

PREVENTION OF ARTERIAL LINE EMBOLISM

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Cardiopulmonary bypass has been generally proven to be a useful adjunct to the surgical correction of many cardiac abnormalities. However arterial line embolism is one of the serious complications of open heart surgery. When it occurs, serious physiologic disturbances take place. Especially cerebral embolism is far more serious than the other organ embolism because of its greater morbidity and mortality rate. Many cardiac surgeons have contrived to prevent this complication.

Air bubbles mingled in the arterial line during cardiopulmonary bypass is very easy to cause embolism. With careful management of pump oxygenator, the complication of the massive air embolism has not been seen. However, there are many potential sources of emboli, such as micro-air bubble, fat, blood clot, tissue fragments, silicone and other foreign particles.

This paper is to describe the present status of the arterial line embolism and to discuss upon its prevention.

Postoperative convulsion is an obvious symptom of the arterial line embolism. In the past six years from Jan. 1966 to Dec. 1971, 655 open heart surgeries were performed in our hospital. Twenty-four out of 525 cases of congenital heart disease (4.6%), and nine out of 130 cases of acquired valvular heart disease (6.9%), developed convulsions in the early post-operative period. Fatal cerebral embolism which was manifested by intractable general convulsions and deep coma, occurred in 14 patients of congenital heart disease (2.7%) and 8 patients of acquired valvular heart disease (6.2%).

Frequency of the occurrence of cerebral embolism also increased with the increment of bypass time. The patient, who had convulsions but did not lose consciousness, recovered completely without any sequelae. These convulsions were seemingly caused by a small amount of air. However severe cerebral embolism was attributed to the detachment of the intracardiac thrombus mass and other foreign bodies. Recently the use of disposable bubble oxygenator is very popular because of the easiness of handling and of small amount of priming blood. However it is reported that silicone anti-foam coated on the debubbling mesh in the disposable bubble oxygenator easily detaches from the mesh with the passage of bypass time. Detached silicone antifoam becomes floating microemboli which has a possibility to cause a cerebral embolism. The brain of two patients who had general convulsions, did not awake from the anesthesia and expired, were examined. Massive silicone emboli in the whole cerebral capillaries were found.

We analyzed the distribution of the fat droplets including silicone droplets in the cerebral and glomerular capillaries of the autopsies and experimental animals on which were performed, valve replacement.

These data suggest that open heart surgery using a disc oxygenator less than 3 hours revealed no remarkable fat emboli in comparison with the general surgery, and that long perfusion, however, using a disc

oxygenator and even short perfusion using a bubble oxygenator brought about massive fat and or silicone emboli. The etiology of the convulsion is sometimes obvious and sometimes proven by the pathologic examination, but it is often difficult to be determined.

The etiology of arterial line embolism is classified as follows, (1) air bubbles from the pump oxygenator, (2) intracardiac trapped air and (3) foreign bodies. Following are the methods of prevention of the embolism employed at present in our hospital.

1. Air bubbles from the pump oxygenator.
 - (a) Visible air bubbles mingled in the arterial line system are to be prevented by keeping blood level in the oxygenator to a certain height.
 - (b) For the prevention of the small-sized air bubble in the arterial line, two air traps are placed; one at the inflow side and the other at the outflow side of the roller pump.
2. Intracardiac trapped air.
 - (a) Removal of air particularly from the left side of the heart before the termination of cardiopulmonary bypass, is quite important. Needle with syringe aspiration of the aortic root as well as the left ventricular apex, while appendage left atrium is manually reversed, is probably the simplest and most commonly used method to prevent air embolism. Sometimes left side down and right side down rotation of the operation table is done by anesthesiologist.
 - (b) Special venting line system of our own design is used in certain cases to remove the residual intracardiac air.
 - (c) Carbon dioxide gas (1.0L/min.) is blown into the operative field.
3. Foreign bodies such as blood clot, intracardiac thrombus, tissue fragment, silicone and fat.
 - (a) All blood clots and tissue fragments should be cleaned up using wall sucker prior to perfusion, and then cardiotomy sucker starts to use.
 - (b) The filters are placed in the line of cardiotomy suction and venting line in order to catch a crashed thrombus mass or a blood clot. These filters can be replaced whenever necessary during cardiopulmonary bypass. The filters are also incorporated inside the bubble oxygenator and inflow side of the roller pump. Especially Dacron wool filter inserted in the arterial line is able to catch microthrombi down to 40 micron in size.
 - (c) Attention should be paid to the amount of silicone used in the bubble oxygenator when the debubbling mesh is too much greasy. We use the disc oxygenator for the open heart surgery if long perfusion will be expected preoperatively.

SUMMARY

Arterial line embolism is uncommon but leads to serious consequence when emboli enter the cerebral circulation. The prevention of arterial line embolism according to the etiological sources was discussed. The meticulous care to prevent embolization of any cause will decrease the incidence of this serious complication.