Original Article

Usefulness of One-stage Coronary Artery Bypass Grafting on the Beating Heart and Abdominal Aortic Aneurysm Repair

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Abdominal aortic aneurysm (AAA) is commonly associated with coronary artery disease (CAD). Simultaneous coronary artery bypass grafting (CABG) with cardiopulmonary bypass (CPB) under cardiac arrest and AAA repair may be considerably invasive. Recently CABG under the beating heart without CPB has been reported as a less invasive method. We report the combined operation of CABG on a beating heart and AAA repair for AAA patients with CAD, and compare it with a separate operation. A retrospective review of the records of consecutive patients who underwent elective combined procedure or single operation for CABG on a beating heart and/or repair of the AAA between May 1999 and October 2001 was carried out. Ten patients underwent combined procedures. A single operation, CABG on a beating heart or repair of AAA, were performed in 27 or 19 patients. There were no significant differences with regard to intraoperative blood loss, transfusion and postoperative intubation time among the three groups. There was no operative mortality for any of the three groups. All cases were discharged without severe complications and with patent coronary bypass grafts. There was a decrease in mean total hospital costs for the combined operation group compared with the CABG group plus AAA repair group (3.34 million versus 5.87 million yen). Combined CABG on a beating heart and AAA repair on a one-step approach appears to be a safe and useful therapeutic strategy for AAA patients with CAD. (Ann Thorac Cardiovasc Surg 2004; 10: 29–33)

Key words: coronary artery bypass grafting, abdominal aortic aneurysm, combined operation, off-pump coronary artery bypass

Introduction

Patients with abdominal aortic aneurysm (AAA) frequently have coexistent coronary artery disease (CAD).[1] CAD is the most common cause of death following AAA repair.[2] Those with significant CAD should undergo myocardial revascularization before surgical treatment of AAA. Coronary artery bypass grafting (CABG) before AAA repair has been shown to decrease postoperative and long-term cardiac mortality.[3] However, the disadvantage of a staged procedure is postoperative rupture of AAA following CABG, while simultaneous CABG with cardiopulmonary bypass (CPB) under cardiac arrest and AAA repair may be considerably invasive. Recently CABG under the beating heart without CPB has been reported as a less invasive method.[4,5] Combined CABG on a beating heart and AAA repair may reduce the invasiveness of simultaneous CABG with CPB under cardiac arrest and AAA repair. We report our experience with combined CABG on a beating heart and AAA repair, and compare this with a separate operation, and review the usefulness of the combined procedure.

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Methods

Patients

A retrospective review of the records of consecutive patients who underwent elective combined procedure or single operation for CABG on a beating heart and/or repair of AAA between May 1999 and October 2001 was

Table 1. Preoperative patients demographics

Demographics	CABG/AAA	CABG	AAA
No. of patients	10	27	19
Age (yr)	72±8	65±8	73±7
Male/female	9/1	19/8	13/6
AAA size (mm)	62±12	–	54±10
Symptomatic/asymptomatic AAA	3/7	–	5/14
Symptomatic/asymptomatic CAD	2/8	26/1	–
LVEF (%)	58±12	52±17	58±18

CABG, coronary artery bypass grafting; AAA, abdominal aortic aneurysm; CAD, coronary artery disease; LVEF, left ventricular ejection fraction.

carried out. Ten patients underwent combined procedures. A single operation, CABG on a beating heart or repair of AAA, was performed in 78 or 19 patients. Preoperative evaluation included an abdominal computed tomographic scan, aortograpic, and coronary angiography (CAG). Significant coronary stenosis on the CAG (more than 75% stenosis on New York Heart Association [NYHA] coronary classification) was an indication for coronary revascularization. Patients of AAA with significant coronary stenosis were indicated to simultaneous CABG on a beating heart, not percutaneous transluminal coronary angioplasty (PTCA). Twenty-seven patients of CAD with one or two vessel disease of the 78 CABG cases were selected as the patients with single operation of CABG on a beating heart because the patients with the combined operation had CAD with one or two vessel disease. We compared intraoperative and postoperative data between these three groups. Patient demographics for these groups are summarized in Table 1. Symptoms of AAA patients with the combined operation included abdominal pain in one and abdominal discomfort in two. All patients of AAA with the combined operation were referred to our division for diagnosis of AAA. As a rule we perform preoperative CAG for all AAA patients.

Surgical procedure and perioperative management

The first stage of the combined surgical procedure started with coronary revascularization followed by repair of the aortic aneurysm. The patients in the combined procedure group basically received an extended midline sternotomy with an incision from the sternal notch to the superior border of the pubic symphysis. The patients with a single operation of CABG were operated on via a median sternotomy, and the patients in the single AAA repair group were operated on via a median incision from the xyphoid to the superior border of pubic symphysis.

The selection of grafts and their target coronary arteries was individualized, however, every effort was made to conduct complete revascularization using arterial conduits. Basically, the left anterior descending artery (LAD) was revascularized with the left internal thoracic artery (LITA). The right coronary artery (RCA) was often revascularized with the right gastroepiploic artery (RGEA). The left radial artery (LRA) was mostly used with the left circumflex artery (LCX) as a free graft. After midline incision and harvest of the appropriate grafts, the pericardium was opened. A local coronary stabilizer (Octopus-2 coronary stabilizer, Medtronic, Inc., Minneapolis, MN) was placed onto the target coronary artery. Coronary stabilization of the posterior aspect of the heart was further supported with appropriate retropericardial suspension suture.[6] Heparin (initial dose, 100 units/kg body weight) was administered to maintain an activated clotting time (ACT) of more than 200 seconds during the anastomosis. Dopamine hydrochloride was administered as required for a systolic arterial pressure of greater than 80 mmHg. Intraoperatively, isosorbide dinitrate and diltiazem were maintained with continuous injection (1.0 μg/kg/min). The coronary shunt (ClearView®, Medtronic, Inc.) was used to establish distal coronary perfusion. Distal anastomoses were performed by the double parachute technique using 7-0 or 8-0 polypropylene sutures. Proximal free-graft anastomoses to the ascending aorta were done using 5-0 or 6-0 polypropylene sutures with a side clamp applied to the ascending aorta. Off-pump CABG (OPCAB) was performed in nine patients of the combined operation group. In one case of the group, the anastomosis to the branch of LCX was not easy due to unstable hemodynamic change (hypotension), hence the centrifugal pump and pulmonary assist with closed circuit was established between the ascending aorta and right atrium. Seventeen patients from the CABG group underwent OPCAB, and the other 10 patients of the group, underwent repair with the centrifugal pump and pulmonary

Table 2. Operative and postoperative data

Variable	CABG/AAA	CABG	AAA
No. of CABG	1.3±0.5	1.6±0.5	–
Y/I graft replacement	9/1	–	18/1
Total heparin (unit)	7,328±1,624	6,364±3,590	3,750±1,155[a]
Max ACT (sec)	286±49	305±104	264±66
Operation time (min)	367±67[b]	241±42	240±35
Intraoperative blood loss (ml)	841±538	483±208	1,445±1,195
Transfusion (unit)	2.5±3.5	1.6±2.5	1.6±2.4
Postoperative intubation time (h)	9.3±6.9	9.4±9.4	4.3±13
CABG patency (%)	100	98	–
Mortality (%)	0	0	0
Total hospital cost (million yen)	3.34±0.53	3.18±1.07	2.69±0.94

[a]$p<0.05$, AAA vs. CABG/AAA, CABG; [b]$p<0.05$, CABG/AAA vs. CABG, AAA.
CABG, coronary artery bypass grafting; AAA, abdominal aortic aneurysm; ACT, activated clotting time.

assist with a closed circuit.

The aortic aneurysms were repaired with collagen-impregnated Dacron bifurcated or tube grafts. Every effort was made to conduct revascularization of the inferior mesenteric artery.

All patients on whom CABG was carried out underwent postoperative coronary angiography before discharge.

Statistical methods

Statistical analysis was performed using StatView® version 5.0 (SAS Institute Inc., Cary, NC). Results were expressed as mean ± SD. Differences in patient demographics and intraoperative and postoperative factors were determined by Student's t test or analysis of variance depending on the number of groups for comparison. Significant differences were reported for p values less than 0.05.

Results

There were no significant differences with regard to age, diameter of AAA, left ventricular ejection fraction, number of bypasses, intraoperative blood loss, number of packed red blood cell transfusions during operation, and postoperative intubation time among the three groups. The patients in the combined operation group spent a significantly longer time in operation time compared with the single operation groups, CABG group and AAA repair group (Table 2).

Postoperative complications of the combined group included respiratory failure (hypoxemia due to peripheral atelectasis) in one and liver dysfunction (rise of transaminase) in one, those of the CABG group included wound dehiscence in two, pneumonia in one and paroxysmal atrial fibrillation in one, and those of AAA repair group included wound dehiscence in three and graft fever in one. However, none of the forementioned cases were serious. There were no postoperative myocardial infarctions or major cardiac complications. There was no operative mortality for any of the three groups. All cases were discharged without severe complications and with patent coronary bypass grafts.

There was no significant difference with regard to total hospital costs among the three groups (Table 2). There was a decrease in mean total hospital costs for the combined operation group compared with the CABG group plus AAA repair group (3.34 million yen versus 5.87 million yen).

Discussion

CAD is common in patients with AAA. CAD is the leading cause of postoperative death following AAA rapair.[2] The 5-year mortality rate from myocardial infarction in patients who had preoperative evidence of heart disease is four times higher than that for patients without CAD.[3] Golden and colleagues[7] recommended cardiac evaluation and coronary revascularization if indicated before AAA repair. The common course is for the treatment of CAD to be undertaken first, followed by AAA repair. Improvements in CABG and PTCA before AAA operation have clearly decreased both early and late mortality.[8,9] Single vessel disease can be treated by PTCA. How-

ever, it was demonstrated that PTCA carries a significantly greater chance of repeat intervention and recurrence of angina than CABG.[10,11]

Symptomatic and/or large size AAA left untreated carries a high risk of rupture and is therefore associated with a high mortality.[12] Patients with large symptomatic AAA are at risk for aneurysm rupture if staged procedures are adopted. Some reports[13,14] have demonstrated the increased incidence of AAA rupture after major abdominal and thoracic operations. The first operation and the postoperative factors may play a role in hastening aneurysm rupture. A single operation avoids repeat anesthesia and prevents two separate convalescence periods. Thus, a combined procedure could be justified providing there is no additional operative risk to the patient. There are other advantages of the combined procedure. The combined approach may be cost effective because a second hospitalization and a second procedure can be avoided,[15] and there may be the added benefit of a favorable psychological effect for the patient. However, on-pump conventional CABG is known to be invasive due to the CPB. CPB and cardioplegic arrest result in known 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 renal failure, the operative mortality rate of the combined surgery with CPB under cardiac arrest is reported to be 11-25%.[16-18] Baumgartner et al.[5] document that patients at highest risk for undergoing CPB, including those of advanced age and having ventricular dysfunction, are precisely the ones in whom OPCAB may be the most useful. And it is reported that OPCAB reduces hospital cost, postoperative length of stay, and morbidity compared with CABG on CPB and is safe and effective.[4] In patients with a single coronary revascularization, minimally invasive direct coronary artery bypass (MIDCAB) may be indicated. However, a recent report showed that MIDCAB is a challenging technique as demonstrated by the longer times of surgery and coronary occlusion with a tendency towards a higher risk of conversion and wound infection.[19] Gersbach et al.[20] demonstrate that OPCAB, comparing MIDCAB, is more comfortable for both patient and surgeon. Therefore, we performed the coronary revascularization on the beating heart using the sternotomy approach.

In our results, the operating time of the combined operation group was significantly longer compared with the single operation groups, CABG group and AAA repair group. Our simultaneous procedure was completed without severe complications in all cases, and they were discharged with patent coronary artery grafts. These data, our operative and postoperative results, are thought to be acceptable in surgical invasiveness. In one case, an anastomosis to the posterolateral coronary branch was difficult with hemodynamic change, therefore we performed the revascularization on the beating heart under cardiopulmonary support with a closed circuit to ensure hemodynamic stability. This system may prevent major blood loss due to mild heparinization. There was no significant difference with regard to total hospital costs among the three groups, combined operation group, CABG group and AAA repair group. Total hospital costs is notably decreased for patients undergoing the combined procedure compared with those undergoing a staged operation. All cases were discharged without severe complications and with patent coronary bypass grafts.

We conclude that combined CABG on the beating heart and AAA repair on a one-step approach appears to be a safe and effective therapeutic strategy for AAA patients with CAD. Our study contained a small number of patients, and a study with a large number of patients will be needed to demonstrate the benefit of the one-stage procedure. Early results for off-pump beating CABG has already been established.[4] In the combined surgery further follow-up studies are necessary to determine long-term results.

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