How-to-do-it

Returning reservoir blood to right atrium during extracorporeal circulation for descending aortic surgery

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Abstract

We report our techniques on conducting a closed-circuit femoral—femoral bypass during descending aortic surgery by which collected blood can be easily returned into the right atrium. The main circuit was composed of a centrifugal pump, an artificial membrane lung, and a filter. A reservoir with a roller pump was connected to the main circuit via a filter. Extracorporeal circulation was established by right atrial drainage via the femoral vein and femoral arterial return. On aortic crossclamping, systemic blood pressure was controlled by activating the roller pump in reverse rotation and shifting the body blood into the reservoir temporarily. For a small amount of bleeding after aortotomy, the reservoir blood was returned via the femoral artery by activating the roller pump in normal rotation. When a large amount of bleeding was present making the systemic blood pressure fall, the main circuit was clamped just distal to the centrifugal pump and reservoir blood was directly returned to the right atrium to maintain systemic pressure. Confirming that bleeding was reduced, the clamp distal to the centrifugal pump was gradually released and blood was delivered to both the right atrium and the femoral artery. We believe that our system is a highly beneficial modality.

Keywords: Descending thoracic aorta; Surgery; Extracorporeal circulation; Closed circuit; Right atrium

1. Introduction

In surgery for the descending thoracic aorta, various modalities of extracorporeal circulation had been introduced to protect the spinal cord and abdominal organs. However, it was sometimes difficult to maintain systemic blood pressure in the event of rapid blood loss during conventional extracorporeal circulation. In order to improve response to massive bleeding, we adopted a modified closed-circuit femoral—femoral bypass by which collected blood could be easily returned to the right atrium.

2. Technique

We utilized this pump system for descending thoracic aortic aneurysm repair. The main circuit was composed of a centrifugal pump, an artificial membrane lung and a filter. The reservoir was connected to the main circuit proximal to the centrifugal pump to enable blood delivery by a roller pump. Blood suction system was maintained by the wall suction connected to the reservoir. After full-dose heparin (body surface area \times 9000 units) was intravenously administered, extracorporeal circulation was established by right atrial drainage via the femoral vein and femoral arterial return. On aortic crossclamping, systemic blood pressure was controlled by activating the roller pump in reverse rotation and shifting the body blood into the reservoir temporarily (Fig. 1A). From a small to moderate amount of bleeding after aortotomy, the reservoir blood was returned via the femoral artery by activating the roller pump in normal rotation (Fig. 1B). When the large amount of bleeding made systemic blood pressure fall, the main circuit was clamped just distal to the centrifugal pump and reservoir blood was directly returned to the right atrium to maintain systemic pressure (Fig. 1C). Confirming that bleeding was reduced, the clamp distal to the centrifugal pump was gradually released and blood was delivered to both the right atrium and the femoral artery. When the bleeding was controlled, the clamp was removed and drainage from the right atrium as well as complete return to the femoral artery was restored (Fig. 1B). Direct intercostal artery perfusion, if needed, was applied by supplying blood from the side-branch just distal to the arterial filter. The flow was controlled by a single additional roller pump usually used for the delivery of cardioplegic solution (not shown in the diagrams).
3. Clinical results

Between 2002 and 2004, 10 consecutive patients underwent replacement of the descending aorta under this pump system. Patient characteristics and operative data are shown in Table 1.

Mostly, rapid autotransfusion into the right atrium was required several times during an operation. The systemic blood pressure was maintained to be 90 mmHg or over, whereas the central venous pressure was carefully monitored not to exceed 15 mmHg.

4. Discussion

For spinal cord and visceral protection during descending thoracic aortic surgery, several types of extracorporeal circulation such as left-heart and venoarterial bypass with closed circuit or venoarterial bypass with open circuit have been utilized [1—5]. We now use a closed-circuit femoral—femoral bypass in conjunction with a reservoir controlled by a roller pump, and the clinical outcomes were acceptable. The first advantage of our pump system is that it is easy to deal with sudden massive bleeding without delay. A time lag is likely to occur between the elevation of systemic blood pressure and the return of the reservoir blood via the femoral artery. This problem theoretically may be managed by using an open-circuit femoral—femoral bypass. However, since returning blood into the right atrium using the recirculation circuit necessitates the somewhat confusing manipulation of the clamps, it may be difficult to respond to sudden bleeding and systemic blood pressure drop. On this point, the perfusionist using our system only has to place one clamp at the main circuit and can then concentrate on adjusting the reservoir level by the roller pump.

Another advantage of our system is that the systemic blood pressure can be closely controlled on aortic cross-clamping by siphoning a proportion of the circulating volume into a reservoir temporarily, as an alternative to vasodilating agents.

Furthermore, circulatory arrest can be applied by the same circuit, if needed. This is not possible when left-heart bypass is used.

Table 1

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<th>Gender</th>
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<th>CPB time (min)</th>
<th>Crossclamping time (min)</th>
<th>Lowest rectal temperature</th>
<th>CSF drainage</th>
<th>Intercostal artery reconstruction</th>
<th>Ventilation time (h)</th>
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CPB, cardiopulmonary bypass; CSF, cerebrospinal fluid.
Similar to surgery for the aortic arch or thoracoabdominal aortic aneurysms, descending aortic operations are carried out using various modalities in various institutions. Among them, we believe that our system can be a beneficial alternative.

References


