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Double Sequential Synchronised Cardioversion for Refractory Unstable Ventricular Tachycardia: A Case Report

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Abstract

Treatment for refractory unstable Ventricular tachycardia (VT) with a pulse remained a challenge. Antiarrhythmic are recommended, although there is a risk of exacerbating hypotension in a patient who is already hemodynamically unstable. Herein, we described the double sequential synchronised cardioversion (DSSC) technique for treating a patient with refractory unstable VT with a pulse. A 67-year-old gentleman presented with chest pain, sweating, and dizziness. He was hypotensive with a heart rate of 220 beats/min. His electrocardiogram demonstrated monomorphic VT. He received two shocks of conventional cardioversion delivered via anterior-lateral pads placement, and three shocks vector-change cardioversion via anterior-posterior pads with amiodarone infusion, but neither were able to reverse the VT. We employed DSSC technique, and VT successfully reverted after third attempt. Although double sequential external defibrillator has been extensively studied for pulseless VT/ventricular fibrillation, such DSSC technique to treat refractory VT to conventional cardioversion has never been explored.

Introduction

Electrical Storm (ES), a potentially lethal condition, is defined as three or more episodes of prolonged ventricular tachcyardia (VT), ventricular fibrillation (VF), or appropriate shocks from an Implanted Cardioverter Defibrillator (ICD) occurring in a 24-hour period. The most common type of ES is monomorphic VT, which has a frequency of 86–97% [1]. The initial management for VT with pulse should proceed according to American Heart Association (AHA) Advanced Cardiac Life Support (ACLS) guidelines. For an unstable patient with sustained VT with a pulse, synchronised cardioversion is the first line of treatment. If VT is resistant to repeated shocks, antiarrhythmic drugs such amiodarone or lidocaine may be used, although doing so has a risk of lowering blood pressure in a patient with hemodynamic instability [2].

Double sequential external defibrillators (DSED) have been extensively studied for refractory VF. Defibrillation pads are positioned in two different planes (anterior-lateral and anterior-posterior) from two defibrillators machine. A recent trial demonstrated higher survival to hospital discharge and good neurological outcome in patients receiving DSED compared to standard defibrillation [3]. However, double sequential synchronised cardioversion (DSSC) has never been studied for refractory VT with a pulse. Herein, we present a technique of DSSC of a patient with unstable VT resistant to conventional synchronised cardioversion.

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Case Report

A 67-year-old gentleman presented to the Emergency Department (ED) with a complaint of crushing chest pain, sweating, and dizziness for one day. He had no history of medical conditions and cardiac disease. His Body Mass Index (BMI) was 24. Upon arrival to ED, he was tachycardic at 220 beats per minute, hypotensive with a blood pressure at 86/64 mmHg, and saturated well under room air. Physical examination showed cold periphery with reduced pulse volume. His cardiovascular and respiratory examinations were unremarkable. Cardiac monitor showed a regular wide complex tachycardia and Electrocardiogram (ECG) demonstrated monomorphic VT (**Figure 1**). He was administered with fentanyl infusion. Synchronised cardioversion was attempted at escalating joules 100 J and 120 J on a biphasic defibrillator with anterior-lateral pad placement. During reassessment, he continued to have monomorphic VT with a heart rate of 220 beats per minute and his blood pressure was 90/40 mmHg.

Vector-change defibrillator was utilised, and the pads were positioned anterior-posterior. Shock was delivered three times consecutively at 200 J and intravenous amiodarone was instituted after a third shock.The rhythm did not alter. Two additional pads were placed anterior-lateral and another two pads remained at anterior-posterior (**Figure 2 & 3**). Each set of pads was connected to a separate defibrillator machine (Philips Heart Start MRx). Two operators operated sequentially to administer dual shocks at 200 J through anterior-posterior and anterior-lateral pads connected to two different defibrillators. The rhythm converted to sinus rhythm after three DSSC attempts. Repeated ECG revealed sinus rhythm with widespread ST-segment depression over anterior and inferior leads with ST-segment elevation over aVR suggestive of subendocardial ischaemia or proximal Left Anterior Descending Artery (LAD) stenosis (**Figure 4**). He reported no complications from the procedure. The defibrillator device was undamaged.

His initial laboratory examination showed high-sensitive troponin I was 134.9 ng/ml. Bedside echocardiography demonstrated preserved systolic function with ejection fraction of 65%. He was referred to cardiology team. His angiogram showed only a mild stenosis over LAD. Patient underwent cardiac Magnetic Resonance Imaging (MRI) for suspected cardiomyopathy and Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC). However, the results did not fulfil ARVC criteria. A cardiac MRI showed non-specific Right Ventricular Insertion Point (RVIP) fibrosis identified by Late Gadolinium Enhancement (LGE) with no evidence of previous myocardial infarction or myocardial infiltrative disease. He had good biventricular systolic function.

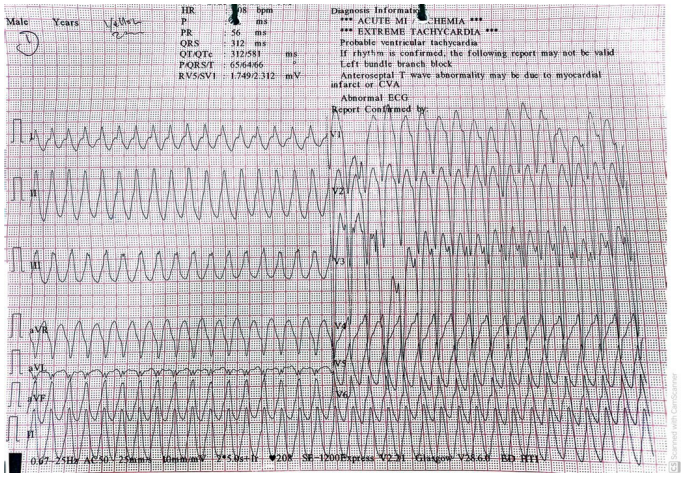

Figure 1: Initial ECG shows monomorphic ventricular tachycardia.

Subsequently, he was planned for implantable cardioverter defibrillator insertion.

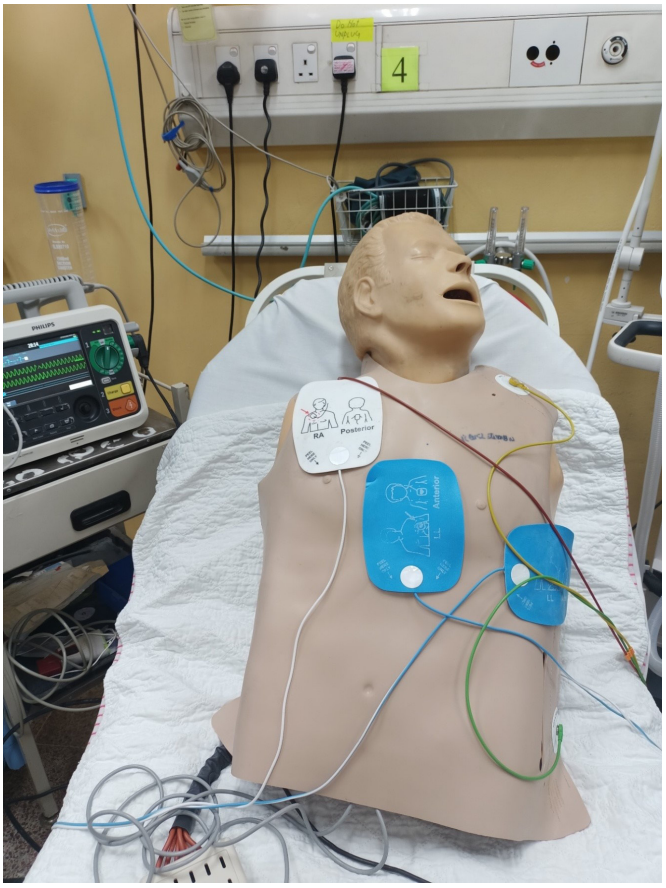

Figure 2: Schematic showing pad placement for double sequential synchronised cardioversion. Pads were placed inferior to right clavicle and lateral to cardiac apex. Another set of pads were placed anterior-posterior but not touching the first set of pads.

Figure 3: Anterior-posterior pad placement.

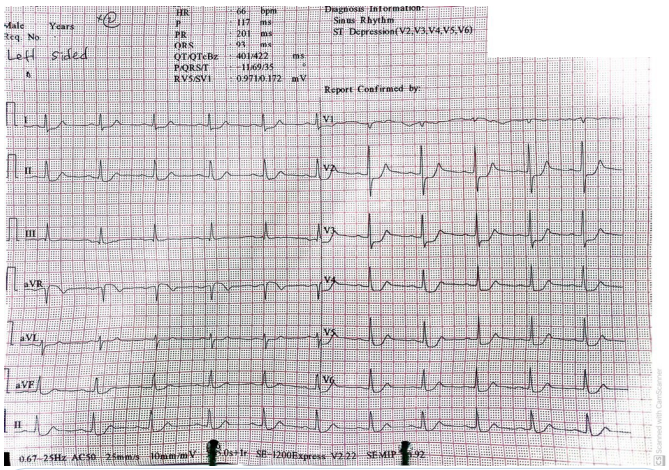

Figure 4: Post cardioversion ECG shows widespread ST-segment depression and ST-segment elevation in lead aVR.

Discussion

To the best of our knowledge, there was only one case of the DSSC technique for refractory VT with a pulse that had been reported in the literature.Sheikh et al. employed the DSSC technique to successfully convert VT to sinus rhythm after two attempts of standard cardioversion, and single attempt of vector-change cardioversion.The authors reported post-cardioversion erythema that did not require any further treatment. The only difference between this case and ours is that in this case, the cause of the VT was due to myocardial infarction, whereas in our case, the cause was unknown [4].

The use of DSSC for refractory Atrial fibrillation (AF) had been described in the literatures [5,6]. In a study of 21 patients with refractory AF to conventional cardioversion, sinus rhythm was achieved in 19 patients with DSSC without major adverse events [5]. In another series of 15 patients with refractory AF to standard cardioversion, 13 patients had achieved sinus rhythm with DSSC technique. Authors reported no major complications including increasing cardiac enzymes (creatine kinase MB fraction), hemodynamic compromise, heart failure, higher AV nodal blockage, stroke, or transient ischaemic cerebral events [6].

The current AHA guidelines recommended intravenous amiodarone for hemodynamically unstable VT that persist or recur after a maximal energy shock. The guidelines did not, however define specifically when VT is regarded resistant to synchronised cardioversion [2]. We defined VT as refractory when three conventional cardioversions were unsuccessful at terminating the VT. Amiodarone was successful in terminating VT in a stable patient, but it may exacerbate hypotension in patients who were hemodynamically unstable. Previous trials showed that 10% to 30% of patients using amiodarone developed hypotension [7]. Lidocaine is recommended as an alternative to amiodarone. In a trial comparing amiodarone, lidocaine, and placebo for sustained VT/VF in 3026 patients with out-of-hospital cardiac arrest showed that lidocaine was significantly superior to placebo in achieving return of spontaneous circulation (ROSC). However, neither amiodarone nor lidocaine demonstrated better survival rate and good neurological outcome at discharge compared to placebo [8]. Sympathetic blockade is another alternative to standard ACLS-guided treatment. In a study of 49 patients who had a recent myocardial infarction complicated by an electrical storm, it was found that sympathetic blockade using left stellate ganglionic blockade or beta blockers (esmolol or propranolol) combined with amiodarone was superior to lidocaine alone in terms of 1-week and 1-year survival rates.This study, however, was not randomised, and the treatment was chosen based on physician preference, which might have caused bias [9].

Although numerous theories have been put forth, the exact mechanism by which DSSC terminates VT is unknown. Vector change defibrillation delivered a higher voltage gradient at the posterior of the ventricle, which is where fibrillation is most likely to reoccur or fail to terminate after standard defibrillation. Using the DSED or DSSC technique, the second shock resulted in a higher voltage and more energy delivered to the myocardium [3]. There was a higher likelihood of effectively reversing VT/VF when multiple electrical vectors and a higher voltage were delivered synchronously to the vulnerable myocardium, particularly in patients with larger body habitus [4].

In our case, the patient had unstable refractory VT. He received two shocks of conventional cardioversion delivered via anterior-lateral pad placement, and three shocks vector-change cardioversion via anterior-posterior pads at the maximum joule with amiodarone infusion, but neither were able to reverse the VT. We employed DSSC technique and VT successfully reverted after third attempt. His post-cardioversion ECG showed ischemic changes, and a higher troponin level may indicate that myocardial ischemia triggered the VT. However, the angiography study was unremarkable, and cardiac MRI revealed RVIP.It is unclear whether patients with RVIP have an increased risk of developing major arrhythmias [10].

DSSC is an alternative approach for hemodynamically unstable VT with a pulse that was refractory to conventional synchronised cardioversion. More research is required to determine the effectiveness of DSSC in terminating VT and its safety.

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Conflicts of interest: No declaration.

Presentation(s) at a meeting: The case was presented as a poster at the 2023 Emergency Medicine Annual Scientific Symposium, Malaysia.

Ethical statements: No ethical approval was required for this journal because this case report does not contain human participants or animals. Verbal consent was obtained for the patient.

Patient consent for publication: The patient verbally consented to the case report's publication. No patient identifiable information was used, and the images were anonymised.

Availability of data and materials: The anonymised data are available from the corresponding author.

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