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Keys to a Safe and Effective Cardioversion

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Abstract

Cardioversion is a frequently performed procedure to terminate atrial arrhythmias; commonly atrial fibrillation and atrial flutter, to relieve symptoms and improve cardiac performance. In simple terms, it involves the delivery of high energy electrical shock to patient's chest wall to the heart to interrupt abnormal electrical currents to restore it to normal sinus rhythm. Prior to performing this procedure, there are several safety checks undertaken for a safe and successful outcome. There is a 48 hours safety window for cardioversion without appropriate anticoagulation and the need for continuation of appropriate anticoagulation for 4-6 weeks after cardioversion to reduce the risk of stroke. Advance practice providers (APPs) are emerging as an integral part of the cardiovascular team and they have been recognized as safe provider to perform cardioversions autonomously with appropriate clinical training using AHA Guidelines directed protocols. The AHA Guidelines for a safe and successful cardioversion will be discussed in this article.

Keywords: Cardioversion; Arrhythmias; Atrial fibrillation; Atrial flutter; Anticoagulation therapy; Stroke; Risk of stroke; 48 hours safety window; Sinus rhythm

Introduction

Advance practice providers (APPs) are emerging as an integral part of the cardiovascular team and they have been recognized as safe provider to perform cardioversions autonomously with appropriate clinical training using AHA guidelines directed protocols. A recent evidence-based study also concluded that APPs can safely perform cardioversions autonomously using appropriate tools, protocols, and checklists of procedures directed and supervised by physicians that have effective outcomes and excellent patient satisfaction [1].

Definition & Physiology

Cardioversions and defibrillations are two commonly used procedures for patients with abnormal heart rhythms. Cardioversion is a commonly used procedure to terminate abnormal cardiac arrhythmia, most commonly atrial fibrillation and atrial flutter. To restore a normal heart rhythm, cardioversion delivers high energy electrical shock through the chest wall to the heart muscles. This delivery of high energy electrical shock that is synchronized to the QRS Complex is cardioversion, whereas the delivery of non-synchronized electrical shock that is given randomly during the cardiac cycle is defibrillation [2].

Delivering a synchronized electrical shock that depolarizes the tissue involved in a reentrant circuit during cardioversion terminates arrhythmias. The circuit is unable to propagate or sustain reentry by depolarizing all excitable tissue of the circuit by making the tissue refractory. Cardioversion terminates those arrhythmias resulting from a single reentrant circuit, such as an atrial flutter, an atrioventricular nodal reentrant tachycardia, an atrioventricular reentrant tachycardia, or a monomorphic ventricular tachycardia. Cardiac muscle and conduction tissue are simultaneously activated by high energy electrical impulses. An interruption of reentrant circuits takes place, breaking the repeating cycle, and terminating the arrhythmia. Thereafter, the sinus node begins to fire again restoring a normal heart rhythm.

Indications

One of the most common indications for an elective outpatient cardioversion procedure is atrial or supraventricul arrhythmias, especially atrial flutter and atrial fibrillation. The ventricular arrhythmias; ventricular tachycardia and ventricular fibrillation are commonly treated with an emergent defibrillator shock. Elective cardioversion for atrial flutter/fibrillation are commonly performed in the post anesthesia care unit (PACU). In cardiovascular intensive care unit or in an emergency department (CVICU/ED) setting, defibrillation is done in emergent VT/VF cases. However, there are no rigid rules where one procedure can be done and the other cannot be done. Pregnancy is not a contraindication for cardioversion. Fetal heart monitoring during the procedure is recommended but should not delay emergent defibrillation.

Pre-Cardioversion Safety Checks

- Informed consent: Prior to the procedure an informed consent must be obtained explaining benefits versus risks and alternative available options.
- Prior to performing cardioversion; potassium (K) and magnesium (Mg) levels should be checked. K level should be >4 & Mg level should be >2.
- If patient is on digoxin therapy, check digoxin levels. Life-threatening ventricular arrhythmias can occur with a combination of low serum potassium levels and toxic levels of digoxin while cardioverting the patient.
- Anticoagulation: If performing an elective cardioversion for atrial fibrillation or flutter and the patient is on Warfarin, INR levels must be consistently therapeutic (2.0-3.0) for at least four weeks prior to the procedure. If on NOACs (Xarelto, Apixaban, Pradaxa), patient must be on it for four weeks prior to the procedure without interruption. In my observation patients who have undergone

gastric bypass surgery have a questionable absorption status. These patients should be anticoagulated with traditional Warfarin with regular INR checks for the accuracy of their anticoagulation status rather than NOACs.

- Appropriate sedation, generally given by an anesthesiologist, must be administered as it is a painful procedure.
- Aspiration prevention, a suction apparatus should be within immediate reach.
- If patient with device, the device analyzer should be within reach.
- If K and Mg levels are inadequate, replace prior to the procedure.
- If not anticoagulated appropriately: Confirm, how long the patient has been in arrhythmia. If patient has been in arrhythmia <24-48 hours, proceed with cardioversion.
- If patient has been in arrhythmia >48 hours, a trans esophageal echocardiogram (TEE) is required to rule out left atrial/left atrial appendage thrombus.
- If TEE is negative for thrombus, proceed with cardioversion.

Factors affecting Success of Cardioversion

Device related variables: The outcome of cardioversion is based on a number of electrode characteristics. These include electrode position; pad size, and hand-held versus patch electrodes [3]. The amount of energy also has an impact upon the outcome of the cardioversion procedure. It is important to make sure that the skin is clean, dry and free of hair for good adhesion of electrodes. Several studies have suggested that lesser energy is required with electrodes positioned in anteroposterior fashion than anterio-anterior position. The success rate with the anteroposterior electrode position is higher compared to anterio-anterior electrode position [4] (Figure 1).

Patient with device: Patients with permanent pacemaker/implantable cardioverter defibrillator (PPM/ICD) require special attention to electrode placement. Electrodes should be placed at least 12 cm away from the device. Preferably the electrode pads should be in the anteroposterior position and avoid any contact with the skin overlying the device.

Patient related variables: The type of arrhythmia and the patient's clinical condition are important determinants for a successful outcome of the procedure. Patients with primary atrial fibrillation are easier to cardiovert than patients with secondary atrial fibrillation resulting from an uncompensated congestive heart failure and hypotension. The duration or amount of time an arrhythmia, both atrial and ventricular, has been present also determines the outcome. The longer the duration, the harder it is to keep patients in rhythm. The more recent the onset of an arrhythmia, the greater is the success with cardioversion. Some studies have shown that patients with more recent onset of arrhythmia have higher chances remaining in sinus rhythm for a longer period of time compared to the patients who have had chronic arrhythmias.

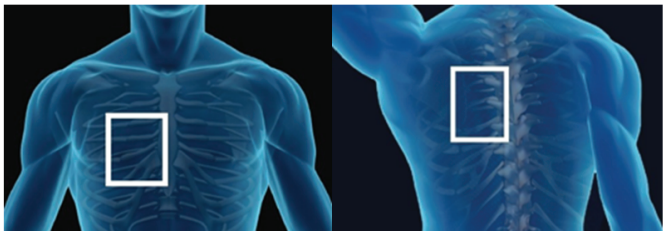

Figure 1: Electrode positions.

The energy requirements are different for organized and non-organized arrhythmias. Organized arrhythmias, such as atrial flutter, arise from a discrete reentrant circuit which is easily depolarized by smaller amounts of current of 100 Joules (J). Higher energy of 200-360 J is often required for non-organized rhythms, such as atrial fibrillation, polymorphic ventricular tachycardia, and ventricular fibrillation. The wave fronts are multiple and involve more myocardial mass, thereby requiring more energy (200-360J) for termination.

Antiarrhythmic drugs: Loading patient with adequate amount of antiarrhythmic drugs prior to an elective cardioversion have resulted in better outcomes and patients tend to remain in normal sinus rhythm for a longer period of time compared to patients who are not loaded with antiarrhythmic drugs (AAD).

Procedure

A cardioversion procedure is performed in a hospital-based setting, such as PACU, as an elective outpatient procedure on closely monitored stable patients. It is also performed as an emergent procedure for a hemodynamically unstable patient in a CVICU/ED setting in a hospital or in a procedure room that is specially equipped for cardioversion. Patients are connected to monitors for continuous monitoring of heart rate, rhythm, oxygen levels, breathing rate, and blood pressure. The electrical shocks during cardioversion are painful, so moderate conscious sedation is performed by anesthesiologist to put patients asleep transiently. Intubation with endotracheal tube is not necessary for this procedure. The skin is shaved, cleaned, and dried after which two electrode patches or paddles are applied to the skin. After these preparatory steps and when the patient is adequately sedated, high energy electrical current is delivered through these patches. The amount of energy used depends upon the arrhythmia. Subsequent higher energy electrical shocks may be needed if the initial attempt at converting the heart rhythm to sinus rhythmis unsuccessful [2].

The cardioversion procedure itself takes only a few seconds once all the preparatory setups described above are complete. The patient usually awakens and is alert five to ten minutes after the procedure when the anesthesia wears off.

Steps

- Verify informed consents obtained for procedure, anesthesia, and anticoagulation and obtain TEE if required
- Electrodes placement
- Check defibrillator: SYNC
- Time out
- Sedation by anesthesia is appropriate
- Select Joules as required. Atrial flutter: 100J. atrial fibrillation: Start with 200J; attending Electrophysiologist's (EP) discretion
- Charge, Clear, Shock.

Complications

- Provocation of other fast or slow arrhythmias
- Extremely slow sinus rates because of sinus node dysfunction and medications
- Sedation related complications: Aspiration
- Skin Burn/Irritation

The cardioversion procedure in itself can sometimes initiate other fast or slow arrhythmias. In order to avoid provoking a dangerous arrhythmia, the electrical shock must be timed with the heartbeat. Occasionally after

cardioversion, the sinus node may not work properly and a very slow heart rate may result in some patients, especially in patients who have been on rate controlled with beta blocking agents. To correct this problem, it may be necessary to pace and at times (rarely) a temporary or a permanent pacemaker insertion may be required. Practitioner should be prepared to trans-cutaneous pace patients for persistent bradycardia or defibrillate patients for unstable ventricular rhythms. Sometimes a stroke can occur if the electrical shock either causes a clot that is already present to dislodge and travel to the brain or to another part of the body. These scenarios are less likely in patients who have had an arrhythmia for less than 24 to 48 hours. However, Cardioversion does not cause "formation of a new clot."

AHA Guidelines for Prevention of TE Complications

Table 1 is the summary of recommendations for electrical and pharmacological cardioversion of AF and Atrial Flutter [5].

Post-Procedure Care

- Patients can go home once wide awake, alert, oriented, and able to swallow well.
- Patients who have been sedated are recommended not to drive for at least 24 hours, therefore, a family member or friend should drive due to residual effects of anesthesia.
- Some patients have irritation of the skin in the area where the shock was delivered and patches applied. It is advised not to rub anything on the area. Some suggest applying a soothing cream such as Aquaphor® or Eucerin® may reduce irritation.

Follow-up Instructions

- Advise patients to continue taking anticoagulation pills for the next four weeks with no interruption. It is important that patient and the family members understand that the risk of stroke is higher after the cardioversion procedure if no anticoagulation is taken. Thus, it is very important to continue with anticoagulation with no interruption for four weeks after the cardioversion procedure.
- Adhere with drugs: AAD or rate controlled (Per EP/Cardiologist).
- Resume activities as tolerated; no driving for 24 hours.
- Keep appointments with EP/Cardiology as scheduled.
- Adequate hydration, regular activities, and exercises are encouraged.
- Compliance with medication, diet, and exercises for adequate blood pressure management is encouraged for normal rhythm.

Recommendations	COR	LOE	References
Prevention of thromboembolism			
With AF or atrial flutter for ≥48 h, or unknown duration, anticoagulate with warfarin for at least 3 wk before and 4 wk after cardioversion	I	B	(110-113)
With AF or atrial flutter for >48 h or unknown duration, requiring immediate cardioversion, anticoagulate as soon as possible and continue for at least 4 wk	I	C	N/A
With AF or atrial flutter <48 h and high stroke risk, IV heparin or LMWH, or factor Xa or direct thrombin inhibitor, is recommended before or immediately after cardioversion, followed by long-term anticoagulation	I	C	N/A
Following cardioversion of AF, long-term anticoagulation should be based on thromboembolic risk	I	C	N/A
With AF or atrial flutter for ≥48 h or unknown duration and no anticoagulation for preceding 3 wk, it is reasonable to perform TEE before cardioversion and then cardiovert if no LA thrombus is identified, provided anticoagulation is achieved before TEE and maintained after cardioversion for at least 4 wk	IIa	B	(114)
With AF or atrial flutter ≥48 h or unknown duration, anticoagulation with dabigatran, rivaroxaban, or apixaban is reasonable for ≥3 wk before and 4 wk after cardioversion	IIa	C	(115-117)
With AF or atrial flutter <48 h and low thromboembolic risk, IV heparin, LMWH, a new oral anticoagulant, or no antithrombotic may be considered for cardioversion	IIb	C	(118)
Direct-current cardioversion			
Cardioversion is recommended for AF or atrial flutter to restore sinus rhythm. If unsuccessful, cardioversion attempts may be repeated.	I	B	(119)
Cardioversion is recommended for AF or atrial flutter with RVR, that does not respond to pharmacological therapies	I	C	N/A
Cardioversion is recommended for AF or atrial flutter and pre-excitation with hemodynamic instability	I	C	N/A
It is reasonable to repeat cardioversion in persistent AF when sinus rhythm can be maintained for a clinically meaningful time period between procedures	IIa	C	N/A
Pharmacological cardioversion			
Flecainide, dofetilide, propafenone, and IV ibutilide are useful for cardioversion of AF or atrial flutter, provided contraindications to the selected drug are absent	I	A	(120-125)
Amiodarone is reasonable for pharmacological cardioversion of AF	IIa	A	(126,127)
Propafenone or flecainide ("pill-in-the-pocket") to terminate AF out of hospital is reasonable once observed to be safe in a monitored setting	IIa	B	(120)
Dofetilide should not be initiated out of hospital	III: Harm	B	(124,128)

AF indicates atrial fibrillation; COR, Class of Recommendation; IV, intravenous; LA, left atrial; LMWH, low-molecular-weight heparin; LOE, Level of Evidence; N/A, not applicable; RVR, rapid ventricular response; and TEE, transesophageal echocardiography.

Table 1: 2014 AHA/ACC/HRS Guidelines for Management of Patients with Atrial Fibrillation.

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