EDITORIAL COMMENT

Outcome of Coronary Bypass Surgery and Left Ventricular Dysfunction

Insufficient myocardium cell number and muscle mass seem to be the underlying causes of the dysfunction of the left ventricle (LV). In revascularization it is aimed to recover normal functions of alive myocardium cells that were dysfunctioning under ischemic conditions due to coronary obliteration.

The technological developments in the recent years and the improvements in the coverage of the patient influenced myocardial revascularization in a positive way. The survival rates have increased. Many risk factors which have been accepted as contraindication for coronary revascularization in recent years, are no handicap anymore nowadays (1, 2).

Thus, it is found out that other treatment modalities should be reviewed in the coronary artery disease with low function of the ventricle. Milano CA et al. (3), reported a study including patients with ejection fraction (EF) less than or equal to 0.25 underwent isolated coronary artery bypass grafting (CABG). The study evaluated whether patients with coronary artery disease and severely depressed LV EF would benefit from CABG. Operative mortality was 11%. Survival at 1 year and 5 years was 77.2% and 57.5%, and was better than estimated survival with medical therapy alone. Survivors experienced significant improvement in angina class, congestive failure class, and follow-up EF. Of 22 preoperative factors evaluated by univariate survival analysis, five were associated with significantly greater mortality: presence of other vascular disease, female gender, hypertension, elevated LV end-diastolic pressure, and depressed cardiac index. Considering length of hospitalization, three factors showed significant adverse effect in a multivariate Cox model: time on cardiopulmonary bypass, acute presentation, and female gender. These data and review of the literature suggest that patients with coronary artery disease and severely depressed EF benefit from CABG, and specific preoperative factors may help to determine optimal treatment (3).

Although patients with severe ventricular dysfunction have improved long-term survival times after coronary bypass procedures, operative morbidity and mortality rates remain high. A report from Canada by Christakis GT et al. (4) identified the contemporary risk factors for isolated CABG in this high-risk subgroup. Study included a total of 12,471 patients underwent isolated CABG. Among 3 study groups, patients with preoperative EFs greater than 40% had a lower operative mortality rate (2.3%) than that of the patients with EFs between 20% and 40% (4.8%) and that of those with EFs less than 20% (9.8%). However, patients with EFs of less than 20% were demographically distinct from those with higher EFs. This group was older, with fewer women, a higher frequency of left main stenosis, and more frequent requirement of urgent operation for unstable angina. The traditionally accepted risk factors–urgency of operation, left main coronary artery stenosis, reoperation, sex, and age–were predictive of risk of operative death for patients with EFs greater than 40%. The risk of operative death for patients with EFs between 20% and 40% was predicted by urgency of operation, reoperation, gender, myocardial protection, and age. The only predictor of risk of operative death for patients with EFs less than 20% was urgency of operation (4).

Patients undergoing isolated CABG who have severe ventricular dysfunction are therefore a highly selected, high-risk subgroup of patients whose risk depends on the urgency of operation. Strategies to improve the results in these patients should be focused on patient selection, improvement of myocardial protection, and more aggressive preoperative treatment of myocardial ischemia. Due to inoperability, the thought of the high percentage of the operation mortality, or the poor distal coronary arterial bed, more patients with the coronary artery disease are referred to transplantation. It is known that the five years survival rate of transplantation is about 70% (5).

Yazışma Adresi: Prof. Dr. Azmi Özler
Kalamış Fener Cd.9/3 Nur Apt.
Kızıltoprak İSTANBUL Fax:0216 4143297

Heart transplantation is another effective treatment modality. Raising the rate of survival and increasing the quality of life after transplantation depend on a secure immunosuppression and a better coverage of the patient. Compared to the medical treatment the results are much better (6). The difficulties accompanying the transplantation, namely immunosuppression, dependence of the patient to hospital for the rest of his life, need for a close follow-up and the high probability of rejection make it a treatment far from ideal and research for ideal treatment is still going on.

Yet another adjuvant treatment modality for dispute group of high surgery risk and poor LV coronary artery disease patients is transmyocardial laser revascularization (TMLR). Lutter G et al. (7) applied comparison study with 23 end-stage coronary artery disease patients who were treated with TMLR as sole therapy without the use of IABP. The creation of transmural channels was performed by a CO2-laser. All patients were evaluated by hybrid positron emission tomography (perfusion SPECT and viability PET) and ventriculography preoperatively. The perioperative mortality of this combined procedure (TMLR and IABP) was zero. The reported data support the concept to start IABP preoperatively in patients with reduced LV contractile reserve in order to provide cardiac support during the postoperative phase of reversible decline of LV function induced by TMLR (7).

Conventional CABG using cardiopulmonary bypass carries relatively high mortality and morbidity for patients with LV dysfunction. Coronary artery bypass grafting without cardiopulmonary bypass is a viable alternative to conventional CABG particularly for patients with extreme LV dysfunction or those with coexisting risk factors, such as acute myocardial infarction and cardiogenic shock (8).

Arom KV et al. (9) from Minneapolis, analyzed outcomes of 387 patients with normal and poor LVEF underwent off-pump coronary artery bypass (OPCAB) procedure. The two groups (LVEF < or =30 and LVEF>30) were compared using univariate analysis. Short-term clinical outcomes for both groups of OPCAB patients are encouraging and allow continuing to offer this approach to the broad patient population (9). According to Baumgartner FJ, there is a significant reduction in intraoperative blood transfusion requirements, as well as a significant reduction in the incidence of neurologic, renal, and prolonged ventilatory complications in the off-pump group (10).

There are yet another challenging questions. Does the manipulation of the heart during off-pump coronary artery bypass (OPCAB) procedure further compromise the hemodynamic stability of a patient with depressed LV function compared with the conventional coronary artery bypass (CCAB) approach? Does this manipulation induce a more dramatic hypoperfused state that may contribute to an increase in the incidence of related complications or mortality? Arom KV et al's (11) retrospective review of data attempted to answer the above concern. Despite recognized hemodynamic derangement during cardiac displacement, these groups of OPCAB patients appeared to tolerate the procedure well. Multivessel coronary artery bypass utilizing the OPCAB approach in patients with depressed LV function of equal to or less than 30% is appropriate and applicable. Attention to intraoperative details and hemodynamic management could be credited for the success with OPCAB (11). Previous reports have demonstrated that reoperative coronary revascularization, advanced age, female sex, and impaired LV dysfunction are independent predictors of operative mortality after CABG. Coronary artery bypass grafting without cardiopulmonary bypass (off-pump CABG) has been proposed as a potential therapeutic alternative in these high-risk patient groups (12). Despite the substantial learning curve associated with off-pump CABG, early outcomes of off-pump CABG in high-risk patients are better than those associated with the conventional on-pump CABG approach. These results suggest that off-pump CABG is a safe alternative to on-pump CABG in high-risk patients. Randomized prospective studies are needed to validate the results of these initial retrospective reports and to demonstrate the long-term benefits of this approach (12).

There are different ideas whether viability tests are necessary preoperatively or not. Concerning the coronary artery patients with low EF (<30% or 20%), it is beneficial to display the pre-operative viability and graftabilty or akinesis-dyskinesis.

Wiggers H et al. (13), reported a study on utility of different algorithms of identification of patients with heart failure who could potentially benefit from revascularization. Thirty-five coronary artery bypass (graft) patients with an EF of 35±7% underwent preoperative 18F-fluoro-2-deoxyglucose positron emission tomography (PET), low-dose dobutamine echocardiography (LDDE), and exercise testing. Follow-up by echocardiography and coronary angi-

ography was performed 6 months after CABG. The sensitivity for prediction of reversible myocardial dysfunction was highest for PET and for ST depression or angina pectoris during exercise testing (93%). The specificity did not differ between LDDE (81%), PET (67%), and resting ECG (71%), but was lowest for exercise testing. In patients with a negative exercise test, recovery was unlikely, and further viability testing may not be needed. In patients with a positive test, recovery may occur, and additional PET or LDDE should be performed. This strategy awaits further evaluation in larger patient populations with heart failure (13).

In the article submitted by İslamoğlu F et al. (14) and published in this issue of the Anatolian Journal Of Cardiology, (that aimed to search for the effects of pre-operative risk factors on mortality resulting from coronary artery by-pass surgery without having made a prior viability test applied on 252 coronary artery patients suffering from damaged ventricular function (EF<30%)), the results have shown that hospital mortality is 5.6%, average 4 year survival rate is recorded to be 78%. In a similar study, the results of a prospective analysis carried on 72 patients have come out to be 3.8% for hospital mortality and 5 year survival rate 68% (15). Looking at the profile of the patients, for the published study of İslamoğlu F et al. (14) is expected to be lower, the outcome is nearly twice as that of the other study regarding the hospital mortality rates. Probably, the reason for that may be arising from surgical strategy. Mickleborough LL et al. later on published a study comparing two groups of 125 patients with low EF's based on the surgical strategy difference (16). In their experiment, two patient groups operated with two different myocardial protection techniques named "Temperature Mapping Cardioplegia (TMC)" and standard technique have been compared for the effects of preoperative risk factors on mortality and morbidity post-operatively. In the experimental group, mortality and morbidity rates were found to be lower than in the control group. Temperature Mapping Cardioplegia method have yielded the following results: hospital mortality is 4%, peropmyocardial infarction (MI) 4%, post-op IABP usage rate 15%, post –op low cardiac output syndrome (LCO) 19%. However, the values recorded for the standard group (where standard cardioplegia method was applied) were higher, hospital mortality 11%, perop MI 7%, post-op IABP usage 30%, post-op LCO is 30%. Comparison of İslamoğlu F et al. (14) results with the findings of this study, displays similarity with the standard group regarding the patient profile and the method used. However, İslamoğlu F et al. (14) reported mortality rate as 5.6%, perop MI - 1.58%, post-op IABP usage- 3.57% and post-op LCO - 3.57%.

The striking differences between the study of İslamoğlu F et al. (14) and the previous studies are:

1. In the previous studies, the criteria for damaged left ventricule function is taken to be EF<20%, for İslamoğlu F et al. the criteria is EF<30%.

2. In similar studies, LV scar tissue and its surgical intervention have been included in the mortality, whereas in İslamoğlu F et al. study cases with ventricular aneurysm have been excluded.

The working period (5 years) and the large number of patients which fit the research criteria have set the stage for more objective statistical results in the presented prospective study. Looking at the patient profile, observed better renal performance (renal failure 0.8%) and a lower pre-operative IABP usage (0%) in patients with low LV function (EF<30%) are interesting.

Comparative analysis allows to reveal why results obtained by İslamoğlu F et al. are clearly superior than those found in literature. Moreover, it is sufficient by itself to open the debate on the necessity of using an additional modified myocardial protection method (Temperature Mapping Cardioplegia). However, according to this study, while the surgical strategic differences that bring about the absolute success are not defined, pre-operative viability research is emphasized as unnecessary.

In the light of the results of recent studies prevailing in literature; LV hypertrophy (LV size) and low EF (20%) are mentioned as the pre-operative risk factors in coronary artery disease (17). In patients with poor ventricular function and with chamber dilation, it is not possible by preoperative conventional ventriculography to determine which areas of the heart are scarred and will take advantage of partial ventriculectomy-aneurysmectomy (18). Some centers recommend use of pre-operative viability tests for choosing patients for revascularization (19-21).

Patients without supply-demand disorder and without an evident dyskinesis are considered as bad candidates for surgery. Those patients having a graftable coronary artery with poor ventricular function and akinetic-dyskinetic ventricle benefit from surgery well.

What's recommended is to plan the operative procedure evaluating the regional wall thickness and contractility. If an area has become thin and there is scar tissue, ventricular volume should be contracted by excising the area and geometry should be made close to normal for optimal ventricular function, wall tension and volume should be decreased. Mickleborough LL et al, in one series reported that operative mortality for patients with ventriculectomy was low and acceptable (4%) and five years survival was higher (72%) compared to those without ventriculectomy (14).

Conclusion

Concerning the coronary artery disease patients with low EF (<30% or 20%), it is beneficial to display the pre-operative viability and graftabilty or akinesis-dyskinesis. In patients with a negative exercise test, recovery was unlikely, and further viability testing may not be needed. In patients with a positive test, recovery may occur, and additional PET or LDDE should be performed.

For such patients any procedure of surgical grafting (CABG or OPCAB) and if necessary partial ventriculectomy may be done not only easily but also with low mortality and first option should be surgical treatment. If viability is lacking, grafting won't be of any use and it will result even in mortality. Thus, for this group of coronary artery disease patients, heart transplantation is accepted as the first thing. In the future with the advances in application of Myocid Regeneration methods, new horizons will open for those patients.

Modification of advanced myocardial protection methods (Temperature Mapping Cardioplegia) and planning of operation strategy targeting the patient (CABG-OPCAB, or hybrid procedures-TMLR+bypass) will lower the rate of mortality morbidity while increasing the long term survival rate in patients with low EF.

For this group of patients, adding transmyocardial laser revascularization (TMLR) to surgical revascularization when needed will again have a positive effect on mortality and morbidity and enhancement of long term survival rates.

Dr. Azmi Özler,
Dr. Siyami Ersek Göğüs Kalp
Damar Cerrahisi Merkezi, İstanbul

References

1. Miller DC, Stinson FB, Oyer PE, et al. Discriminant analysis of changing risks of coronary artery operations: 1971-1979. J Thorac Cardiovasc Surg 1983; 85: 197-213.
2. Killip T, Passamani E, Davis K, CASS Principal investigators and their associates. Coronary artery study (CASS): a randomized trial of coronary bypass surgery. Eight years follow-up and survival in patients with reduced EF. Circulation 1985; 72(Suppl 5): 102-9.
3. Milano CA, White WD, Smith LR, et al. Coronary artery bypass in patients with severely depressed ventricular function. Ann Thorac Surg 1993; 56: 487-93.
4. Christakis GT, Weisel RD, Fremes SE, et al. Coronary artery bypass grafting in patients with poor ventricular function. J Thorac Cardiovasc Surg 1992; 103: 1083-91.
5. Stevenson JW, Fowler MB, Shroeder JS, Dracup KA, Clark SH,Fond V. Patients denied cardiac transplantation for nonmedical criteria. J Am Coll Cardiol 1986; 7: 9A.
6. Heck CF, Shumway ST, Kaye MP. The registry of the International Society for Heart Transplantation: sixth official report - 1989. J Heart Transplant 1989; 8: 271-6.
7. Lutter G, Saurbier B, Nitzsche E, et al. Transmyocardial laser revascularization (TMLR) in patients with unstable angina and low ejection fraction. Eur J Cardiothorac Surg 1998; 13: 21-6.
8. Moshkovitz Y, Sternik L, Paz Y, Gurevitch J, Feinberg MS, Smolinsky AK, Mohr R Primary coronary artery bypass grafting without cardiopulmonary bypass in impaired LV function. Ann Thorac Surg 1997; 63(Suppl): S44-7.
9. Arom KV, Emery RW, Flavin TF, Kshettry VR, Petersen RJ. OPCAB surgery: a critical review of two different categories of pre-operative ejection fraction. Eur J Cardiothorac Surg 2001; 20: 533-7.
10. Baumgartner FJ, Yokoyama T, Gheissari A, Capouya ER, Panagiotides GP, Declusin RJ. Effect of off-pump coronary artery bypass grafting on morbidity. Am J Cardiol 2000; 86: 1021-2.
11. Arom KV, Flavin TF, Emery RW, Kshettry VR, Petersen RJ, Janey PA. Is low ejection fraction safe for off-pump coronary bypass operation? Ann Thorac Surg 2000; 70: 1021-5.

12. Stamou SC, Corso PJ. Coronary revascularization without cardiopulmonary bypass in high-risk patients: a route to the future. Ann Thorac Surg 2001; 71: 1056-61.
13. Wiggers H, Egeblad H, Nielsen TT, Botker HE. Prediction of reversible myocardial dysfunction by positron emission tomography, low-dose dobutamine echocardiography, resting ECG, and exercise testing. Cardiology 2001; 96: 32-7.
14. İslamoğlu F, Apaydın AZ, Özbaran M, Yüksel M, Telli A, Durmaz İ. Predictors of outcome after coronary bypass surgery in patients with ejection fraction ventricular dysfunction. Ana Kar Der 2002; 2: XXX
15. Mickelborough LL, Maruyama H, Takagi Y, Mohamed S, Sun Z, Ebisuzaki L. Results of revascularization in patients with severe left ventricular dysfunction. Circulation 1995; 92 (Suppl 2): 73-9.
16. Mickelborough LL, Carson S, Tamariz M, Ivanov J. Results of revascularization in patients with severe left ventricular dysfunction. J Thorac Cardiovasc Surg 2000; 19: 550-7.
17. Kawachi K, Kitamura S, Hasegawa T, et al. Increased risk of coronary artery bypass grafting for left ventricular dysfunction with dilated left ventricle. J Cardiovasc Surg 1997; 38: 501-5.
18. Mickleborough LL, Maruyama H, Liu P, Mohamed S. Results of left ventricular aneurysmectomy with a tailored scar excision and primary closure technique. J Thorac Cardiovasc Surg 1994; 107: 690-8.
19. Kleikamp G, Posival H, Minami K, El-Banayosy A, Korfer R. Ischemic cardiomyopathy-revascularization vs. transplantation. Eur J Cardiothorac Surg 1997; 11(Suppl): S1-4.
20. DiCarli MF, Asgarzadie F, Schelbert HR, et al. Quantitative relation between myocardial viability and improvement in heart failure symptoms after revascularization in patients with ischemic cardiomyopathy. Circulation 1995; 92: 3436-44.
21. Afridi I, Grayburn PA, Panza JA, Oh JK, Zoghbi WA, Marwick TH. Myocardial viability during dobutamine echocardiography predicts survival in patients with coronary artery disease and severe left ventricular systolic dysfunction. J Am Coll Cardiol 1998; 32: 921-6.