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# SHOULD THE MAIN PULMONARY ARTERY BE INCLUDED IN THE AORTIC CLAMP?

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**A**pplication of a cross clamp to the ascending aorta proximal to the arterial return aortic cannula is a condition sine qua non in open heart surgery to avoid systemic air embolism, and loss of perfusion pressure, and is therefore essential for the survival of the patient. It is customary to all cardiac surgeons to dissect the adventitial fold between the ascending aorta and the main pulmonary artery, and sometimes to pass an umbilical tape around the ascending aorta to clamp the ascending aorta separately without including the main pulmonary artery in the aortic cross clamp.

Surgical experience with more than 6000 open heart procedures over the last 12 years has shown us that the inclusion of the main pulmonary artery in the aortic cross clamp in most of open heart procedures, is far superior than clamping the ascending aorta separately and alone. In all procedures on the left heart, such as coronary artery bypass or coronary endarterectomy procedures, mitral or aortic valve repair or replacement (MVR/AVR), and correction of congenital anomalies concerning the left heart, and in most of the procedures in the right heart such as tricuspid valve repair or replacement (TVR), correction of Ebstein's anomaly, total anomalous pulmonary venous return, Mustard or Senning procedures for d-TGA etc., we have found that inclusion of the main pulmonary artery in the aortic cross clamp is far superior than separate cross clamping of the ascending aorta. The rationale for such proposal is following:

A) In spite of all efforts of meticulous deairing of the heart; often minute and occasionally large air bubbles enter the coronary arterial circulation, especially the anteriorly located right coronary artery (RCA). Coronary arterial air embolism can arise on a flaccid heart while the surgeon controlling the competence of the mitral valve, and injecting saline into the empty left ventricle (LV), a phenomena that can also arise on or after releasing the aortic cross clamp. The RCA is more involved with coronary air embolism as it lies anteriorly on the roof of the ascending aorta, and can be therefore less covered with a film of blood as compared to the left main coronary artery (LMCA) at the moment of

releasing the aortic clamp. However, air embolism can still occur in the left main coronary artery. Coronary air embolism can turn into a dreadful complication as severe arrhythmias, alteration of myocardial contractility, and even low cardiac output necessitating cardiotoxic support. Fatalities due to iatrogenic coronary arterial air embolism have been reported. The absolute assurance of complete removal of the entire coronary arterial air can only be guaranteed if retrograde perfusion of the coronary sinus, coronary veins and coronary arteries is performed. If the surgeon includes the main pulmonary artery (MPA) in the aortic cross clamp, and fills the right atrium (RA) and right ventricle (RV) completely with blood by releasing the umbilical caval tape from the superior or inferior vena cava, and occluding the venous return line temporarily, the collected venous blood in the RA and RV can have only one outlet, namely the coronary sinus. Therefore, retrograde venous perfusion of the latter occurs, and finally the venous blood escapes under vision from the aortic root needle removing with it all large and minute air bubbles from the coronary arterial system. Application of this technique in the last 5000 open heart procedures has practically totally eliminated problems with intraoperative coronary arterial air embolisms.

B) Another advantage is avoidance of dissection between the ascending aorta and the main pulmonary artery, and of necessity to pass an umbilical tape around the ascending aorta, and therefore avoidance of iatrogenic injury of a dilated main or right pulmonary artery.

C) Assurance of complete and perfect cross clamping as both blades of the aortic pulmonary artery if they are thinned out in patients with pulmonary hypertension. Cross clamp will include enough strong tissue and the entire circumference of both great arteries. The blade on the aortic side goes proximal and in front of the right pulmonary artery, that on the pulmonary side goes just in front and cephalad to the left atrial appendage. Such an aortapulmonary mode of application of the aortic cross clamp will assure complete clamping of the entire

circumference of the aorta without any leak of oxygenated blood from the perfusion cannula and distal aorta. This is a cumbersome emergency which leads to inability to arrest the heart in spite of large amount of delivered cardioplegia in addition to the possible reduction or loss of the perfusion pressure.

D) Evaluation of the tricuspid valve prior, or after performing valvuloplasty is easier done if the MPA is clamped as the RV will fill with saline completely, and faster if the outlet of the RV is occluded (inclusion of the MPA in the aortic cross clamp).

E) Formation of froth due to mixture of blood and air in the MPA is a potential risk that can put a considerable burden on the ischemic RV after releasing the aortic cross clamp. Inclusion of the MPA in the clamp preserves a good amount of blood in the pulmonary arterial system and practically prevents totally the formation of froth in the MPA and RV provided that the RV is filled well with saline or blood before releasing the aortic cross clamp.

F) The advantages of the application of the cross clamp as an aortapulmonary cross clamp are manifold and therefore contributory to the success of the open heart procedure. The disadvantages of aortapulmonary clamping is the absolute necessity to establish dual bicaval total cardiopulmonary bypass with umbilical taping of the superior (SVC), and inferior caval veins (ICV), and retrieval of the cardioplegic solution from the RA by means of small atrial stoma to decompress the RV and avoid right ventricular distention. Partial unicaval bypass can not be considered if aortapulmonary clamping is anticipated. Since researchers have however stated that bicaval total cardiopulmonary bypass is superior to unicaval type as the first has better and faster cooling and rewarming characteristics ability to retrieve the delivered cardioplegic solution avoiding hemodilution and excessive hyperkalemia with their deleterious effects, and finally as less incidence of postoperative atrial or ventricular arrhythmias occur if bicaval cannulation with total cardiopulmonary bypass is used, We believe that the application of bicaval total

cardiopulmonary bypass is simple and can only be advantageous, so that aortopulmonary cross clamping can be applied in most of the cases except three contraindications to its use. Resection of an aneurysm of the ascending aorta, surgery on the left main coronary artery (LMCA) such as surgical patch angioplasty where dissection of both great arteries, and separate aortic cross clamping becomes a must and finally pulmonary valvotomy and reconstruction of the right ventricular outflow (RVOT). When aortopulmonary clamping is used in aortic valve procedures care must be taken to avoid invagination and inclusion of the

medial wall of the main pulmonary artery in the aortotomy suture line which can either lead to mild, moderate or severe supra-ventricular pulmonic stenosis with consequent acute right ventricular distention and failure.

### Reference

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