EFFECTIVENESS OF INCOMPLETE MYOCARDIAL REVASCULARIZATION IN CHRONIC CORONARY OCCLUSIONS

UDC 616.132.2–008.64–005.4
Received 25.09.2012

© **E.B. Shakhov,** Postgraduate, the Department of Radiodiagnosis, the Faculty of Doctors' Advanced Training[1];
B.G. Alekyan, D.Med.Sc., Professor, Academician of Russian Academy of Medical Science,
Head of the Department of Interventional Radiology and Cardiovascular Therapy[2]

[1]Nizhny Novgorod State Medical Academy, Minin and Pozharsky Square, 10/1, Nizhny Novgorod, Russian Federation, 603005;
[2]Bakulev Scientific Centre for Cardiovascular Surgery of Russian Academy of Medical Science, Rublyovskoe shosse, 135, Moscow, Russian Federation, 121552

The aim of the investigation was to assess the effectiveness of incomplete and complete myocardial revascularization in patients with multivessel disease of coronary circulation combined with chronic total occlusion (CTO) localized in the right or left coronary artery.

Material and methods. There were analyzed the results of interventions in 80 patients (60 male (75%) and 20 female (25%)) aged 37–76 years (mean age 53.9±2.8 years) with CTO. Incomplete revascularization was performed in 40 patients, complete revascularization — in 40 cases. Echocardiography findings of left ventricular function were compared in both groups before and after incomplete and complete endovascular revascularization.

Results. Twelve months after incomplete and complete revascularization there was found significant improvement or normalization of left ventricular myocardial function in both groups compared to basic data. The results of incomplete myocardial revascularization one year after the intervention turned out to be as effective as those after CTO recanalization.

Key words: ischemic heart disease; chronic total occlusions; endovascular revascularization; coronary arteries; incomplete revascularization; complete revascularization.

One of the most challenging problems in interventional cardiology is certainly the treatment of chronic coronary occlusions detected in 30–40% of patients with ischemic heart disease [1, 2]. Along with an occlusion of one of coronary vessels, concomitant stenoses are found on angiograms of 60–70% patients [3].

According to current trends, an increasingly greater number of interventional cardiologists are working to realize the idea of "an open vessel", maximum complete myocardial revascularization by both endovascular methods, and coronary artery bypass graft [4, 5]. In addition, the capabilities of intervention radiology in some cases can be limited by anatomic features of coronary arteries, as well as technical difficulties, and due to these limitations the number of successful interventions is decreased by up to 70–80% [6, 7]. Coronary artery bypass graft can be extremely dangerous for seriously ill elderly patients with heart failure and left ventricular (LV) dysfunction [8, 9].

In modern literature there is no agreement of opinion on the treatment of patients with chronic total occlusions (CTO), who cannot undergo complete myocardial revascularization using both endovascular, and surgical techniques for various reasons.

The aim of the investigation was to assess the effectiveness of incomplete and complete myocardial revascularization performed when recanalization of chronic occlusion in one of coronary beds is impossible, compared to the results of complete correction of arterial sclerotic disease.

Material and methods. We analyzed the results of interventions in 80 patients with CTO: 20 female (25.0%) and 60 male (75.0%) aged 37–76 years (mean age: 53.9±2.8 years).

All patients had myocardial infarction (MI) in past history: 62 patients (77.5%) had one MI, 14 patients (17.5%) — two MI, and four patients (5.0%) — three MI. Effort angina was found in 32 (40.0%) patients, early postinfarction angina — in

For contacts: Shakhov Evgeniy Borisovich, tel. +7 910-79-550-79; e-mail: es-ngma@yandex.ru

17 (21.2%) patients, effort and rest angina — in 16 (20.0%) patients, progressive angina — in 10 (12.5%), painless myocardial ischemia — in 5 (6.3%). Angina functional class (FC) I was determined in 12 (15.0%) examined patients, FC II — in 24 (30.0%), FC III — in 28 (35.0%), FC IV — in 16 (20.0%).

Comorbidity was revealed in 60 patients (75.0%), including diabetes mellitus — in 5 patients (8.3%), arterial hypertension — in 45 patients (75.0%), atrial fibrillation — in 6 patients (10.0%), and ventricular arrhythmia — in 4 (6.7%).

All patients underwent complete clinical and laboratory examination. Echocardiography (echoCG) and Doppler cardiography were performed on Medison 8000 EX (Korea), Acuson 128 XP/10 (USA) using sensors of 3.0 and 3.5 MHz. In the course of investigation much attention was paid to the study of echocardiographic parameters of LV function: ejection function (EF), regional contractility damage index (RCDI), VE/VA (diastolic function).

Table 1

The characteristic of patients in study groups

	Group 1 — incomplete revascularization (n=40)	Group 2 — complete revascularization (n=40)	p
Female, absolute number/%	10/25	10/25	1.0
Male, absolute number/%	30/75	30/75	1.0
Mean age, years	54.1±2.6	53.8±3.5	0.773

Note: the percentage of the number of patients in the analyzed group is indicated

Selective coronarography (SCG), as well as therapeutic interventions were performed in interventional radiological operating rooms equipped by angiographic apparatuses "Angioscop D33" ("Siemens", Germany), "Advantx LCV+" ("General Electric", USA), and "Innova 3100 IQ" ("General Electric", USA). For quantitative assessment of coronary arteries condition we calculated total coronary bed lesion index (TCBLI) [10]:

$$TCBLI=(arterial\ damage\ score/240)\times 100\%,$$

where arterial damage score was determined using a special table [11]. According to the character of the performed endovascular intervention, all patients for the purposes of the present study were divided into two groups (Table 1).

Group 1 included 40 patients who underwent incomplete myocardial revascularization consisting in correction of stenotic disorders alone, due to the impossibility of endovascular recanalization of chronic coronary occlusion localized in the left or right coronary artery (Fig. 1).

Group 2 (control group) included 40 patients with complete myocardial revascularization consisting in chronic coronary occlusion recanalization in the left or right coronary artery, as well as the correction of concomitant stenotic lesions (Fig. 2).

All patients were followed up 12 months later. The data were statistically processed using Statistica 6.0. The findings are presented as M±sd, where M is mean value, sd — mean square deviation. The distribution of the studied parameters was normal, or close to normal, that was the

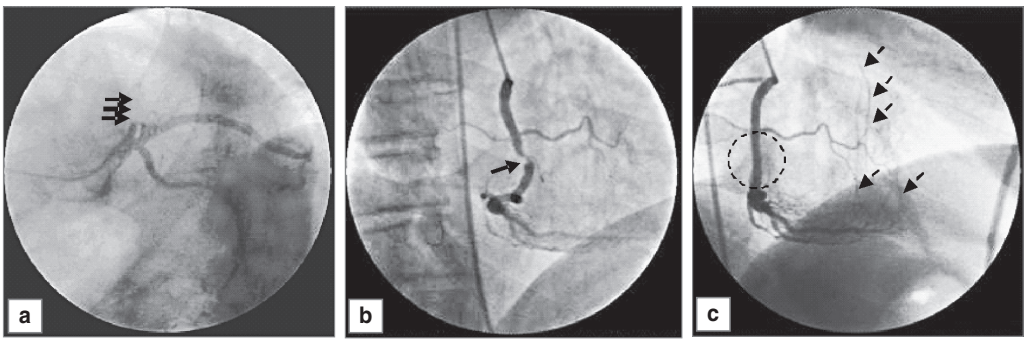

Fig. 1. Case of incomplete myocardial revascularization: *a* — chronic occlusion of anterior descending artery; *b* — concomitant stenotic lesion of the right coronary artery; *c* — concomitant stenotic lesion is corrected, bypath to the anterior descending artery is determined

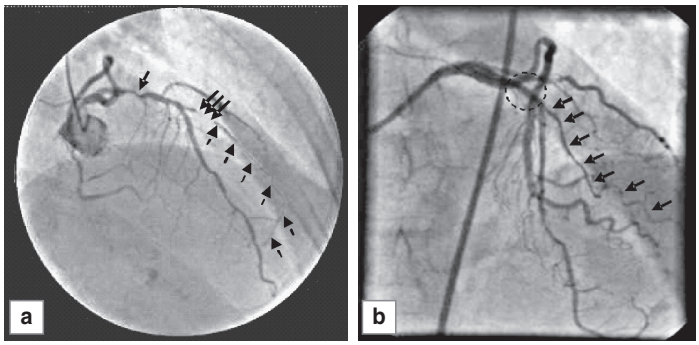

Fig. 2. Case of complete myocardial revascularization: *a* — chronic occlusion of diagonal branch and concomitant stenotic lesion of the anterior descending artery; *b* — occlusion and concomitant stenotic lesion are corrected

reason for using parametric criteria of statistical analysis. The sampling of 80 patients was adequate to achieve 90% of chances in detecting significant mean difference of all studied parameters, when significance level is 5% ($p<0.05$) using paired and non-paired t-test; p values less than 0.001 are presented as $p<0.001$ [12].

Table 2

Left ventricular functional parameters in patients of different groups preoperatively and 1 year after the intervention

Parameters	Group 1		p_1	Group 2		p_2
	Initial	1 year after		Initial	1 year after	
LV EF (%)	51.8±9.2	56.8±5.5	<0.920	52.0±6.3	56.8±7.2	<0.001
LV RCDI	1.29±0.36	1.05±0.14	<0.113	1.15±0.31	1.08±0.25	<0.001
VE/VA	0.96±0.31	1.15±0.21	<0.111	1.12±0.48	1.19±0.23	<0.001
TCBLI	36.7±12.1	—	0.349	33.4±10.1	—	0.349

Note: p_1 — statistically significant difference of initial values in groups; p_2 — pre- and postoperative statistically significant difference of initial values in groups.

Results. In group 1 preoperatively abnormal echoCG indices of LV function were revealed in 34 patients (85%) (Table 2). Initial systolic dysfunction (SD) was determined in 13 patients (32.5%), SD in combination with impaired segmental contractility (ISC) — in 14 (35.0%), SD and diastolic dysfunction (DD) combined with ISC was diagnosed in 7 (17.5%). 6 patients (15%) of group 1 had no initial LV myocardial functional failure; TCBLI in this group was equal to 36.5±11.0.

In group 2 preoperatively abnormal echoCG indices of LV function were revealed in 26 patients (65%). Initial SD was revealed in 12 patients (30.0%), SD and ISC — in 9 (22.5%), SD and DD in combination with ISC — in 5 (12.5%). 14 patients (35%) of this group had no initial LV myocardial functional failures, TCBLI being equal to 33.4±10.2.

A year after incomplete myocardial revascularization 55% of group 1 patients had normal findings of LV function. At the same time, the impairment of main myocardial indices (See Table 2) was revealed in 18 patients (45.0%). 8 patients (20%) had SD, 10 patients (25.0%) — SD and ISC. No combined systolic, diastolic dysfunctions and impaired segmental contractility was revealed in patients 12 months after the intervention. Revascularization degree in the group varied from 6 to 92%.

A year after complete myocardial revascularization 60% of group 2 patients had normal findings of LV function. At the same time, the impairment of main myocardial indices was revealed in 16 patients (40.0%). 7 patients (17.5%) had SD, 5 patients (12.5%) — SD and ISC. 4 patients (10.0%) had SD and DD combined with ISC. Revascularization degree in the group was 100%.

In both groups there were no intraoperative and postoperative fatal cases, as well as recurrent MI and other complications.

Discussion. Initial LV dysfunction was diagnosed in most (75%) enrolled patients with chronic total occlusions. The presence of similar echoCG picture of myocardial dysfunction in patients from both groups enabled to perform a correct comparative study. The analysis of initial echoCG values in 15% of group 1 patients and in 35% of group 2 patients showed normal values of systolic, diastolic function, as well as regional myocardial contractility. This fact can be explained by myocardium adaptation to chronic ischemia conditions, especially if there had been no previous history of transmural myocardial infarction and there was collateral blood flow to the area of chronic occlusion [13].

A year after revascularization the examined patients of both groups had statistically significant improvement of basic echoCG indices of LV function. These changes clearly indicated LV function improvement, and therefore, the effectiveness of the performed surgical intervention. Without sufficient myocardial perfusion due to chronic total occlusion, a part of myocardium in order to maintain its life activity is known to tend to the transition to lower metabolic control level. There are formed myocardial areas in acontractile condition — hibernating myocardium [14].

After the recovery of sufficient antegrade coronary blood flow or the increase of collateral blood flow to the area of chronic ischemia there is observed the functional recovery of these myocardial areas. Therefore, LV myocardial function improvement or normalization can occur only if myocardium is viable in the zone of chronic ischemia and has sufficient antegrade or retrograde perfusion.

We are of the opinion that the improvement of left ventricular function found in group 1 patients with incomplete myocardial revascularization can be explained by the increase of collateral blood flow to occluded artery-recipient due to the correction of stenotic lesions of artery-donor. The improvement and normalization of basic LV myocardial functional indices in group 2 patients are due to the recovery of antegrade blood flow on coronary magistral arteries and branches with simultaneous intra- and heterocoronary collaterals.

Conclusion. The procedures of incomplete and complete myocardial revascularization performed in patients with chronic total occlusions are effective methods improving basic echocardiographic indices of left ventricular function. Since successful results can be observed only if myocardium is viable in the zone of myocardial chronic ischemia, and its sufficient antegrade or retrograde perfusion, incomplete revascularization can be considered to provide such conditions to the full extent.

Incomplete myocardial revascularization is a new approach to endovascular correction of chronic total occlusions of coronary arterial bed of the heart in case of impossibility of endovascular recanalization of chronic coronary occlusion.

References

1. Danchin N., Angioi M., Rodriguez R. Angioplasty in chronic coronary occlusion. *Arch Mal Coeur Vaiss* 1999; 99(Suppl 11): 1657–1660.

2. Meier B., Luethy P., Finci L., Steffenino G.D., Rutishauser W. Coronary wedge pressure in relation to spontaneously visible and recruitable collaterals. *Circulation* 2008; 75: 906–913.

3. Safley D.M., House J.A., Marso S.P., Grantham J.A., Rutherford B.D. Improvement in survival following successful percutaneous coronary intervention of coronary chronic total occlusions: variability by target vessel. *JACC Cardiovasc Interv* 2008; 1(3): 295–302.

4. Lopotovskiy P.Yu., Yanitskaya M.V. *Mezdunarodnyj zurnal intervencionnoj kardioangiologii — International Journal of Interventional Cardioangiology* 2006; 10: 22–26.

5. Prasad A., Rihal C.S., Lennon R.J., Wiste H.J., Singh M., Holmes D.R. Jr. Trends in outcomes after percutaneous coronary intervention for chronic total occlusions: a 25-year experience from the Mayo Clinic. *J Am Coll Cardiol* 2007; 49(15): 1611–1618.

6. Ioseliani D.G., Gromov D.G., Sukhorukov O.E., Khotkevich E.Yu., Semitko S.P., Isaeva I.V., Verne Zh.-Sh., Arabadzhyan I.S., Ovesyan Z.R., Aligisheva Z.A. *Mezdunarodnyj zurnal intervencionnoj kardioangiologii — International Journal of Interventional Cardioangiology* 2008; 15: 22–31.

7. Arablinskiy A.V. *Mezhdunarodnyy meditsinskiy zhurnal — International Medical Journal* 2000; 1: 2–6.

8. Ott R.A., Tobis J.M., Mills T.C., Allen B.J., Dwyer M.L. ECMO assisted angioplasty for cardiomyopathy patients with unstable angina. *ASAIO Trans* 1990 July; 36(3): M483–M485.

9. Gaudino M., Santarelli P., Bruno P., Piancone F.L., Possati G. Palliative coronary artery surgery in patients with severe noncardiac diseases. *Am J Cardiol* 1997 Nov; 80(10): 1351–1352.

10. Shakhov B.E., Sharabrin E.G., Shakhov E.B., Blinov P.A., Shakhova E.B., Chebotar' E.V. *Diagnosticheskaya i interventsionnaya radiologiya — Diagnostic and Interventional Radiology* 2009; 2(3): 39–47.

11. Petrosyan Yu.S., Ioseliani D.G. *Kardiologia — Cardiology* 1976; 12(16): 41–46.

12. Shea K.G., Sink E.L., Jacobs J.C. Clinical practice guidelines and guideline development. *J Pediatr Orthop* 2012 Sept; 32(Suppl 2): S95–S100.

13. Paizis I., Manginas A., Voudris V., Pavlides G., Spargias K., Cokkinos D.V. Percutaneous coronary intervention for chronic total occlusions: the role of side-branch obstruction. *EuroIntervention* 2009; 4(5): 600–606.

14. Rahimtoola S.H. Myocardial hibernation: clinical manifestations and importance. *Dialog Cardiovasc Med* 1997; 2: 59–75.