Hypotension after Release of Aortic Cross-clamp

To the Editor—A decrease in mean arterial pressure (MAP) often accompanies release of the aortic cross-clamp during open heart surgery. The reasons ascribed to this phenomenon are reactive myocardial hyperemia and vasodilator effect of myocardial stretch receptors and addition of a fully dilated myocardial vascular bed to the circulation. To the best of our knowledge, the extent of the decrease in MAP has not been reported. Therefore, we investigated the extent of the decrease in MAP and systemic vascular resistance (SVR) following the release of aortic cross-clamp in 100 consecutive adult patients undergoing open heart surgery. The various surgical procedures performed were mitral valve surgery (open mitral valvotomy (OMV), mitral valve replacement (MVR)), 45; aortic valve replacement (AVR), 7; double valve procedures (OMV + AVR, MVR + AVR), 12; coronary artery bypass graft, 14; and others (including atrial septal defect, ventricular septal defect, atrial myxomas), 22. Anesthesia was provided by morphine (approximately 1 mg/kg), and standard bypass techniques with Ringer’s lactate prime was used. Cold potassium cardioplegia with moderate hypothermia (28°C) was used for myocardial protection. An indwelling radial arterial cannula was used to measure MAP. SVR was calculated using the formula $\text{SVR} = \frac{\text{MAP} \times 80}{\text{pump flow}}, \text{dynes-s-cm}^{-5}$. Central venous pressure was maintained at 0, and no attempt was made to fill the heart during the study period. Patients in whom vasodilators were used during cardiopulmonary bypass (CPB) were excluded. Measurements were made just before the release of cross-clamp (control), just after the release of cross-clamp when the pump flows were normal (2.4 l/m², this was taken as 0 min), and 1, 3, 5, and 10 min after cross-clamp release. During this period, the patients were awaiting rewarming, and the final stage of the operative procedure was being completed. Between 5 and 10 min after release of cross-clamp, 32 patients were separated completely from CPB; hence, at 10 min, data from 68 patients are presented.

There were 60 males and 40 females with a mean age of 29.4 ± 13.9 yr and mean weight of 46 ± 13 kg. The mean duration of aortic cross-clamping and CPB was 53 ± 27 min and 30 ± 48 min, respectively. The results are summarized in table 1. Statistical analysis was done by using one-way analysis of variance, and if found significant, Student’s t test (two-tailed) was applied. A P value of <0.05 was deemed significant. There was a 27% decrease in MAP and 31% decrease in SVR, 1 min after the release of aortic cross-clamp. Although there was some recovery during subsequent period, the change continued to remain statistically significant up to 10 min after the release of aortic cross-clamp. MAP and SVR decreased in all the patients except 9 and 3 patients, respectively, at 1 min. The mean temperature at the time of release of aortic cross-clamp was 33.7 ± 2.7°C.

Pearson’s correlation coefficient was calculated to determine the relationship between the temperature and duration of bypass and extent of decrease in MAP and/or SVR. A poor correlation was found between these variables with an r value ranging between 0.08 and 0.16. There also was no difference in the extent of decrease in MAP and SVR in the various types of surgical procedures except that, in group “others,” the decrease in MAP was less as compared with those undergoing valve procedures (P < 0.01).

We conclude that there is a significant decrease in MAP (27%) and SVR (31%) after the release of aortic cross-clamp, and it persists for 10 min.

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References

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Table 1. Hemodynamic Data

<table>
<thead>
<tr>
<th>Before Release of Cross-clamp (min)</th>
<th>0</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP (mmHg)</td>
<td>65 ± 14</td>
<td>48 ± 15*</td>
<td>47 ± 15*</td>
<td>51 ± 16*</td>
<td>53 ± 17*</td>
</tr>
<tr>
<td>SVR (dynes·s·cm⁻⁵)</td>
<td>1,699 ± 511</td>
<td>1,199 ± 411*</td>
<td>1,163 ± 365*</td>
<td>1,246 ± 455*</td>
<td>1,295 ± 455*</td>
</tr>
</tbody>
</table>

MAP = mean arterial pressure; SVR = systemic vascular resistance.
* P < 0.00001.
† P < 0.001.