Successful Conversion of Post-Cardiac Surgery Electric Storm in a Child

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Background: The management of ventricular electrical storm can prove to be a challenge for the clinician given its complexity and life threatening consequences. **Case characteristics**: 8-year-old boy with repeated life-threatening polymorphic ventricular tachycardia following aortic valve replacement surgery. **Intervention**: Defibrillated 45 times in addition to multiple antiarrhythmic drugs. **Outcome**: Conversion to stable sinus rhythm with normal neurological outcome. **Message**: Electric storm can be controlled by combination of multiple intravenous antiarrhythmic drugs.

Keywords: *Defibrillation, Electrical storm, Ventricular tachycardia.*

Electrical storm has been infrequently reported in children, and variable management strategies have been described in literature [1]. It is defined as occurrence of three or more distinct episodes of ventricular tachycardia (VT) or ventricular fibrillation (VF) within 24 hours, requiring defibrillation. Sustained VT that resumes after one or more sinus cycle and within 5 minutes of efficacious therapeutic intervention by the defibrillator is regarded as severe form of electrical storm [2]. We report electric storm in a child and made a good recovery.

CASE REPORT

An 8-year-old-boy was admitted to our hospital with complaints of progressive breathlessness and intermittent fever for last one month. He previously underwent aortic valve replacement (21 mm St. Jude prosthetic valve) for congenital aortic stenosis, almost a year back. He was treated for suspected infective endocarditis (culture negative) elsewhere. A 12-lead electrocardiogram (ECG) revealed sinus tachycardia with normal QTc interval (0.42 sec), normal progression of R waves and left bundle branch block pattern. A 2D echocardiography with color doppler revealed severe left ventricular dysfunction (left ventricular ejection fraction (LVEF) 25%) with stuck aortic valve (no vegetations). He developed hemodynamically stable ventricular tachycardia after admission and was started on intravenous amiodarone. His initial blood cultures were negative and baseline sepsis screen was negative. He underwent repeat aortic valve replacement (19 mm TTK Chitra aortic mechanical tilting disc prosthesis). Intraoperative findings revealed stuck aortic valve with vegetations; valve tissue was sent for histological and microbiological study, which grew carbapenem resistant *Klebsiella pneumoniae*.

Postoperative trans-esophageal echocardiography revealed biventricular dysfunction (LVEF 10-15%), and no residual gradient across aortic valve. He had sinus bradycardia with intermittent atrioventricular (AV) dissociation with slow ventricular conduction; amiodarone was tapered over 36 hours and he was maintained on overdrive AV sequential pacing. The patient was in low cardiac output state with fluctuating hemodynamics on moderate inotropic support. On 2nd postoperative day, patient developed recurrent episodes of polymorphic ventricular tachycardia with unstable hemodynamics on controlled ventilation (***Fig.* 1**). Arterial blood gas (ABG) analysis revealed normal electrolytes and acid base physiology. In next 8 hours, 45 DC shocks (up to 8J/kg) were delivered due to recurrence of VTs after transient reversion to sinus rhythm. He also received two boluses of intravenous (IV) amiodarone (5 mg/kg) and repeated doses of IV lidocaine (1 mg/kg) followed by their infusions. Since the patient was poorly responsive, he was also started on IV esmolol infusion after bolus. There was no significant change in QTc interval despite multiple doses of amiodarone. Magnesium sulphate and glucose-insulin-potassium infusion did not convert the arrhythmia. Finally, it was controlled with deep sedation

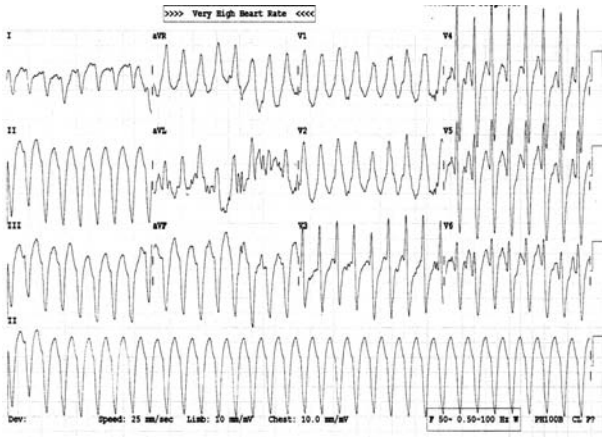

***Fig.* 1** *ECG during the episode of electric storm.*

and paralysis with fentanyl, midazolam and vecuronium, with infusions of lidocaine at 40 μg/kg/min, amiodarone at 20 μg/kg/min and esmolol at 100 µg/kg/min.

Post-event, he had LVEF of 10% with septal and apical akinesis, borderline low blood pressure and high left atrial pressure. Inotropic support was reoptimized with dobutamine and milrinone, and ventilation was continued for next 72 hours.

His left ventricular function gradually improved and he was extubated on 6th postoperative day with normal neurological status. He was continued on oral amiodarone, metoprolol and acetyltolinesterase inhibitors. At follow-up 14 days later, he was in sinus rhythm consistently.

DISCUSSION

The mechanisms of electrical storm are quite complex and not well understood. It has been postulated that cellular and membrane alterations can increase intracellular calcium overload, with altered action potential duration and morphology leading to its onset [3,4]. The important role of increased sympathetic tone has been well documented. Many conditions including ischemia, surgery [5] and hyperthermia [6] can precipitate increased adrenergic output.

Specific antiarrhythmics indicated for electrical storm include amiodarone, procainamide, lidocaine and bretylium. Current Advanced Cardiac Life Support (ACLS) guidelines recommend amiodarone for cardiac arrest in children associated with shock-refractory VT/VF. Studies examining the effect of intravenous amiodarone in the management of electrical storm have reported its efficacy [7].

Beta-antagonists – targeted to attenuate enhanced sympathetic output – are also evolving as a promising modality [8]. In our patient, we used esmolol (predominantly a β-1 antagonist), which can be used as an infusion and dose can be easily titrated based on response. Left stellate ganglion blockade, though effective, requires a high level of expertise, and may not be feasible. Importance of deep sedation and even paralysis in this setting cannot be overemphasized.

Given the unstable nature of the disease, electric storm often requires combination therapy. Manolis, *et al*. [10] reported a case using triple drug intervention with a beta antagonist, class III antiarrhythmic, and a class IB antiarrhythmic.

Despite repeated defibrillations and severe left ventricular dysfunction, our patient made a good recovery with aggressive supportive treatment. It is imperative that practising paediatricians are well versed with Pediatric Advanced Life Support guidelines to manage these challenging resistant arrhythmias.

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REFERENCES

1. Clausen H, Pflaumer A, Kamberi S, Davis A. Electrical storm in children. Pacing Clin Electrophysiol. 2013;36: 391-401.
2. Proietti R, Sagone A. Electrical storm: Incidence, prognosis and therapy. Indian Pacing Electrophysiol J. 2011;11:34-42.
3. Brooks WW, Conrad CH, Morgan JP. Reperfusion induced arrhythmias following ischaemia in intact rat heart: role of intracellular calcium. Cardiovasc Res. 1995;29:536-42.
4. Tribulova N, Seki S, Radosinska J, Kaplan P, Babusikova E, Knezl V, *et al*. Myocardial Ca2+ handling and cell-to-cell coupling, key factors in prevention of sudden cardiac death. Can J Physiol Pharmacol. 2009; 87:1120-9.
5. Schmidt TD, Muir AJ. A case of electrical storm in a liver transplant patient. Transplant Proc. 2003;35:1437-8.
6. D'Aloia A, Faggiano P, Brentana L, Boldini A, Curnis A, Bontempi L, *et al*. Recurrent ventricular fibrillation during a febrile illness and hyperthermia in a patient with dilated cardiomyopathy and automatic implantable cardioverter defibrillator. An example of electrical storm. Int J Cardiol. 2005;103:207-8.
7. Kowey PR. An overview of antiarrhythmic drug management of electrical storm. Can J Cardiol. 1996;12:3-8B.
8. Nademanee K, Taylor R, Bailey WE. Treating electrical storm: sympathetic blockade versus advanced cardiac life support-guided therapy. Circulation. 2000;102:742-7.
9. El-Sherif N. The challenge of management of electrical storm out-of-hospital cardiac arrest. Cardiol J. 2007; 14:326-8.
10. Manolis A, Katsivas A, Vassilopoulos C, Tsatiris C. Electrical storm in an ICD-recipient with 429 delivered appropriate shocks: therapeutic management with antiarrhythmic drug combinations. J Interv Card Electrophysiol. 2002;6:91-4.