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Our experience with complete revascularization on beating heart in patients with acute coronary syndrome

Akut koroner sendromlu hastalarda atan kalpte komplet revaskülarizasyon deneyimimiz

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ABSTRACT

Background: In this study, we present our results with complete revascularization in patients with acute coronary syndrome undergoing coronary artery bypass grafting on beating heart.

Methods: Between January 2014 and December 2014, a total of 48 patients (37 males; 11 females; mean age 62±10 years; range, 41 to 82 years) who underwent complete revascularization on beating heart with a diagnosis of acute coronary syndrome were retrospectively analyzed. Initial procedure consisted of the left internal thoracic artery-left anterior descending artery grafting in all patients. Following the revascularization of the left anterior descending artery, remaining anastomoses were performed. Postoperative intensive care unit parameters, 30-day mortality rate, and altered left ventricle systolic function were recorded.

Results: The mean number of bypass graft anastomoses were 2.7±1.2 (range, 1 to 5) during a mean time of 49.2±2 (range, 10 to 122) min. The mean time from the onset of angina symptoms to surgery was 32.3±40 (range, 1 to 216) hours. One-third of the patients did not require any inotropic support postoperatively, while three patients required intraaortic balloon pump support. Two patients requiring intensive inotropic support and IABP during the immediate postoperative period died on postoperative Days 1 and 3, respectively. Another patient died due to complications associated with prolonged intensive care unit stay on postoperative Day 27. The mean time to discharge was 8.4±3.8 (range, 3 to 27) days in the remaining patients.

Conclusion: Our study results suggest that complete revascularization on a beating heart can be safely applied in the first-line setting in experienced centers for the surgical management of acute coronary syndrome, as it reduces systemic inflammatory response which may, otherwise, result from cardiopulmonary bypass, prevents global ischemia, and enables rapid reperfusion.

Keywords: Acute coronary syndrome; beating heart coronary artery bypass grafting; stunning.

ÖZ

Amaç: Bu çalışmada atan kalpte koroner arter baypas greftleme yapılan akut koroner sendromlu hastalarda komplet revaskülarizasyon sonuçlarımız bildirildi.

Çalışma planı: Ocak 2014 - Aralık 2014 tarihleri arasında akut koroner sendrom tanısı ile atan kalpte komplet revaskülarizasyon uygulanan toplam 48 hasta (37 erkek, 11 kadın; ort. yaş: 62±10 yıl; dağılım, 41-82 yıl) retrospektif olarak incelendi. Başlangıç işlemi, tüm hastalarda sol internal torasik arter ve sol ön inen arter greftlemesi idi. Sol ön inen arterin revaskülarizasyonunu takiben, geriye kalan anastomozlar yapıldı. Ameliyat sonrası yoğun bakım parametreleri, 30 günlük mortalite oranları ve sol ventrikül sistolik fonksiyonundaki değişiklik kaydedildi.

Bulgular: Ortalama baypas greft anastomoz sayısı, ortalama 49.2±2 (dağılım, 10-122) dk. süresince 2.7 (dağılım, 1-5) idi. Anjina semptomlarının başlamasından cerrahiye kadar geçen süre 32.3±40 (dağılım, 1-216) saat idi. Hastaların üçte birinde ameliyat sonrası dönemde inotropik destek ihtiyacı olmazken, üç hastada intraaortik balon pompası desteği gerekti. Ameliyattan hemen sonraki dönemde yoğun inotropik destek ve intraaortik balon pompası gerekli olan iki hasta ameliyat sonrası sırasıyla 1. ve 3. günlerde kaybedildi. Bir diğer hasta da yoğun bakım ünitesinde uzun süreli kalışa bağlı komplikasyonlar nedeniyle ameliyat sonrası 27. günde kaybedildi. Diğer hastalarda taburculuğa kadar geçen ortalama süre, 8.4±3.8 (dağılım, 3-27) gün idi.

Sonuç: Çalışma bulgularımız, aksi takdirde kardiyopulmoner baypas ile elde edilen sistemik inflamatuvar yanıtı azalttığı, global iskemiyi önlediği ve hızlı reperfüzyon sağladığı için, atan kalpte komplet revaskülarizasyonun akut koroner sendromun cerrahi tedavisinde deneyimli merkezlerde birinci basamakta güvenli bir şekilde uygulanabileceğini göstermektedir.

Anahtar sözcükler: Akut koroner sendrom; atan kalpte koroner arter baypas greftleme; stunning.

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Patients with acute coronary syndrome (ACS) may exhibit varying degrees of clinical severity at presentation from a hemodynamic stability to cardiogenic shock.[1] In hemodynamically unstable patients, apart from percutaneous coronary intervention (PCI), off-pump coronary artery bypass grafting (OPCABG) can be performed as the revascularization method.[1] While revascularization is frequently achieved by the use of stenting in the target lesion, only 5% of the cases with ACS are operated.[1]

Due to high risk of morbidity and mortality, coronary artery bypass grafting (CABG) in ACS patients is preferred for those who are hemodynamically unstable or not amenable to PCI, or in those who have severe three-vessel disease or left main coronary artery (LMCA) lesions.[2] Surgical revascularization reduces the risk of major cardiovascular complications in multivessel ACS by enabling complete revascularization.[3] In patients with cardiogenic shock, as well as in stable cases requiring emergency/early surgery, OPCAB has been reported to have similar morbidity and mortality, compared to on-pump coronary artery bypass grafting (ONCABG) under cardiopulmonary bypass (CPB).[2,4-6]

Currently, no consensus on the ideal timing of CABG after ACS is available, partly due to the need to address the balance between the adverse effects of the systemic inflammatory response on injured myocardium caused by CPB against the benefits of the procedure in each patient individually.[1] Complete revascularization with OPCABG can be performed irrespective of the time from the onset of ACS symptoms to reduce the risk of ischemia-reperfusion injury and to prevent the systemic complications of CPB.[7] In this article, we present our results with complete revascularization in patients with ACS undergoing OPCABG.

PATIENTS AND METHODS

Between January 2014 and December 2014, patients with ACS manifestations who underwent surgery in our unit were retrospectively analyzed. In our center, early revascularization is favored for patients with a diagnosis of ACS, and those with an indication for CABG are operated as early as possible. In addition, ONCABG is given precedence over other procedures. During this time period, OPCABG was successfully performed in 48 ACS patients, and none of the patients required CPB. Therefore, demographic characteristics and pre- and postoperative data of a total of 48 patients were analyzed.

The diagnosis of ACS was based to a spectrum of clinical presentations ranging from ST-segment elevation myocardial infarction (STEMI) to non-ST-segment elevation myocardial infarction (NSTEMI) or unstable angina.[8] Patients who had left main disease with a SYNTAX score of >32 and three-vessel disease with a SYNTAX score of ≥23 and two-vessel disease without suitability for PCI were considered eligible for surgery. Exclusion criteria were as follows: aforementioned anatomic criteria and ongoing angina and/or hemodynamic instability, and eligibility for PCI. The study protocol was approved by the local Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Surgery was carried out under general anesthesia. All patients received high-dose nitroglycerine during surgery, as well as norepinephrine infusion to maintain perfusion pressure. After median sternotomy, a left internal thoracic artery (LITA) graft was prepared. Using standard sternum retractors and vacuum-activated stabilizer, distal anastomoses were performed. Initially, left anterior descending (LAD) artery/LITA anastomoses were done to ensure the perfusion of the LAD zone for the later stages of surgery. Subsequently, the coronary artery anastomoses were performed in the diagonal and circumflex artery zones, using several maneuvers including deep pericardial suspension, right-sided rotation of the operation table and right-sided manipulation of the heart, and release of the pericardium and soft tissues. Following completion of the left-sided distal anastomoses in the heart, proximal anastomoses were done using side-clamps. If bypass was also planned for the right coronary artery or its branches, their proximal anastomoses were, then, carried out simultaneously with the left-sided proximal anastomoses. After removal of the side-clamp, the planned right-sided coronary anastomoses were completed. After hemostasis, the surgery was terminated and the patients were transferred to the intensive care unit.

Statistical analysis

Statistical analysis was performed using the Microsoft Office, Excel software (Microsoft Office 2010). All numerical data were expressed in mean ± standard error, while categorical variables were expressed in percentage.

RESULTS

The mean age of the overall patient group was 62±10 (range, 41 to 82) years, and 77% of the patients were males. Table 1 shows the demographic and preoperative data of the patients. The mean time from the onset of angina symptoms to surgery was 32.3±40 (range, 1 to 216) hours. Twelve patients

Table 1. Preoperative demographical data of the patients

Variable	n	%	Mean±SD
Age (years)			62±10.4
Male	37	77.1	
Smoking	12	25	
Hypertension	22	45.9	
Diabetes mellitus	15	31.3	
Hypercholesterolemia	41	85.4	
Chronic renal failure	16	33.3	
Alcohol	5	10.42	
Atrial fibrillation	3	6.3	
Preoperative EF (%)			52.4±6.5
Preoperative troponin I (pg/mL)			1497±2060
Preoperative CK-MB (ng/mL)			14.9±31.5

SD: Standard deviation; EF: Ejection fraction; CK-MB: Creatinine phosphokinase-myocardial band.

had a preoperative ejection fraction of less than 50%, while the remaining subjects had normal systolic functions. The mean number of bypass graft anastomoses were 2.7±1.2 (range, 1 to 5) during a mean time of 49.2±2 (range, 10 to 122) min. Only 22 patients required blood transfusion. Three patients required revision due to postoperative bleeding (Table 2). Postoperatively, three patients required intra-aortic balloon pump (IABP) support, while 16 patients received no mechanical or pharmacological support. The mean time to discharge was 8.4±3.8 (range, 3 to 27) days. Three patients died in the postoperative period. Of these, two died on postoperative days 1 and 3, after the intensive postoperative inotropic and IABP support. Another patient died on postoperative day 27 due to complications associated with prolonged intensive care unit stay (Table 2). During the postoperative follow-up, no patients had arrhythmia, while none of them needed pacing. The remaining patients were discharged uneventfully with a time to discharge of 8.2±3.9 (range, 3 to 13) days. No patients had perioperative neurological complications and none of them had cardiac problems during follow-up.

DISCUSSION

In patients with cardiogenic shock, surgical revascularization within the first six hours or after day 3 has been reported to reduce perioperative mortality and morbidity.[5,9] Surgery postponed until a period of less severe inflammation with the hope of reduced tissue fragility may prolong the duration of myocardial ischemia and lead to increased myocardial injury. Also, the use of a CPB device may be associated with increased systemic inflammatory response. Earliest possible complete surgical revascularization on a beating heart in patients with ACS may be undertaken in any stage of myocardial stunning with a low perioperative risk. In the present study, we included 48 patients who were surgically treated immediately following the diagnosis of ACS, regardless of the time from the onset of symptoms, and OPCABG was successfully performed with a postoperative mortality of 6% and no need for switch to CPB. Similarly, Fattouch et al.[10] showed that OPCABG reduced early mortality and morbidity in patients with STEMI compared to the conventional procedure. Only two-thirds of the patients required low-dose postoperative inotropic support for a mean time of 43 hours. Three patients who died postoperatively had an increased mean intubation time, hospitalization, and need of inotropic support. When these patients were excluded, our results are consistent with the literature data..

Table 2. Operative findings

Variable	n	%	Mean±SD
Symptom to operation duration (min)			32.3±40.2
Number of distal bypass			2.6±1.2
Revision	3	6.3	
Erythrocyte replacement (units)			0.45±1
Duration of operation (min)			49.2±27.1
Duration of intubation (h)			12.9±11.5
Duration of inotropic support (h)			43±80.8
Duration of hospitalization (d)			8.4±3.8
Postoperative ejection fraction (%)			48.5±1.6
≤30 day mortality	3	6.3	

SD: Standard deviation.

In general, current guidelines on ACS management recommend revascularization with stenting of the target vessel in the angiography laboratory, while deferring intervention to other stenotic segments to a later stage.[11,12] In centers where CABG is mostly performed under CPB, complete revascularization is usually postponed, particularly in hemodynamically stable patients with the concerns of prolonged duration of surgery and systemic inflammatory response. However, since this approach leads to a delay in complete revascularization, myocardial remodeling is also delayed. In STEMI with multivessel disease, intervention on all vessels rather than the target lesion alone is associated with a reduced risk of major cardiovascular complications.[3,13] As a result, OPCABG may be safely performed with the advantage of early complete revascularization and low perioperative risk in centers with expertise in such procedures.[14] It also provides improved myocardial protection for ACS, compared to prolonged aortic cross-clamping.[13] The main advantages of OPCABG in high-risk patients include the reduced risk of neurological, renal, and respiratory complications, reduced re-operation due to bleeding, perioperative myocardial infarction, and mortality.[15,16] In addition, OPCABG has been shown to be associated with a reduced need for blood products, shortened duration of hospital and ICU stay with the benefits resulting from the presence of cardiac circulation during the stunning phase.[17-19] Similarly, our patients were extubated in the early postoperative period and less than half required blood replacement therapy. Therefore, not only the systemic inflammation due to myocardial infarction, but also the effects of CPB and blood products have been minimized.

In patients with ACS, severe narrowing or reduced blood flow in a vessel not caused by an infarction may reduce systolic functions, thereby, increasing the risk for cardiovascular events.[20] A stepwise approach or complete revascularization at the time of presentation have been reported to reduce the risk of major cardiovascular events in STEMI.[3,20] Early complete revascularization results in a rapid improvement in cardiac systolic functions and provides maximum long-term protection of ejection fraction. Although early surgical revascularization is basically similar to primary percutaneous transluminal coronary angioplasty (PTCA), it offers an additional benefit of enabling the surgeon to intervene on long segments or calcified lesions.[5] Although patients referred to CABG frequently have more complex coronary lesions, the 30-day and one-year mortality in both procedures have been reported to be comparable.[5] In our series, despite the confirmed diagnosis of ACS prior to surgery, the requirement for inotropic support was minimal and the patients were discharged on postoperative day 8 with systolic functions comparable to their baseline values.

Furthermore, revascularization with percutaneous interventions or CABG may be performed in cardiogenic shock developing after acute myocardial infarction (AMI). White et al.[5] reported similar outcomes with PTCA in patients with cardiogenic shock undergoing surgery within the first six hours. However, Weiss et al.[9] reported an increased risk of mortality in patients undergoing CABG within the first two days, compared to those who were operated three or more days later. On the other hand, Parikh et al.[21] reported similar risk levels in NSTEMI patients who were operated not more than 48 hours after admission. Delayed reperfusion in a hibernating-stunning heart may increase myocardial stress levels. When surgery is delayed in hemodynamically stable ACS patients, low-molecular-weight heparin and clopidogrel used during this period may also increase the risk of bleeding.[21] A low level of 30-day mortality has been reported with OPCABG in hemodynamically stable patients who underwent emergency CABG.[4] Similarly, our patients underwent surgery immediately after the diagnosis was confirmed. Hemodynamic instability did not seem a factor affecting the operative success. According to our results, we can conclude that the patients who have hemodynamic instability have more benefits from OPCABG, compared to stable patients.

Moreover, intracoronary shunts are not routinely recommended in OPCABG, since they may be associated with an endothelial injury. These shunts should be preferred for bypass procedures involving less severe stenosis of coronary arteries supplying large zones.[22] In addition, cardiac manipulation poses a significant risk in OPCABG, particularly in hemodynamically unstable patients with cardiogenic shock. On the other hand, giving priority to the grafting of the lesion supplied by the collateral vessel may reduce this risk. Accordingly, shunts were not routinely utilized in our patients. Anastomosis was completed within 10 min, allowing early perfusion, and shunts were reserved for those with hemodynamic instability during anastomosis. Hemodynamic stability may be achieved by first carrying out LAD anastomosis, followed by the completion of the bypass on the left side, and finally by the anastomosis of the proximal segments. If right-sided bypass is required, priority should be given to the proximal anastomosis during other proximal anastomoses.

In conclusion, early revascularization in patients with acute myocardial infarction allows tissue

perfusion at hibernation-stunning stage, before the development of myocardial necrosis, leading to an early improvement of cardiac functions. Subsequently, it increases the long-term life expectancy and functional capacity. In the presence of a coronary lesion causing infarction, complete revascularization improves the ventricular perfusion, thereby, offering the benefit of an increased collateral circulation. Our study results suggest that complete revascularization on a beating heart can be safely applied in the first-line setting in experienced centers for the surgical management of acute coronary syndrome, as it reduces systemic inflammatory response which may, otherwise, result from cardiopulmonary bypass, prevents global ischemia, and enables rapid reperfusion.

Declaration of conflicting interests

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