Case Report

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Intra-luminal Breakage of Aortic Cannula during Cardiopulmonary Bypass: A Rare and Catastrophic Complication

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Abstract

Cardiopulmonary bypass (CPB) is an essential requisite to facilitate cardiac surgery. Any malfunctioning in the aortic cannula or arterial system will produce neurological and other vital organs injury. The authors faced very high aortic line pressure during VSD patch closure under CPB. Early detection of high aortic line pressure needs strict vigilance and monitoring of CPB function. Prompt establishment of normal pump flow after normalization of line pressure along with brain protection methods may save the life of patient.

Keywords: Aortic cannula; Brain protection; Cardiopulmonary bypass; Intra-luminal breakage; Aortic line pressure.

Introduction

Cardiopulmonary bypass (CPB) is an essential requisite to facilitate open heart surgery. Aortic or arterial cannula helps to perfuse all the organs while venous cannula helps to exsanguinate the cardiac chambers during cardiac surgery with cardioplegic arrest. Any malfunctioning in the aortic cannula or arterial system will produce neurological and other vital organs injury. Postoperative neurological, renal and gut ischemic injuries are reported after successful cardiac surgery.[1,2] The vigilant monitoring of the arterial system flow and line pressure will guide to detect the malfunction and prevent the catastrophe. The diagnosis and management of aortic cannula malfunction must be prompt. The authors describe a case of intraluminal breakage of aortic cannula leading to high line pressure during ventricular sepal defect (VSD) closure under CPB.

Case History

A 2 year old girl was planned for VSD closure under CPB. Activated coagulation time (ACT) of 500 seconds was achieved after systemic heparinization. Ascending aorta was cannulated with 8 Fr Biomedicus wire reinforced cannula. The proper aortic cannulation confirmed with adequate line pressure, which was less than equal to systemic pressure with good oscillation of pressure in pressure gauge monitor. Superior vena cava was cannulated via right atrium appendages with 14Fr straight venous cannula. CPB was commenced and partial support of CPB started by single venous return, perfusion pressure of 45 mm Hg and aortic line pressure of 110 mm Hg. Inferior vena cava was cannulated with 14 Fr angled venous cannula. Adequate venous drainage was confirmed and the patient went to full cardiopulmonary support switching off from the ventilator support.

Cooling of the patient was started up to 32^0 C. After application of Aortic Cross Clamp (ACC), St. Thomas cardioplegia was administered with a dose of 20 ml/kg and surgical procedure started for the closure of ventricular septal defect. After 12 minutes of cross clamp i.e. 16 minutes after CPB initiation, suddenly the arterial pump was stopped because of the sudden rise in aortic line pressure up to more than 350 mmHg. The surgical and anesthesia team members were alerted. The arterial line connection, aortic cannulation site and CPB circuit connection were verified. At that moment aortic cannula was covered with sterile surgical VSD ring to cover the outer part of surgical field for good exposure of VSD septum and prevent sutures entanglement. The exact cause of sudden increase of aortic line pressure was not found. The arterial pump was restarted again with minimum possible flow of 20 ml/kg which was limited by the maximum aortic line pressure of 250 mmHg. Perfusion pressure was 19 mmHg. Best possible management were started by further cooling the patient immediately, head was packed with ice packs and deep trendelenburg position established, barbiturates and mannitol were administered. During this problem, some manipulation of aortic cannula was tried. After 2 or 3 minutes of this incidence, the arterial line pressure was reduced towards normal and we were able to give adequate pump flow and achieved the perfusion pressure of 50 mm Hg and aortic line pressure of 150 mm Hg. By this time VSD closure was completed. The arterial cannula and connection at the patient side was re-examined. The arterial cannula (8 Fr Biomedicus) was found to be kink (compressed) and broken at middle of the cannula with some small blood leak (Fig. 1). The site was manipulated to keep the patency of the cannula and cannula was also straightened so that broken site may get closed. After protamine reversal the aortic cannula was removed and re-examined again. It was found that the wire inside the cannula at middle portion was broken. When the stylet of the cannula was introduced into the lumen of the cannula it was difficult to pass beyond the compression or kinking site. Patient weaned from CPB with NTG and dobutamine support therapy. After 8 hours patient became gradually awake and trachea was extubated. Post tracheal extubation neurological examination revealed no gross neurological deficit. Further course was uneventful.

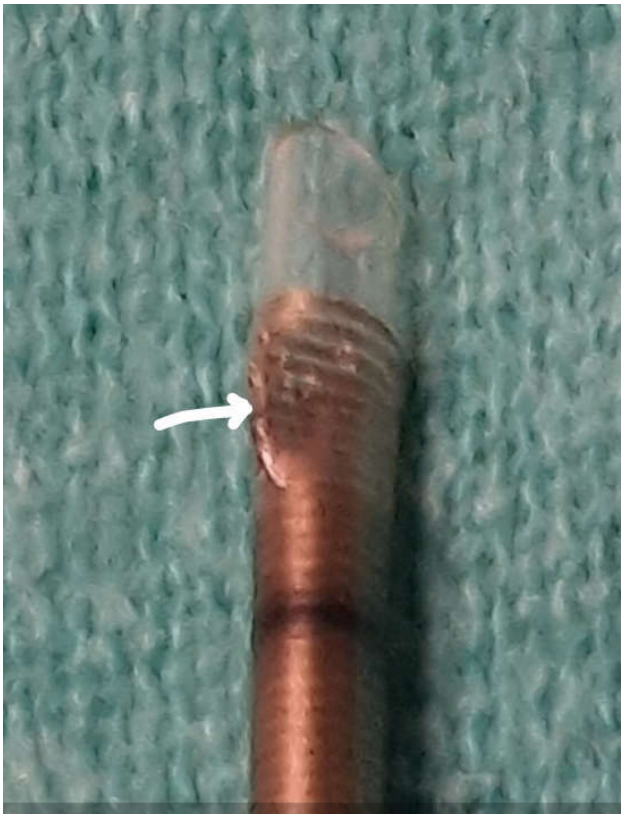

Fig. 1: Image showing the compression (indicated by white arrow) of aortic cannula due to breakage of reinforced wire inside the lumen wall.

Discussion

Aortic or arterial line pressure refers to the pressure in the arterial line which runs from the heart lung machine to the patient; in distinction to the pressure being monitoring in the patient's arterial system via a line in the radial artery or elsewhere. Aortic line pressure should be monitored in all patients immediately after connecting the arterial line from the heart lung machine to the aortic cannula after it has been placed in the patient's ascending, and continuously monitored throughout CPB. Immediately after connecting the arterial line to the aortic cannula which has been placed in the aorta (or elsewhere) the aortic should be compared to the reading from the systemic arterial pressure (i.e., in the radial or femoral arteries). The "aortic line pressure" should be pulsatile and have similar mean pressure. The incidence of high aortic line pressure during CPB is the commonest complication and to overcome to this there should be an alarm on this pressure monitor which indicates higher pressure and some groups' serve this into the arterial pump to slow it down or turn off the pump if excessive pressure is detected.

Presently with the advanced technology and routine use of wire re-enforced aortic cannula by the expertise surgical team during the CPB the incidence of high aortic line pressure is very rare. The cause of high "arterial line pressure" could

be systemic arterial hypertension, placement of the arterial cannula into a branch vessel (e.g., innominate, left carotid or left subclavian artery), intramural placement of the arterial cannula, aortic dissection, tip of arterial cannula abutting the wall of the aorta, kinking of the arterial line, clamp still on the arterial line, too small an arterial cannula, obstruction of the arterial micro-filter / bubble trap, and excessive flow through the cannula (due to error in calibration or function of the arterial pump).[3, 4]

In the present case the aortic line pressure at the time of cannulation was normal with good oscillation at the commencement of CPB. The high aortic line pressure was noticed when the interrupted suture across the VSD was placed for patch closure. Lots of traction might be applied to visualize the margins of VSD for exact suturing. During this particular moment high stress must be generated on the cannula, leading to breakage of the reinforced wire and collapse of the lumen (Fig. 1) and kinking leading to high aortic line pressure. The high line pressure was automatically resolved after fixing the patch across the VSD. Hence the most probable cause would be the very acute folding of aortic cannula at the center or inadvertent clamping on cannula by metallic snap / clamp when the aortic cannula was covered under the VSD ring cloth. Because of the alarm system of CPB equipment and machineries were intact and well functional; the accident was immediately detected and promptly managed.

The use of an alarm on pressure monitor which indicates over pressure and servo-regulator into the arterial pump to slow it down or turn off if excessive pressure is detected.[4] The physical examination of the cannula at the level of manufacturer laboratories could have been able to explore the exact cause. It was very helpful to detect early high aortic line pressure during CPB. The report of such incidence of broken reinforce wire of aortic cannula is rare in literature, and may be kept in perfusionist / team member's mind as a cause for high aortic line pressure.

Conclusion

Early detection of high aortic line pressure needs strict vigilance and monitoring of CPB function by the perfusionist and team. The exact management would vary according to time, duration and severity of the complication. Prompt establishment of normal cardiopulmonary function along with brain protection methods may save the life of patient. Protection of aortic cannula and line placed above the surgical field with folded gauze sheet may be advisable to avoid accidental kinking and damage to cannula by sharp instruments.

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