

# The efficacy of synchronized direct current shock in reverting long standing persistent atrial fibrillation in to sinus rhythm; What helps to achieve high success rate

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## Abstract:

**Background:** Atrial fibrillation is the most frequent cardiac arrhythmia encountered in general medicine and cardiology practice. Synchronized direct current shock is a known safe and effective procedure to revert long standing persistent atrial fibrillation into sinus rhythm.

**Objectives:** The Objective of current study was to assess the efficacy of synchronized direct current shock in reverting long-standing persistent atrial fibrillation into sinus rhythm and recognizing factors that help in achieving high success rate.

**Patients and Methods:** Patients with long-standing atrial fibrillation who were seen at the author's private clinic and Al-Hassani Heart Center in Sulaimanya from April 2018 to December 2020 were chosen for rhythm control subjected to synchronized direct current cardioversion under heavy sedation applying a modified anterolateral paddles position with 200J and 300J successively according to the reversion dose required.

**Results:** In this case series study 61 patients were included thirty-one males 30 females The success rate was 89%. Even patients with atrial fibrillation duration more than 2 years showed a success rate of 84%. The recurrence rate of atrial fibrillation was 30% within a follow up period of one month to 2 years. The modified paddles position has helped in achieving high reversion rate where success increased from 62% to 85% and failure rate decreased from 38% to 15%. The shock dose needed for reversion ranged from 200J to 300 J. There was no correlation between the needed dose for reversion and body weight where patients with body weight of 71-80kg, more than 80% reverted with 200J. Pre shock antiarrhythmic drugs did not facilitate the conversion, the reversion rate in patients with or without antiarrhythmic drugs were 85% and 82% successively. No per procedure complications were seen.

**Conclusion:** Electrical cardioversion of atrial fibrillation with modified paddles position is a safe, effective and smooth procedure with significantly high success rate and very low incidence of complications even with very long-standing atrial fibrillation.

**Keywords:** atrial fibrillation, direct current shock, antiarrhythmic drugs, cardioversion.

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## Introduction:

Atrial fibrillation (AF) is the most frequent cardiac arrhythmia encountered in general medicine and cardiology practice. A total of 3.046 million new cases of AF worldwide were registered in the database during 2017. The estimated incidence rate for 2017 was 403/millions inhabitants which was 31% higher than the corresponding incidence in 1997 1. It is more common during the old age group 2. Atrial fibrillation is a major risk factor for ischemic stroke and provokes important financial burden with significant morbidity and mortality 1, 3, 4. Electrical cardioversion by synchronized direct current shock

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(SDCS) for AF is a very safe and highly effective procedure with very rare complications 2,3. The duration of atrial fibrillation and the response to SDCS are the main two indices to classify AF as paroxysmal, persistent, late (long standing) persistent or chronic permanent atrial fibrillation. If the duration of the symptomatic AF is of few hours to 7 days and the rhythm is restored spontaneously, pharmacologically or by SDCS, into sinus rhythm (SR) the AF is classified as paroxysmal. If the AF duration is beyond 7 days and reverted to SR, the AF is labeled as persistent. If the duration of AF is of more than 12 months and reverted to SR with SDCS, the AF is defined as long standing persistent one. Permanent AF is that when it is accepted by patient and physician, and no further attempts to restore/maintain sinus rhythm will be undertaken. However, if a rhythm control strategy is adopted, the arrhythmia would be re-classified as 'long-standing persistent AF' 6. Assessing the duration of AF

depending on the symptoms is not always accurate, because AF can be asymptomatic or with non-specific symptoms<sup>5</sup>. In clinical practice it is quite common to fail to exactly spot the duration of AF relying on symptoms of palpitation, dizziness, syncope or dyspnea<sup>7, 8</sup>. In our regional clinical observation, this aspect of AF assessment is prevalent. Those classifications are not always applicable to identify the type of AF, because of the unclear duration of symptoms and lack of ECG data to clarify when the patient was in SR last time. Applying SDCS to achieve rhythm control is highly successful in paroxysmal AF and even in long standing persistent type but to label an AF patient as chronic permanent, it is not sharply known and trying SDCS in long standing AF is not rare to achieve rhythm control<sup>4,5</sup>. Patients who were subjected to SDCS were found to have lower rates of complications with shorter duration and lower cost of hospitalization<sup>4, 5, 6</sup>. Achieving rhythm control is hemodynamically effective to improve cardiac output and heart failure (HF) in AF patients<sup>4,5</sup>. Pharmacological cardioversion (PCV) is widely used but it is not free of drug side effects and complications specifically with heart failure. SDCS is quick, safe and more effective than drug therapy to revert AF into SR<sup>5, 9</sup>. Many practitioners may use drugs before considering SDCS either to achieve or to facilitate reversion with SDCS<sup>5, 6,9,10</sup>. Both the drug-shock and shock-only strategies were highly effective, rapid, and safe in restoring sinus rhythm for patients in the emergency department with acute AF<sup>9</sup>. The predicting factors for reversion into SR by SDCS are not always clear. Studying such factors is of significant clinical value for patient selection for rhythm control rather than rate control strategy during the management of long standing AF<sup>11, 12</sup>. Maintaining SR with antiarrhythmic drugs (AAD) is an important aspect of treating AF. Flecainide, propafenone, amiodarone, and dronedarone showed similar efficacies for maintaining SR after electrical cardioversion<sup>13</sup>.

#### **Patients and Methods:**

Patients with AF, seen at the author's private clinic and at Al-Hassani Cardiac Center in Sulaimanya from April 2018 to January 2021, were included in this case series study. Patients were assessed by history of symptoms, previous ECG data to see when the patient was last time been in SR, investigations for the underlying cardiac and non-cardiac etiologies of AF, and then deciding whether the patient is suitable for rhythm control or rate control strategies. Rhythm control strategy is decided if: a) the AF is paroxysmal when the duration of AF is 7 days or less, b) the AF is long standing persistent when the duration of AF is around 1 year and rhythm control is felt more helpful, and c) if the AF is chronic permanent when duration is more than 1 year and a benefit of rhythm control is higher and the patient agreed on this indication. Once rhythm control is chosen, consideration of SDCS is

done either directly or after a trial of chemical reversion with oral flecainide for 2-3 days or amiodarone for 14 days. Provisionally, patients who revert to SR by drug therapy were excluded from this study. Oral anticoagulant (OAC), including novel oral anticoagulant (NOAC) as rivaroxaban, in the majority of cases was started once the AF is diagnosed and for not less than 48-72 hours before the SDCS is delivered. Transthoracic echocardiography (TTE) was done to all patients where LA size was measured, the LA cavity was inspected carefully for the presence of thrombi and LV function was assessed. Patients who showed LA thrombi were excluded from this study. The TTE was repeated immediately before shock delivery. After an overnight fasting of the patient, thorough pre-procedural assessment of the physical status, risk assessment and discussion with the patient and the relatives to obtain verbal or written informed consent were performed. Peripheral intravenous cannulation, admission to the catheter-lab, positioning the patient in supine position with a shoulder support, pre-procedural pure oxygen administration via nasal cannula or face mask with or without an oropharyngeal airway and connection to non-invasive monitors, were carried out in all patients successively. Intra-procedural administration of IV mixture of ketamine 25mg plus fentanyl 25-37.5µg followed by a titrated dose of IV propofol 80-140mg according to the physical status and body weight, was aimed at heavy sedation and unawareness. Synchronized electrical cardio version was conducted once the patient was losing communication with the environment. Generally, this anesthetic technique was sufficient to conduct cardioversion even if more than one SDCS was needed in the same session without awareness. The heart rhythm was monitored by the defibrillator ECG monitoring facilities (Cardioserv from GE Health care technologies, Chicago, Illinois, USA) choosing one lead with the highest sensed R wave, usually lead I. The R wave should be sensed perfectly and sustainably by the monitoring device and the synchronization of the shock was observed clearly by the marked synchronization sign. In the first 21 patients the two DC-shock paddles were positioned anteriorly over the chest wall, the positive paddle at the cardiac apical area in the anterior axillary line and the negative one at the upper right parasternal area (position 1) and for the remaining 40 patients the paddles' position was modified to the positive at the left mid-axillary line and the negative at the right mid-infra clavicular area (position 2). Under smooth and satisfactory sedation state agreed by the anesthetist, a first SDCS of 200J was delivered and the rhythm instantly observed for reversion in to SR. If the rhythm is still AF, then a SDCS of 300J was delivered, a second 300J dose was repeated if AF still persisting, with 2- to 3-minutes interval between the shocks. No higher SDCS than 300J was delivered. The weight of the patient was considered as an indicator of the chest wall thickness

and was correlated to the SDCS dose needed for reversion. The procedure was labeled as successful if SR was achieved and failed if the rhythm was still AF after the second dose of 300J. The failed AF reversion patients were classified as chronic permanent, and ventricular rate (VR) control strategy was adopted with VR slowing drugs including BB, calcium channel blockers and in few cases digoxin was added. Neurological assessment had been performed immediately after recovery of consciousness. The patients were kept under observation at high dependency unit for 2-3 hours. Following discharge from the center, NOAC were planned to continue after reversion into SR for at least 6 months and for longer term if AF is considered as chronic permanent. Those who reverted into SR were maintained on an oral antiarrhythmic drug, either flecainide in a dose of 100mg twice daily or amiodarone in loading dose of 800mg for 3 days, 600mg for 3 days, 400mg for 3 days and then 200mg maintenance. Patients were followed up at the outpatient (OP) clinic after 6 weeks and then every 3 months or according to the recurrence of symptoms. At the OP clinic, patients were assessed by symptoms improvement, rhythm monitoring for AF recurrence by 12 leads ECG and 48 hours Holter monitoring. LV function improvement and LA size were assessed by echocardiography.

### **Results:**

The total number of patients included in this case series study was 61 patients. Thirty-one were males and 30 were females. The age of participants ranged from 27-75 years. The period of the study was from April 2018 to January 2021. The weight of patients ranged from 65 -105kg The Underlying heart diseases in the group were IHD in 23(38%) patients where 13(21%) of them were with heart failure and 10(2%) without. DCM was found in 7(11%). Tachycardia-induced DCM and HF were found in 7(11%). Thyrotoxicosis was seen in 2 patients and atrial septal defect (ASD) was seen in one patient. No structural heart disease was found in 21(34%) patients. The approximate assessment of duration of AF, based on symptoms, history and the available previous ECG records, was as follows: 1-2 months or less seen in 13(21%) patients, 2 months to 1 year in 16(26%) patients, the more than one-year duration of AF was classified into two groups; those with an assumed duration of 2-3 years were 19(31%) and those with a duration of 4-5 years were 13(21%) patients. The presenting symptoms of AF were palpitation in 55(90%) patients, SOB in 47(77%) patients, dizziness in 14(23%) patients, syncope was seen in 10(16%) patients and chest pain in two patients. Three patients presented with dyspnea only. Many patients have more than one symptom. All the patients started on OAC therapy before reversion trial whether with AAD or SDCS. The OAC was rivaroxaban in 54(89%), Dabigatran in 5(8%) and warfarin in 2 patients (3%). A failed trial of drug therapy to convert

AF into SR was seen in 50(82%) patients, 13 patients with flecainide 100mg bd for 3 days, amiodarone loading in 16 patients for 14 days, digoxin in 4 (which was already being given by the physician) and BB in 17 patients. No AAD trial was given in 11(18%) patients where SDCS was done primarily due to the relatively urgent need to convert the patient into SR for marked symptoms, HF and fast VR. Provisionally, the patients who revert to SR by drug therapy were excluded from this study. The reversion rate with SDCS in the group received AAD before SDCS was 85% and in those who did not receive pre-shock AAD was 82%. The LA size was enlarged in 51(84%) of patients where the cut-off value for the normal LA size was considered 3.5cms. In 10(16%) patients only, the LA size was 3.5cm or less. The VR was 220/minute maximum to 100/ minute minimum. The success in reverting AF into SR was seen in 54 patients (89%) and failure was noticed in 7(11%). In those patients with AF duration of 2-4 years, the success was seen in 27 out of 32 patients (84%). In 13(21%) patients, AF duration of 4-5 years has been successfully reverted to SR by SDCS. In the 54 patients who reverted to SR, the dose of the shock was 200J in 31(57%), first 300J in 14 (26%), second 300J in 3(6%), in 5 patients 150J was successful and in only one patient 100J was enough to revert the patient into SR. The dose of SDCS correlation to the patient's body weight was shown in Table 4. In 71-80% of heavy weight patients of more than 80kg AF was reverted with 200J. No much difference in the successful dose in relation to the build and weight of the patient was noticed. The paddles position 1 was applied for 21 patients and position 2 for 40. In the first position the success rate was 62% and failure was noticed in 38%, while within position 2 the success rate was 85% and the failure was 15%. With long-term AAD the recurrence of AF was seen in 30% which occurred after 10 days to 11 months after conversion into SR. Post-procedural recovery time was 15-25 minutes in the vast majority. No recall of the procedure or anesthetic mortality was recorded. One patient developed sinoatrial arrest and, therefore, immediate trans-venous temporary, and then, permanent pacemaker was done. Two patients developed sever pulmonary edema 4 hours after reversion in to SR, treated with IV diuretics and improved quickly. Fifty patients (82%) were seen in follow up and 11(18%) did not attend. The period of follow up amongst the 50 patients who turned up for follow up ranged from one month to two years after SDCS. The NYHA functional class before conversion into SR was II-III in 19 patients, I-II in 17 and I in 18 patients which remarkably improved after reversion into SR (Figure 1). The LVEF was in the range of 25-48% during AF and rose up to a range of 40-65% after achieving SR. The recurrent AF patients were advised either for pulmonary vein isolation (PVI) ablation therapy, drug rate control or His ablation and biventricular (BV) or His bundle pacing according to clinical status and patient preference.

**Table (1) Demographic features of the 61 patients included in the study.**

Total 61 patients	
31 M	
30 F	
Age: 27-75 Y	
Period of data collection: 12.4.2018 - 6.1.2021	
HT 35	
DM 16	
40 underlying SHD:	
13 IHD &HF	
10 IHD no HF	
7 DCM&HF	
7 TIC&HF	
2 Thyrotoxicosis	
1 ASD	
21 No SHD	
Assessed Duration of AF	
13 1-2 M	
16 3M-1 Y	
19 2-3 Y	
13 4-5 Y	
Presenting Symptoms	
55 P	
47 SOB	
14 DZ	
10 S	
2 CP	

HT: hypertension. DM: diabetes mellitus. IHD: ischemic heart disease. HF: heart failure. DCM: dilated cardiomyopathy. TIC: tachycardia-induced cardiomyopathy. SHD: structural heart disease. ASD: atrial septal defect. P: palpitation. SOB: shortness of breath. DZ: dizziness. S: syncope. CP: chest pain.

**Table (2) The SDCS outcomes and dose delivered.**

Total	Success SR	Dose/J	Failed
61	54(89%)	2001	7(11%)
		31(57%)	3002
		3001	

	14(26%)
	3002
	3(6%)
	150
	5(9%)
	100
	1(2%)

J: joules. SR: sinus rhythm. 200: 1,first SDCS. 300: 1,2 first &second SDCS..

**Table (3) Follow-up period of reverted patients and AF recurrence rate and time after reversion**

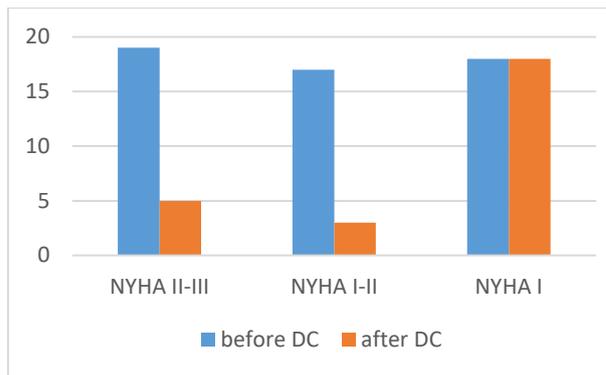
Total SR	FU	NFU	RC
54	50(93%)	4(7%)	15 from 50(30%)
	1M 13		10D 3
	6M 23		1M 3
	1Y 7		2M 3
	2Y 7		5M 1
			6M 2
			7M 2
			11M 1

.SR: sinus rhythm. FU: follow up. NFU: no follow up. RC: recurrence. D: day. M: month. Y: year.

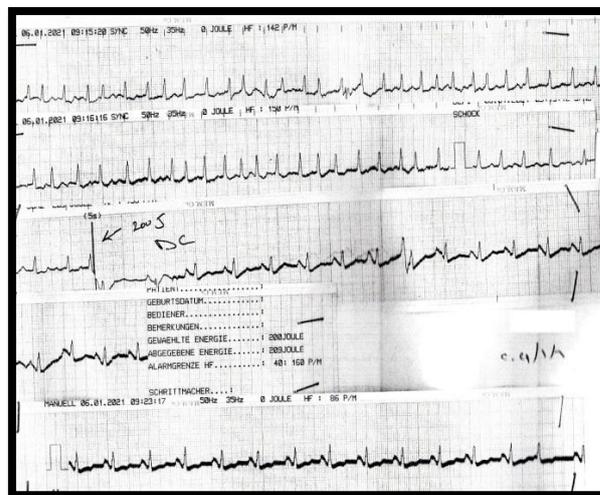
**Table (4) Correlation of successful dose of SCDS to the body weight in the 54 patients reverted to SR**

Weight/Kg	Dose/J	No. reverted	% from the Group
Groups 54 total group			
60-70 1	200	1	100%
71-80 10	200	8	80%
	300	2	20%
81-90 38	200	27	71%
	3001	8	21%
	3002	3	8%
91-105 5	200	4	80%
	3002	1	20%

Kg: Kilogram. J: Joules. 3001: first 300. 3002: second 300.



**Figure (1) Number of patients with NYHA functional class improvement after reversion of AF into SR i.e . before and after DC shock.**



**Figure (2) ECG strip showing the SDCS delivery of 200J reverting the AF into sinus rhythm.**

**Table (5) Significant improvement in the success rate of reversion in paddle position 2 in comparison to paddle position 1**

First 21	Last 40
PDLP 1	PDLP 2
S 13 (62%) F 8(38%)	S 34(85%) F 6(15%)
200 J 6	200J 25
300J 2	300J 5
300J 4	300J 1
150 J 1	150 J 1
	100 1

PDLP: paddle position. S: success. F: failed. J: joules.

**Discussion:**

Achieving a stable SR in patients with AF has been known to improve symptoms, quality of life (QOL)

and LV function remarkably although some studies had shown a relatively similar improvement in these parameters with ventricular rate control rather than rhythm control 4,5. The SDCS has been known as a safe, effective and quick method for reverting AF patient into SR for such a long time 2-4,7. The factors which affect success rate for reversion are important to achieve the highest possible reversion rate. Although the duration of AF is known to be an important predicting factor for reversion as mentioned by 10,11 who showed that a duration of more than 2yr is classified as permanent AF, but in our study we have achieved a reasonable high success rate of reversion in 84% of patients with AF duration of 2-4 years and in 21% of patients with AF duration of 4-5 years. This encourages cardiologist to consider DC cardioversion even with quite long standing AF, which has been considered as chronic permanent by other authors 10, 11. The required dose of SDCS varies from one patient to another. Patients' weight reflecting thick or thin chest walls, the presence of SHD, the use of AAD before the SCDS and patient's age have been considered to play a role in choosing the dose of DC shock 11. We did not find a clear correlation between these factors and the reversion rate with SDCS (Table 4). In our series, we started with 200J rather than lower doses to minimize the number of shocks needed and we applied 300J if the initial 200J failed. This will shorten the anesthesia and the procedure time. The paddle position modified from position 1to position 2 had significantly improved the success rate of reversion. Previous work by Alp comparing antero-lateral to antero-posterior paddle position had come to conclude that the antero-lateral paddle position appears more effective for DC cardioversion of persistent atrial fibrillation15. While another study showed that an anterior-posterior electrode position is more effective than the anterior-lateral position for external cardioversion of persistent atrial fibrillation16, we adopted a new modification of anterolateral paddle position called position 2 where we moved the apical paddle from the traditional anterior axillary line to the mid-axillary line and the negative paddle to the right infra-clavicular area from the right parasternal position. With this paddle position 2 we achieved a significantly higher success rate than the traditional anterolateral position labeled as paddle position 1 (Table 5). We did not find a similar modification in the literature. With the long-term AAD, the recurrence rate of AF was rather comparable to that of catheter ablation (PVI) during a similar follow up period 14.

**Conclusion:**

SDCS is a highly successful method for reverting AF into SR even with very long standing AF of more than 2 years duration. The paddle position 2 has achieved a better success for reversion. SCDS reversion of AF and long term AAD is reasonable method of

treatment before considering catheter ablation therapy.

Limitation of the study

The total number of patients is rather small and the follow-up period was relatively short. Therefore, longer follow-up is needed to assess the recurrence rate more precisely.

#### Author's contributions:

Both authors have done the same contribution for patients data analysis and writing the manuscript.

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## كفاءة الرجة الكهربائية المنسقة في ارجاع فرفرة أذنين القلب المتواصل الطويل المدى الى النسق الجيبي الطبيعي . ما الذي يساعد للحصول على نسبة ارجاع عالية؟

الدكتور عمار طالب الحمدي  
الدكتور آزاد جلال علي

### الملخص

**المقدمة:** ان فرفرة أذنين القلب هي من أكثر اللانظميات القلبية شيوعا في الطب الباطني العام و أمراض القلب. أن الرجة الكهربائية المنسقة هي طريقة آمنة ومؤثرة و معروفة لأرجاع فرفرة أذنين القلب الى النسق الجيبي الطبيعي.

**هدف الدراسة:** تقييم كفاءة الرجة الكهربائية المنسقة لأرجاع فرفرة أذنين القلب المتواصل الطويل المدى الى النسق الجيبي الطبيعي و تمييز العوامل المساعدة للحصول على أعلى نسبة ارجاع.

**المرضى و طريقة البحث:** ادرج في الدراسة المرضى اللذين لديهم فرفرة أذنين القلب الطويلة المدى و اللذين راجعوا عيادة المؤلف و مستشفى الحسيني في السليمانية خلال الفترة من نيسان 2018 الى كانون ثاني 2021 و اللذين أختيروا للسيطرة النظامية حيث عرضوا للرجة الكهربائية المنسقة تحت التخدير العميق مستعملا طريقة محورة لوضع الأقطاب الكهربائية في الوضع الأمامي الجانبي و اعطاء جرعة 200 او 300 جول تعاقبيا حسب الجرعة الناجحة.

**النتائج:** أدرج في هذه الدراسة لحالات متسلسلة 61 مريضا , 31 رجال و 30 نساء.نسبة نجاح الأرجاع كانت 89% و نسبة الفشل 11%.حتى في الحالات المزمنة لأكثر من سنتين كانت نسبة النجاح 84%. كانت نسبة رجوع فرفرة اذنين القلب 30% خلال فترة متابعة من شهر الى سنتين.ان الطريقة المحورة لوضع الأقطاب المحورة ساعدت للحصول على نسبة ارجاع أعلى.كانت جرعة الرجة الضرورية للأرجاع من 200-300 جول.لم يتبين وجود علاقة بين جرعة الأرجاع المطلوبة و بين وزن المرضى. استعمال ادوية مثبتات النبض قبل الرجة لم يساعد في تسهيل مهمة الأرجاع.لم تلاحظ اختلاطات خلال الاجراء المذكور.

**الاستنتاج:** ان الأرجاع الكهربائي لفرفرة أذنين القلب بواسطة وضع الأقطاب المحور هو اجراء امن ومؤثر و سلس و يعطي نسبة نجاح عالية و نسبة اختلاطات واطئة حتى في فرفرة الأذنين طويلة المدى جدا.

**الكلمات المفتاحية:** فرفرة أذنين القلب, الرجة الكهربائية