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Intra-Aortic Balloon Counterpulsation Following Bentall's Procedure for Annuloaortic Ectasia

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Abstract

We report three male patients aged 28, 30 and 35 years respectively undergoing Bentall's procedure for annuloaortic ectasia with severe aortic regurgitation and acute type A aortic dissection who developed refractory ventricular failure unresponsive to medical management. The failing circulation was successfully re-established using intra-aortic balloon counterpulsation. Aortic counter pulsation facilitates recovery of ventricular function and appears to be a reasonable alternative in select instances of refractory heart failure following Bentall's procedure for annuloaortic ectasia with aortic dissection as a salvage option.

Keywords: Intra-aortic balloon counterpulsation; Mechanical circulatory assistance; Aortic dissection; Bentall's procedure; Annuloaortic ectasia

Introduction

Circulatory failure following Bentall's procedure for annuloaortic ectasia with type an aortic dissection is common and contributes significantly to perioperative mortality. There is no reported case of Intra-Aortic Balloon Counterpulsation (IABC) to support the failing ventricle following Bentall's procedure for annuloaortic ectasia but 12 cases of type A aortic dissection with 41.6% mortality have been reported despite using IABC [1,2]. Although IABC is used to treat postcardiotomy cardiogenic shock, its use for circulatory support in these patients is traditionally contraindicated. The successful use of IABC for a failing circulation in three adult patients undergoing Bentall's procedure for annuloaortic ectasia with severe Aortic Regurgitation (AR) and aortic dissection has prompted us to report this case series.

Case Presentation

Between January 2016 and June 2018, three male patients aged 28, 30 and 35 years respectively with Marfan's syndrome and annuloaortic ectasia presented with new onset excruciating precordial pain radiating to left upper limb. Notable clinical findings included tachypnoea, tachycardia, unequal upper and lower limb pulses, raised jugular venous pressure with hemodynamic decompensation requiring preoperative mechanical ventilatory support. Chest radiography revealed massive cardiomegaly with findings of acute pulmonary oedema. Electrocardiography showed left ventricular hypertrophy with ischemic ST-T changes in the left precordial leads. Transthoracic echocardiography revealed massive cardiomegaly, moderate pericardial effusion, severe AR, Left Ventricular End-Diastolic and End-Systolic Diameters (LVEDD, LVESD) of 7-7.5 cm and 5-5.5 cm and Left Ventricular Ejection Fraction (LVEF) of 15% to 20%. Computerised Tomographic (CT) angiography confirmed the diagnosis of annuloaortic ectasia with type A aortic dissection and normal coronary arteries.

All patients underwent emergency Bentall's procedure under moderately hypothermic Cardio Pulmonary Bypass (CPB) through femoral arterial and bicaval venous cannulation. Antegrade and retrograde cold blood hyperkalemic cardioplegia was used for myocardial preservation. A Dacron composite graft with a mechanical heart valve [(St. Jude Medical Inc.; Minn); (Conduit 25 mm, 1 patient; 27 mm, 2 patients) was used in all patients.

The dissection extended circumferentially 360º around both coronary ostia in all patients. The coronary buttons were anastomosed in an end-to- side fashion on the composite graft. The distal anastomosis was performed in an end-to-end fashion; on a circumferential pericardial strip [3]. Aortic cross-clamp time was 91, 110 and 135 min respectively.

One patient required IABC prior to disconnecting from CPB because of poor ventricular function,

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while other two patients required IABC 6 and 8 hours post-surgery for refractory Low Cardiac Output Syndrome (LCOS). Postoperatively, both patients were in sinus rhythm with stable hemodynamics on moderate inotropic support (dopamine, dobutamine, epinephrine and milrinone) with a mean right atrial pressure of 14-15 mmHg respectively. Pharmacological afterload reduction was limited because of systemic hypotension. 2D-echocardiography revealed LVEF of 0.15, 0.20 and 0.25 respectively. The measured Cardiac Index (CI) was 1.4-1.6 l/min/m^2 and mixed venous oxygen saturation (SVO_2) was 28% to 35% respectively. The IABC Data scope system 97e pumping console (Data scope Corporation Cardiac Assist Division, New Jersey, and USA) with a true sheath less 7.5 French, 34CC balloon catheters was used. All patients required hemofiltration for pulmonary oedema and ascites. It produced an immediate improvement in blood pressure with suprasystolic diastolic augmentation. After 6 hr to 7 hrs of balloon support, the CI increased to 2.6-2.8 l/min/m^2 and SVO2 to 68% to 80%. No patients suffered extension of dissection flap, aortic trauma or rupture as confirmed on CT angiography. After 96, 120 and 168 hrs, patients were successfully weaned from IABC. There was no operative death. Follow-up (12 to 30 months, median 19 months) revealed NYHA class I with good biventricular function.

Comment

Whereas the use of IABC is well documented in adults with acute left ventricular dysfunction after myocardial infarction, Coronary Arterial Bypass Grafting (CABG) and ventricular aneurysmectomy, its therapeutic benefit in patients after Bentall's procedure for annuloaortic ectasia with or without aortic dissection has not been demonstrated [3-5]. Despite improved management strategies and myocardial preservation, the immediate and long-term results are disappointing because of refractory LCOS following surgery [3-5].

Cardiac or circulatory failure is common after type A dissection repair accounting for 50% mortality [1,3,5]. There is an increase in the mortality associated with LCOS following CABG and AVR from 33% to 60% over the past 3 eras [4]. The underlying pathologic state causing LCOS is secondary to a combination of several factors, including pre-existing left ventricular hypertrophy and/or dilatation, myocardial fibrosis, pulmonary hypertension-induced right ventricular hypertrophy and/or dilatation, coronary under perfusion, improper myocardial preservation, ischemic cardiomyopathy, prolonged cross-clamp and bypass times, poor preoperative left ventricular function and impaired pulmonary and renal function [1-5].

The concerns regarding IABC use in patients with aortic dissection are extension of the residual dissection flap, occurrence of biventricular dysfunction and the delicately buttressed coronary ostial and distal graft-aortic anastomoses being subjected to pulsatile flow of IABC, thus predisposing to mechanical dehiscence and rupture [1-5].

Extracorporeal Membrane Oxygenation (ECMO) and Left Ventricular Assist Devices (LVAD) are the most prevalent means of mechanical circulatory assistance in patients undergoing Bentall's procedure with or without aortic dissection [6]. The main problems with ECMO are postoperative coagulopathy, extension of the dissection flap by retrograde blood flow from a peripheral cannula and malperfusion [6].

In contrast, IABC pumping facilitates recovery of left ventricular function by decreasing the afterload, increasing aortic diastolic pressure, CI and improving coronary perfusion. This, in turn, decreases left ventricular end-diastolic pressure and left atrial pressure and indirectly helps the sub pulmonary ventricle. Another advantage of IABC is the ease of application [1-5].

In our series, all patients preoperatively had a cardiothoracic ratio of 0.8-0.9, LVEDD 7.0 cm to 7.5 cm, LVESD 5 cm to 5.5 cm, and LVEF 10% to 15% with aortic root enlargement and type an aortic dissection extending circumferentially 360º around both coronary ostia. Despite using optimal inotropic support, one patient required institution of IABC prior to discontinuing CPB and two patients required elective institution. Indications and timing for IABC after valve surgery remain controversial [4,5].

The role of prophylactic IABC is debatable. The Benchmark registry and STS database show that 52.4% and 63.4% respectively are inserted preoperatively in cardiac surgical patients [4]. Bolooki and colleagues recommended "preoperative" use of IABC in patients with moderate or severe left ventricular dysfunction according to laid down criterions [7].

Timing of initiation of support remains difficult since its use as an absolute 'last resort' decreases the possibility of success. Randomized studies need to define specific indications, proper timing of intervention and factors that predict a successful outcome. The paucity of report of IABC following Bentall's procedure has prompted us to report the case series.

Conclusion

Post-Bentall's patients with aortic dissection can benefit from IABC for left and biventricular failure, despite adequate inotropic support, akin to patients undergoing CABG. Three cases presented herein contribute to the increasing body of evidence supporting IABC as a reasonable intervention.

We advocate caution against widespread use of IABC after Bentall's procedure. Clearly, there must be an exhaustive search for adequacy of surgery, exclusion of any other surgically correctable cause(s) like mechanical cardiac/coronary compression due to blood collection, para conduit leakage, and overlooked significant CAD.

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