MIOCARDIAL VIABILITY ASSESSMENT IN CARDIAC SURGERY:
CLINICAL PRACTICE AND PROGNOSTIC VALUE

F.E. Abbasov
Academician M. Topchubashov Scientific Surgery Center, Baku, Azerbaijan

Abstract. About 6 million new cases of coronary heart disease (CHD) are registered in the world with more than 1.3 mln of them in Europe. The development of chronic ischemic heart disease (CHD) is the most important factor contributing to the increased prevalence of heart failure. Heart failure (HF) associated with the CHD is one of the main causes of mortality and morbidity. The long term prognosis of patients with HF is poor and this is despite the modern pharmacotherapy and device-based therapy (Hobbs et al., 2002). Surgical revascularization is an alternative approach in patients with chronic CHD and HF. However, high surgical risk, especially in patients with severe LVH or very low LVEF, and poor clinical outcomes with lack or minimal improvement in LV function after revascularization prevent the more active and extensive use of surgical revascularization methods in this group of patients. However, the high surgical risk in patients with severe LV dysfunction (LVD) or with very low LV EF as well as poor clinical results with absence or insignificant improvement in LV function following revascularization prevent more active and wider use of surgical revascularization in these groups of patients.

Considering the high morbidity and mortality among patients with chronic CHD and HF after surgical revascularization, there is a need for correct, careful selection of patients that can benefit the most from revascularization. The research demonstrates that patients with dysfunctional, but viable myocardium can benefit from revascularization with good clinical outcomes. However, patients with nonviable myocardium are not good candidates for revascularization given the lack of significant improvements in the clinical end points. When we talk about the myocardial viability, i.e. hybernating myocardium, the key question of interest for cardiac surgeons is to be able to predict the functional LV recovery after revascularization. Obviously, the restoration of blood flow to the zone of postinfarction scar would not be helpful as there is no anticipation of functional improvement of that part of heart muscle. At the same time, it is important to determine the volume of myocardium which the contractile function can be restored after revascularization. This article is intended to serve the needs of cardiac surgeons and cardiologists in selection of patients for surgical revascularization including the timely assessment of myocardial viability and expected clinical prognosis following revascularization.

Keywords: ischemic cardiomyopathy, hybernation, revascularization, myocardial viability.

Corresponding Author: Professor Fazil Abbasov, Head of the Heart Surgery Department, Academician M. Topchubashov Scientific Surgery Center, Baku, Azerbaijan, Phone: +994 50 320 96 26, e-mail: fazilabbas50@gmail.com

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1. Introduction

Coronary artery disease (CAD) continues to be a leading cause of morbidity and mortality in the world. Over 6 mln new cases of CAD are registered in the world with over 1.3 mln occurring in Europe. In Azerbaijan over 80% of 56,000 of deaths registered every year are attributed to noninfectious diseases (NCD). And about 60%
(32,000) are attributed to the cardio-vascular diseases. The chronic CHD is the most important factor contributing to the increase in the incidence of heart failure with LVD. HF/LVD is one of the main causes of mortality and morbidity among the patients with CHD. CHD with HF/LVD is an important cause of increased healthcare spending in developed world and in majority of developing countries (Hobbs et al., 2002).

In acute cases, including myocardial infarction (MI), the percutaneous coronary angioplasty (PCA) or intervention (PCI) and thrombolysis are considered as a standard approach to decrease the area of myocardial necrosis. However, majority of developing countries lack the necessary technical and human resources to perform PCI or thrombolysis (methods to restore the myocardial perfusion) in patients in need. In many countries access to such technologically advanced interventions are very limited given the financial, technological, geographical and other reasons. In addition, the delayed presentation of patients to the specialized medical institutions is yet another important reason leading to prolonged ischemia, development of ischemic cardiomyopathy and HF/LVD with structural changes of the myocardium.

Long-term prognosis of patients with HF secondary to CHD is poor and it is despite the modern pharmacotherapy. The results of Framingham study on HF demonstrated that during 1990-1999, the 5-year survival of men with HF was 59% and of women – 45%. It is important to note that mortality is especially high among older patients with HF (No et al., 1993). It is true that modern pharmacotherapy has led to significant improvement in survival and quality of life of patients with HF. Wider use of biventricular pacemaker and implantable intracardiac defibrillators (ICD) enabled to improve clinical results in selected group of patients with higher risk of sudden cardiac death or in symptomatic patients on maximized pharmacotherapy (Fuster et al., 2011).

Surgical revascularization is an alternative approach in patients with chronic CHD and HF. The results of the myocardial revascularization in patients with symptomatic and asymptomatic chronic systolic LVD secondary to CHD are debatable up until today. Determination of dysfunctional but viable myocardial segments amenable to revascularization can play decisive role in selection of correct approach to treatment. However, high surgical risk particularly among the patients with severe LVD or very low LV EF as well as poor clinical outcomes with absence or minimal improvement of LV function after revascularization prevents more active and wider use of surgical revascularization methods in this group of patients (Ho et al., 1993).

At the same time, Schinkel A.F. et al. (2004, 2007) demonstrated that improvement of myocardial function and LV EF is reported in 40% of patients after successful revascularization. It was also noted that third of dysfunctional segments of myocardium had an improved function (Schinkel et al., 2007). Given the high morbidity and mortality in patients with chronic CHD and HF after revascularization, there is a need in correct and careful selection of patients who would benefit from revascularization the most. This benefit goes beyond the clinical improvement and entails also benefit to public health and healthcare economy. Multiple studies to determine the potential of surgical revascularization in patients with CHD and HF confirmed that LVD is not always irreversible. It is now proven that decrease in contractile function of myocardium is related to scarring of heart muscle, but is also due to reversible dysfunction of myocardium. These segments of myocardium contain cardiomyocytes that are not actively contracting, but continue to keep minimal amount of oxygen consumption and main components of cellular metabolism. It seems that these cells are in sort of «deep sleep» (Ho et al., 1993).
The research also demonstrated that hybernating myocardium as well as decrease in function of myocardial segments at rest and during stress secondary to prolonged decrease in coronary blood flow can partially or completely be reversed after revascularization. The term "hybernating myocardium" defines the regional LVD. It develops as the consequence of prolonged hypoperfusion of myocardium when myositis are still viable but their contractile capacity is decreased. Mandatory criteria for hybernating myocardium is an integrity of cellular membranes and continued metabolism of glucose. After improvement of blood flow following successful reperfusion and/or decrease in need for one, the LV dysfunction can be partially or completely reversed (Allman et al., 2002). If transitional LVD continues despite the lack of irreversible injuries and also restoration of blood flow, the resultant condition is referred to as «stunned myocardium». Concept of hybernating and stunned myocardium enabled researchers and clinicians to develop diagnostic approaches for evaluation of post infarction changes in myocardium. However, considering the sensitivity of myocardium to ischemia, it is important to note that contractile dysfunction usually develops after acute ischemic attack. Duration and impact area of ischemic attack is directly proportional to irreversibility of myocardial injury and defines the necrosis of heart muscle (Wijns et al., 2010).

The research shows that patients with dysfunctional but viable myocardium are candidates for revascularization with good clinical results. However, patients with nonviable myocardium are not candidates for revascularization due to lack of significant improvement in clinical endpoints. When we talk about defining the viability, i.e. hybernating myocardium, cardiac surgeons are interested in predicting the potential of functional restoration of LV after revascularization. Naturally, the restoration of blood flow to the area of postinfarction scar have no proven benefits and thus shall not be attempted. At the same time, it is important to determine the volume of myocardium that can benefit from revascularization with improved contractility.

Based on the available research, the European Society of Cardiology and European Association of cardiothoracic surgeons adopted the recommendation to evaluate the viability of myocardium as part of overall process aimed to determine the indications for surgical revascularization in patients with CAD and LVD. Noninvasive evaluation of myocardial viability is used to choose the treatment strategy in patients with chronic CHD and systolic LVD. Various methods of visualization including PET, dobutamin stress echocardiography and single photon emission computer tomography (SPECT) were used to evaluate the viability of myocardium and predicting the clinical results after revascularization. Different studies have been carried out to describe and assess the efficiency and indications for various methods of diagnostic evaluation, including stress ECHO-CG, speckle-ECHO-CG, MRI, SPECT, PET or combination of abovementioned methods (Dilsizian & Bonow, 1993). In general, nuclear medicine based visualization techniques have high sensitivity, while the techniques used to determine the contractile capacity have less sensitivity but higher specificity (Bax et al., 2001). MRI has high diagnostic accuracy for evaluation of transmural volume of scar tissue and contractile reserve of myocardium. However, its potential to determine the viability and predict the degree of restoration of myocardial contractility is not better than other methods. Differences in the results obtained through various methods are not significant and usually experience or availability of each method defines which one would be used. Interestingly, the use of above mentioned diagnostic methods in various researches enabled to define that 50% of dysfunctional myocardial segments in patients


with chronic CHD are viable and can be subjected to revascularization. These results underline the need for standardized approach to the preoperative determination of myocardial viability in patients with chronic CHD or chronic ischemic cardiomyopathy related to IDH as well as in patients with HF.

PET with 18F-deoxyglucose is currently regarded as «gold standard» for determination of myocardial viability. This method is based on information about myocardial glucose metabolism. Normal or increased metabolism of glucose in the area of hypoperfusion is characteristic for viable cardiomyocytes (Wu et al., 2007). The different substrate - 11C-palmitate – is used to determine the metabolism of fatty acids using the PET scan. Availability of only one PET center in Azerbaijan established in 2016 and high costs associated with this methods, prevents the wider application of this method for viability determination. There is a need for standardized approach that will be less expensive and less invasive as well as utilize the widely available diagnostic methods in low and middle-income countries which can help cardiologists and cardiac surgeons to make a decision on revascularization of patients.

MRI and ECHOCG are ideal investigation methods to determine the volume of potentially restorable myocardium. Being noninvasive methods, they enable to determine the structural and functional changes as well as define the functional reserve of myocardium.

2. Determination of myocardial viability. Diagnostic markers of viability

Many patients with ischemic cardiomyopathy have viable, but nonfunctioning myocardium. It is when cardiomyocytes in akinetic or hypokinetic segments of myocardium sustain their normal contractile ability and can restore it with the restoration of perfusion. The research shows that viable myocardium is associated with higher survival in patients with CHD and HF/LVD. The results of prospective randomized STICH (Surgical treatment for ischemic heart failure) trial that was aimed at comparing the effectiveness and advantages of bypass and aggressive pharmacotherapy in patients with CHD and LV failure (observation period of 6 years), demonstrated that risk of cardio-vascular mortality is higher in patients with nonviable myocardium when compared with patients with viable myocardium (Bonow et al., 2011).

Differentiation of dysfunctional myocardium into scar tissue and viable myocardium is indeed highly important, specifically in patients that are considered as candidates for surgical or endovascular revascularization. Viable myocardium has certain characteristics which enables its detection. This includes metabolic activity, sustained perfusion and contractile capacity/reserve. Current methods of visualization of the heart are highly informative, but has different sensitivity and specificity. MRI has high diagnostic accuracy for determination of transmural scarring of myocardium, but it is not better than other diagnostic methods in determination of myocardial viability, nor in predicting the restoration of contractile ability of myocardium. Also, PET and MRI enables to reveal disorders of metabolism in heart muscle.

Positive inotropic reserve which is defined as increased contractility to inotropic stimulation is an important differentiating feature of reversible myocardial dysfunction. This sign enables the use of stress ECHOCG to verify the viability of myocardium. In contrary, the nonviable myocardium's (scar) contractility is not improved (negative inotropic reserve) following inotropic stimulation. The use of stress-echocardiography
with dobutamin test can help to assess the LV wall thickness and contractile reserve of myocardium.

3. **Noninvasive methods for myocardial viability determination**

Presently, majority of cardiologists recommend the following algorithm for determination of myocardial viability:

**Phase I** – pharmacological stress-ECHO with dobutamin and stress-MRI with dobutamin.

**Phase II** – perfusional scintigraphy of myocardium with Tc.

**Phase III** – PET, MRI, contrast ECHO with dobutamin.

Stress-ECHO with dobutamin and MRI with dobutamin helps to identify contractile reserve of myocardium. The assessment of myocardial perfusion can be done also by contrast ECHO with dobutamin and MRI with contrast. Last but not least, PET can also be used to verify the existing metabolic activity of myocardium.

Stress-ECHO is the most widely available method. It is also highly informative, relatively inexpensive and most importantly can be found in majority healthcare institutions. There are several advantages of ECHO in comparison with other methods used for viability assessment: lack of radiation, possibility of repeat imaging, and low cost of equipment and relative safety of employed medications for stress testing. However, this diagnostic modality has some disadvantages: inability to visualize coronary arteries, difficulties in visualization of heart on transthoracic ECHO with dobutamin and MRI in patients with emphysema and obesity, as well as semi-quantified assessment of myocardial kinetics.

Stress-MRI with dobutamin can help to determine myocardial viability in poorly contracting segments. The use of low dose dobutamin will lead to improvement of contractility of myocardial wall, but higher doses will lead to depressed contractility of myocardium. Therefore, in case of viable but hypokinetic myocardium we will observe both reactions.

The use of MRI and ECHO for viability determination is greatly discussed below.

**Cardiac MRI:**

**Methodology:** MRI enables the assessment of anatomy of the heart and LV, depth and extent of fibrosis, contractility of LV and its functional reserve. Stress MRI with dobutamin dose can be used to identify the viability of myocardium. Stress MRI with dobutamin is aimed at assessment of contractile reserve of myocardium, which is similar to stress-ECHO and carried out per similar protocol. At the same time, stress MRI has some advantages in comparison with stress-ECHO as it has higher spatial resolution and reproducibility.

According to the criteria on cardiac MRI published in 2006, MRI with contrast is recommended for determination of myocardial viability and potential for functional recovery before the surgical revascularization. MRI with gadolinium contrast is another diagnostic modality to differentiate between reversible and irreversible changes of myocardium. During this procedure, the gadolinium-based contrast material is accumulated in necrotic, nonviable myocardium. It is suggested that an increase in intracellular fluid volume secondary to disordered membrane permeability of cardiomyocytes affects the kinetics of gadolinium rendering it to be accumulated in scarred myocardium.
The dissinergized segments in the ischemic zone can be registered by MRI. MRI helps to define the linear size of LV, calculate the volume of LV, myocardial mass and EF. Calculation of functional parameters by noncontract cardiac MRI along with detailed evaluation of cardiac anatomy and structural changes of myocardium often provides the sufficient volume of diagnostic information and eliminates the need for use of invasive imaging.

The use of gadolinium based contrast materials during MRI enables the visualization of postinfarction cardiofibrosis zones. Gadolinium injected into peripheral vein travels freely in the blood unbound to blood proteins. Gadolinium is accumulated in extracellular spaces and eliminated via kidneys. Elimination or clearing of gadolinium from scarred myocardial tissue happens more slowly. The areas of cardiofibrosis can be accurately visualized as the areas of signal hyperintensity on T1-weighted MRI imaging obtained 7-10 minutes after contrast injection. The thickness of area highlighted by contrast has direct relationship with the depth of myocardial injury. This area extends to full thickness of myocardium in transmural injury and in case of nontransmural infarction it only extends to subendocardium (Glaveckaite et al., 2014).

**Predictive value.** Although the zones of akinesis or hypokinesis only indicate the existence of postinfarction changes in particular segment of myocardium and thus do not provide sufficient data on possibility to restore the contractility, however these data shall be used as part of more complex approach to overall prognostic assessment. End diastolic thickness of ventricle has an important value. Thinning of ventricular wall to less than 5.5 – 6.0 mm corresponds with significant myocardial injury and thus associated with poor prognosis. Research demonstrated that decrease in ventricular wall thickness to less than 4 mm is associated with poor prognosis and improvement of contractility occurs in only 5% of these patients. Thus, patients with ventricular wall thickness of less than 4 mm are not candidates for surgical revascularization. Assessment of myocardial viability by MRI demonstrates that there is practically no observed recovery of contractility in segments with transmural injury. Therefore, revascularization in such patients is not indicated. Patients with transmural myocardial injury who underwent revascularization had mortality of 7.7%, which is twice higher (3.2%) than in patients with nontransmural scar. Perioperative mortality in patients with LV full thickness injury is also significantly higher and ranges between 9 and 12.5% (Glaveckaite et al., 2014). The depth of myocardial injury in nontransmural cardiofibrosis has important prognostic value. The extent of contrast-highlighted area to more than 50% of ventricular thickness can be regarded as transmural injury as reperfusion in such patients lead to restoration of contractile activity in less than 10% of myocardial segments. Restoration of global contractile function of LV in patients with deep scar is dependent on number of damaged segments. Thus, the possibility of restoration of contractile function of myocardium is higher in patients with less damaged segments and less deeper extent of cardiofibrosis.

Patients with subendocardial ischemic injury and areas of cardiosclerosis extending to less than 25% of myocardial thickness has better prognosis of restoration of regional and global contractile function of LV. The restoration of contractile function in such cases is expected in 80-83% (Glaveckaite et al., 2014). In general, the sensitivity of MRI with contrast enhancement and delayed washout of contrast from scarred tissue for detection of myocardial viability is 95% and its negative prognostic value is 90%. Specificity of method is low (62%). However, in the absence of scar or damage to less than 25% of myocardial tissue as well as in transmural injury, the MRI
with delayed washout of contrast is sufficient for decision-making in regards to revascularization. This will also prevent the patient from having additional stress testing (Romero et al., 2012).

The positive effect of revascularization in majority of patients with extent of cardiofibrosis to 25-50% of ventricular wall thickness is debatable. Some authors suggest considering as potentially viable the myocardium with less than 50% contrast enhancement. This rule is suggested for use in daily practice. Other researchers indicate that only 41-45% of damaged LV segments can have their function restored following coronary revascularization.

The use of stress testing has better potential to detect the myocardial viability in patients with the extent of cardiofibrosis to 25-50% of ventricular wall. In one of the meta-analysis Romero J. et al. demonstrated high specificity and positive prognostic value of MRI stress test with dobutamine for detection of contractile capacity of myocardium (Nihoyannopoulos & Vanoverschelde, 2011). This particular method is useful to determine the likelihood that revascularization will restore the LV function. The positive MRI stress test with dobutamine in patients with subendocardial postinfarction cardiofibrosis is associated with 14.4% improvement of LV EF at 6 months following coronary bypass. In patients with negative MRI stress test with dobutamine the observed improvement was only 2.5%.

**STRESS-ECHO with low dose of dobutamine**

Methodology. For many years the ECHOCG had been the main diagnostic modality used to detect myocardial viability. The determination of end-diastolic LV wall thickness enables to obtain basic information about existence or absence of viable myocardium. Significantly thinned walls likely represent scar tissue. In LV segments with end-diastolic wall thickness of less than 6 mm there was no contractile capacity, while it was present in majority of segments with LV wall thickness greater than 6 mm. Use of stress-ECHO with low dose dobutamine enables the improvement of data quality for detection of myocardial viability. Dobutamine mostly binds to and stimulates β1-adrenoreceptors (Katikireddy et al., 2012). Injecting dobutamine in low doses (2.5–10 mcg/kg/min) leads to mild systemic and coronary vasodilatation causing reduced afterload and increase in myocardial perfusion and myocardial blood volume. It has mild inotropic effect mediated through beta-receptors without any significant chronotropic effect. Therefore, in akinetic, ischemic segment wall motion and systolic thickening may improve without steep rise in oxygen demand. The positive low dose dobutamine stress ECHO response depends on the mass of cardiomyocytes, presence of intact contractile apparatus, and baseline residual coronary vasodilator reserve. The dobutamine-induced contractile response is highly specific predictor of viability (Pellikka et al., 2007; McLean et al., 2009). At higher doses (10–40 g/kg/min), wall motion in these segments may further improve or paradoxically diminish, reflecting tachycardia-induced ischemia. Such a response called byphasic and has been shown to be highly predictable of functional recovery after revascularization. It is also suggestive of limited, but present, myocardial reserve in the hibernating myocardium. «Byphasic response» is very characteristic of hybernating myocardium and thus predicts the restoration of function of ventricle after revascularization. And thus “biphasic response” is specific for detection of myocardial viability (Schinkel et al., 2007b). The specificity of biphasic response is 89% but the sensitivity is modest at 74% (Camici et al., 2008).
The meta-analysis by Schinkel et al., (2007) showed that low-dose dobutamine echocardiography had a cumulative sensitivity and specificity of 81% and 78% respectively, with a positive predictive value (PpV) and negative predictive value (NpV) of 75% and 83% respectively, (p<0.05). It was also found that high-dose dobutamine echocardiography had a higher sensitivity (83%) and NpV (85%) than low-dose dose (p < 0.05), whereas specificity and ppV were comparable. A review by Camici et al (2008) showed that low dose dobutamine echocardiography has superior specificity, lower PpV and similar NpV compared to nuclear imaging (Collier et al., 2017).

**Speckle ECHOCG:**

Methodology. During the last years the analysis of myocardial deformity with the novel method of speckle-tracking during stress-ECHO (Ran et al., 2016) has gained popularity to assess the myocardial kinetics. It is based on the observation that ultrasound images contain many small particles, natural acoustic markers, which move together with the tissue and can be identified on adjacent frames (Urheim et al., 2000). Two-dimensional speckle-tracking echocardiography is a technique that provides measurements of strain in three planes, by tracking patterns of ultrasound interference (‘speckles’) in the myocardial wall throughout the cardiac cycle (D’Hooge et al., 2000). Since its initial use over 15 years ago, it has emerged as a tool that provides more robust, reproducible and sensitive markers of dyssynchrony than tissue Doppler imaging. Myocardial deformation (strain) and deformation rate (strain rate) provide multidimensional evaluation of myocardial mechanics (longitudinal, radial, and circumferential function) and have the added advantage of being able to detect subtle wall motion abnormalities of regional function that do not decrease global LVEF (Bansal et al., 2010; Galiuto et al., 2011; Bansal et al., 2013). Deformation imaging has been shown to provide unique information on regional and global ventricular function with some studies showing reduced inter- and intraobserver variability in assessing regional left ventricular (LV) function (Djordjevic-Dikic et al., 2011).

Bansal and colleagues (2010) revealed that longitudinal and circumferential strain and strain rate measurements at rest and low-dose dobutamine concentrations were predictive of functional recovery post-revascularization using strain-based imaging (Afridi et al., 1995).

4. **Discussion**

**Viability of myocardium and effectiveness of revascularization**

Detection of myocardial viability is of significant interest for cardiologists, cardiac surgeons and patients with severe impairment of regional contractility as it helps to determine the viable LV segments for further revascularization. The research demonstrates that over 50% of patients with electrocardiographically confirmed MI has viable myocardial segments along with necrotized tissue. The detection of myocardial viability in patients with LVD has also important prognostic value. Conservative management of patients with diminished LV function and signs of hibernating myocardium is associated with higher mortality.

So far, research exploring the use of noninvasive methods for detection of myocardial viability has looked into various clinical criteria including improvement of regional LV function (segments), improvement of global function (LV EF), improvement in NYHA HF class and ability to endure the physical workload (metabolic...
equivalents), reversibility of LV remodeling (its volume), prevention of sudden cardiac death (ventricular arrhythmias) and long-term prognosis (survival). Improved LV function after revascularization is considered an important confirmation of myocardial viability (Senior et al., 2009).

Number of studies looked into prognostic value of myocardial viability detection. All the research until now has demonstrated a decrease in cardiac events in patients with confirmed viable myocardium who underwent revascularization. It is obvious, that revascularization stabilizes unstable substrate of dysfunctional but viable myocardium. Moreover research also demonstrated a decrease in re-hospitalizations secondary to congestive heart failure among patients with significant amount of viable myocardium.

Thus, the assessment of myocardial viability has important and long-lasting implications in the treatment of patients with HF/LVD secondary to CHD. As such in these patients, the revascularization improves the survival. Hybernating and stunned myocardium are key mechanisms of reversible dysfunction of viable myocardium and of development of HF signs in patients with CHD. Stress-ECHO with low dose dobutamine and MRI without contrast and stress-MRI with dobutamine are some of modern diagnostic tools used for visualization of the heart that enables to differentiate viable myocardium from scar tissue (Windecker et al., 2014). Obtained information can be used for more accurate stratification of risks and selection of right approach in management of patients with LVD of ischemic origin. The results of many clinical research studies reconfirms that revascularization of viable myocardium provides for reversibility of LV remodeling, improvement of regional and global function, decrease in HF symptoms and survival improvement in these patients.

Evaluation of relative prognostic value of various methods for detection of viable myocardium demonstrates that myocardial scintigraphy is the most sensitive method to predict the restorability of myocardial function post-revascularization, while stress-ECHO with low dose dobutamine is the most specific.

Nowadays, the differentiation of viable myocardium from nonviable one can be done with the use of PET, scintigraphy, MRI with contrast and several ECHO modalities. The use of stress-ECHO with low dose dobutamine and MRI, including without contrast and stress-MRI with dobutamine are the most practical from clinical and economic standpoint, as they are the most widely available.

In recent years, the new ECHO modality aimed at assessment of deformation parameters has been gaining popularity as part of preoperative evaluation of patients with CHD for revascularization and CRT. Currently speckle-tracking ECHO is very promising modality for detection of myocardial viability and assessment of LV contractility. Considering the high interoperator reliability, lack of angle dependency and possibility for automated monitoring gives speckle-tracking ECHO a significant advantage for accurate measurements and predicts it wider application in research and clinical practice in years to come.

5. Conclusion

There is a growing tendency in utilization of surgical and endovascular revascularization in patients with chronic CHD with LVD/HF. The presence of viable myocardium under sustained and prolonged ischemia secondary to limited coronary blood flow provides the pathophysiological bases for such an approach.
It is not debatable anymore that the detection of myocardial viability before surgical revascularization aimed at determination of its relevance and usefulness is mandatory. This is especially true for preoperative evaluation of patients with significantly decreased LV contractility. Compared with patients without viable myocardium, patients with signs of hybernating myocardium have improved prognosis after revascularization.

Identification of viable myocardium in patients with ischemic dysfunction of LV is an important step in the management of patients with CHD and thus also reflected in the 2014 European recommendations on myocardial revascularization. Presence of viable myocardium provides a basis for an effective use of such treatment modalities as aorto-coronary bypass and PCI. Volume of viable myocardium, the degree of myocardial injury and possibility for restoration of coronary blood flow are factors that impact the clinical outcomes. Restoration of adequate blood flow to the ischemic but viable myocardium enables to decrease the clinical symptoms and signs of disease and improve the patient quality of life.

Contemporary cardiology has sufficiently informative diagnostic tools to detect the myocardial viability and stress-ECHO with low dose dobutamine and MRI with gadolinium are most widely available, noninvasive, relatively inexpensive and highly informative methods employed.

Sensitivity, specificity and PPV of stress-echo with low dose dobutamine is about 81%, 86% и 83%, respectively. Use of speckle-tracking analysis during stress ECHO has significantly improved the detection of viability and decision making for revascularization.

Cardiac MRI with contrast, including Stress MRI with dobutamine as part of patient selection for surgical revascularization has an important value in defining the potential for restoration of myocardium’s contractile function following revascularization. Cardiac MRI with detection of cardiofibrosis helps to identify patients with transmural (transmural scar) and the ones with subendocardial (less than 50% of wall thickness) ischemic injury. Inotropic stimulation with low dose dobutamine as a test for detection of myocardial viability enables to predict the post revascularization results in patients with nontransmural post infarction cardiofibrosis extending to less than 50% of myocardial thickness.

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