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 patients 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).
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 graftability or akinesis-dysskinesis.

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-
That of the other study regarding the hospital mortality expected to be lower, the outcome is nearly twice as for the published study of Islamoglu F et al. (14) is 68% (15). Looking at the profile of the patients, operative LCO is 30%. Comparison of Islamoglu 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, Islamoglu F et al. (14) reported mortality rate as 5.6%, per-op MI - 1.58%, post-op IABP usage - 3.57% and post-op LCO - 3.57%.

The striking differences between the study of Islamoglu F et al. (14) and the previous studies are:
1. In the previous studies, the criteria for damaged left ventricular function is taken to be EF<20%, for Islamoglu 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 Islamoglu 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 Islamoglu 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 graftability 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.

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References


