction with those of Wong et al. In our study, a slower ventricular rate just before the cardioversion predicts a delayed pattern of reversion. The number of APCs within SR after reversion was significantly more frequent in the DG than the IG. This may suggest that there is still an active atrial discharge after reversion but not sufficient to continue the AF which is consistent with Wong's explanation. The duration of AF after delivering the DC shock in the delayed group can be long enough to make the treating physician intend another DC shock but according to our findings it is advisable to wait even for 1-2 minutes for the AF to revert into SR before considering delivering another DC shock.The successful dose of DC shock to revert AF into SR in the two groups was not significantly different. The recurrence rate of atrial fibrillation in the IG was almost similar to that in the DG, a finding that does not help to predict recurrence.

Limitations: The number of patients is relatively small.

Conclusion:
The slow VR before DC shock is the main predictor for delayed conversion of atrial fibrillation by DC shock. Another predictor of delayed conversion is the appearance of APCs after DC shock delivery. In clinical practice delayed reversion should be carefully observed before delivering another DC shock.

Authors' declaration:
We confirm that all the Figures and Tables in the manuscript belong to the current study. Besides, the Figures and images, which do not belong to the current study, have been given permission for re-publication attached to the manuscript. Authors sign on ethical consideration's approval-Ethical Clearance: The project was approved by the local ethical committee in (Place where the research was conducted or samples collected and treated) according to the code number **(123 on (15.08.2018)**

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The manuscript should mention the contribution of each author to the research done:
Study conception & design: (Amar T. Al-Hamdi). Literature search: (All authors). Data acquisition: (All authors). Data analysis & interpretation: (All authors). Manuscript preparation: (Azad J. Ali & Becker S. Alzand). Manuscript editing & review: (All authors).

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ماذا يحكم إرجاع فرفرة أذين القلب إلى النبض الطبيعي المباشر أو المتأخر؟

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الخلاصة
الخلفية: إن إرجاع النبض الطبيعي بواسطة الرجة الكهربية في فرفرة أذين القلب قد يكون مباشرا أو متأخرا.
الهدف: بحث خصائص كل من الإرجاع المباشر أو المتأخر لفرفرة أذين القلب.
المرضى والمنهجية: أجريت الدراسة في مركز الحسني لأمراض القلب في الفترة من تشرين الأول 2018 الى شباط 2022. أدرج في هذه الدراسة مرضى فرفرة أذين القلب المستمر الذين أرجعوا الى النبض الطبيعي بواسطة الرجة الكهربية. أظهرت مجموعة منهم إرجاعا مباشرا وأظهرت الأخرى إرجاعا متأخرا بعد عمل الرجة. درست الظواهر التالية: فترة فرفرة أذين القلب، مدى سرعة البطين قبل الإرجاع، العلاج السابق للرجة، وزن المرضى، وحجم الأذين الأيسر في كلا المجموعتين اعلاه.
النتائج: من المجموع الكلي ل 86 مريضا لفرفرة أذين القلب المستمرة عرضوا للرجة الكهربية، أرجع 77 مريضا (89%) إلى النبض الطبيعي وأدرجوا في هذه الدراسة. أرجع خمسون مريضا مباشرة و 27 أرجعوا متاخرا. كان معدل سرعة البطين أسرع في المجموعة المباشرة 138± 22 مقارنة ب 75±18 في المجموعة المتأخرة. ان ظهور ضربات أذينية هاجرة بعد الرجة كان أكثر في المجموعة المتأخرة. لم يكن تأثير ألعلاج الدوائي المسبق ذو أهمية في كلا المجموعتين. كانت فترة اللانضمية أقصر في المجموعة المباشرة.
الإستنتاج: إن الإرجاع المتأخر أو المباشر لفرفرة أذين القلب إلى النسق الطبيعي بواسطة الرجة الكهربية يحكم بسرعة البطين السابقة للإرجاع وظهور ضربات أذينية هاجرة بعد الرجة الكهربية.
الكلمات المفتاحية: إرجاع فرفرة؛ أذين القلب المباشر؛ المتأخر.