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SURGICAL REVASCULARIZATION AND ITS EFFECT ON PROGNOSIS IN PATIENTS AFTER ACUTE MYOCARDIAL INFARCTION

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Summary. *The recovery of viable (hibernating) myocardium is possible only after surgical revascularization, in contrast to stunning myocardium the recovery of which is spontaneous. The aim of the study was to determine the effect of therapy (medical or surgical revascularization) on the clinical course and echocardiographic findings during a one-year follow-up of patients after acute myocardial infarction. The investigation included 195 patients hospitalized for acute myocardial infarction. Prior to discharge, all patients underwent DSE test. During a 12-month follow-up, the patients underwent 3-month coronarography and possible surgical revascularization (ACB) (57 patients), depending on the presence of viable myocardium and/or residual ischemia. The patients were divided into two groups: the first group underwent ACB, and the second received medical treatment. Both groups showed significant dynamics of change in WMSI during the follow-up, but a lower degree of significance was registered in the group under medical treatment ($p<0.02$ vs. $p<0.01$). Neither group showed statistically significant dynamics of change in EF and QRSS values. The dynamics of change in regional motility between the groups was investigated using Pearson chi-square test. A statistically significant difference in the dynamics of change in all regional motility impairments was established, with the significance of difference of $p<0.01$ for hypokinetic segments, $p<0.02$ for akinetic, and $p<0.001$ for dyskinetic segments. A timely performed surgical revascularization allows for a significantly faster recovery of segmental contractility and a safer clinical course during one-year follow-up after AMI.*

Key words: *AMI, viable (hibernating) myocardium, surgical revascularization, DSE test*

Introduction

In recent years, numerous studies have been focused on the functional recovery of dysfunctional myocardial viability after revascularization, especially in patients with dysfunction of the left ventricle (1). Heart insufficiency, as a consequence of ventricular dysfunction, is the leading cause of morbidity and mortality. On the other hand, ventricular dysfunction resulting from ischemia is a dynamic and reversible process (2). After AMI, a possible finding is the region of irreversible damage surrounded by myocardial stunning in the pre-infarct zone with hibernating myocardium distally from coronary stenosis of the infarct or some other artery. Previous ischemic episodes can precondition myocardial regions (3,4,5), whilst future ischemic events, in resting or effort conditions, contribute to the contractile dysfunction. A finding of viability is of considerably lower clinical significance relative to prediction of functional recovery after revascularization (6). Dynamics of functional recovery after revascularization differs in each case alone and depends on the degree of histological abnormality and the quality of revascularization procedure (7).

Patients and Methods

The investigation was done as a prospective study within the period January 1997-June 2001. The aim of the study was to determine the effect of therapy (medical or surgical revascularization) on the clinical course and echocardiographic findings in patients after acute myocardial infarction during one-year follow-up.

The study included a total of 195 patients with acute myocardial infarction who were hospitalized and treated at the Coronary Unit of the Clinic for Cardiovascular Diseases, Clinical Center - Niš. On admission, the diagnosis of AMI was established on the basis of the existing WHO criteria, that is, an adequate clinical picture and electrocardiographic and biochemical parameters.

The evaluation of damage severity of the left ventricle myocardium after AMI was done by electrocardiographic and echocardiographic methods.

Electrocardiographically, the scar size was assessed using the complete version of Selvester QRS scoring system with 54 criteria and a maximum score of 32 points.

Echocardiographically, the global contractile function was assessed by ejection fraction (EF) and the regional by assessing the function of 16 segments.

Semiquantification was done by scoring the disorders of regional contractility: normokinesis - 1 point, hypokinesis - 2 points, akinesis - 3 points, and dyskinesis - 4 points. Semiquantitative index of the left ventricle contractile function, i.e., WMS (total sum of wall motility) was obtained by adding up the values of regional motility of segments. Dividing by the number of segments, which were visualized, WMSI (motility index) was determined.

The assessment of the left ventricle function was performed in basal conditions on 3^{rd}-4^{th} day after admission, 13^{th}+/–3 days, immediate to pharmacodynamic test, and during the follow-up.

Prior to discharge from the Clinic, the patients underwent symptom-limited exercise test using the BRUCE or MOD BRUCE protocol treadmill testing.

After one day, patients were subjected to Dobutamin stress echocardiographic test according to the following protocol: continuous infusion of dobutamin with increasing doses of 5, 10, 15, 20, 30, 40 mcg/kg/min in three-minute periods. The response of segments with impaired motility in resting condition was classified as follows:

a) biphase response: improvement followed by homo or heterozonal worsening after administration of increased doses;
b) progressive improvement of regional contractility;
c) progressive worsening; and
d) unchanged segmental contractility.

Following the obtained test results, the patients were referred to invasive diagnostics, performed in objective circumstances (such as war instability). After coronarography, the patients continued with medical treatment or underwent surgical revascularization. Invasive diagnostics and revascularization were performed within the first months (2-3 months after survived myocardial infarction).

One year monitoring included six-month and one-year follow-ups of subjective and objective, i.e., clinical status of the patient, electrocardiographic and echocardiographic examination with the estimation of therapy effects according to the anamnestic data and reasons for possible rehospitalizations (angina pectoris, reinfarction, arrhythmias, heart insufficiency).

Results

Of 111 patients who underwent coronarography, 42 had received thrombolytic and 69 had received conventional therapy. In the group treated with thrombolytic therapy, 6 patients had single-vessel, 6 patients double-vessel, and 30 patients multi-vessel coronary disease. In the group treated conventionally, there were 18 patients with single-vessel, 45 with double-vessel and 6 patients with multi-vessel coronary disease.

Fiftyseven patients (45 males and 12 females) underwent surgical revascularization. On admission, 33 patients (27 males and 6 females) received thrombolytic therapy and 24 patients (18 males and 6 females) received conventional therapy.

In the group treated with thrombolytic therapy, 27 patients with multi-vessel, 3 with double-vessel and 3 with single-vessel coronary disease underwent surgical revascularization.

In the group treated conventionally, surgical revascularization was performed in 21 patients with double-vessel and in 3 patient with multi-vessel coronary disease.

On the basis of surgical revascularization, the patients were divided into two groups that were further monitored for WMSI, EF, and QRSS dynamics of change.

In the group that underwent surgical revascularization, Student's t-test was used for establishing a statistically significant difference in the values of basal WMSI and WMSI at six-month follow-up ($p<0.01$), as well as in the values of basal WMSI and WMSI at one-year follow-up ($p<0.001$). No relevant difference was found between the values of WMSI at six-month and one-year follow-ups. The values of EF and QRSS didn't show a statistically significant difference (Table 1).

Student's t-test was also used in the group that didn't undergo surgical revascularization for establishing a significant difference in the values of basal WMSI and WMSI at six-month follow-up ($p<0.02$), as well as in the values of basal WMSI and WMSI at one-year follow-up ($p<0.02$), but of less significance compared to the group that underwent surgery. No statistically significant difference was established between the values of WMSI at six-month and one-year follow-ups. The values of EF and QRSS didn't show a statistically significant difference (Table 2).

Given the clinical variables and coronarographic findings, a significant difference was found between these two groups with respect to the incidence of angina pectoris ($p<0.05$) ("in favor of" the patients treated with ABC) and with respect to the incidence of double-vessel ($p<0.01$) and multi-vessel coronary disease ($p<0.001$). No statistically significant difference was found between other clinical variables or relative to rehospitalizations (Table 3).

Dynamics of change in regional motility with respect to surgical revascularization

In the group that underwent ABC, 217 normokinetic and 87 dyssynergic segments were registered in basal conditions, of which 57 were hypokinetic, 24 akinetic, and 6 dyskinetic segments.

At 6-month follow-up, there were 259 normokinetic and 45 dyssynergic segments, of which 25 were hypokinetic, 18 akinetic, and 2 dyskinetic segments.

At 12-month follow-up, there were 251 normokinetic and 37 dyssynergic segments, of which 23 were hypokinetic, 12 akinetic, and 2 dyskinetic segments (Table 4).

In the group of patients who didn't undergo ACB, 893 normokinetic and 323 dyssynergic segments were registered under basal conditions, of which 207 were hypokinetic, 86 akinetic, and 30 dyskinetic segments.

Table 1. Significance of difference in WMSI, EF and QRSS during the follow-up of patients treated with surgical revascularization

	WMSI			EF			QRSS		
	basal-6m	basal-12m	6m-12m	basal-6m	basal-12m	6m-12m	basal-6m	basal-12m	6m-12m
t	3.36	4.11	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.
p	<0.01	<0.001	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.

Table 2. Significance of difference in WMSI, EF, QRSS during the follow-up of patients who didn't undergo surgical revascularization

	WMSI			EF			QRSS		
	basal-6m	basal-12m	6m-12m	basal-6m	basal-12m	6m-12m	basal-6m	basal-12m	6m-12m
t	2.50	2.72	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.
p	<0.02	<0.02	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.	n. s.

Table 3. Significance of difference in clinical variable frequency and coronarographic finding with respect to surgical revascularization.

	AP	fatigue	dyspnea	reIM	aneur	single-vessel	double-vessel	multi-vessel	hospital
t	2.29	n.s	n.s	n.s	n.s	n.s	3.35	5.73	n.s
p	<0.05	n.s	n.s	n.s	n.s	n.s	<0.01	<0.001	n.s

Table 4. Dynamics of regional motility in the group that underwent ACB

	Normokinetic	Hypokinetic	Akinetic	Dyskinetic
Basal	217	57	24	6
6-month follow-up	259	25	18	2
12-month follow-up	251	23	12	2

Table 5. Dynamics of regional motility in patients who didn't undergo ACB

	Normokinetic	Hypokinetic	Akinetic	Dyskinetic
Basal	893	207	86	30
6-month follow-up	1008	118	68	22
12-month follow-up	1016	95	66	23

Table 6. Significance of difference in the dynamics of regional motility disorders between the observed groups

	Hypokinetic		Akinetic		Dyskinetic	
	ACB yes	ACB no	ACB yes	ACB no	ACB yes	ACB no
Basal	57	207	24	86	6	30
6-month	25	118	18	68	2	22
12-month	23	95	12	66	2	23
χ^2	8.16		7.24		25.30	
P	<0.01		<0.02		<0.001	

At 6-month follow-up, there were 1008 normokinetic and 208 dyssynergic segments, of which 118 were hypokinetic, 68 akinetic, and 22 dyskinetic segments.

At 12-month follow-up, there were 1016 normokinetic and 184 dyssynergic segments, of which 95 were hypokinetic, 66 akinetic, and 23 dyskinetic segments (Table 5).

A difference in the dynamics of change in regional motility impairments between the observed groups was investigated using Pearson's chi-square test. A statistically significant difference of change in all regional motility disorders was found, with the significance of difference of $p<0.01$ for hypokinetic segments, $p<0.02$ for akinetic, and $p<0.001$ for dyskinetic segments (Table 6).

Discussion

A total of 57 patients underwent surgical revascularization. The patients were referred to invasive examination on the basis of clear clinical findings with abundant symptomatology, expressed electrocardiographic changes and clear positive exercise test for ischemia. Of patients with performed coronarography, 39 patients with biphasic response to the test, 12 patients with improvement of segmental motility, 6 patients with worsening underwent surgical revascularization. It is clear that the onset of ischemia was one of the most important reasons for performing surgical revascularization, in case of a concomitant viable myocardium. No statistically relevant difference of EF and QRSS values was established either in the group under surgical revascularization or in the group that didn't undergo surgery. In

both groups, a significant difference in WMSI values during hospitalization and at 6- and 12-month follow-ups was established. However, the difference was considerably higher in the group under surgical revascularization ($p<0.01$ vs. $p<0.02$ at six-month follow-up and $p<0.001$ vs. $p<0.02$ at one-year follow-up). This difference was supportive of the fact that most patients underwent surgery within the first six months, which favored the recovery of hibernating myocardium over the next six-month period after surgery. The existing difference between basal and six-month follow-up values suggests a spontaneous recovery of myocardial stunning. The period of recovery of contractile function after revascularization is most variable. Although numerous studies report fast recovery of myocardial function after revascularization, a prolonged and gradual recovery for months after revascularization has been also reported. Using DSE test, it is possible to demonstrate the contractile reserve of segments running late with recovery and being a likely consequence of stunning after revascularization of hibernating myocardium (8,9,10).

A statistically significant difference in the dynamics of recovery of segmental motility was established between the patients under surgical revascularization and those who didn't undergo surgery, by comparing the number and dynamics of recovery of hypokinetic, akynetic, and dyskinetic segments. In the patients who underwent surgery, the dynamics of segmental motility improvement was considerably faster with respect to all aspects of contractility disorders. This confirms the finding that surgical revascularization is significant for the recovery of dysfunctional but viable segments.

There was a difference as to the presence of single-vessel, double-vessel, and multi-vessel coronary disease, in that the patients with double- and multi-vessel coronary disease mostly underwent surgical revascularization.

Conclusion

A timely performed surgical revascularization allows for a significantly faster recovery of segmental contractility. Regarding the clinical variables, no significant difference during the follow-up was registered between the patients who underwent revascularization and those who received medical therapy, but a positive trend of segmental motility recovery was noticed in the group that underwent revascularization. As the investigation was done in patients with predominantly uncomplicated myocardial infarction, the patients who underwent surgical revascularization were during the follow-up equaled to patients in whom revascularization was not indicated.

References

1. Camici GP, Wijns W, Borgers M, et al. Pathophysiological mechanisms of chronic reversible left ventricular dysfunction due to coronary artery disease (hibernating myocardium). Circulation 1997; 96: 3205-3211.
2. Fox FK, Cowie RM, Wood AD, et al. New prospectives on heart failure due to myocardial ischemia. Eur Heart J 1999; 20: 256-261.
3. Cave CA, Silverman SA, Apstein SC. Ishemic preconditioning does not protect against contractile dysfunction in the presence of residual flow. Studies in the isolated, blood-perfused rat Heart. Circulation 1997; 96: 3087-3094.
4. Šimurdova M, Braveny P. ATP-sensitive potassium channels and cardiac protection. Exp Clin Cardiol 1998; 3: 3-9.
5. Patel JD, Purcell JH, Fox M. K. on behalf of the CESAR 2 Investigators: Cardioprotection by opening of the K_{ATP} channel in unstable angina. Is this a clinical manifestation of myocardial prre-conditioning? Results of a randomized study with nicorandil. Eur Heart J 1999; 20: 51-56.
6. Afridi I, Quershi U, Kopelen AH, et al. Serial changes in response of hibernating myocardium to inotropic stimulation after revascularization: A dobutamine echocardiographic study. J Am Coll Cardiol 1997; 30: 1233-1238.
7. Murphy E, Cross RH, Steenbergen C. Na/H and Na/Ca exchange: their role in the rise in cytosolic free (Ca) during ischemia and reperfusion. Eur Heart J Supplements 1999; 1 (Suppl K): K18.
8. Bax JJ, Wijns W, Cornel HJ, et al. Accuracy of currently available techniques for prediction of functional recovery after revascularization in patients with left ventricular dysfunction due to chronic coronary artery disease: comparison of pooled data. J Am Coll Cardiol 1997; 30: 1451-1456.
9. Sicari R, Picano E, Landi P, et al. on Behalf of the Echo Dobutamine International Cooperative (EDIC) Study. Prognostic value of dobutamine-atropine echocardiography early after acute myocardial infarction. J Am Coll Cardiol 1997; 29: 254-260.
10. Vasan SR, Levy D, Larson GM, Benjamin JE. Interpretation of echocardiographic measurements: A call for standardization. Am Heart J 2000, 139(3): 412-417.

HIRURŠKA REVASKULARIZACIJA I EFEKAT NA PROGNOZU BOLESNIKA NAKON AKUTNOG INFARKTA MIOKARDA

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Kratak sadržaj: *Oporavak vijabilnog hiberniranog miokarda, moguć je jedino nakon sprovedene hirurške revaskularizacije, za razliku od ošamućenog, gde je oporavak spontan. Cilj istraživanja bio je procena efekta terapije (medikamentne ili hirurške revaskularizacije) na klinički tok i ehokardiografski nalaz tokom jednogodišnjeg praćenja bolesnika nakon akutnog infarkta miokarda. Ispitivanjem je obuhvaćeno 195 pacijenata hospitalizovanih zbog akutnog infarkta miokarda.Pre otpusta, pacijenti su podvrgnuti DSE testu. Tokom perioda praćenja, a u roku od 3 meseca pacijenti su podvrgnuti koronarografiji i eventualnoj hirurškoj revaskularizaciji (ACB) (57 pacijenta) zavisno od postojanja vijabilnog miokarda i/ili rezidualne ishemije. Period praćenja je iznosio 12 meseci. Pacijenti su podeljeni u dve grupe: I-podvrgnuti ACB-u i II-tretirani medikamentima. Obe ove grupe su pokazale značajnu dinamiku promene WMSI tokom perioda praćenja, ali sa manjim stepenom značajnosti u grupi tretiranoj medikamentima ($p<0.02$ v. $p<0.01$). Vrednosti EF i QRSS nisu pokazale statistički značajnu dinamiku promene u obe grupe. Dinamika promene regionalnog motiliteta izmedju posmatranih grupa ispitivana je x2 testom. Nadjena je statistički značajna razlika dinamike promene svih regionalnih poremećaja motiliteta, pri čemu je za hipokinetične segmente značajnost razlike iznosila $p<0.01$, za akinetične $p<0.02$, a za diskinetične $p<0.001$. Pravovremeno sprovedena hirurška revaskularizacija, omogućava značajno brži oporavak segmentne kontraktilnosti, i pruža bezbedniji klinički tok tokom jednogodišnjeg praćenja nakon AIM.*

Ključne reči: *AMI, vijabilni miokard, hirurška revaskularizacija, DCE test*