Outflow switch technique during the left heart bypass to prevent the distal embolization in the distal aortic arch surgery

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Abstract

Aortic cross-clamping has the risk of inducing the postoperative embolization including the stroke during the repair of distal aortic arch with the use of left heart bypass. In this paper, we present a modified technique to reduce the embolization by switching the outflow of the left heart bypass from left atrium to the side branch of the inserted graft.

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1. Introduction

Stroke is a devastating complication in surgery of the thoracic aorta, however, it may not be adequately appreciated as a common sequel to descending aortic operations. Recent study by Goldstein et al. demonstrated that the stroke does indeed occur in descending aortic operations as frequently as in ascending aortic operations. They recommended the antembolic measures, including gentle aortic manipulation, through debridement, transesophageal echocardiography, carbon dioxide flooding of the field and proximal clamp application before initiating femoral perfusion [1].

Here we also emphasize the risk of stroke while releasing the clamp and advocate switching the outflow port of left heart bypass (LHB) from the left atrium (LA) to the branch of the inserted graft which may prevent the detached debris from getting into the cerebral circulation in the surgery of distal aortic arch or proximal descending aorta.

2. Technique

The operative technique involved a left antero-axillary thoracotomy for the distal aortic arch aneurysm [2]. LA was cannulated as an outflow site and the femoral artery or distal thoracic aorta as an inflow site. Once the LHB was established, the proximal aorta was cross-clamped either between the left carotid artery and the left subclavian artery or just distal to the left subclavian artery. Perfusion was maintained with a centrifugal pump (Medtronic INTERSEPT CB6500; Minneapolis, MN, USA) to keep the mean distal aortic pressure over 70 mmHg. Blood filter (Medtronic AFFINITY CB351) was incorporated in the inflow line. The proximal aorta was transected and the graft with a side branch was anastomosed. After completing the proximal anastomosis, the blood drainage was switched from LA to the side branch at the same time of declamping. (Fig. 1). This procedure thus prevents the tiny debris from getting into the turbulent flow near the re-instituted clamp by sucking into the side branch. Fig. 2 shows the macroscopic picture of the blood filter and the electron microscopic picture of the tiny debris, which was trapped by the mesh of the blood filter. These debris which otherwise might have flowed into the cerebral circulation have been demonstrated in the recent three out of five cases, in which the filters had been examined under the electron microscope following the distal aortic arch replacement under LHB.

3. Discussion

The repair of the distal aortic arch in patients with degenerative aneurysms and superimposed atherosclerosis can be a particularly hazardous procedure. The options for repairing these aneurysms are: (1) LHB with clamping the aorta between the left carotid artery and left subclavian artery through the left lateral thoracotomy and; (2) deep hypothermic circulatory arrest (DHCA) with or without retrograde cerebral perfusion (RCP) either through a left lateral thor-
acotomy or median sternotomy. DHCA has several advantages such as no usage of cross-clamping, technical simplicity and bloodless operative field, however DHCA itself does not flush back the tiny debris from the cerebral tributaries, even with the concomitant use of RCP. LHB which maintains the cerebral blood flow during the procedure, can avoid the cerebral global ischemia and also prevents the coagulopathy by the profound hypothermia, thus reducing the morbidity especially in the high-risk patients. However, the reported risk of the postoperative stroke in cross-clamp- ing technique is ranging from 3 to 14%, which is higher than that in DHCA [3–5]. Several techniques have been demonstrated to reduce the embolization [5]. Among them, external flushing is the most commonly used method, which flushes the aorta through the graft after completing the proximal anastomosis. However, re-occlusion of the graft for the distal anastomosis may induce the turbulence near the clamp, which may disrupt the debris from the injured aortic wall, thus resulting in the embolization. Internal flushing is another method to prevent the embolization. In this method, the proximal clamp is released only after the graft is in place, thus flushing the debris distally. This technique, however, has a risk of producing the distal embolization and is sometimes difficult in controlling bleeding from the proximal anastomosis through the limited operative field.

Outflow switch technique, which has been demonstrated here is a method to prevent the turbulent flow near the re-instituted clamp by draining the blood through the side branch of the graft that is placed just proximal to the clamp, thus, evacuating the debris which may be detached from the injured aortic wall following clamping. This method is simple and may increase the benefits of LHB by reducing the incidence of embolization.

References


