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Coronary revascularization in patients with ischemic left ventricular dysfunction

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Abstract

Background: Coronary artery disease (CAD) dominates in the contemporary world among the causes of left ventricular dysfunction (LVD). Prognosis of survival and the course of heart failure (HF) are worse in patients with CAD than in many kinds of non-ischemic cardiomyopathy. Development of cardiac surgery technologies and formation of the relevant evidence base have significantly expanded the role of revascularization in patients with CAD and reduced left ventricular ejection fraction (LVEF). The possibility and expediency of coronary artery bypass grafting (CABG) for improving left ventricular ejection fraction (LVEF), clinical course of HF and survival are evidence-based. Stenting is less effective than coronary artery bypass grafting (CABG) regarding the influence on primary endpoints but improves the quality of life of patients with CAD and ischemic LVD.

Conclusions: In patients with ischemic LVD, surgical revascularization can ensure an improvement in the pumping function of the heart, provided there is a sufficient amount of viable myocardium. From the standpoint of evidence-based medicine, the effectiveness of CABG surgery in patients with multivessel lesion of the coronary bed and LVD has been proven for correction LVEF, improvement of the course of the disease and prediction of survival compared with the optimal drug therapy. Percutaneous intervention is inferior to surgical revascularization in terms of its effect on endpoints, but it can make an improvement in the quality of life of patients with ischemic LVD. Evaluation of myocardial viability may be of additional importance for the decision on the feasibility of CABG in the presence of multivessel coronary artery disease combined with a sharp decrease in LVEF.

Key words: coronary artery disease, reduced left ventricular ejection fraction, myocardial revascularization.

Introduction

Heart failure (HF) combined with a reduced left ventricular ejection fraction (LVEF) determines an unfavorable prognosis for survival and is associated with frequent hospitalizations due to decompensation of the blood circulation. According to the Framingham study, the average life expectancy of patients with LVEF is less than 20% and clinical manifestations of HF is 1.7 years in men and 3.2 years in women [22]. Coronary atherosclerosis prevails among the causes of left ventricular systolic dysfunction (LVSD), and the survival prognosis in patients with coronary artery disease (CAD) is worse than in many types of non-ischemic cardiomyopathy [11]. At the same time, unlike many other causes of left ventricular dysfunction (LVD), patients with CAD potentially have a chance of recovery of myocardial contractile function after revascularization.

Multivessel coronary artery disease and concomitant diabetes mellitus are often found in patients with reduced LVEF, presenting strong arguments in favor of surgical myocardial revascularization. On the other hand, background LVD is associated with a certain increase in the risk of "major" cardiac surgeries and was even considered a limitation for their implementation. The first attempts of surgical treatment of patients with CAD and LVD were made almost half a century ago [27]. Initially, coronary artery bypass grafting (CABG) surgery in patients with LVD resulted in high mortality (from 1.4 to 18.6%) and multiple postoperative complications [35]. However, due to the rapid development of cardiac surgery technologies and formation of an appropriate evidence base, the role of revascularization in patients with ischemic LVD has gradually expanded [17, 26, 30]. Despite this, according to a recent review of clinical practice, the incidence of coronaroventriculography (CVG) in patients with newly diagnosed HF is still insufficient [9]. Moreover, a number of questions remain unanswered regarding the selection of patients and monitoring the effectiveness of revascularization, in particular regarding the possibility of LVD correction after surgery. This review summarizes the current understanding of the possibilities and the choice of the optimal method of revascularization in patients with ischemic LVD and signs of HF.

Ischemic cardiomyopathy and myocardial viability

In 1970, G. Burch offered the term "ischemic cardiomyopathy", referring to the course of CAD with multiple lesions of the coronary arteries, increased ventricular heart sizes and clinical symptoms of congestive HF [7]. The cause of myocardial dysfunction in such patients is the decreased blood flow in the subendocardial zones. Progressive decrease in the availability of high-energy compounds and acidosis cause increased myocardial rigidity, while volume overload of the heart causes dilatation of its chambers. An important feature of ischemic cardiomyopathy is the potential reversibility of regional and global abnormalities in LV function.

The term "viable myocardium" refers to ischemic heart muscle with a reduced functional capacity which does not have, or has a limited amount of scar tissue, which in turn determines the potential possibility of restoring its function after revascularization. With LVD progression myocardial viability is ensured due to a significant limitation of its energy expenditure, that is, the state of hibernation. There should be a distinction between hibernating and "stunned myocardium", the latter being a condition of post-ischemic LVD, which persists after reperfusion, despite the restoration of coronary blood flow [12].

Determining the percentage of viable myocardium using stress echocardiography, perfusion scintigraphy or magnetic resonance imaging with contrast enhancement may be useful in candidates for revascularization or heart transplantation after undergoing common myocardial infarction with left ventricular aneurysm, as well as in patients with CAD and LVEF less than 35% in the absence of a large scar. It should be noted that in many patients with the above-mentioned clinical and instrumental characteristics, dyspnea is often equivalent to angina, making it difficult to determine treatment priorities. Although the best survival prospects for patients with viable myocardium have been convincingly proven, so far no direct evidence has yet been obtained of the role of viability assessment for choosing between drug therapy and surgical revascularization [6].

CABG compared to medical treatment therapy

The results of many studies indicate the possibility of improving the long-term survival of patients with CAD and LVD after surgical revascularization compared with drug therapy [13, 36]. In 1994, Yusuf et al. carried out a cumulative analysis of data from seven largest studies of that time, comparing the effects of CABG and drug therapy on 10-year survival (n = 2650). More than 50% of patients were diagnosed with a three-vascular lesion of the coronary arteries. In CABG group, a positive effect on survival and symptoms was observed compared with drug therapy: mortality over 10 years was 26.4 and 30.5%, respectively ($p = 0.03$). Ultimate benefit of surgical revascularization was the greatest in patients with LVD, with the mortality rate almost halved [38].

It should be noted that in the first revascularization studies, patients from the comparison group could not receive a number of modern medicines. At that time, statins and blockers of the renin-angiotensin system were not yet available; other agents with proven beneficial prognostic effects, such as antiplatelet agents, beta-blockers and mineralocorticoid receptor antagonists, have not been used routinely. Of course, this feature somewhat limits the possibility of extrapolating the data to the current population of patients with CAD and LVD. However, from the standpoint of evidence-based medicine, new convincing evidence has recently emerged in favor of CABG in patients with LVD who received optimal drug therapy [31, 36].

In a surgical treatment for ischemic heart (STICH) study 1212 patients with CAD and LVEF ≤35% (mean LVEF ratio of 27%) were randomized into CABG groups and optimal drug therapy. After 5 years, the frequency of death cases from all causes did not differ in the compared groups. At the same time, the analysis of a number of secondary efficacy criteria (death from all causes or hospitalization due to HF, death from all causes or hospitalization due to cardiovascular reasons, death from all causes, or the need for revascularization) showed the best results in the CABG group [36]. The results of a 10-year STICHES observation showed an ultimate increase in the life expectancy of patients after CABG by 1.44 years (7.73 versus 6.29 years, respectively). The results obtained present a convincing argument in favor of the implementation of CABG in patients with CAD and LVD [37].

The STICH study revealed a clear dependence of patients' survival on the volume of viable myocardium. Retained viability testified in general to the better prospects for survival both after CABG surgery and in the presence of drug therapy, but was not a specific indicator of the potential benefits of surgical revascularization [6]. Obviously, the inconsistency of the data obtained was due to the relatively small number of cardiovascular events in the compared groups and the lack of a unified methodology for determining the viability of the myocardium. In general, the assessment of viability can be considered in a modern clinic as an additional criterion for predicting the results of CABG in patients with initially reduced LV pump function [4].

CABG in comparison with the stentation of coronary arteries

From the standpoint of evidence-based medicine, the results of surgical revascularization compared with coronary artery stenting in patients with CAD and LVD were compared in a small number of randomized studies, as well as retrospective observations. In a meta-analysis of 19 studies involving 4766 patients with LVEF less than 40% who underwent percutaneous interventions, hospital and annual mortality rates after stenting did not differ from those in CABG studies [21]. In another study, no significant differences were found in the survival of patients with CAD and LVD (LVEF less than 35% in 446 patients) after stenting and CABG with 36-month follow-up (72% vs. 69%, respectively) [32]. In a HEART study, stenting or CABG was performed in patients with ischemic LVD and viable myocardium. After 4 years no difference was found in the compared groups either in mortality from all causes, or in indicators of the quality of patients' life. At the same time, the study of only 138 patients was not powerful enough to assess the differences between groups in terms of their impact on the endpoints. [8]. The advantages of CABG compared with coronary artery stenting in patients with LVD are identified during the long-term follow-up in studies with a large number of patients [5, 18]. At the same time, stenting retains its place as a means of improving the quality of life of patients with the corresponding anatomical indications.

The benefit of CABG is most noticeable in patients with more pronounced and complex stenosing lesions of the coronary arteries. According to the analysis of a subgroup of patients with a "stem" lesion from SYNTAX study, the difference in treatment results in favor of CABG compared with stenting was evident in patients with moderate or severe coronary lesions determined by the SYNTAX scale [16]. In the FREEDOM study, the beneficial effect of CABG on survival was proven in patients with diabetes mellitus, who often have diffuse coronary artery lesion [10]. Therefore, concomitant diabetes mellitus in patients with two or more coronary arteries lesions (including those with CAD and reduced LVEF) is a strong argument in favor of CABG, rather than stenting [25].

Revascularization in consensus guidelines

First of all, in the European guidelines for the diagnosis and treatment of HF, indications are given for CVG in patients with HF [29]. In particular, CVG is recommended for patients with angina pectoris, with myocardial revascularization being potentially possible. In addition, symptomatic ventricular arrhythmias or a postponed episode of cardiac arrest with successful resuscitation are indications for CVG. CVG should also be considered in patients with HF and moderate or high pretest likelihood of CAD and evidence of ischemia when performing non-invasive stress tests.

In patients with stable CAD, the decision to perform revascularization is based on angiographic and clinical criteria, and the goal of revascularization is to improve the prognosis of survival and / or their quality of life [26]. Both of these tasks are undoubtedly relevant for patients with LVD of ischemic etiology. It is important to take into account the absence of LVEF lower threshold when assessing the feasibility of revascularization. Moreover, improvement in the prognosis and the course of disease after CABG is most pronounced in patients with ischemic LVD.

When choosing the optimal method of revascularization, it is necessary to consider not only the severity of atherosclerosis of the subepicardial coronary arteries, but also the state of the distal bed, as well as the collateral blood flow. Ischemic LVD is often accompanied by a multivessel lesion, and LVEF decreases with the increase of the total lesion of the coronary bed [1]. According to the European guidelines [26], CABG surgery is indicated for patients with stenosis of the left coronary arterial trunk, three-vascular lesion or a two-vascular lesion, including the anterior descending artery, taking into account the severity of the lesion of the coronary bed on the SYNTAX scale. Based on the results of the STICH study (which did not include patients with stem lesions and III-IV functional classes angina), CABG was recommended for patients with HF and LVEF ≤35%, lesion of the left anterior descending artery or a multivessel lesion, to reduce mortality and hospitalizations from cardiovascular causes [29]. LVD is a convincing additional argument in favor of performing CABG surgery in the presence of the corresponding changes in the anatomy of the coronary bed and clinical symptoms, since it is in the category of patients with reduced LVEF that the most convincing evidence of the beneficial effect of revascularization on survival is obtained [14, 17, 28, 38].

The American guidelines for CABG also indicate that the presence and severity of LVD is one of the clinical factors influencing the choice of the optimal method of revascularization. According to their authors, the existing evidence base has certain limitations, especially in patients with severe LVD, but the data on the effectiveness of CABG are more convincing compared to stenting. Clinical parameters, such as anatomy of the coronary arteries, the presence of concomitant diabetes mellitus or chronic kidney disease, as well as the opinion of the patient, are important for choosing a management strategy for patients with coronary heart disease and LVD. The final decision is made jointly by an interventional cardiologist and a heart surgeon [17].

In some special cases of a pronounced decrease in LVEF, the final decision on the feasibility of CABG can be made taking into account the assessment of myocardial viability. In particular, the absence of conclusive evidence of recurrent ischemia combined with a small number of viable myocardium is considered an argument against the surgical treatment. In general, the criteria for the selection of patients for revascularization depending on the state of viability of the cardiac muscle are still not clearly defined due to the lack of evidence base and the lack of a consistent research methodology. It should be also noted that in patients with terminal HF, heart transplantation may be considered.

Revascularization effectiveness criteria

Unlike randomized studies, where the effect of revascularization is evaluated by endpoints, in clinical practice the main criteria for the effectiveness of the intervention are changes in the pumping function of the heart and quality of life, which is primarily determined by clinical symptoms. The increase in LVEF, in turn, favorably influences the course and prognosis of the disease [19]. The data of most studies indicate a positive effect of revascularization on the global pumping function of the heart and local contractility in the area of functioning shunts in patients with LVEF less than 40-30% [3, 33, 34]. Greater growth of LVEF was recorded after myocardial revascularization in patients with worse initial indices of LVEF [15]. At the same time, in patients with initially preserved LVEF, a slight decrease in LVEF was observed in the postoperative period [20]. In the original study of the authors (n = 111), the median of LVEF in 6-12 months after CABG surgery increased from 35 (quartile 30-39) to 42 (35-45%), on average – by 18.9% (5.3 -32.4%) [2]. Moreover, in most cases, the growth of the LVEF was not immediately observed, but from the end of the first month after the operation. With an increase in the duration of postoperative follow-up, the increase in LVEF achieved during the first year of observation usually does not continue increasing, and the LVEF indicator comes to its plateau [23]. Obviously, there remains the need to study the predictors of favorable or negative dynamics of LVEF in patients with CAD after CABG surgery.

Another sensitive indicator of the outcome of revascularization intervention is the reduction in clinical symptoms and improvement in the quality of life associated with health status of patients. This aspect in patients with ISHD and LVD can be determined not only by LVEF and HF functional class according to NYHA classification, but also by age, sex and associated diseases. The correct selection of patients for surgical revascularization allows us to expect an improvement in the quality of life indicators after the intervention in the vast majority of patients, this improvement being more tangible than in the presence of drug therapy [24]. Stenting of the coronary arteries has advantages in influencing the quality of life soon after the intervention, while the advantages of CABG become apparent 6-12 months after the operation.

Conclusions

Coronary atherosclerosis is the most common cause of a decrease in LVEF and the occurrence of HF in the modern world. In patients with ischemic LVD, surgical revascularization can ensure an improvement in the pumping function of the heart, provided there is a sufficient amount of viable myocardium. From the standpoint of evidence-based medicine, the effectiveness of CABG surgery in patients with multivessel lesion of the coronary bed and LVD has been proven for correction LVEF, improvement of the course of the disease and prediction of survival compared with the optimal drug therapy. Percutaneous intervention is inferior to surgical revascularization in terms of its effect on endpoints, but it can make an improvement in the quality of life of patients with ischemic LVD. Evaluation of myocardial viability may be of additional importance for the decision on the feasibility of CABG in the presence of multivessel coronary artery disease combined with a sharp decrease in LVEF.

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