Abdominal aortic aneurysm (AAA) is commonly associated with coronary artery disease (CAD). Eleven patients underwent the combined operation of coronary artery bypass grafting (CABG) on the beating heart and AAA repair: 10 underwent off pump CABG and 1 patient required centrifugal pump and pulmonary assist with closed circuit because of unstable hemodynamics. All cases were discharged without severe complications and with patent coronary bypass grafts. (Circ J 2002; 66: 755–757)

Key Words: Abdominal aortic aneurysm; Beating heart coronary artery bypass; Combined operation; Off pump coronary artery bypass

Patients with an abdominal aortic aneurysm (AAA) frequently have coexisting coronary artery disease (CAD), which is the most common cause of death following AAA repair; and those with significant CAD should undergo myocardial revascularization before surgical treatment of the AAA. Coronary artery bypass grafting (CABG) before AAA repair decreases postoperative and long-term cardiac mortality, but the disadvantage of a staged procedure is postoperative rupture of the AAA and simultaneous CABG, with cardiopulmonary bypass (CPB) under cardiac arrest, and AAA repair can be very invasive. CABG of the beating heart without CPB has been reported as less invasive, and the combination of this and AAA repair may be a less invasive procedure. We report our experience with this technique.

Methods

Patients

We retrospectively reviewed the records of consecutive patients who underwent combined beating heart CABG and AAA repair between May 1999 and October 2001, and found 11 patients (9 male (82%) and 2 female (18%)) with a mean age of 73±7 (SD) years (range, 58–82 years). The mean size of the aneurysms was 61±12 mm (range, 40–80 mm). Preoperative evaluation included abdominal computed tomography, aortography, and coronary angiography (CAG). Significant coronary stenosis on the CAG (>75% stenosis on the New York Heart Association coronary classification) indicated the need for coronary revascularization. Four patients had symptomatic AAA, and the other 7 had asymptomatic aneurysms; 2 of them had symptomatic coronary artery stenosis. Risk factors included hypertension in 9 patients (82%), diabetes mellitus in 2 (18%), chronic obstructive pulmonary disease in 3 (27%), and chronic renal dysfunction in 2 (18%). The mean ejection fraction was 59±12% (Table 1).

Surgical Procedure

The first stage of the combined surgical procedure started with coronary revascularization followed by repair of the AAA. Ten patients underwent extended midline sternotomy with an incision from the sternal notch to the superior border of pubic symphysis, and one patient had a midline lower sternotomy (inverted L incision) from the right 3rd intercostal space to the superior border of pubic symphysis. The selection of grafts and their target coronary arteries was individualized; however, every effort was made to achieve complete revascularization using arterial conduits. After midline incision and harvest of the appropriate grafts, the pericardium was opened. A local coronary stabilizer (Octopus-2 coronary stabilizer, Medtronic, Minneapolis, MN, USA) was placed onto the target coronary artery. Coronary stabilization of the posterior aspect of the heart was further supported with an appropriate

Table 1 Preoperative Characteristics of the Patients

<table>
<thead>
<tr>
<th>No. of patients</th>
<th>11</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>73±7</td>
</tr>
<tr>
<td>M/F</td>
<td>9/2</td>
</tr>
<tr>
<td>AAA size (mm)</td>
<td>61±12</td>
</tr>
<tr>
<td>Symptomatic/asymptomatic AAA</td>
<td>4/7</td>
</tr>
<tr>
<td>Symptomatic/asymptomatic CAD</td>
<td>2/9</td>
</tr>
<tr>
<td>Preoperative risk factors</td>
<td></td>
</tr>
<tr>
<td>HT</td>
<td>9 (82%)</td>
</tr>
<tr>
<td>DM</td>
<td>2 (18%)</td>
</tr>
<tr>
<td>COPD</td>
<td>3 (27%)</td>
</tr>
<tr>
<td>Chronic renal dysfunction</td>
<td>2 (18%)</td>
</tr>
<tr>
<td>EF (%)</td>
<td>59±12</td>
</tr>
</tbody>
</table>

AAA, abdominal aortic aneurysm; CAD, coronary artery disease; HT, hypertension; DM, diabetes mellitus; COPD, chronic obstructive pulmonary disease; EF, ejection fraction.
Table 2 Operative and Postoperative Results

<table>
<thead>
<tr>
<th></th>
<th>No. of coronary bypass grafts</th>
<th>Y/I graft replacement</th>
<th>Operation time (min)</th>
<th>Intraoperative body loss (ml)</th>
<th>Transfusion (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.4±0.5</td>
<td>9/2</td>
<td>373±68</td>
<td>864±506</td>
<td>1.5±2.8</td>
</tr>
</tbody>
</table>

Intraoperative body loss was expressed as mean ± SD.

Statistical analysis was performed using Statview version 4.5 (SAS Institute, Cary, NC, USA) and the results were expressed as mean ± SD.

### Results

The average number of coronary bypass grafts was 1.4±0.5. In the abdominal aortic position, 9 (82%) bifurcated (Y) grafts and 2 (18%) straight tube (I) grafts were implanted, and left renal artery reconstruction was carried out in 1 case. The mean operating time was 373±68 min. Intraoperative blood loss was 864±506 ml. The number of packed red blood cell transfusions was 1.5±2.8 units during the operation and 2.5±3.4 units postoperatively. Mean postoperative intubation time was 9.5±6.8 h. Postoperative complications included respiratory failure (hypoxemia because of peripheral atelectasis) in 1 patient and liver dysfunction (rise in the concentration of transaminase) in 1 patient; however, neither case was serious. No-one developed postoperative myocardial infarction or major cardiac complications. The mean postoperative stay was 24±10 days. The overall graft patency rate determined by postoperative CAG before discharge was 100% (15/15) (Table 2). All cases were doing well after discharge.

### Discussion

CAD is common in patients with AAA and is the leading cause of postoperative death following AAA repair. The 5-year mortality rate from myocardial infarction in patients who had preoperative evidence of heart disease is 4 times higher than that for patients without CAD, and therefore it has been recommended that cardiac evaluation and coronary revascularization, if indicated, be carried out before AAA repair. Generally, the CAD is treated first, followed by AAA repair, and improvements in CABG and percutaneous transluminal coronary angioplasty (PTCA) before AAA operation have clearly decreased both early and late mortality. Single-vessel disease can be treated by PTCA, although there is a significantly greater chance of repeat intervention and recurrence of angina than with CABG. In the present study, the average number of coronary bypass grafts was small because the patients for the most part had asymptomatic CAD.

Symptomatic and/or large AAAs untreated have a high risk of rupture, and therefore high mortality, and patients with a large symptomatic AAA are at risk if a staged procedure is adopted. There is an increased incidence of AAA rupture after major abdominal and thoracic operations with the primary operation and then postoperative factors playing a role in hastening rupture of the aneurysm. A single operation avoids repeat anesthesia and 2 convalescence periods, and is thus justified providing there is no additional operative risk to the patient. There are other advantages of a combined procedure: it is cost effective because a second hospitalization and procedure are avoided and the added benefit of a favorable psychological effect. However, on-pump conventional CABG is invasive because of the need for CPB. CPB and cardioplegic arrest result in physiologic inflammatory, coagulopathic and embolic states that may result in end-organ damage. In patients with complications, impaired left ventricular function, poor respiratory function and/or renal failure, the mortality rate of combined surgery with CPB under cardiac arrest is reported to be 0–25%. The patients at highest risk for undergoing CPB, including those of advanced age and having ventricular dysfunction, are precisely those for whom OPCABG may be the most useful. OPCABG also reduces hospital cost, the length of postoperative stay and morbidity compared with CABG on CPB, and is safe and effective.

In patients requiring one coronary revascularization, a minimally invasive direct coronary artery bypass (MIDCABG) may be indicated; however, it is a challenging technique because of the longer time of the surgery and...
coronary occlusion and has a higher risk of conversion and wound infection;\textsuperscript{24} Gersbach et al compared OPCABG and MIDCABG and found the former to be more comfortable for both patient and surgeon;\textsuperscript{25} which is why we chose beating heart CABG with a stenotomy approach.

Our simultaneous procedure was completed without severe complications in all cases, and all were discharged with patent coronary artery grafts. Our operative and post-operative results had an allowable and acceptable surgical invasiveness. In 1 case, anastomosis to the posterolateral coronary branch was difficult because of a hemodynamic change, so instead we performed the revascularization on the beating heart under cardiopulmonary support with a closed circuit to ensure hemodynamic stability.

We conclude that combined CABG on the beating heart and AAA repair in a one-step approach is a useful therapeutic strategy. Early results for off-pump beating heart CABG have already been established;\textsuperscript{4,26} and follow-up studies to determine the long-term results are now required.

**References**