

Case Report

Management of cardiac electrical storm: a case report

Olajide O. Oresegun^{1*}, Kamar T. Adeleke¹, Michael O. Sanusi², Morenikeji E. Oluwaferanmi¹,
Felix O. Sogade²

¹Tristate Cardiovascular Associates, Babcock University Teaching Hospital, Ilishan-Remo, Ogun State, Nigeria

²Georgia Arrhythmia Consultants and Research Institute, Macon, Georgia, United States of America

Received: 01 September 2022

Accepted: 30 September 2022

***Correspondence:**

Dr. Olajide O. Oresegun,

E-mail: oresegunolajide@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

There is a steady increase in the incidence of intra-cardiac device complications in patients with structural heart diseases. Cardiac electrical storm is associated with deleterious clinical and psychological sequelae. Management can be challenging in a resource-poor environment. Old anti-arrhythmic medications can still be effective when conventional ones fail.

Keywords: Cardiac electrical storm, Implantable cardioverter defibrillator, Structural heart disease

INTRODUCTION

Clinical trials have established the efficacy of implantable cardioverter defibrillator (ICD) therapy in lowering the risk of sudden cardiac death (SCD) in high-risk patients, especially in heart failure.¹ Despite life-saving benefits, ICDs shocks have some negative consequences, including psychological morbidity, reduced quality of life, increased hospitalization, and thus economic burden. A recent study documented significant reductions in cases of physical and mental well-being after a shock that further declines with an increasing number of shocks.² Cardiac electrical storm (CES) is occurrence of 3 or more episodes of sustained ventricular tachycardia, ventricular fibrillation/appropriate ICD shocks in a 24-hour time frame.³

We report on a 64-year-old patient who received sixty-four (64) appropriate ICD shocks for fast ventricular tachycardia (heart rates > 200 bpm) within three days with consequent depletion of battery life, significant anxiety, and deterioration in the quality of life.

CASE REPORT

A 64 years old male patient was admitted to our facility due to recurrent, painful implantable cardioverter

defibrillator shocks a day before presentation. He reported ten painful shock episodes before presentation, which he described as one having generalized muscle spasms. There was associated palpitation, shortness of breath, chest discomfort, dizziness, sweating, and anxiety prior to the shocks. He was diagnosed with non-ischemic cardiomyopathy (EF-26%) 6 years prior (after left heart catheterization at our centre) and had a single chamber implantable cardioverter defibrillator implanted a year later following an episode of unsustained ventricular tachycardia.

EKG on admission demonstrated multifocal ventricular premature complexes. Transthoracic echocardiogram revealed dilated cardiac chambers with severe left ventricular systolic dysfunction (EF-26%), mild pericardial mild effusion, severe functional mitral and tricuspid regurgitations. Subsequently, we performed an ICD interrogation, which revealed multiple appropriate ICD therapies between 22/01/2021 and 25/01/2021 until the battery of the Biotronic ICD was depleted to 17%. In summary, the patient suffered 3 appropriate shocks on 22/01/2021, 17 appropriate shocks on 23/01/2021, and 44 appropriate shocks on the 24th of January, 2021 (Figures 1-3).

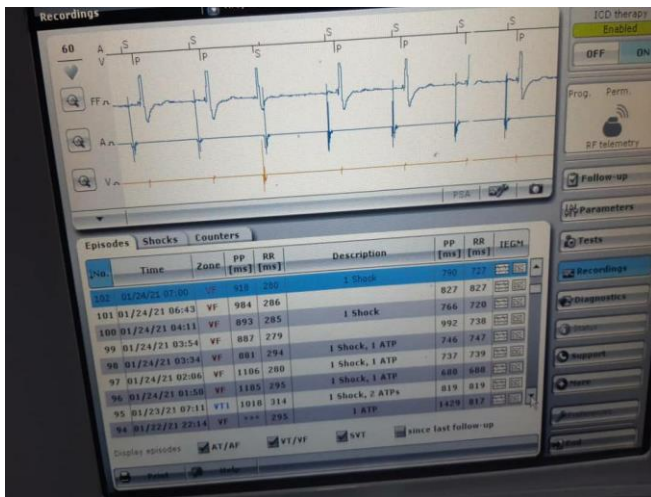


Figure 1: ICD interrogation report showing multiple episodes of ventricular fibrillation and shock therapies delivered.

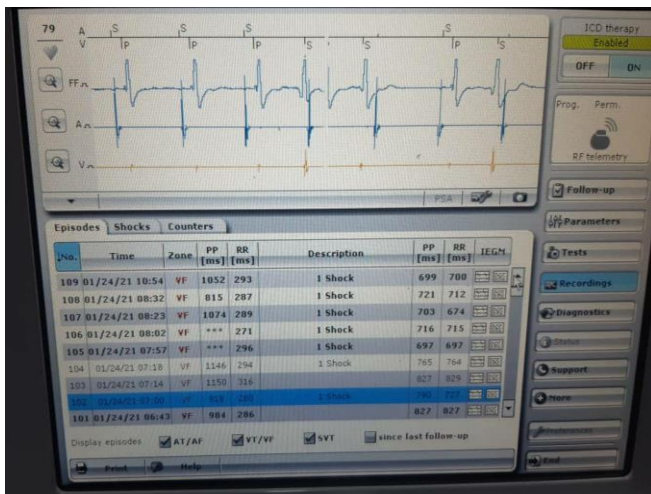


Figure 2: ICD interrogation report revealing multiple episodes of ventricular fibrillation and shock therapies delivered.

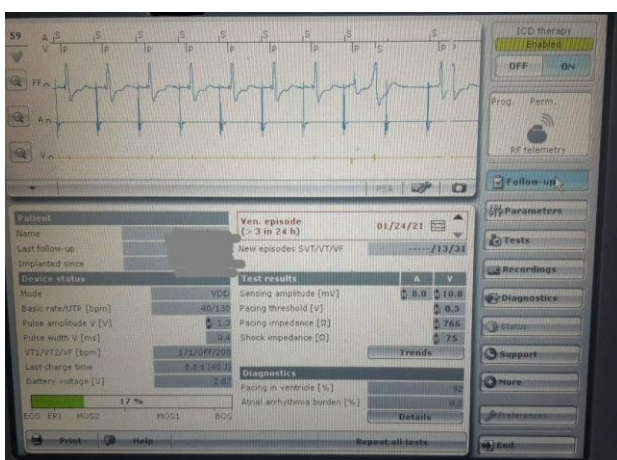


Figure 3: ICD Interrogation summary page showing ICD details and estimated battery life span of 17%.

Serum potassium was mildly reduced 3.4 mmol/L (Reference 3.5-5.0 mmol/L) while other parameters were within the normal range. Serum ionized calcium, full blood count, thyroid function parameters were within normal ranges. He had parenteral potassium (20 mmol KCL) and magnesium sulphate (2 gm) repletion and repeat serum potassium (24 hours into admission) was 4 mmol/L. His chest radiograph revealed cardiomegaly with no evidence of ICD lead fracture or displacement (Figure 4).

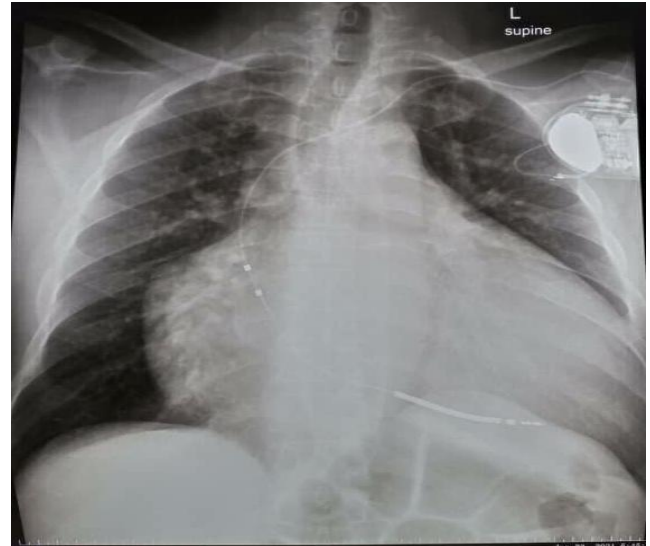


Figure 4: Chest radiograph of the patient showing intact ICD lead integrity.

He was on adequate maximal tolerated guideline-directed medical therapies including carvedilol and angiotensin-receptor blockers. Initial therapies with parenteral and oral amiodarone failed in controlling the ICD shock episodes. There are no resident Electrophysiologists in Nigeria to our knowledge and we contact colleagues in the diaspora for assistance using mobile phone application (WhatsApp). Recommendations were made to utilize sedation with parenteral benzodiazepines and oral phenytoin (Dilantin). This has been beneficial in our overseas colleague's experience in similar situation both in Nigeria and elsewhere. Further ICD shocks were prevented following institution of these recommendations. Currently we do not have the capacity or expertise to perform intra-cardiac mapping and ablation procedures for ventricular tachycardia or stellate ganglion blockage. He made significant symptomatic improvement with cessation of the ICD shocks after commencement of oral phenytoin at 100 mg twice daily, much to his relief and that of his concerned relatives. He was satisfied with the level of care and his clinical progress. After counseling the patient and his caregivers, a new ICD battery was implanted on the 12th February, 2021 and he was discharged three days later on tabs phenytoin 100 mg twice a day and anti-failure regimen.

The patient's ICD (single chamber) was implanted just over 4 years prior in September, 2016. The last ambulatory

interrogation was on 13th January, 2021 which revealed 2 episodes ventricular fibrillation (which were successfully terminated by anti-tachycardia pacing) and an estimated battery longevity of 58%. His next scheduled out-patient clinic appointment was for April 2021.

DISCUSSION

There has been a steady increase in the number of ICD implantations and patients with long-lasting devices worldwide with a corresponding increase in device-related complications.⁴ ICD shock, whether appropriate (for ventricular tachycardia or fibrillation) or inappropriate (due to artifact, device malfunction or supraventricular tachycardia) is associated with increased mortality.⁵ Undoubtedly, ICDs have been shown to save lives but the therapies can sometimes be a double-edged sword.⁵

Several complications of therapies whereby resource limitation becomes a challenge in our experience include managing lead-related complications, device infection, pocket erosions, and cardiac electrical storm (CES) as evidenced in our patient. CES can manifest during the acute phase of a myocardial infarction, in the presence of a structural heart disease, an ICD, or an inherited arrhythmic syndrome. Typically, CES has a poor outcome due to attendant myocardial injury.³

Risk factors for CES include advanced age, male sex, a low LV ejection fraction (LVEF), and New York heart association functional class III or IV heart failure.³

Effective management of CES is multidisciplinary requiring prompt identification of the precipitant (acute myocardial ischemia, electrolyte imbalance, worsening heart failure, hyperthyroidism), knowledge of the arrhythmia mechanisms, therapeutic options, ICD programming, and emerging techniques for the treatment of refractory cases.³

The therapies that eventually helped our patient are based on available anti-arrhythmic medications and authors' prior experiences. One of the well acceptable therapies during CES is to reduce the impact of the painful therapies to the patient by sedation and sometimes administration of general anaesthesia.⁶

After failure of conventional anti-arrhythmic drug (amiodarone) for use in our patient, we initiated therapy with phenytoin (Dilantin). Phenytoin possibly played a dual role in this situation both as a class 1B anti-arrhythmic agent and as a sedative, inhibiting excessive discharges of the central (sympathetic) nervous system (adrenergic drive).⁷

A recent report has documented the successful use of phenytoin in controlling idiopathic refractory ventricular fibrillation, even in situations where conventional anti-arrhythmic agents, especially amiodarone, wasn't effective.⁷ Amiodarone exerts its anti-arrhythmic action

predominantly by prolonging the action potential duration (class III effect), sodium channel blocking (Class I effect) and beta-blocking effect. Blockade of the outward current (I_K) during the plateau phase of the cardiac action potential leads to unopposed entry of depolarizing current (I_{Ca-L} and I_{Na}) causing prolongation of action potential duration and intracellular calcium overload in purkinje fibers leading to the development of early after-depolarization.⁸ Phenytoin may be more effective in suppressing ventricular ectopy, especially in an ischemic or damaged myocardium, because it blocks calcium-dependent depolarizing current in the plateau phase of the cardiac action potential favoring the repolarization of depolarized purkinje fibers, increasing the effective refractory period and preventing early after-depolarization formation.⁹ Furthermore, by blocking the sodium channel, phenytoin also inhibits conduction of EAD from the purkinje network to the surrounding myocardium.⁹

In order to address psychological challenges, our patient was reviewed by the mental health team and had twelve (12) sessions of psychotherapy before discharge from hospital. He was also placed on anxiolytics and caregivers were encouraged to give social and emotional support.

Studies have documented strategies (pharmacological and non-pharmacological) helpful in managing electrical storm and their attendant negative effects on mortality and they include: adrenergic blockade with beta blockers (propranolol), anti-arrhythmic agents (amiodarone, sotalol, lignocaine, procainamide), anaesthetic agents (propofol, benzodiazepine). Left stellate ganglion blockade and thoracic epidural anaesthesia have also reportedly suppressed electrical storms refractory to multiple anti-arrhythmic agents and beta-blockade therapy.^{6,10}

Non-pharmacological strategies include strategic ICD programming to deliver anti-tachycardia pacing for fast ventricular tachycardia to reduce the need for shocks. Others are remote monitoring of ICD function (telemetry), intra cardiac mapping and radiofrequency ablative therapy.¹⁰

CONCLUSION

An increasing number of patients with ICDs, pacemakers and CRTs require sufficient manpower and technical resources to guarantee high quality monitoring and interventions in order to reduce avoidable morbidity and mortality.

Further training program for cardiology out-patient clinics should be implemented since this is an emerging specialty in Nigeria and there is a significant dearth of knowledge concerning ICD function and trouble-shooting.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: Not required

REFERENCES

1. Moss AJ, Zareba W, Hall WJ. Prophylactic implantation of a defibrillator in patients with myocardial infarction and reduced ejection fraction. *N Engl J Med*. 2002;346:877-83.
2. Schulz SM, Massa C, Grzbiela A. Implantation Cardioverter defibrillator shocks are prospective predictors of anxiety. *Heart lung*. 2013;42:105-11.
3. European Heart Rhythm Association, Heart Rhythm Society, Zipes DP, Camm AJ, Borggrefe M, Buxton AE et al. ACC/AHA/ESC 2006 guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: a report of the American College of Cardiology/American Heart Association Task Force and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to Develop Guidelines for Management of patients with Ventricular Arrhythmias and the prevention of Sudden Cardiac Death). *J Am Coll Cardiol*. 2006;48(5):e247-346.
4. Bardy GH, Lee KL, Mark DB. Amiodarone or an Implantable Cardioverter Defibrillator for congestive heart failure. *N Engl J Med*. 2005;352:225-37.
5. Poole JE, Johnson GW, Hellkamp AS. Prognostic importance of defibrillator shocks in patients with heart failure. *N Engl J Med*. 2008;359:1009-17.
6. Mahajan A, Moore J, Cesario DA, Shivkumar K. Use of thoracic epidural anaesthesia for management of electrical storm. *Heart Rhythm*. 2005;2(12):1359-62.
7. Golian M, Bhagirath KM, Sapp JL. Idiopathic ventricular fibrillation controlled successfully with phenytoin. *J Cardiovasc Electrophysiol*. 2011;22:472-4.
8. Kannakeril PJ, Roden DM. Drug-induced long QT and Torsades de pointes: Recent advances. *Curr Opin Cardiol*. 2007;22:39-43.
9. Scheuer T, Kass RS. Phenytoin reduces calcium current in the cardiac purkinje fiber. *Circ Res*. 1983;53:16-23.
10. Nademanee K, Taylor R, Bailey WE, Rieders DE, Kosar EM. Treating electrical storm: sympathetic blockade versus advanced cardiac life support-guided therapy. *Circulation*. 2000;102(7):742-7.

Cite this article as: Oresegun OO, Adeleke KT, Sanusi MO, Oluwaferanmi ME, Sogade FO. Management of cardiac electrical storm: a case report. *Int J Adv Med* 2022;9:1127-30.