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Direct Current Cardioversion for Lone Atrial Fibrillation in a Parturient with Placenta Accreta

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Abstract

Lone Atrial Fibrillation (AF) is a term used to describe AF occurring without clinical or echocardiographic evidence of cardiopulmonary disease including hypertension or an endocrine disorder. AF is rare in pregnancy however the cardiovascular physiological changes in pregnancy can promote arrhythmogenesis. Major concerns for a parturient with lone AF involve thromboembolic events and hemodynamic instability which would compromise the fetal-maternal unit. Clinical management of AF in pregnancy is the same as in a non-pregnant patient however faster intervention is required. American College of Cardiology, American Heart Association and European Society of Cardiology guidelines state management of AF considers rate control versus rhythm control by either chemical or Direct Current Cardioversion (DCCV). Synchronized DCCV is indicated if a patient becomes hemodynamically unstable as in our case. It has been successfully performed in all trimesters of pregnancy with a high success rate and with no evidence fetal harm. We report a case of preoperative lone AF treated with DCCV under general anesthesia for hemodynamic deterioration in a parturient who presented for a scheduled cesarean hysterectomy for a placenta accreta.

Abbreviations

AF: Atrial Fibrillation; DCCV: Direct Current Cardioversion; ACC: American College of Cardiology; AHA: American Heart Association; ESC: European Society of Cardiology; RVR: Rapid Ventricular Response; OR: Operating Room; ECG: Electrocardiogram; bpm: Beats Per Minute; NSR: Normal Sinus Rhythm; BP: Blood Pressure; FHR: Fetal Heart Rate; CCU: Cardiac Care Unit; CTG: Cardiotocogram; TTE: Transthoracic Echocardiogram; EF: Ejection Fraction; J: Joules; VTE: Venous Thromboembolism

Introduction

Atrial Fibrillation (AF) is the most common arrhythmia encountered in adults [1]. Its occurrence in pregnancy is rare unless there is an underlying condition [2-4]. A parturient who develops AF should be evaluated for structural heart disease, pulmonary embolism, electrolyte imbalance, alcohol abuse, hyperthyroidism and adverse drug effects eg. tocolytic agents such as terbutaline. Lone AF describes AF occurring without clinical or echocardiographic evidence of cardiopulmonary disease including hypertension [5]. It is a diagnosis of exclusion. Lone AF in a parturient is very rare and only a few case reports exist [6-10]. Management of AF in pregnancy is the same as in a non-pregnant patient. Rapid intervention is required due to potential detrimental effects on mother and fetus. American College of Cardiology, American Heart Association and European Society of Cardiology, (ACC/AHA /ESC) guidelines state management of AF considers rate control with digoxin, beta blocker or calcium channel antagonist, versus rhythm control by either pharmacological or Direct Current Cardioversion (DCCV) [11]. Synchronized DCCV is indicated if a patient is hemodynamically compromised. It is non-invasive, highly efficient and lacks any pro-arrhythmic effect. The guiding principle when delivering DCCV is that the electrical current depolarizes cardiac cells allowing the sinus node to resume normal pacemaker activity. DCCV has been successfully performed in all trimesters of pregnancy with no evidence of significant fetal harm and with a high success rate of over 90% [12]. The first report of a direct current being delivered to a heart for ventricular fibrillation was during cardiac surgery in 1947. Later, Lownin 1962 applied synchronized DC shocks to convert AF and ventricular tachycardia to Normal Sinus Rhythm (NSR) [13]. Lone AF may also been managed surgically and more recently with ablation technologies. The first surgical Maze procedure was performed in 1987. This procedure involved creating incisions

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Table 1: AF management guidelines in pregnancy by ACC/AHA /ESC [11].

Class I
1. Digoxin, a beta blocker, or a non-dihydropyridine calcium channel antagonist is recommended to control the rate of ventricular response in a pregnant patient with AF.
2. Direct-current cardioversion is recommended in pregnant patients who become hemodynamically unstable due to AF.
3. Protection against thromboembolism is recommended throughout pregnancy for all patients with AF (except those with lone AF and/or low thromboembolic risk). Therapy (anticoagulant or aspirin) should be chosen according to the stage of pregnancy.
Class IIb
1. Heparin: first trimester and last month of pregnancy IV or intermittent SQ
2. LMWH SQ: first trimester and last month of pregnancy
3. Oral anticoagulant: during second trimester
4. Quinidine or procainamide: pharmacologic cardioversion in hemodynamically stable pregnant patient

in both the left and right atria that would direct the propagation of the sinus impulse through both atria while interrupting the multiple macro reentrant circuits thought to be responsible for AF [14]. A series of improvements has culminated in a less invasive Cox-Maze IV procedure. The introduction of new ablation technologies utilizing radiofrequency energy, microwave, cryoablation, laser, and High-Frequency Ultrasound (HIFU) are also being used as alternatives to the "cut-and-sew" technique for the surgical treatment of AF [14]. We report a case of a sudden onset lone AF with rapid ventricular response (RVR) attributed to an episode of excessive retching prior to induction in a parturient who presented for a scheduled cesarean hysterectomy for a placenta accreta. The lone AF was refractory to pharmacological management but was later successfully treated with DCCV.

Case Presentation

A 25-year-old woman, gravida 3 para 2, presented to the Operating Room (OR) at 36 weeks gestation for a scheduled cesarean hysterectomy for placenta accreta. Past medical history was significant only for hemoglobin C trait and α-thalassemia carrier status. Her obstetric history included one normal vaginal delivery and one cesarean delivery secondary to failure to progress, both at full term. She denied any history of cardiac disease or arrhythmia. Her preoperative hemoglobin was 11 g/dL (12-15.5 g/dL). In preparation for an anticipated major intra-operative hemorrhage, two 16-gauge peripheral intravenous cannulae, an 8.5 F rapid infusion catheter and a 20-gauge radial arterial line were placed preoperatively. The patient was pre-medicated with intravenous famotidine, metoclopramide and oral sodium citrate. During pre-oxygenation, the patient complained of nausea and started vigorously retching. During this episode, her monitored electrocardiogram (ECG) changed from NSR, 80 beats per minute (NSR 60-100 bpm) to a rapid irregular rhythm of 190 bpm. The patient was otherwise asymptomatic and her blood pressure (BP) remained stable at 110-120/70 mmHg. Carotid sinus massage and Valsalva maneuvers were unsuccessful. Two bolus doses of adenosine 6 mg followed by 12 mg were administered intravenously without effect. Esmolol 20 mg was also given intravenously without success. A 12-lead ECG showed AF with RVR. A cardiology consult was made and the start of the case was delayed in order to identify the etiology of this acute onset AF. Continuous Cardiotocography (CTG) monitoring throughout this episode showed a category 1 Fetal Heart Rate (FHR) tracing. An esmolol infusion was initiated before transferring the patient to the Cardiac Care Unit (CCU). The cardiac work up over the next two hours indicated normal electrolytes and thyroid stimulating hormone level as well as a normal transthoracic Echocardiogram (TTE) with an Ejection Fraction (EF) of 55% (normal values 55%-70%). Typical transthoracic echocardiographic findings in normal pregnancy include mild 4 chamber dilation with transient, trivial mitral regurgitation and physiological tricuspid (as seen in this case) and pulmonary regurgitation. The left ventricle ejection fraction does not change in normal pregnancy. While on the CCU, her BP deteriorated and the esmolol infusion was discontinued. In the belief that the patient was decompensating hemodynamically, the team decided to perform DCCV under a double set-up in the OR. The now urgent return to the OR also coincided with the onset of uterine contractions. A decision was made that immediately following DCCV under general anesthesia the cesarean hysterectomy would follow. Maternal pre-induction vital signs were BP 90/65 mmHg, heart rate 160-180 bpm, respiratory rate 18/min and SpO_2 100% on room air. The patient was placed supine with left uterine displacement and anterior-posterior (sternum and left scapular) defibrillator pads were applied. Continuous CTG showed a category I FHR tracing. General anesthesia was administered with a rapid sequence induction using remifentanil 100 mcg, esmolol 20 mg, etomidate 15 mg and succinylcholine 80 mg. Post-intubation hemodynamics remained unchanged. A single, synchronized DCCV, 150 Joules (J) shock was discharged and her AF with RVR converted to NSR at 110 bpm. The patient's BP also improved to 118/70 mmHg. After NSR was confirmed, surgery commenced. General anesthesia was maintained with an oxygen, nitrous oxide and sevoflurane mix and rocuronium for neuromuscular blockade. The neonatologist was informed about the bolus administration of remifentanil and esmolol on maternal induction. A 2585 g male infant was delivered within 3 minutes of incision, with Apgar scores 7 and 9 at 1 and 5 minutes. The duration of the case was 2 hours 35 minutes with an estimated blood loss of 1800 ml and urine output 550 ml. The patient received 5 L crystalloid, 500 ml colloid and 2 units of packed red blood cells. The patient remained in NSR throughout the remainder of the case, but frequent premature atrial contractions and atrial bigeminies were observed. At the end of the procedure, a bilateral transversus abdomen is plane block was performed using total 40 ml of bupivacaine 0.25% to assist postoperative analgesia. Extubation was uneventful and the patient was transferred to the CCU for overnight cardiac monitoring after a stable period in recovery. A repeat postoperative TTE while in NSR showed an EF of 55% with moderate tricuspid regurgitation. After an uneventful recovery, she was discharged home on warfarin for one month with her infant on postoperative day five.

Discussion

Lone AF accounts for fewer than 12% of all cases of AF, but in some series, it represents over 30% [15,16]. While the exact mechanism of lone AF is complex, it is reported that a fluctuation in autonomic

balance is involved in the initiation of paroxysmal atrial fibrillation [17]. We believe in our case the lone AF with RVR occurred due to autonomic fluctuation and excessive vagal stimulation caused by an episode of severe retching. Vagal stimulation is an established determinant of vulnerability for AF by shortened atrial effective refractory periods [18]. Excessive vagal stimulation also causes a macro re-entry circuit in the atrium, a less commonly recognized trigger for lone AF [19,20]. Further patient investigation did not identify any other contributable causes.

AF in a pregnant patient requires prompt investigation to identify the etiology and any underlying medical problems. Basic evaluation for AF includes history and physical examination, ECG, blood tests for thyroid hormone and electrolytes, and echocardiography. If underlying causes are identified, therapy is directed towards correction of said problem eg. structural heart disease; hyperthyroidism. More invasive investigations for arrhythmia such as tilt-table testing, exercise treadmill or cardiac catheterization are rarely indicated during pregnancy [21]. Echocardiography is an essential tool to assess structural and functional cardiac abnormalities. Information on left ventricular performance is helpful in guiding anti-arrhythmic and antithrombotic therapy. The increased risk of Venous Thromboembolism (VTE) and detrimental effects of fast ventricular rates on the fetus make it important to treat AF early. Rhythm control may be achieved by pharmacological or electrical cardioversion. ACC/AHA/ESC guidelines for the management of AF during pregnancy are summarized in Table 1 [11]. Most antiarrhythmic drugs in pregnancy are classified as category C and cross the placenta which may potentially harm the fetus. These drugs should be avoided especially during the first trimester. Initial concerns regarding significant fetal bradycardia from the use of esmolol infusions in pregnancy evolved from studies done in gravid ewes [22]. In our case the FHR remained a category 1 tracing while the patient was on an esmolol infusion. Data also suggests that cardio selective agents eg. metoprolol should be considered as the incidence of fetal hypoglycemia is very low and they may interfere less with ß2-mediated peripheral vasodilation or uterine relaxation [3]. However, atenolol, a pregnancy category D drug, is associated with intrauterine growth restriction, and should be avoided throughout pregnancy [4]. In the event of AF-induced hemodynamic instability or AF refractory to medical treatment, synchronized DCCV is recommended[11].

Since the introduction of transthoracic DCCV for AF in 1962 [13], it has been successfully used in every trimester of pregnancy with no evidence of significant harm to the fetus [23,24]. The mammalian fetus has a high fibrillation threshold [25] and the current density reaching the uterus is very small [26]. However, the fetus should be monitored during the procedure as transient fetal dysrhythmia has been reported [27]. In our case, FHR monitoring showed a category I tracing throughout DCCV. To maximize success with DCCV, R-wave synchronization is required during cardioversion. Failure to synchronize may lead to energy delivery during the "vulnerable T-wave period" and induce ventricular fibrillation [28]. Energy selection is also important. Although it is desirable to deliver the lowest energy to restore NSR, a low energy may require repeat shocks with a higher energy, which causes myocardial damage. The success rate of cardioversion in AF was 50% with 100 J, compared to 75-85% with 200 J [29,30]. An initial energy of 360 J has been suggested for AF of over 48 hours duration [31]. The size and location of the defibrillator electrodes are important and influence current flow, impedance and outcome. Optimal electrode sizes range from 8-12 cm. Anteroposterior electrode placement provides the best vector for energy delivery to the critical mass of atrial muscle with higher success rates (87%) than with the anterolateral alignment (76%) [32]. Finally DCCV should be avoided in a conscious patient as it may cause long-lasting emotional trauma associated with severe pain. Although DCCV is usually performed under deep sedation without endotracheal intubation, in the pregnant patient it is safer to perform endotracheal intubation for protection against gastric aspiration.

A serious complication of DCCV is a thromboembolic event. The incidence of VTE is reported between 1-7% in patients who do not receive anticoagulation before cardioversion [33,34]. Anticoagulation is recommended throughout pregnancy for all patients with AF except those with lone AF or represents a low VTE risk [11]. In our case, anticoagulation was commenced after DCCV for 4 weeks in the event of atrial stunning. Atrial stunning occurs immediately after cardioversion and improves progressively with a complete resolution within a few minutes to 4-6 weeks depending on the duration of the preceding atrial fibrillation, atrial size, and structural heart disease. Atrial stunning can cause post-cardioversion thromboembolism despite restoration of sinus rhythm [35].

In summary, we report a case of preoperative lone AF unresponsive to pharmacological treatment and treated with DCCV under general anesthesia for hemodynamic deterioration in a parturient. DCCV is the treatment of choice for AF in a pregnant patient with hemodynamic instability or refractory to other medical management. DCCV is safe to the fetus, but FHR monitoring should be maintained during the procedure. For the best outcome in a pregnant patient with AF undergoing DCCV consider, anteroposterior placement of adequately sized electrodes, use of higher energy levels as well as endotracheal intubation to protect against gastric aspiration.

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