Detection of Flow Stop in Bypass Grafts during CABG

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During coronary artery bypass grafting (CABG), blood flow in the grafts was measured with a Flowmeter. We report five cases where early graft occlusion (3/5) and graft failure (2/5) were detected with flowmetry. In only one (1/5) of the cases was ECG-changes seen, and none of the patients had low cardiac output or other signs of graft failure at the end of the operation. The cause of graft failure was tagging (1/5) and rotation (2/5) of internal mammary grafts, and kinking of vein grafts (2/5). All errors were corrected, and control flowmetry showed normal flowrates after correction.

SURGICAL PROCEDURE
The operations were standard coronary artery bypass grafting (CABG) using mild systemic cooling to 32° C and intermittent antegrade infusion of cold crystalloid cardioplegia. Cardioplegia was also infused through the vein grafts with a syringe to give the surgeon a feeling of run off. A median of four distal anastomosis was performed using a single internal mammary artery (IMA) and vein grafts. All distal anastomosis was sutured with 7-0 polypropylene. The pedicle of the IMA grafts was routinely tagged to the heart at the distal end with two sutures of polypropylene 5-0 in each corner of the fascia to avoid tension at the suture line or torsion of the graft. At the end of cardiopulmonary bypass, ECG and cardiac output was applied in all patients.

FLOWMETRY
At the end of the operation (either before or after termination of cardiopulmonary bypass) we measured the blood flow in both IMA and vein grafts using the Flowmeter (Medi-Stim AS, Oslo, Norway). The transit time probes were placed around the vessel giving the true volume flow in ml/min without the need of any zero-line calibration. The mean arterial pressure was recorded. The flow curves as well as the mean flow values are shown on the monitor of the flowmeter. Transit time flowmetry has shown good correlation with the directly measured blood flow¹, and with the Doppler ultrasound method, and it is more feasible for clinical measurements that these methods².

FLOW MEASUREMENT DURING SURGERY
In order to improve the acoustical contact between the flat front face of the probes and the vessel wall, it is recommended that the probe head is immersed in isotonic saline solution for two minutes before use. The degree of acoustical coupling is registered on the monitor of the flowmeter by means of a colour indicator. If, after placing the probe around the vessel, the acoustical coupling is poor, it may be improved by moistening the probe again using blood, saline solution or sterile gel. We found that the 3 mm probe most often had the right size for IMA grafts while the 4 mm probe is more suitable for vein grafts. The flow could be measured in 5 min. in all cases, and there were no complications related to the measurements.
RESULTS
In five patients the flow in the coronary bypass grafts were zero or unexpectedly low due to kinking or rotation of the grafts or occlusion at the anastomotic site (table 1). Cardiac output was considered normal in all cases, and ECG changes with marked ST-elevation were only present in one case. The IMA grafts were untagged and repositioned, one vein graft was routed differently so that it did not kink, and one vein graft was reanastomosed to the coronary artery after crossclamping of the aorta and infusion of cardioplegia at a second time. The final outcomes were uneventful and no patients had myocardial infarction or recurrence of angina pectoris.

<table>
<thead>
<tr>
<th>Case: Gender / age</th>
<th>Cause of obstruction</th>
<th>Flow before correction (ml/ min)</th>
<th>Flow after correction (ml/ min)</th>
<th>ECG changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>M/50</td>
<td>IMA rotated</td>
<td>0</td>
<td>14</td>
<td>-</td>
</tr>
<tr>
<td>M/61</td>
<td>Vein graft kinked</td>
<td>11</td>
<td>31</td>
<td>-</td>
</tr>
<tr>
<td>M/69</td>
<td>Sequential vein graft occluded</td>
<td>0</td>
<td>39</td>
<td>+ST - elevations</td>
</tr>
<tr>
<td>F/46</td>
<td>IMA rotated</td>
<td>0</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>F/61</td>
<td>IMA kinked at anastomosis</td>
<td>2</td>
<td>38</td>
<td>-</td>
</tr>
</tbody>
</table>

CONCLUSION
Early graft occlusion after CABG may have deleterious consequences. Intraoperative measurement of graft flow in IMA and vein grafts during CABG is a useful quality control to reveal technical errors. We would emphasise that this should be mandatory in CABG, since ECG-changes or absence of pulse are insufficient signs to monitor flow in bypass grafts. The Flowmeter is handy and fast to use, and highly reliable for flow measurement.

References

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Correspondence related to the Flowmeter should be forwarded to: Medi-Stim ASA, Marketing Dept., Pb. 4744 Nydalen, NO-0421 Oslo, Norway, or by e-mail: medistim@medistim.com.