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Beating heart surgery

Summary

Coronary artery bypass grafting (CABG) is one of the most frequently performed surgical procedures in developed countries. Concerning the increased incidence of coronary artery disease its application is expected to rise. The standard procedure, using cardiopulmonary bypass (CPB) with cardioplegic arrest for complete revascularisation is safe and effective with a low mortality rate in elective patients. However, there is still a substantial morbidity related to CPB and cardioplegic arrest. CPB-related adverse side effects can induce a systemic inflammatory response caused by the activation of plasma protein systems and generate micro emboli. To avoid these deleterious effects, the technique of operating on a beating heart for CABG (OPCAB) has been introduced. The introduction of cardiac stabilisers and other technical devices have improved the surgical procedure leading to comparable conditions concerning the quality of anastomoses. Therefore this technique is becoming increasingly popular and many reports support the theoretical and practical advantage compared to standard procedures. The advantage of OPCAB procedure also includes the reduction of postoperative morbidity with a shorter hospitalization and lower cost containment. Particularly the benefit of elderly and high-risk patients from OPCAB surgery is encouraging.

This review presents the OPCAB-technique we routinely perform in our institution. We also discuss some considerations which should be addressed if this technique is to establish as a part of the surgical treatment in patients with coronary artery disease.

Key words: coronary artery bypass grafting (CABG); cardiopulmonary bypass; off-pump surgery

Zusammenfassung

Die koronare Bypass-Operation ist eine der häufigsten chirurgischen Eingriffe in der westlichen Welt und wird unter Berücksichtigung der zu erwartenden Bevölkerungsentwicklung auch weiter steigen. Dank Entwicklung der extrakorporalen Zirkulation (Herz-Lungen-Maschine) in den 1950er Jahren ist die Operation zu einem sicheren und effektiven Verfahren geworden, das bei elektiven Patienten eine geringe Mortalität aufweist. Dank Forschung und Entwicklung im Bereich der Medizinaltechnik ist es nicht nur gelungen, die extrakorporale Zirkulation zu optimieren, sondern auch das Wissen über Nachteile und Folgeschäden zu erweitern. So hat in den letzten Jahren das Operieren am schlagenden Herzen (OPCAB) eine Renaissance erfahren und gewinnt dank technischer Hilfsmittel, die eine vollumfängliche Visualisierung der Koronargefäße und eine sichere Anastomosen-Technik erlauben, zunehmend an Popularität. Erste Berichte zur technischen Durchführung wurden abgelöst von prospektiv randomisierten Studien, die ermutigende Resultate bezüglich geringerer postoperativer Morbidität, verbunden mit verkürzter Hospitalisation und geringerer Kosten, ergaben. Insbesondere Berichte über verbesserte Ergebnisse bei Älteren oder Hochrisikopatienten lassen aufhorchen und implizieren ein zügiges Umsetzung schlüssiger Gesamtkonzepte zur Behandlung von Patienten mit koronarer Herzkrankheit.

Key words: koronare Bypass-Operation; extrakorporale Zirkulation; OPCAB-Revaskularisation

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Introduction

Coronary artery bypass grafting (CABG) is an effective and safe procedure in the treatment of patients with multi-vessel coronary artery disease. Since the introduction of extracorporeal circulation (ECC) in the early nineteen fifties its application is nowadays one of the most performed surgical procedure worldwide [1]. During the last decade the improvements in surgical and anaesthesiological techniques have reduced the mortality under 3% in elective patients [2]. However, despite many advances in the technical development of ECC, there is still a significant morbidity related to the use of cardiopulmonary bypass [3, 4]. These ECC-related adverse side effects induce a systemic inflammatory response and generate micro emboli with postoperative neurological damage [5–7]. To reduce these deleterious effects, the application of beating heart surgery without the use of ECC (OPCAB) becomes more and more popular in the last years [8–10].

In our institution 25% of myocardial revascularisations are performed in OPCAB-technique. The objective of this paper is to present our experience and to discuss some considerations regarding clinical outcome.

Surgical technique

Anaesthesiological management with haemodynamic monitoring is performed using arterial pressure line, Swan-Ganz catheter and continuous transoesophageal echocardi-

graphy (TEE) during each procedure [11]. To maintain normal body temperature, the patients are placed on a warming mattress and covered with a warm-air blanket. The operating theatre is warmed up to 22 °C. All procedures are performed with median sternotomy. Internal thoracic artery (ITA) and saphenous vein graft (SVG) are used as bypass conduits. To visualise all target vessels, a deep pericardial stitch between the inferior vena cava and the right lower pulmonary vein is performed. A V-shaped sponge is inserted between a stiff and long tourniquet. Pulling the V-shape sponge gently toward the left side, the heart can be displaced completely without changing the haemodynamic parameters. To perform a technically appropriate distal anastomosis, a stabiliser is placed on the corresponding area (fig. 1). In our institution, we use a tissue suction stabiliser (Octopus IV™ Medtronic Inc., Minneapolis, USA). In case of an enlarged left ventricle, a gentle elongation of the axis can be obtained by using a second suction device (Starfish™, Medtronic Inc., Minneapolis, USA). During the anastomosis, the coronary vessel is perfused through an intracoronary perfusion shunt, allowing the surgeon to operate in a bloodless field without fearing ischaemic events. The anticoagulation management is performed similar to patients with cardiopulmonary bypass measuring the activated clotting time (ACT) more than 480 sec. The shedded blood will be collected and retransfused continuously if the volume is more than 200 ml (Cardiotomy: Haemonetics™ Corp., Braintree, USA; Volumetric infusion pump: Imed™960A Aotec, Baar, Switzerland). The patients are extubated on the intensive care unit (ICU) 4 to 8 hours postoperatively, usually discharged from the ICU the next day.

First experience with this technique

We started our OPCAB program in 1998. First using this technique only in patients with 1- or 2-vessel disease, we now perform this procedure in 3-vessel disease regularly. We now elucidate the data of 207 patients operated on in 2001 and 2002. The demographic data are shown in table 1. Thirty-day mortality was 0.96% (2/207), due to stroke and a low cardiac output failure respectively. 23% of the patients with a 3-vessel disease demonstrate a moderate or severe left ventricular dysfunction (EF <40%) but without significant peri- or postoperative complications underlined by a short

Figure 1
Completely luxated heart, visualising the ramus circumflexus of the left coronary vessel.

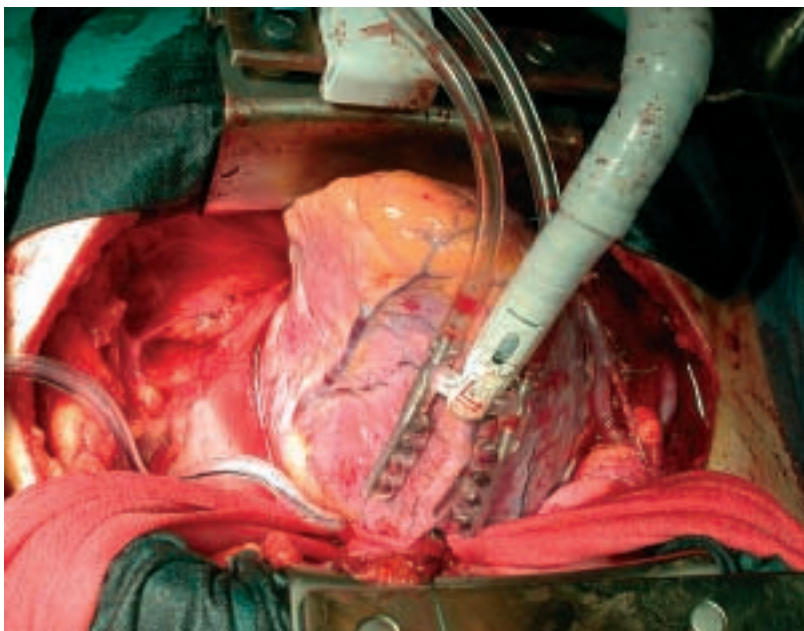


Table 1
Demographic data.

| | 1VD | 2VD | 3VD |
|---|------------|------------|-----------|
| Patients n = 207 | 18 (8.5%) | 26 (12.5%) | 163 (79%) |
| Gender | | | |
| male | 166 (80%) | | |
| female | 41 (20%) | | |
| Age (years) | 68 ± 7.6 | | |
| EF <40% | | | 47 (23%) |
| Number of grafts | 1.8 | 2.1 | 3.2 |
| Operation time (min) | 90 | 95 | 160 |
| Switch to ECC | 4 (2.5%) | | |
| Stay on ICU (days) | 1.6 | | |
| Hospital stay (days) | 10.4 ± 3.2 | | |
| VD = vessel disease; ECC = extracorporeal circulation; EF = ejection fraction; ICU = intensive care unit | | | |

Table 2
Risk factors for coronary artery disease.

| Risk factors | n = 207 |
|-----------------------|---------|
| Hypercholesterolaemia | 68% |
| Hypertension | 60% |
| Current smoker | 35% |
| Obesity (BMI >28) | 17% |
| TIA / PRINT / Stroke | 30% |
| Renal failure | 8% |
| COPD | 8% |

Table 3
Postoperative complications.

| Complications | cardial | extra-cardial |
|--|----------|---------------|
| Myocardial infarction | 6 (2.9%) | |
| Atrial fibrillation | 12 (6%) | |
| Stroke | | 2 (1%) |
| Confusion | | 3 (1.5%) |
| Acute renal failure | | 1 (0.5%) |
| Pneumothorax* | | 4 (1.9%) |
| Sternal wound infection** | | 5 (2.4%) |
| * with new drainage | | |
| ** with sternal instability and re-operation in two patients | | |

stay on the ICU. In 10% of the patients, comorbidity was given by a combination of reduced left ventricular function, renal failure and history of stroke. Therefore these patients are classified as high-risk patients. Sixty percent of all patients had three or more risk factors for developing a coronary artery disease (table 2). In 2.5% (4 patients) we had to switch to cardiopulmonary bypass due to haemodynamic instability or severe arrhythmias. In 6 patients (2.9%) postoperative myocardial infarction was detected, followed by an urgent PTCA to the corresponding coronary vessel in two patients. No re-intervention was necessary due to severe postoperative bleeding. The complications are shown in table 3.

Discussion

Cardiac surgery with the use of ECC is associated with a systemic inflammatory activation (SIRS), leading to an acute phase response with sepsis-like symptoms during postoperative recovery, the main source of postoperative morbidity associated with cardiac surgery [3–5]. Therefore one of the most promoted arguments for the OPCAB procedure is based on the elimination of these deleterious side effects of the ECC [5]. Otherwise in a small but randomised trial, Fransen and colleagues [12] demonstrate that the increase in acute phase reaction was similar in patients treated either with or without ECC. One of the main organs possibly impaired by ECC is the brain. The aetiology of the cerebral injury is multifactorial, but one of the most mentioned causes is the release of micro emboli from different sources [6, 7]. Micro emboli can lead to a neurological impairment defined as cognitive decline which can be detected clinically by different neuropsychological tests. The incidence of cognitive decline after elective coronary surgery with ECC ranges from 28% to 79% postoperatively with a persistent impairment at 6 months in 19% to 57% [6]. Therefore, new trials with OPCAB procedures focussed on this special aspect of neurological impairment were performed demonstrating a better neurological outcome especially in elderly patients [13, 14]. On the other hand, a trial by van Dyk et al. [15] has demonstrated that this improvement of cognitive outcome seen in the first three months in patients undergoing OPCAB is limited and become negligible after one year. Difference in cognitive outcome may be more different in older patients with higher comorbidity. The definition of cognitive decline appears to have limited precision. Rasmussen and colleagues [13] found that 25% of 176 vol-

unteers undergoing 5 neuropsychological tests demonstrate a cognitive decline which appears to be an expression of an individual's natural fluctuation in performance. Therefore it is likely that the true incidence of cognitive decline after coronary artery bypass surgery is lower than generally assumed [15].

Due to the development and refinement of methods to expose and stabilise the target coronary artery the experienced surgeon might now be able to perform not only complete revascularisation but also a good quality of the distal anastomosis. The impact on the long-term outcome is well known [9, 16, 17]. However, as long as long-term follow-ups are missing an increase of early benefits with OPCAB surgery like decrease of hospital mortality, reduced length of stay or other reasons for better cost containment might be at the expense of long-term outcome [16, 18].

Atrial fibrillation (AF) is a frequent complication after coronary artery bypass grafting and the underlying causes which have been related to a variety of preoperative and postoperative factors. Ascione and colleagues [19] demonstrate in a randomised trial with 200 patients that cardioplegic arrest is the main independent predictor of postoperative AF, therefore OPCAB procedure would satisfy the demand of improvement in perioperative patient treatment.

Summary

In the absence of available objective parameters to determine the indication, the application of OPCAB procedure currently depends on the attitude and experience of the surgeon performing the operation. Although randomised trials have suggested a reduced incidence of pulmonary, renal and – most importantly – neurological injury after OPCAB, this technique should be considered as a valuable option in the treatment of selected patients, such as high-risk patients. In these patients OPCAB-technique is a safe and effective procedure to treat the symptoms of a coronary artery disease.

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