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Review Article

Amiodarone in Aortic Root: A Novel Approach to Treat the Refractory Ventricular Fibrillation After Release of Aortic Cross Clamp: A Review

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ABSTRACT

Refractory Ventricular Fibrillation (VF) is referred to as VF that persists or reappears after termination despite three successive shocks delivery, 3 mg of epinephrine, and 300 mg of amiodarone, and failure to obtain the Return of Spontaneous Circulation (ROSC) within 10 min and requires multiple Direct Current (DC) shocks. It is rare but a fatal complication after cardiac surgery. VF often occurs after the release of Aortic Cross-Clamp (ACC) in patients undergoing cardiac surgery using Cardiopulmonary Bypass (CPB). In patients with concentric Left Ventricular Hypertrophy (LVH) of severe aortic stenosis, either continuous VF occurs after release of ACC or reverts to sinus rhythm and crops up again and at times difficult to terminate. Persistent VF and repeated monophasic DC shocks can increase myocardial oxygen demand and myocardial injuries. Intravenous slow bolus or in the CPB circuit of amiodarone, a class III antiarrhythmic agent, has the prominent properties of converting VF and restoring the sinus rhythm. But at times, administration of lignocaine 100 mg, cardioversion with biphasic (10 J-20 J) DC shock and intravenous amiodarone 150 mg or 300 mg fails to revert the VF to the sinus rhythm during weaning from CPB in cardiac surgery for aortic stenosis with concentric LV hypertrophy. In this scenario, the authors have been successfully practicing amiodarone administration in the aortic root for reverting the VF and restoring the sinus rhythm. Administration of amiodarone (150-300 mg diluted in 20 ml normal saline) directly in the aortic root after re-applying a cross clamp for 15-30 seconds, helps in VF termination either reverting to the sinus rhythm or by increasing the sensitivity to DC shock. Not many clinicians have been employing amiodarone in the aortic root (coronary ostia) to manage the refractory VF during weaning off CPB till date. This review will describe the utility of amiodarone in the aortic root (coronary ostia) as a Novel approach to managing the refractory VF after the removal of ACC in patients undergoing cardiac surgery when other conventional therapies fail.

Keywords: Refractory VF; CPB; Aortic stenosis; LVH; Aortic re-clamping; Amiodarone; Class III antiarrhythmic; Aortic root; Coronary ostia; DC shock; Aortic root

INTRODUCTION

Ventricular Fibrillation (VF) is a common happening after unclamping of the aorta during cardiac surgery and often it reverts to normal sinus rhythm either spontaneously or after administration of lignocaine (1.5 mg/kg), or epinephrine boluses (10 mcg-20 mcg) or and a biphasic internal, Direct Current (DC) shock (10 joules-15 joules) or magnesium sulphate (2 gm) in Cardiopulmonary Bypass (CPB) pump [1-6]. However, metabolic and electrolyte disturbances as well as hypothermia, air bubbles in the coronaries should be corrected at this stage. At times, administration of amiodarone is effective for refractory

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VF resistant to lidocaine and cardioversion during weaning from CPB in cardiac surgery for heart diseases with Left Ventricular Hypertrophy (LVH) [7].

The gold standard for management of VF refractory to intravenous lignocaine, adrenaline, amiodarone, metabolic and electrolyte correction during weaning off CPB includes the insertion of a vent in the Left Ventricular (LV) to avoid LV distension and myocardial ischemia and to continue CPB support. Very rarely, these measures may be unsuccessful in VF to restore the sinus rhythm. In this challenging scenario, administration of amiodarone (75 mg-150 mg) in the aortic root after re-clamping the aorta invariably reverts the VF to the sinus rhythm spontaneously or with cardioversion using 10-15 biphasic internal DC shock. This review will describe the utility of the amiodarone administration in the aortic root for the management of VF refractory to conventional treatment.

LITERATURE REVIEW

Searching support

The search for this systematic review includes pub med, google, Cochrane database trials, case reports and case series and Randomized Controlled Trials (RCT) for administration of amiodarone in the aortic root for the refractory VF after release of aortic cross clamp in cardiac surgical patients particularly of concentric LVH. The searching used the words like, refractory VF after cardiac surgery, Amiodarone for refractory VF, high risk patients for refractory VF after release of aortic cross clamp, what is refractory VF. Use of amiodarone in aortic root in cardiac surgery or cardiac catheterization laboratory.

DISCUSSION

VF frequently occurs after Aortic Cross-Clamp (ACC) release in patients undergoing open-heart surgery, which can result in Reperfusion Ventricular Fibrillation (RVF) when myocardium reperfusion is initiated [3-5]. This surgical consequence is associated with a negative impact on morbidity and mortality [8-10]. VF that is refractory after release of ACC, despite defibrillation and the use of various antiarrhythmic agents, can be triggered by hypokalaemia, acidosis, hypothermia, low perfusion pressure, myocardial reperfusion injury, arrhythmogenic foci and air in coronaries. Correction of these underlying conditions and administration of various anti-arrhythmogenic agents generally ensure a successful return to sinus rhythm [3-5,11].

Apart from the conventional therapy against the VF in the patients undergoing cardiac surgery, various authors have employed different approaches to manage the refractory VF after release of ACC. Long time back in year 1984, Robicsek F [12] had reported the successful management of sustained VF in six patients by secondary use of ACC and the administration of crystalloid cardioplegic solution to induce cardiac arrest, followed by the introduction of pacemaker using a ventricular mode. Similarly, Chaudhary has reported that despite normal values of serum potassium, serum magnesium and no air in the LV or aorta on echocardiography, the patient might be experiencing persistent VF. In this scenario the heart may be subjected to the antegrade normothermic blood cardioplegic (10 ml/kg, containing 8 mmol/L of potassium) arrest after re-applying the ACC. After 5 min of cross clamp removal and maintain the full pump flow (2.4 L/m^2) heart starts beating gradually in the sinus rhythm. The author has suggested that potassium cardioplegic induced transient asystole conserves myocardial energy, foster chemical defibrillation, thereby improve VF arrest outcome [13]. Other authors have also reported that infusion of 20 mmol of potassium into the perfusion line successfully converts the post-ischemic VF in 79.9% of patients of VF after release of ACC and the success rate improves to 100% after adding of 10 meq of potassium in 20.1% more patients [14]. M.A. Al Jawad, et al., [4] have reported that prophylactic use of a single dose amiodarone through the pump circuit before cross clamp release reduces the incidence of reperfusion induced ventricular fibrillation and subsequent defibrillation therapy needed. A few case reports describe the use of Extracorporeal Membrane Oxygenation (ECMO) to support patients with refractory VF caused by myocardial infarction. ECMO can be used as a supportive therapy in patients with VF, helping to avoid severe complications or as a bridge to heart transplantation. The authors have also introduced a case of 7-hour VF after cardiac surgery which was bridged with ECMO and was successfully resolved [15].

Scarcely, in patients with severe concentric LVH, and low flow low gradient severe aortic stenosis with myocardial dysfunction, the measures like lignocaine, epinephrine, correction of electrolytes and blood gas values, amiodarone administration on the bypass pump or intravenous, calcium channel blockers, magnesium sulphate or even use LV vent to decompress and deair the LV may be ineffective, leading to a difficult and challenging clinical scenario that failed to respond to conventional treatment. However, as a last resort, amiodarone (150 mg to 300 mg) administration into the aortic root restored spontaneous sinus rhythm with a single DC shock [3].

Amiodarone is a class III antiarrhythmic drug with a complex pharmacological profile. It blocks potassium currents that cause repolarization of the heart muscle during the third phase of the cardiac action potential. This potassium channel-blocking effect results in increased action potential duration and a prolonged effective refractory period in cardiac myocytes. Myocyte excitability is reduced, thus hindering the continuation of tachyarrhythmias by preventing re-entry mechanisms and ectopic foci [16].

In addition, amiodarone also blocks the beta-adrenergic receptors and calcium and sodium channels. Furthermore, it decreases the automaticity of the sinoatrial node, reduces atrioventricular node conduction velocity, and inhibits the ectopic pacemaker automaticity. Therefore, in some instances, it produces the undesired adverse effects like bradycardia, hypotension and the development of Torsades de pointes [17].

Amiodarone is a versatile treatment option for managing various supraventricular tachyarrhythmias, including atrial flutter, refractory

Atrioventricular (AV) nodal tachycardia and AV nodal re-entrant tachycardia. Amiodarone is also indicated for the treatment of monomorphic VT, non-Torsades polymorphic Ventricular Tachycardia (VT) secondary to myocardial ischemia, and pulseless VF and VT unresponsive to Cardiopulmonary Resuscitation (CPR), defibrillation, and epinephrine administration [18]. The Food and Drug Administration (FDA)-approved indications for amiodarone use include its effectiveness in the treatment of malignant ventricular arrhythmias, advanced cardiac life support situations, such as VF and pulseless VT [19].

The authors have successfully used amiodarone (300 mg) in aortic root to revert a refractory VF to sinus rhythm with a single 30 J, DC shock in a patient underwent aortic valve replacement in year 2007 [3]. The VF was refractory to intravenous lidocaine, epinephrine, multiple amiodarone administration and DC shocks (15 J-50 J) and insertion of LV vent. Since then, the authors have been practicing prophylactic amiodarone administration in the aortic root in the patients potential to develop refractory VF like low Ejection Fraction (EF), dilated LV, multiple valve replacement, long duration of Cardiopulmonary Bypass (CPB) and aortic cross clamp and the unpublished data suggest that the amiodarone in aortic root either help to return the spontaneous sinus rhythm or easily reverts the VF with minimum use of biphasic DC shock [10 J-15 J], if it develops on release of aortic cross clamp. Some clinicians hypothesize that diluted amiodarone administration directly into the aortic root breaks up the air bubble in tiny air molecules or disperse into distal coronary to more periphery and dissolve spontaneously and so improve the coronary blood flow and revert the myocardial ischemia and terminates the VF. It is just like a management of VF and cardiac arrest due to coronary air embolism during coronary angiography with a forceful injection of heparin saline (*pushing method*) through the catheter used to fragment the air embolus and allow dispersal distally along with the external cardiac massage and DC shock. Repeated forceful injection of heparinized saline through the catheter fragments and disperse the air emboli into distal coronary circulation and resolve the embolism and reverts the VF [20]. The authors are of the opinion that patients with severe aortic stenosis with concentric hypertrophy undergoing surgical aortic valve replacement are especially susceptible to the persistent VF after release of aortic cross clamp, and can be successfully managed with amiodarone administration in the aortic root after re-applying the ACC.

Limitations

Our review has the following limitations. Firstly, the large case series and randomized clinical trials are not available. Secondly, the optimal regimen and doses of amiodarone used for aortic root are not uniform, as different doses (75 mg to 300 mg) have been used by different surgeons. There is no recommended time for administration of amiodarone before releasing ACC to prevent Refractory VF. Therefore, more large-scale RCTs should be performed to standardize the timing and doses of amiodarone administration in aortic root for refractory VF.

CONCLUSION

It is concluded that amiodarone administration into the root of the aorta can successfully terminate the sustained VF refractory to the standard conventional therapy, occurring after release of the aortic cross-clamp in cardiac surgical patients. It provides an additional option for the treatment of VF but should be reserved for situations in which conventional approaches are unsuccessful. The treating clinicians should identify patients at risk of refractory VF which potentially will gain from early amiodarone administration in the aortic root and success rate as well as the side effects of amiodarone therapy in the coronary ostia while treating the refractory VF in cardiac surgical patients.

CONFLICTS OF INTEREST

None

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REFERENCES

1. Lee YH, Lee KJ, Min YH, Ahn HC, Sohn YD, Lee WW, et al. Refractory ventricular fibrillation treated with esmolol. Resuscitation. 2016;107:150-155.
2. Dunning J, Levine A, Ley J, Strang T, Lizotte Jr DE, Lamarche Y, et al. The society of thoracic surgeons expert consensus for the resuscitation of patients who arrest after cardiac surgery. Ann Thorac Surg. 2017;103(3):1005-1020.
3. Tempe DK, Gandhi A, Mehta V, Banerjee A, Datt V, Ramamurthy P, et al. Administration of amiodarone into the aortic root for persistent ventricular fibrillation after aortic valve replacement. J Cardiothorac Vasc Anesth. 2007;21(3):414-416.
4. Abd Al Jawad M, Shorbagy MS, Saleh M. Prophylactic amiodarone in patients with severe aortic stenosis and left ventricular hypertrophy undergoing aortic valve replacement: Silencing the rebels. J. Egypt Soc Cardio-Thorac Surg. 2017;25(4):337-342.
5. He LM, Zhang A, Xiong B. Effectiveness of amiodarone in preventing the occurrence of reperfusion ventricular fibrillation after the release of aortic cross-clamp in open-heart surgery patients: A meta-analysis. Front Cardiovasc Med. 2022;9:821938.
6. Salaminia S, Sayehmiri F, Angha P, Sayehmiri K, Motedayen M. Evaluating the effect of magnesium supplementation and cardiac arrhythmias after acute coronary syndrome: a systematic review and meta-analysis. BMC Cardiovasc Disord. 2018 :1-10.
7. Morita Y, Mizuno J, Yoshimura T, Morita S. Efficacy of amiodarone on refractory ventricular fibrillation resistant to lidocaine and cardioversion during weaning from cardiopulmonary bypass in aortic valve replacement for severe aortic stenosis with left ventricular hypertrophy. J Anesth. 2010;24:761-764.
8. Yilmaz M, Aydin U, Arslan ZI, Balcı C, Kocogullari CU, Ata Y, et al. The effect of lidocaine and amiodarone on prevention of ventricular fibrillation in patients undergoing coronary artery bypass grafting. Heart Surg Forum. 2014;17(5):E245-E249.
9. Zheng Y, Gu Q, Chen HW, Peng HM, Jia DY, Zhou Y, et al. Efficacy of amiodarone and lidocaine for preventing ventricular fibrillation after aortic cross-clamp release in open heart surgery: a meta-analysis of randomized controlled trials. J Zhejiang Univ Sci B. 2017;18(12):1113.

10. Mita N, Kagaya S, Miyoshi S, Kuroda M. Prophylactic Effect of Amiodarone Infusion on Reperfusion Ventricular Fibrillation After Release of Aortic Cross-Clamp in Patients with Left Ventricular Hypertrophy Undergoing Aortic Valve Replacement: ARandomized Controlled Trial. J Cardiothorac Vasc Anesth. 2019;33(5): 1205-1213.
11. Turkoz A, Toprak HI, Ersoy MO, Gulcan O, Turkoz R. Secondary cross-clamping and blood cardioplegia for refractory ventricular fibrillation after aortic cross-clamp removal. Tex Heart Inst J. 2002;29(3):230.
12. Robicsek F. Biochemical termination of sustained fibrillation occurring after artificially induced ischemic arrest. J Thorac Cardiovasc Surg. 1984;87(1):143-145.
13. Chowdhry V. Cardioplegic arrest as pharmacological defibrillation; A novel approach for refractory ventricular fibrillation. Ann Card Anaesth. 2020;23(4):541-542.
14. Almdahl SM, Damstuen J, Eide M, Molstad P, Halvorsen P, Veel T. Potassium-induced conversion of ventricular fibrillation after aortic declamping. Interact Cardiovasc Thorac Surg. 2013;16(2):143-150.
15. Fux T, Svenarud P, Grinnemo KH, Albage A, Bredin F, Van der Linden J, et al. Extracorporeal membrane oxygenation as a rescue of intractable ventricular fibrillation and bridge to heart transplantation. Eur J Heart Fail. 2010;12(3):301-304.
16. Javot L, Pape E, Yelehe-Okouma M, Barotte E, Divoux E, Gillet P, et al. Intravenous single administration of amiodarone and breastfeeding. Fundam Clin Pharmacol. 2019;33(3):367-372.
17. Smith H, Yeung C, Gowing S, Sadek M, Maziak D, Gilbert S, et al. A review and analysis of strategies for prediction, prevention and management of post-operative atrial fibrillation after non-cardiac thoracic surgery. J Thorac Dis. 2018;10(32):S3799.
18. Soar J, Perkins GD, Maconochie I, Bottiger BW, Deakin CD, Sandroni C, et al. European Resuscitation Council Guidelines for Resuscitation: 2018 update–antiarrhythmic drugs for cardiac arrest. Resuscitation. 2019;134:99-103.
19. J.B. Florek, D.Girzadas. Amiodarone. 2020.
20. Suastika LO, Oktaviono YH. Multiple air embolism during coronary angiography: how do we deal with it? Clin Med Insights Cardiol. 2016;10:CMC-S38040.