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Russia, 101000, Moscow, Sverchkov per., 5
Moscow City Center of Interventional Cardioangiology
(for the Secretary of RSICA)
Phone: +7 (495) 624 96 36
President of RSICA: +7 (915) 301-00-67, +7 (985) 233-62-02
Fax+7 (495) 624-67-33
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Contents

Comparing Multiple Stenting with Staged Myocardial Revascularization in STEMI Patients with Multivessel Coronary Disease

R.S. Tarasov, V.I. Ganiukov, Yu.V. Krotikov, O.L. Barbarash, G.V. Moiseenkov, S.S.Zinchenko, L.S. Barbarash*
Research Institute of Complex Cardiovascular Problems, Kemerovo, Russia

There are several strategies of treatment for STEMI patients with multivessel coronary disease: PCI in the sole IRA, multiple stenting within the frames of primary PCI, staged PCI. Current guidelines for the management of patients with ST-elevation myocardial infarction do not determine the necessary volume of PCI in vessels that are not directly related to the infarction area in patients with stable hemodynamics. However some data suggest that the revascularization of ischemia-inducing stenoses improves the prognosis. To date the question of the feasibility or even the necessity of multiple stenting during primary PCI remains open. We have analyzed our experience with the selection of various strategies of revascularization in shock-free STEMI patients with multivessel coronary disease.

Purpose: to compare the long-term results of various strategies of myocardial revascularization used for the management of patients with ST-elevation myocardial infarction (STEMI) with multivessel coronary disease (MVCD).

Background: the relevance of the discussed is motivated by several factors. First of all, according to literature, the prevalence of MVCD in STEMI patients is as high as 67%. Secondly, MVCD adversely impacts the long-term prognosis for MACE development, and, thirdly, there are no clear criteria concerning the volume of primary percutaneous coronary intervention (PCI) as well as the timing of subsequent stages of revascularization. Current guidelines for the management of STEMI patients do not determine the necessary volume of PCI in vessels that are not directly related to the infarcted area in patients with stable hemodynamics. The decision to perform the intervention in the non infarct-related artery (IRA) should be taken after objective confirmation of ischemia, and multiple stenting (MS) is acceptable only in cases with cardiogenic shock.

ABBREVIATIONS

IRA – infarct-related artery
STEMI – ST-elevation myocardial infarction
MVCD – multivessel coronary disease
MS – multivessel (multiple) stenting
LV EF – left ventricular ejection fraction
PCI – percutaneous coronary intervention
MACE – major adverse cardiac event
non-TVR – non-target vessel revascularization
TVR - target vessel revascularization

* Address for correspondence:
Dr. Roman Tarasov
Russia, 650002, Kemerovo, Sosnovy blv., 6.
Tel. +7 923 526 04 46
e-mail: roman.tarasov@mail.ru
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INTRODUCTION

According to the literature the incidence of multivessel coronary disease (MVCD) in patients with ST-elevation myocardial infarction (STEMI) varies from 40 to 67% (1, 25-28). STEMI patients with MVCD are at high risk for the development of major adverse cardiac events (MACE) within 1 year after primary percutaneous coronary intervention (PCI) (12, 29). While the rate of MACE for patients with single-vessel disease is about 14,5%, for patients with two- and three-vessel disease it is 19,5% and 23,6%, respectively (12). Meanwhile the 5-years risk of death in patients with MVCD is two-fold higher (13). Partially this risk can be explained by the delay of restoration of left ventricular function and progressing of its pathological post-infarction remodeling (14, 15). Besides, it has been shown that MVCD itself is associated with late MACE development (16).

There are several strategies of managements of patients with STEMI and MVCD: PCI of the sole infarct-related artery (IRA), multivessel stenting (MS) performed during primary PCI, multistep PCI. Early Guidelines of the European Society of Cardiology concerning revascularization in STEMI patients after primary PCI and based on non-randomized trials suggested the performance of this procedure in the presence of documented myocardial ischemia in approximately 6 weeks after the discharge from the hospital (17, 18). The idea of delaying the second stage of PCI was supported by

the data showing worse outcomes in STEMI patients who underwent early intervention after primary PCI (19). However later trials have demonstrated the effectiveness and the safety of early revascularization of other arteries in patients with MVCD (20, 21, 22).

Current Guidelines for myocardial revascularization in STEMI do not offer strict instructions concerning the necessary volume of PCI in vessels that are not directly related to the infracted area in patients with stable hemodynamics. However some data are suggestive of the improvement of prognosis after revascularization of ischemia-inducing stenoses (2). To date the question of the feasibility or even the necessity of multiple stenting during primary PCI remains open (3).

Up to now the evidence base for MS in STEMI patients is lacking (3-7). At the same time, negative data concerning MS during primary PCI can be found in the literature. In particular, the increased catecholamine concentration and stress during STEMI can lead to overestimation of the significance of non-target coronary arterial stenoses and unjustified intervention in these vessels (8, 9, 24). Besides, MS in patients with technically challenging coronary lesions is associated with higher of complications and the increase of procedure duration, radiation load and volume of used contrast media (10, 11). The results of recent randomized trial that did not reveal significant differences in the 6-months rate of MACE in the groups of invasive and conservative treatment of STEMI patients with MVCD also dispose to conservative strategy in what concerns the revascularization of non-IRA (23).

MATERIAL AND METHODS

We analyzed long term results (10,6±5,9 months) of different revascularization strategies used for the management of 163 STEMI patients with MVCD, treated in the Research Institute of Complex Cardiovascular Problems in Kemerovo in 2009-2010.

Inclusion criteria:

1. STEMI duration <12 hours and primary PCI.
2. Hemodynamically significant disease (≥70%) of two and more coronary arteries.

Exclusion criteria:

1. Acute heart failure Killip III-IV.
2. Left main coronary artery disease.

The patients have been divided into the following groups:

- Group 1: PCI of the sole IRA followed by medical therapy (n=70) (“PCI of IRA”).
- Group 2: MS during primary PCI (n=30) (“MS”).
- Group 3: staged PCI in STEMI patients with MVCD (n=43) (“staged PCI”).
- Group 4: staged PCI followed by CABG surgery (n=20) (“staged PCI-CABG”).

The main demographic, clinical and angiographic characteristics were comparable in all groups. Mean interval between the steps of revascularization in the groups of “staged PCI” and “staged PCI-CABG” was 111,1±109,4 days and 101±64,2 days, respectively (p>0,05). Double antiplatelet therapy has been prescribed in all patients for 12 months. End-points in this study were death, myocardial infarction, stent thrombosis, target and non-target vessel revascularization (TVR, non-TVR). Besides, we have studied the incidence of combined end-point (death + myocardial infarction + TVR). The incidence of stent thrombosis has been evaluated during the whole period of study in accordance with the commonly accepted ARC (Academic Research Consortium) classification.

The results of study were processed using Statistica for Windows 6.0 software (StatSoft Inc., США). The discrete variables were represented as medians, the continuous variables as mean ± SD. Qualitative characteristics were assessed using 2 criterion. In cases with normal distribution the primary comparison of intergroup data was performed using one-way ANOVA test. The values of p<0,05 were considered as significant.

RESULTS

Comparison of clinical, demographic and angiographic characteristics

The comparison of the studied groups did not reveal significant differences in the main clinical and demographic characteristics. The only exclusion was significant difference (p<0,05) in the incidence of multifocal atherosclerosis between the «staged PCI-CABG” group in which the signs of atherosclerosis in other vascular pools were revealed in 12 patients (60%), and the remaining groups, in which the incidence of multifocal atherosclerosis varied from 20% to 31,4% (p>0,05) (Table 1).

The analysis of angiographic data and the characteristics of the implanted stents in the studied groups has revealed the following:

We noted a significant difference (p<0,05) in the incidence of three-vessel disease between the group “Staged PCI-CABG”, in which significant stenosis of three coronary arteries has been revealed in 17 cases (85%) and other groups, in which the incidence of three-vessel disease varied from 53,3% to 67,1% (p>0,05).

Objective estimation of coronary lesions using SYNTAX score in the groups “PCI of IRA”, “MS” and “Staged PCI” was not significantly different - 21,6±8,9, 19,4±6,7 and 20±8,3, respectively (moderately severe) (p>0,05), while in the group “Staged PCI-CABG” it was 29,9±8,6 (severe lesion), thus demonstrating a significant difference in comparison with similar indices in groups 1, 2 and 3 (p<0,05). (Table 2). Taking into account that our study comprised consecutive patients fulfilling common inclusion criteria, one can say that

Table 1.

Clinical and demographic characteristics.

Characteristics	PCI of IRA (n=70)		MS (n=30)		Staged PCI (n=43)		Staged PCI-CABG (n=20)	
	abs.	%	abs.	%	abs.	%	abs.	%
Age	61,4±9,9		59,6±8,9		59,9±9,7		56,15±6,5	
Males	46	65,7	19	63,3	29	67,5	15	75
LV EF		50,5±8,3		49,3±7,8		51,6±6,2		48,6±7,1
Arterial hypertension	61	87,1	21	70	41	95,3	18	90
Diabetes mellitus	18	25,7	4	13,3	9	20,9	5	25
Multifocal atherosclerosis	22	31,4*	6	20*	10	23,2*	12	60*
Postinfarction cardiosclerosis	15	21,4	2	6,6	4	9,3	4	20
Residual signs of acute cerebrovascular incident	3	4,3	0	0	5	11,6	2	10
Acute heart failure Killip II	11	15,7	5	16,6	5	11,6	2	10

* — significant difference ($p<0,05$) in the incidence of multifocal atherosclerosis between the group of "staged PCI-CABG" and other groups

this study reflects the approaches to the choice of revascularization strategy in STEMI patients with MVCD in real clinical practice. Hence, the severity of coronary disease as assessed by SYNTAX score in the group "Staged PCI-CABG", in all probability, did not predispose neither to MS, nor to staged PCI because of high risk of complications, the increase of the time necessary for PCI performance and the volume of contrast media.

The analysis of the volume of contrast media used for coronary angiography and primary PCI in the studied groups has revealed significant differences ($p<0,05$) between the group "MS" (378,3±139,4 ml) and the other groups, in which this volume varied from 248,5±87,6 ml to 266,5±123,5 ml ($p>0,05$). Also, we revealed a significant difference in the radiation dose ($p<0,05$) between the groups "MS" and "PCI of IRA", on the one hand, and "MS" and "Staged PCI-CABG", on the other hand. At the same time there was no difference in this parameter between the group "MS" and "Staged PCI" (Table 2).

We did not find the differences between the groups in mean number of stents implanted in IRA and non-IRA, the length and the diameter of stents in IRA and non-IRA ($p>0,05$) (Table 2).

The analysis of long-term results of different revascularization strategies

The rate of successful PCI – the blood flow in the target artery ≥ TIMI 3 in the absence of complications – was comparable in the studied groups and varied from 90% to 97,7% ($p>0,05$). Neither did we reveal differences in the mean interval between the stages of revascularization in the groups "Staged PCI" and "Staged PCI-CABG", as well as in the mean duration of the follow-up ($p>0,05$) (Table 3).

The following results were seen in the long-term follow-up, that varied from 9,4±6,5 to 11,2±5,9 months (Table 3): Such end-points as death, MI, TVR, stent thrombosis were not different between the groups ($p>0,05$). At the same time the worse indices for all these end-points have been observed in the group "PCI of IRA". One has to note that both lethal outcomes in the group "MS" occurred after unsuccessful PCI of IRA and of non-IRA, so,

probably, one has to consider these deaths as a consequence of unsuccessful revascularization, and not as the complication of the applied aggressive treatment (Table 4).

We have found a significant advantage of the group "MS" in comparison with "Staged PCI" and "Staged PCI-CABG" in what concerns the incidence of intervention in a non-target vessel: 13,3% vs. 100% and 100%, respectively (p<0,05) (Table 4). When comparing the groups of "MS" and " PCI of IRA" we have noted that while all cases of non-TVR in the group "MS" (n=4; 13,3%) were elective and performed in stable patients, all cases of non-target vessel revascularization in the group "PCI of IRA" (n=5; 7,1%) were performed for an established MI.

The rate of combined end-point including death, MI and TVR was significantly lower in the groups of multiple stenting and staged PCI in comparison with the group of stenting of the sole IRA: 10% and 13,9% vs. 35,7%, respectively (p<0,05) (Table 4).

DISCUSSION

The results of recent trials and registries do no suggest definitive and optimal approaches to revascularization in STEMI patients with MVCD (17-22). In our opinion, the choice of a concrete revascularization strategy in STEMI patients with MVCD should be done individually, with consid-

Table 2.

Angiographic characteristics of patients and implanted stents in the groups of patients.

Indice	PCI of IRA (n=70)		MS (n=30)		Staged PCI (n=43)		Staged PCI-CABG (n=20)	
	abs.	%	abs.	%	abs.	%	abs.	%
Three-vessel disease	47	67,1*	16	53,3*	24	55,8*	17	85*
«Syntax Score»	21,6±8,9**		19,4±6,7**		20±8,3**		29,9±8,6**	
Volume of contrast medium, ml	266,5±123,5 ***		378,3±139,4 ***		258,1±88,6 ***		248,5±87,6 ***	
Radiation dose, mGy	3326,4±1515,9 ****		4141,6±1801,1 ****		3844,4±1897,7		2621,1±1028 ****	
Mean number of stents in IRA	1,2		1,2		1,3		1,2	
Mean number of stents in non-IRA (for the groups "MS" and "Staged PCI")	-		1		1,3		-	
Mean length of stents in IRA, mm	20,5±7,5		22,4±7,5		21,7±6,4		24,2±7,7	
Mean diameter of stents in IRA, mm	3,1±0,4		3,2±0,5		3,3±0,6		3,3±0,5	
Mean length of stents in non-IRA, mm (for the groups "MS" and "Staged PCI")	-		17,1±5,1		21,7±14,4		-	
Mean diameter of stents in non-IRA, mm (for the groups "MS" and "Staged PCI")	-		3,3±0,6		3,2±0,6		-	

* — significant difference (p<0,05) in the incidence of three-vessel disease between the groups "Staged PCI-CABG" and the other groups

** — significant difference (p<0,05) in the severity of coronary disease as assessed by SYNTAX score between the groups "Staged PCI-CABG" and the other groups

*** — significant difference (p<0,05) in the volume of contrast medium between the group "MS" and the other groups

**** — significant difference (p<0,05) in the radiation dose between the group "MS" and the other groups

Table 3.

Success and particularities of revascularization in the studied groups.

Indice	PCI of IRA (n=70)		MS (n=30)		Staged PCI (n=43)		Staged PCI-CABG (n=20)	
	abs.	%	abs.	%	abs.	%	abs.	%
Successful PCI of IRA	67	95,7	29	96,6	42	97,7	18	90
Mean interval between the stages of revascularization in the groups “Staged PCI” and “Staged PCI-CABG”, days	-		-		111,1±109,4		101±64,2	
Mean duration of long-term follow-up, months	10,9±6,6		11±4,8		11,2±5,9		9,4±6,5	

P=NS

Table 4.

Outcomes in the studied groups.

Indice	PCI of IRA (n=70)		MS (n=30)		Staged PCI (n=43)		Staged PCI=CABG (n=20)	
	abs.	%	abs.	%	abs.	%	abs.	%
Death	6	8,6	2	6,6	2	4,6	0	0
Myocardial infarction	9	12,8	0	0	2	4,6	0	0
TVR	10	14,3	1	3,3	2	4,6	3	15
Non-TVR	5	7,1*	4	13,3*	43	100*	20	100*
Stent thrombosis	5	7,1	1	3,3	1	2,3	0	0
Repeated revascularization (TVR + non-TVR)	15	21,4**	5	16,6**	43	100**	20	100**
Combined end-point (death + MI + nonTVR)	25	35,7***	3	10***	6	13,9***	3	15

* — significant difference (p<0,05) in the rate of intervention in a non-target vessel (non-TVR) between the group “PCI of IRA” and the groups “Staged PCI”, “Staged PCI-CABG”, as well as between the group “MS” and the groups “Staged PCI”, “Staged PCI-CABG”

** — significant difference (p<0,05) in summary rate of interventions in target (TVR) and non-target (non-TVR) vessels between the group “PCI of IRA” and the groups “Staged PCI”, “Staged PCI-CABG”, as well as between the group “MS” and the groups “Staged PCI”, “Staged PCI-CABG”

*** — significant difference (p<0,05) in the rate of combined end-point (death + myocardial infarction + TVR) between the groups “MS” and “Staged PCI” in comparison with the group “PCI of IRA”

eration for many clinical and angiographic. If we take into account the higher rate of death, MI, TVR and stent thrombosis in the group «PCI of IRA» in comparison with the strategies that provide simultaneous or staged complete revascularization, it becomes evident that staged PCI, staged PCI-CABG or multivessel stenting can be optimal approaches for the management of STEMI patients with MVCD (2-7, 20-22).

In our study the mean interval between the steps of revascularization in the group of «staged PCI» and «staged PCI-CABG » was 111,1±109,4 days and 101±64,2 days, respectively. With such timing of staged revascularization we have noted satisfactory long-term results for all end-points. In particular, the rate of death in the groups of «staged PCI» and «staged PCI-CABG» was 4,6% and 0, respectively.

It is worth that despite questionable place of multivessel stenting within the frames of primary PCI in patients without cardiogenic shock (3-8, 9, 24), the results of this strategy in our study were

not worse in comparison with staged PCI or staged PCI-CABG in any end-points, in hospital as well as in long-term period. Moreover MS has demonstrated significant advantage in the rate of non-target vessel revascularization (Table 4).

Taking into account that our study was retrospective and comprised consecutive patients, it reflects the approaches to the choice of revascularization strategy for STEMI patients with MVCD in real clinical practice. Herewith the severity of coronary lesion assessed by SYNTAX score in the group «staged PCI-CABG» did not predispose to MS or staged PCI because of high risk of complications, the increase of time necessary for PCI and of the volume of contrast medium, which is in consistency with the literature data (10, 11).

The choice of strategy of MS in our study was primarily related to a moderate coronary lesion as assessed by SYNTAX score (19,4±6,7), which, in its turn, was associated with higher rate of PCI success despite some increase of the volume of contrast medium (Table 2). The reasonability of the chosen strategy of MS was confirmed also by the analysis of long-term outcomes. Both lethal cases in the group of MS (6,6%) occurred after unsuccessful PCI of IRA and if non-IRA, and should be considered not as a complication of the aggressive approach, but as a result of a failed revascularization(Table 4).

Thus, long-term results of the use of MS strategy did not demonstrate the increase of the risk of complications and of the rate of achieving the end-points in comparison with the strategy of staged revascularization. Moreover, MS was associated with reliable advantages in the rate of revascularization on non-target vessel (Table 4). At the same time the groups of MS, as well as the groups of staged PCI and staged PCI-CABG has demonstrated the advantages over «PCI of IRA» strategy in the long-term follow-up (Table 4).

Taking into account the high rate of MACE (death, MI, TVR, stent thrombosis) in the group «PCI of IRA» and the satisfactory results of multivessel stenting and staged revascularization, one can say with evidence that in clinical practice the patients with STEMI and MVCD should receive multiple stenting or the second step of revascularization (PCI or CABG, depending on clinical and angiographic features). In our study the intervals between the steps of revascularization (PCI – PCI or PCI – CABG) did not exceed 101±64,2 and 111,1±109,4 days, respectively.

On the base of our data we hypothesize that one of the main factors associated with the benefits of MS during primary PCI is a moderate severity of the coronary lesion, that can be objectively assessed with the use of SYNTAX score. Some aggravating factors can significantly increase the duration of PCI, the volume of the contrast medium, the risk of MACE in early and long-term follow-up. One cannot exclude that SYNTAX score along with the clinical data, the morphology of coronary arterial stenoses, the results of IVUS, can be considered as the criteria giving way to optimization of the indications for MS or staged intervention in patients with MVCD.

CONCLUSION

1. The strategy of stenting of sole IRA in STEMI patients with MVCD is associated with the highest rate of MACE.

2. The results of treatment (death, MI, stent thrombosis, TVR) in the groups of multiple stenting, staged PCI and staged PCI-CABG are not significantly different.

3. The strategy of multiple stenting during primary PCI is associated with lower rate of revascularization of non-target vessels in the long-term in comparison with staged revascularization [non-TVR 13,3% vs. 100%, respectively ($p<0,05$)].

4. Multivesel stenting as well as staged PCI had significant advantages over PCI of IRA in the rate of combined end-point ($p<0,05$).

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Immediate and Long-Term Results of Endovascular Treatment of Patients with Multivessel Coronary Disease

E.R. Khayrutdinov[2,3], Z.Kh. Shugushev[1,2], D.A. Maksimkin[1,2], A.G. Faybushevich[1], A.V. Arablinsky[1,3,4], Yu.V. Tarichko[1].*

[1] Chair of Surgery of People's Friendship University of Russia;

[2] Semashko Central Clinical Hospital №2 of the JSC "Russian Railroads";

[3] Botkin City Clinical Hospital,

[4] Chair of therapy and adolescent medicine of Russian Medical Academy of Postgraduate Education, Moscow, Russia

We have analyzed immediate and long-term results of endovascular treatment using various tactics of myocardial revascularization in 171 patients with multivessel coronary disease. The duration of the follow-up varied from 12 to 18 months. Complete myocardial revascularization was achieved in 63 patients, functionally adequate myocardial revascularization – in 86 and incomplete myocardial revascularization – in 22 patients. Our results suggest that the tactics of complete and functionally adequate myocardial revascularization give comparable immediate and long-term results in patients with multivessel coronary disease. Incomplete revascularization of the coronary bed leads to the decrease of immediate clinical success rate of the intervention, the increase of the rate of myocardial infarctions and CABG in the long-term follow-up.

Key words: *coronary artery disease, multivessel coronary disease, tactics of myocardial revascularization.*

PURPOSE OF STUDY:

To compare the results of various tactics of endovascular myocardial revascularization in patients with CAD with multivessel coronary disease.

MATERIAL AND METHODS

The study, conducted from 2007, comprised 171 patients in whom 205 endovascular coronary interventions have been performed. The patients have been divided into 3 groups: Gr. I – patients with complete myocardial revascularization (n=63), Gr. II – patients with functionally adequate myocardial revascularization (n=86), Gr. III – patients with incomplete myocardial revascularization (n=22). Main clinical characteristics were comparable in all three groups.

RESULTS

Hospital survival in all three groups was 100%, the rate of MACE was not significantly different (Gr.I - 1,6%, Gr. II - 1,2%, Gr. III - 4,55%, p>0,05). The regress of clinical signs of angina by 2 functional classes and more was seen in 100% of patients from Gr. I and II and in 72,7% of patients from Gr. III (p<0,001). The long-term results (12 to 18 months) have been assessed in all patients. Cumulative index of MACE in the long-term follow-up was comparable between the groups (Gr. I - 11,11%, Gr.II - 13,95% Gr.III - 27,27%, p>0,05), herewith the rate of myocardial infarctions and CABG in Gr. III was significantly higher.

* Address for correspondence:
Dr. Evgueny Khayrutdinov,
Russia, 117574, Moscow, proezd Odoevskogo,
7, bld.1, apt.12
Tel.. +7 916 830 49 64
e-mail: eugkh@yandex.ru

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CONCLUSION

The tactics of complete and functionally adequate myocardial revascularization in multivessel coronary disease give comparable immediate and long-term results. Incomplete myocardial revascularization is associated with the decrease of immediate success rate of the intervention and is characterized by the increase of the rate of myocardial infarctions and CABG in the long-term follow-up.

ABBREVIATIONS

CAD –coronary artery disease
PCI – percutaneous coronary intervention
CABG – aorto-coronary bypass grafting
LV – left ventricle
FC – functional class
CPK – Creatinphosphokinase
MACE – major adverse cardiac events
LAD – left anterior descending artery
LMCA – left main coronary artery

INTRODUCTION

According to various sources, 40% to 60% of all endovascular interventions are being performed in patients with multivessel coronary disease (1, 2). Multiple earlier randomized trials have revealed the advantages of aorto-coronary bypass surgery (CABG) over percutaneous coronary interventions (PCI) in terms of decreasing rate of repeated myocardial revascularization, with the similar rates of mortality and myocardial infarctions (1-4). The introduction of drug-eluting stents into the clinical practice has opened new possibilities in the treatment of these se-

verely ill patients and allowed to decrease the rate of repeated myocardial revascularization (5-10).

However the choice of an optimal method of myocardial revascularization in patients with multivessel coronary disease still remains a subject for discussion. The results of randomized SYNTAX trials suggest that PCI is the method of choice in patients with moderately severe coronary disease (SYNTAX score < 23), while CABG is indicated in patients with high SYNTAX score (≥ 33 баллов). Current Guidelines of the American College of Cardiology and the European Society of Cardiology recommend multidisciplinary approach to the determination of the preferable method of myocardial revascularization in multivessel coronary disease, based on the evaluation of the severity of coronary lesions (SYNTAX score) and the risk of open heart surgery (EuroSCORE). Thus, it is reasonable to perform PCI in patients with high EuroSCORE due to high risk of complications and death after CABG. In cases with low EuroSCORE, PCI is preferable in moderately severe coronary lesions (SYNTAX Score < 32) or isolated lesion of the left main coronary artery (LMCA), while CABG is indicated in severe coronary lesions (SYNTAX Score >33) or LMCA lesion associated with two- or three-vessel coronary disease (11, 12).

The choice of the tactics of myocardial revascularization is still a thrilling and non-solved problem of the management of multivessel coronary disease. Cardiovascular surgeons believe that complete myocardial revascularization has significant advantages over other approaches to myocardial revascularization, however up to now it was not proved in any large prospective randomized trial. The current proofs of the advantages of complete endovascular myocardial revascularization are yet less convenient, and the existing data are based on clinical outcomes of patients included in various registries and earlier studies (13-19). We present our results of endovascular treatment of multivessel coronary disease using different tactics of myocardial revascularization.

MATERIAL AND METHODS

Prospective randomized trial conducted from 2007 through 2010 in Semashko Central Clinical Hospital №2 of the JSC "Russian Railroads" on the base of the Chair of Surgery of People's Friendship University of Russia and Botkin City Hospital, was aimed at the study of different tactics of endovascular treatment of patients with multivessel coronary disease.

Inclusion criteria: exertional angina of FC III - IV (CCA); two- or three-vessel coronary disease; primary coronary lesions.

Exclusion criteria: acute myocardial infarction, history of myocardial revascularization (CABG or PCI), cardiovascular pathology (heart defect, LV aneurysm, aortic aneurysm), requiring surgical correction, allergic reaction to iodine-containing agents.

Prior to the intervention all patients underwent complex laboratory and instrumental examination including mandatory exercise testing and coronary angiography. The patients with the history of myocardial infarction as well as with chronic occlusion of the coronary arteries revealed by coronary angiography, have been evaluated for the presence of viable myocardium. At admission, prior to PCI, optimal medical therapy was adjusted in all patients, and all PCIs were carried out against the background of double antiplatelet therapy.

Immediate results of interventions have been evaluated for the period of hospitalization, from the moment of PCI to the discharge. The following indices were taken into account: complete resolution of clinical signs of angina or the decrease of angina class by at least 2 FC, absence of MACE (death, myocardial infarction, repeated myocardial revascularization), normal values of cardiospecific enzymes (Troponine T and CPK-MB) within the first 24 hours after PCI.

In the long-term follow-up we have evaluated the rate of death, acute myocardial infarctions, recurrent angina, repeated myocardial revascularization (CABG or PCI) and MACE. In order to evaluate the long-term results, the patients have been routinely admitted in 12-18 months after the procedure for complex examination including exercise testing. In case of recurrence or progressing of angina the patients were admitted for coronary angiography.

In total, 171 patients were included in the study in conformity with the above-mentioned criteria. The severity of coronary lesions by SYNTAX Score and the risk of open heart surgery by EuroSCORE have been evaluated for each patient. If PCI was judged feasible, the randomization was made using computer-aided random number generation. On the basis of this method 92 patients have been included in the group of incomplete myocardial revascularization and 83 – in the group of complete myocardial revascularization. All patients underwent exercise testing. The patients in whom complete myocardial revascularization was not achieved, underwent repeated exercise testing. According to its results, the patients with persisting myocardial ischemia were assigned to the group of incomplete myocardial revascularization, and the patients without myocardial ischemia – to the group of functionally adequate myocardial revascularization. In patients randomized to the group of incomplete myocardial revascularization, the symptom-related artery has been determined on the basis of coronary angiography and the results of exercise testing. Hereafter PCI has been performed on this artery. In case of successful PCI the patients underwent a new exercise testing. If it was negative, the patients were assigned to the group of functionally adequate myocardial revascularization, and if myocardial ischemia persisted, the patients were submitted to repeated PCI and assigned to the group of complete myocardial revascularization. In case of unsuccessful PCI the patients, who had been randomized in the group of incomplete myocardial revascularization, were referred to CABG.

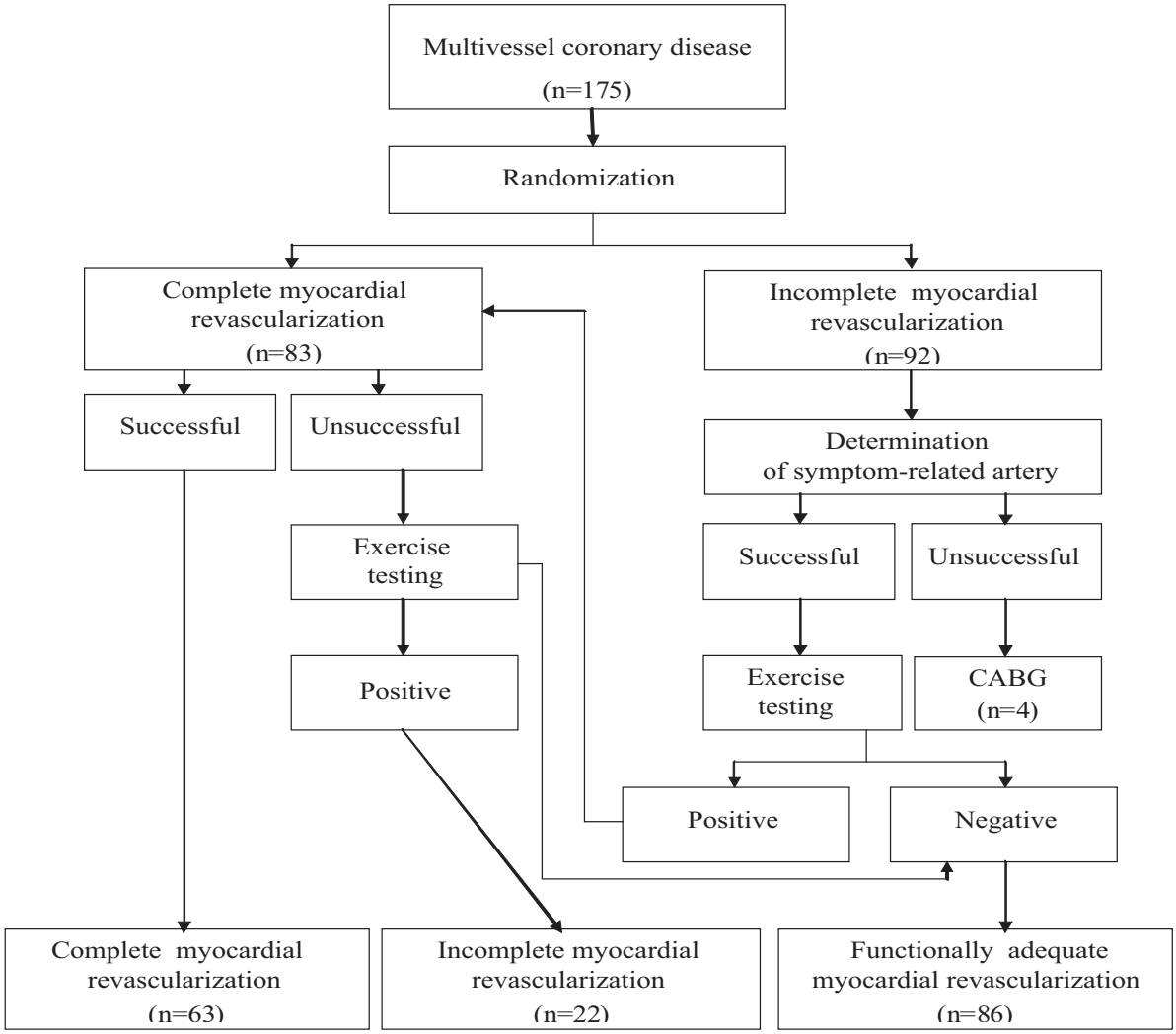

Figure 1. Design of study

Thus, according to the results of endovascular treatment the patients have been divided into 3 groups: Gr. I – complete myocardial revascularization (n=63), Gr. II – functionally adequate myocardial revascularization (n=86) and Gr. III – incomplete myocardial revascularization (n=22); another 4 patients after unsuccessful attempt of revascularization of the symptom-related artery have been referred to CABG and after that were excluded from the study. The algorithm of endovascular treatment of patients included in the study is presented in figure 1.

The main clinical characteristics of patients were comparable in all groups of study. The majority of patients were middle-age males. There were more patients with exertional angina of FC III than with FC IV. The most common risk factors of CAD were arterial hypertension, hypercholesterolemia and smoking. Type 2 diabetes mellitus was found in one in five patients on the average. Over one half of patients had the history of one or several myocardial infarctions. Angiographic characteristics of patients included in our study are presented in Table 1.

The studied groups were comparable in terms of the number of involved arteries and the presence of calcifications in the coronary arteries. The incidence of borderline stenoses was comparable in groups I and II, and far lower in group III. Bifurcation stenting was significantly more commonly performed in the group of complete myocardial revascularization. The stenting of the LMCA was performed in 9 patients included in the study due to the high risk of open-heart surgery as assessed by EuroSCORE. The incidence of chronic coronary occlusions was comparable in groups I and II. In the group of incomplete revascularization of the coronary bed chronic coronary occlusions have been revealed in all patients.

Statistical analysis of the results was performed using MS Statistica 7.0 software. The difference was considered statistically significant at $p<0,05$.

RESULTS

In total, 375 stents have been implanted in 171 patients included in our study. The patients received different types of stents: drug-eluting (74,1%) and bare metal stents (25,9%).

Within the first 24 hours after PCI the increasing level of Troponine T was observed in 6 patients from Gr. I and in 3 from Gr. II. In Gr. III patients the level of Troponine T did not increase. On the average, the indices of Troponine T (Gr. I - 0,05±0,3 ng/ml, Gr. II - 0,04±0,4 ng/ml, Gr. III– 0 ng/ml, p>0,05) and CPK-MB (Gr. I - 24,1±4,1 U/l, Gr.II– 18,6±2,9 U/l, Gr. III– 19,6±3,2 U/l, p>0,05) were comparable in all groups.

Hospital survival in all groups was 100%. The incidence of myocardial infarctions also was comparable in all groups. Intraoperative intramural myocardial infarction developed in one patient in the group of complete myocardial revascularization due to the occlusion of 2 mm large diagonal branch. One patient from the group of functionally adequate revascularization had a myocardial infarction caused by subacute stent thrombosis after bifurcation T-stenting of the circumflex artery and the obtuse margin branch. Most probably, this was due to the underdeployment of the stent implanted in the side branch. Also one patient in the group of incomplete myocardial revascularization developed myocardial infarction due to subacute stent thrombosis in the LAD. Further investigation revealed this patient's resistance top Clopidogrel. The incidence of MACE and repeated procedures of myocardial revascularization was not different between the studied groups (Table 2). During in-hospital stay, total regress of clinical signs of angina was seen after PCI in patients from Gr. I and Gr. II. In Gr. III clinical signs of angina in 10 patients (45,5%) regressed up to FC I, and in 12 patients – to FC II. Herewith clinical signs of angina regressed by 2 FC in 16 patients (72,7%) and by 1 FC – in 6 (27,3%). Thus, the regress of

Table 1.

Angiographic characteristics of patients

Angiographic indices	Gr.I n = 63	Gr. II n = 86	Gr. III n = 22	P
Involved arteries, n per 1 patient	2,2±0,5	2,5±0,5	2,5±0,5	>0,05
Stenoses > 50%, n per 1 patient	2,5±0,8*	3,1±1,2	3,3±1,1	0,02
Stented stenoses, n per 1 patient	2,5±0,7	1,4±0,7	1,5±0,6	>0,05
Borderline stenoses, n	20 (31,7%)	42 (48,8%)	2 (9,1%)*	0,001
Bifurcation stenoses	31 (49,2%)*	22 (25,6%)	6 (27,3%)	0,008
Type of bifurcation stenting: «provisional T» «complete» stenting	 29 (46,1%)* 2 (3,2%)	 21 (24,4%) 1 (1,2%)	 6 (27,3%) 0 (0%)	 0,007 >0,05
Lesion of the left main coronary artery, n	7 (11,1%)*	2 (2,3%)	0 (0%)	0,03
Lesion of the proximal LAD, n	27 (42,8%)	36 (41,8%)	13 (59,1%)	>0,05
Chronic occlusion, n	31 (49,2%)	53 (61,6%)	22 (100%)*	0,0001
Calcified artery, n	20 (31,7%)	21 (24,4%)	8 (36,4%)	>0,05
Implanted stents, n	2,9±1,0*	1,9±1,0	1,9±0,9	0,0002
Total length of implanted stents, mm	66,6±27,1*	46,3±25,5	43,6±24,6	0,0007
Mean diameter of implanted stents, mm	3,1±0,3	3,1±0,3	3,0±0,4	>0,05
SYNTAX score	22,1±7,4	23,0±8,8	28,9±8,5*	0,0005

* - statistically significant difference

Table 2.

Immediate (hospital) results of intervention

Index	Gr.I n = 63	Gr. II n = 86	Gr. III n = 22	P
Mortality	0 (0%)	0 (0%)	0 (0%)	>0,05
Myocardial infarction	1 (1,6%)	1 (1,2%)	1 (4,5%)	>0,05
Stent thrombosis	0 (0%)	1 (1,2%)	1 (4,5%)	>0,05
Repeated myocardial revascularization	0 (0%)	1 (1,2%)	1 (4,5%)	>0,05
Repeated PCI	0 (0%)	1 (1,2%)	1 (4,5%)	>0,05
CABG	0 (0%)	0 (0%)	0 (0%)	>0,05
MACE	1 (1,6%)	1 (1,2%)	1 (4,5%)	>0,05
TIMI 3 blood flow	62 (98,4%)	86 (100%)	22 (100%)	>0,05
Immediate clinical success	57 (90,5%)	83 (96,5%)	16 (72,7%)*	0,002

* — statistically significant difference

functional class of angina by 2 FC and more was noted in 100% of patients from the groups of complete and functionally adequate revascularization and in 72,7% of patients from the group of incomplete myocardial revascularization (p<0,001).

Immediate results of interventions were satisfactory in 57 patients (90,5%) from the group of complete myocardial revascularization and in 83 (96,5%) from the group of functionally adequate myocardial revascularization; these indices were comparable. In the group of incomplete myocardial revascularization immediate satisfactory results were achieved in 16 patients (72,7%), that is significantly less common than in the first two groups (p=0,002).

Multifactor analysis of the results of endovascular treatment of patients included in the group of incomplete myocardial revascularization allowed to determine the risk factors preventing the performance of myocardial revascularization in a necessary volume. The most important among them are the presence of chronic occlusion, the occlusion length > 20 mm, high risk of PCI as assessed by SYNTAX Score, the calcification of the involved segment (Figure 2).

Long-term results have been evaluated in all patients in 12 to 18 months after the procedure (mean follow-up duration 14,8 ± 2,5 months). Mean duration of the follow-up in the groups of complete and functionally adequate myocardial revascularization was comparable (14,9 ± 2,7 and 15,1 ± 2,3 months, respectively, p>0,05). Mean duration of the follow-up in the group of incomplete myocardial revascularization was shorter in comparison with Gr. I and II (13,6 ± 2,7 months, p=0,03). All patients included in the study received double antiplatelet therapy (Aspirin and Clopidogrel), 84,8% received ß-blockers, 88,9% - ACE inhibitors and 93% received statins.

Total survival in the long-term follow-up was comparable in all groups (table 3). One patient from the group of complete myocardial revascularization died from anaphylactic shock at 18 months of the follow-up. Also one patient died in the group of functionally adequate myocardial revascularization – this death, occurred in 15 months, was due to decompensation of the heart failure. There were no deaths in the group of incomplete myocardial revascularization.

The incidence of myocardial infarctions was comparable in groups I and II. There were no cases of acute myocardial infarction in the group of complete coronary revascularization, while in the group of functionally adequate coronary revascularization 1 patient (1,2%) had an infarction in the territory of unstented borderline stenosis in 9 months after PCI. In the group of incomplete coronary revascularization myocardial infarction developed in 2 patients (9,1%), which is significantly more common (p=0,016), than in Gr. I and II. One case of myocardial infarction in Gr. III was due to late DES thrombosis in 14 months after PCI. This patient stopped to take Clopidogrel. In the second case myocardial infarction occurred in the territory of unstented borderline stenosis at 12 months of the follow-up.

The groups of complete and functionally adequate myocardial revascularization were comparable in terms of the incidence of repeated coronary revascularization (PCI and CABG). In the group of incomplete myocardial revascularization repeated coronary revascularization (PCI and CABG) were

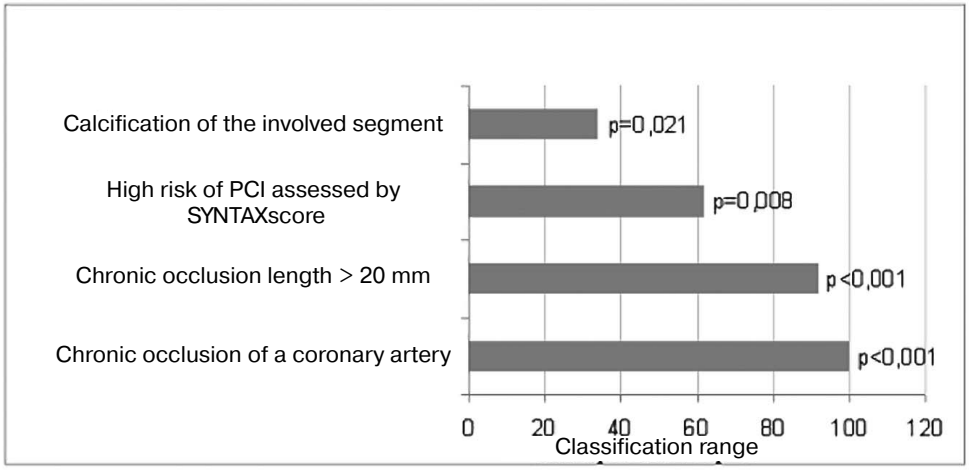

Figure 2. Risk factors preventing the performance of the whole volume of myocardial revascularization

more common than in Gr. I and II, however significant difference was seen only for CABG.

The causes of late angina recurrence have been analyzed in all groups (Table 4). In the group of complete myocardial revascularization late angina recurrence have been noted in 6 patients (9,5%), and all of them underwent repeated endovascular interventions. In all cases angina recurrence was due to in-stent restenosis. In 5 patients (7,9%) restenosis occurred in bare metal stents, and in one patient (1,6%) edge DES restenosis has been revealed.

Late angina recurrence in the group of functionally adequate myocardial revascularization was seen in 11 patients (12,8%), who underwent repeated PCI. In 6 cases (7,0%) angina recurrence was due to in-stent stenosis, in 4 (4,6%) – to the progressing atherosclerotic process and in 1 case (1,2%) – to the development of atherosclerotic process in a previously intact coronary artery. In 4 cases (4,6%) restenosis developed in bare metal stents, and in 2 cases (2,3%) – in DES.

In the group of incomplete myocardial revascularization clinical signs of angina progressed in the long-term follow-up in 6 patients (27,3%). For this reason 5 patients (22,7%) underwent repeated PCI, and 1 patient (4,5%) had a CABG operation. In 3 cases (13,6%) the aggravation of clinical signs of angina was caused by progressing stenotic atherosclerotic process, in 1 (4,5%) – by in-stent stenosis of previously implanted BMS, and in 1 case (4,5%) – by late DES thrombosis.

Thus, the incidence of restenosis, late stent thrombosis, as well as of the development of atherosclerotic process in previously intact coronary artery was similar in the studied groups. The progressing of stenotic atherosclerotic process was significantly more common in the group of incomplete myocardial revascularization, while its incidence in the groups of complete and functionally adequate myocardial revascularization was similar.

Cumulative index of MACE was similar in the groups of complete (11,1%) and functionally adequate myocardial revascularization (13,9%). In the group of incomplete coronary revascularization MACE were seen more commonly (27,3%), then in Gr. I and II, however the difference was not statistically significant (p>0,05). The Kaplan-Meier curve of MACE-free survival is presented at figure 3.

DISCUSSION

When it became evident that the outcome of patients with multivessel coronary disease is highly dependent on the completeness of revascularization, cardiovas-

Table 3.

Long-term results of the intervention

Index	Gr.I n = 63	Gr. II n = 86	Gr. III n = 22	P
Mortality	1 (1,6%)	1 (1,2%)	0 (0%)	>0,05
Myocardial infarction	0 (0%)	1 (1,2%)	2 (9,1%)*	0,016
Repeated myocardial revascularization	6 (9,5%)	11 (12,8%)	6 (27,3%)	>0,05
Repeated PCI	6 (9,5%)	11 (12,8%)	5 (22,7%)	>0,05
CABG	0 (0%)	0 (0%)	1 (4,5%)*	0,033
MACE	7 (11,1%)	12 (13,9%)	6 (27,3%)	>0,05

* — statistically significant difference

Table 4.

The causes of angina recurrence assessed by coronary angiography

Cause	Gr. I n = 63	Gr. II n = 86	Gr.III n = 22	P
In-stent stenosis	6 (9,5%)	6 (7,0%)	1 (4,5%)	>0,05
Late stent thrombosis	0 (0%)	0 (0%)	1 (4,5%)	>0,05
Atherosclerotic process development in a previously intact coronary artery	0 (0%)	1 (1,2%)	0 (0%)	>0,05
Progressing atherosclerosis	0 (0%)	4 (4,6%)	3 (13,6%)*	0,02

* — statistically significant difference

cular surgeons have been the first to rise the question of approaches to myocardial revascularization. The first trials have shown better survival and smoother course of the disease in patients after complete coronary revascularization (2, 20). However several authors have pointed out that with the increasing duration of the follow-up initial advantages of complete myocardial revascularization can be lost (2, 4, 20). Thus, a question arises – is it always necessary to strain after complete revascularization, if it is associated with the increasing risk of intervention?

As it has turned out, some patients do not need complete revascularization, as the occluded artery can supply an area of non-viable myocardium. Besides, the patients in whom complete myocardial revascularization is feasible, as a rule have less damaged coronary arteries and better contractile capacity of the myocardium, which can explain more favorable course of the disease in this group. Some studies have demonstrated that the only factor influencing patients' survival after CABG is not the completeness of myocardial revascularization, but the state of myocardial contractility (20-23).

A special attention should be paid to the patients with borderline coronary stenoses, in whom complete myocardial revascularization is rather easy to achieve. However the later trials have shown that with adequate pharmacological therapy including statins, such stenoses can persist unchanged for a long time (24-26). Besides, stenting of each particular stenosis increases the risk of intra-procedural complications and late restenosis and, as a consequence, of the necessity of repeated coronary revascularization.

For this reason at present it is essential to consider the tactics of partial (incomplete) functionally adequate myocardial revascularization, when a "symptomatic" stenosis, responsible for myocardial ischemia, is found by invasive or non-invasive technique. Then this stenosis is subject to stenting (23, 27, 28).

On view of the aforesaid, our study was aimed at the evaluation of different tactics of endovascular myocardial revascularization in patients with multivessel coronary disease. In the conformity with a specially developed algorithm, endovascular interventions have been performed in the groups of complete and incomplete myocardial revascularization after randomization. Thus, we have formed three groups of patients: with complete myocardial revascularization, functionally adequate myocardial revascularization and incomplete myocardial revascularization. Our results show that complete and functionally adequate myocardial revascularization give comparable immediate results and are characterized by complete disappearance of clinical signs of angina after PCI. Herewith, incomplete myocardial revascularization leads to the persistence of clinical signs of angina and, as a consequence, to the decrease of immediate clinical success rate.

The rate of MACE in the long-term follow-up in patients with complete and functionally adequate coronary revascularization also is comparable and most commonly is associated with the necessity of repeated PCI. Herewith repeated PCI in the group of complete myocardial revascularization have been performed for restenosis in previously implanted stents. The incidence of in-stent stenosis in the group of functionally adequate myocardial revascularization was lower, however the need in repeated PCI was also related to the progressing of stenotic atherosclerotic process. The long-term follow-up in the group of incomplete myocardial revascularization was characterized by increased incidence of MACE in comparison with Gr. I and II. However these differences were not statistically significant, which can be explained by a small number of patients in this group. Herewith the incidence of myocardial infarctions and the need in CABG in the long-term follow-up after incomplete coronary revascularization were significantly higher.

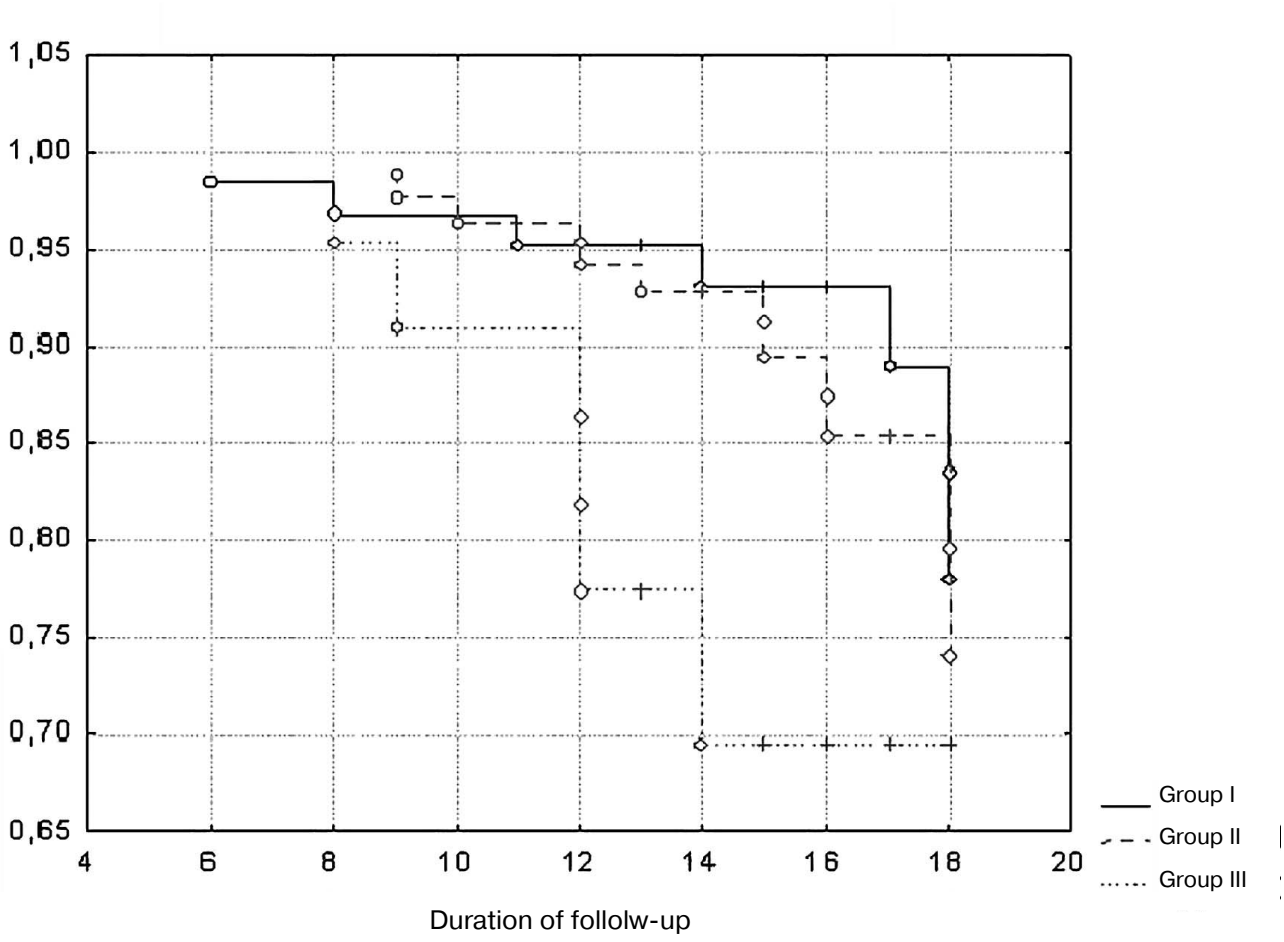

Figure 3. Dynamics of MACE-free survival.

In general, our results suggest high effectiveness and safety of functionally adequate myocardial revascularization in patients with multivessel coronary disease. Meanwhile, the patients in whom complete or functionally adequate myocardial revascularization is unfeasible, should be referred to CABG.

CONCLUSIONS

1. The tactics of complete and functionally adequate myocardial revascularization in patients with multivessel coronary disease are highly effective and provide comparable immediate and long-term results.

2. Incomplete myocardial revascularization is associated with a decreased immediate clinical success rate as well as an increased incidence of myocardial infarction and CABG in the long-term follow-up.

3. The risk factors inhibiting the realization of myocardial revascularization in a necessary volume are: chronic occlusion of a coronary artery, coronary occlusion length > 20 mm, high-risk PCI as assessed by SYNTAX Score and calcification of the involved segment.

4. The most common cause of late recurrence of clinical signs of angina after complete myocardial revascularization in patients with multivessel coronary disease is in-stent stenosis. Late recurrence of angina after functionally adequate myocardial revascularization, as a rule, is caused by progressing stenotic atherosclerotic process and in-stent stenosis.

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The Causes of Thromboses in the Coronary Artery Stent

V.I. Ganiukov, A.A. Shilov, N.S. Bokhan, G.V. Moiseenkov, L.S. Barbarash*
RAMS Institution "Research Institute for Complex Issues of Cardiovascular Diseases", the Russian Academy of Medical Sciences (RAMS), Siberian Branch, Kemerovo, Russia.

The study was aimed at the determination of the factors influencing the development of stent thrombosis.
Acute coronary syndrome, delayed intake of Clopidogrel decreased left ventricular ejection fraction have been recognized among the main factors of stent thrombosis.
Besides, our study has shown that male sex, age over 60, multivessel disease and coronary occlusion also are the factors that increase the risk of stent thrombosis.
According to our results, the rate of stent thrombosis in patients with diabetes mellitus is not higher than in other patients.
Keywords: *stent thrombosis, percutaneous coronary intervention.*

ABBREVIATIONS

MI — myocardial infarction
UA — unstable angina
DM – diabetes mellitus
ACS — acute coronary syndrome
PCI — percutaneous coronary intervention
LAD – left anterior descending artery
RCA — right coronary artery
CxA – circumflex artery
BMS – bare metal stent
DES – drug eluting stent

INTRODUCTION

Stent thrombosis is a rare but threatening complication that can clinically manifest as MI, UA or sudden coronary death (1). The improvement in technique of stent implantation and the introduction of the regimen of double antiplatelet therapy considerably lessened the incidence of this complication from 16 ±0.4% to 2.8±1.2% in 1992-2002 (23, 27). Thrombosis of bare metal stents occurs in less than 1% of cases, more commonly within the first month after the implantation (1, 25). The subject of late thrombosis of DES is widely discussed today. According to some studies (2, 3, 22, 26, 28), the incidence of this complication for first-generation DES is 1.2-1.3% that is higher comparing to BMS, although the statistically significant difference hadn't been achieved (22). The clinical importance of these events remains a subject for further discussions (4).

Regardless of the type of implanted stent, some factors related directly to the patient's condition, to the procedure itself and the technique of intervention, as well as with to the lesion of coronary arteries play an important role in the development of acute and subacute stent thrombosis. Meanwhile, in the long term the development of this complication is more or less related to the extent of endothelization of vascular wall and the intensity of antiplatelet therapy (5).

Factors associated with the patient's condition include DM, ACS, elderly age, low ejection fraction, serious cardiac complications within 30 days after the procedure, the history of MI, resistance to Clopidogrel, hypersensitivity reaction (6, 7, 8, 9, 10, 11, 12, 13, 14).

Factors associated with the coronary arteries lesion include – "C" type lesion, in-stent restenosis, calcification, total occlusion, bifurcation or multivessel lesion, stenosis of venous shunt, long stented segment (8, 10, 12, 14).

Factors associated with technical particularities of the procedure include slow-reflow or no-reflow after the stenting, incomplete (suboptimal) stent expansion, residual dissection, "crush" technique of bifurcation stenting, occlusion of the side branch, delayed healing of the vascular wall, a need to use inhibitors of glycoprotein receptors IIb/IIIa (9, 12, 15, 16).

Stopping desaggregant therapy in the long-term after the procedure is also one of important factors of stent thrombosis development. Thus, according to the data of a multicenter study compsiring 2229 patients with stent thrombosis from 1 till 9 months after the PCI, in 29% of cases the cause of late thrombosis was premature cessation of antiplatelet therapy (24).

At the same time there are no data concerning combined exacerbating effect of already known factors on stent thrombosis development; this fact has determined the purpose of our study.

The purpose of our work was to determine the influence of different factors combinations that are responsible for development of coronary stent thrombosis.

MATERIAL AND METHODS

Results of 2225 PCIs performed in 2006-2008 in the Research Institute for Complex Issues of Cardiovascular Diseases, The Russian Academy of Medical Sciences, Siberian Branch, Kemerovo were retrospectively analyzed. Stent thrombosis was

* Address for correspondence:
Dr. Vladimir Ganyukov
6, Sosnovy Boulevard, Kemerovo, 650002, Russia
Fax: +7(3842) 64-27-18
Phone: +7 (3842) 341550, +79131273905,
e-mail: ganyukov@mail.ru
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registered in 62 patients (2.8%), among them - in 47 patients (75.8%) after PCI performed for acute coronary syndrome (ACS). In the remaining cases PCI was performed for chronic CAD. In this study we used the classification of stent thrombosis suggested by the Academic Research Consortium (ARC) in 2006 (19): acute — within 24 hours, subacute — 24 hours–30 days, late — 30 days–12 months, and very late — >12 months after the procedure; definite/confirmed — development of ACS and angiographic confirmation of stent thrombosis/occlusion, or pathological-anatomical confirmation of stent thrombosis; probable — unexplained death within 30 days after stenting, MI in the territory of the target vessel without angiographic confirmation of stent thrombosis; possible — unexplained death later than in 30 days after stenting.

Correlation and regression analysis methods were used in the study. Values in the tables are presented as arithmetic mean of variational series ± standard deviation. Alternative hypothesis with significance level no less than 95% (p=0.05) was used as statistic hypothesis. All parameters were subject to the normal distribution. In order to check hypothesis about equality of means the paired Student's t-test was used. The significance of the differences in the allele rate between the samples compared was assessed using 2-test. For conducting factor analysis the Varimax rotation method with Kaiser normalization were used. Biostat and SPDD (version 13) software was used for calculations.

204 patients without clinically or angiographically revealed signs of stent thrombosis in the long-term follow-up were randomly assigned to the control group.

The groups were comparable in terms of age, sex, concurrent pathology and immediate success of PCI (Tables 1, 2, 3).

Besides the time of stent thrombosis development we also have evaluated patients' clinical condition, the urgency of intervention, the type of lesion, initial percentage of stenosis, regimen of anticoagulant therapy, and the type of stents (DES vs. BMS).

RESULTS

In total, 78 stents have been implanted in 62 patients with stent thrombosis after PCI. In 50 cases only one stent was implanted during PCI, 2 and more stents were implanted into the target artery during endovascular intervention in 12 patients. Satsfactory results - TIMI 3 blood flow – were obtained in all PCI. Within 1 month thrombosis was diagnosed in 27 of 62 patients (43.6%), the late thrombosis was revealed in 18 cases (29%) and very late thrombosis was confirmed in 17 patients (27.4%).

In 56 (90.3%) cases stent thrombosis was considered as definite, in 2 patients (3.2%) as a probable one, and in 4 (6.5%) –possible stent thrombosis was diagnosed. Stents thrombosis was revealed in 72 of 78 implanted stents (92.3%).

Stent thrombosis led to death in 2 cases (3.2%), myocardial infarction (MI) developed in 22 patients (35.5%), in the remaining cases (38; 61.3%) unstable angina was present.

The analysis of eventual causes of stent thrombosis revealed the following patterns (Table 4).

As we can see from Table 4, one of the factors of stent thrombosis is performing PCI in ACS: more than 75% of PCIs in the main group were performed in patients with this nosological entity, it is significantly different (p=0.006) from the control group where only 44.6% of endovascular interventions were conducted in the presence of ACS. Coronary occlusion was also a predictor of stent thrombosis – the number of thromboses in the main group was significantly higher than in the control group (59.7% and 33%, respectively , p=0.01). Multivessel coronary lesions were significantly more common in the stent thrombosis group (50%) comparing to the control group (33%), p<0.001. Long stented segment was one more factor increasing the risk of stent thrombosis occurrence: 25.3 ± 5.8 mm in the main group comparing to 18.6 ± 7 mm in the control group, p<0.001. Duration of double antiplatelet therapy before and after PCI turned out to be a significant cause of stent thrombosis. Noncompliance with recommended antithrombotic therapy in the group of stent thrombosis is significantly higher (p<0.001).

In order to analyse the influence of dominant factor on the stent thrombosis, extraction factor analysis was performed using the Varimax rotation method and Kaiser normalization (Table 5).

As we can see from Table 5, besides above mentioned causes, decreased left ventricular ejection fraction (< 50%) turned out to be an additional separate factor increasing the risk of stent thrombosis. At the same time we have revealed associated factors (multivessel lesion with occlusion of the coronary artery, patient's age older than 60, and male sex) that, being combined, increase the probability of stent thrombosis.

DISCUSSION

Among the factors associated with the patient's condition in our study, the presence of acute coronary syndrome has become one of the main predictors of stent thrombosis. More than 75% of PCIs complicated by stent thrombosis development in the long-term follow-up were performed in patients with ACS. Preventive therapy with Clopidogrel was not performed in patients with ACS because of urgent character of the procedure, and in most cases in the main group (77.4%) this drug was used during PCI. The late intake of Clopidogrel (during PCI), as we can see from Table 5, was one of the factors of subsequent stent thrombosis. In our study we have received a correlation between the decreased (< 50%) LV ejection fraction and occurrence of stent thrombosis.

Table 1.

Comparison of clinical and demographic parameters in the main and control groups.

Criteria	Main group (n=62)	Control group (n=204)	Significance
Males	51 (82,3%)	174 (85,3%)	P = 0.705
Females	11 (17,7%)	30 (14,7%)	
Age (years)	54,5±10	56,3±8,2	P = 0.152
Arterial hypertension	58 (93,6%)	181 (88,7%)	P = 0.389
Diabetes mellitus	12 (19,3%)	33 (16,1%)	P = 0.696
Ejection fraction (%)	55,1 ± 10,7	57,3 ± 9,3	P = 0.107

Table 2.

Comparison of angiographic data in the main and control groups.

Target vessel	Main group (n=68)	Control group (n=223)	Significance
LAD	31 (45,6%)	117 (50,2%)	P = 0.594
RCA	28 (41,2%)	90 (38,6%)	P = 0.812
CA	9 (13,2%)	26 (11,2%)	P = 0.152
Mean stent diameter (mm)	3,0 ± 0,5	3,0 ± 0,5	P = NS

Table 3.

Comparison of immediate angiographic results in the main and control groups.

Criteria	Main group (n=62)	Control group (n=204)	Significance
Immediate success of procedure	62 (100%)	204 (100%)	P = NS
TIMI 3 blood flow	62 (100%)	204 (100%)	P = NS
Complications	0	0	P = NS
Stent diameter in place of implantation (mm)	3,2 ± 0,3	3,3 ± 0,5	P = 0.136
Percentage of residual stenosis	6,2± 2,7	6,6 ± 2,2	P = 0.237

Table 4.

Significant differences of various criteria in the main and control groups.

Criteria	Main group (n=62)	Control group (n=204)	Significance
ACS	47 (75,8 %)	91 (44,6 %)	P = 0.006
Multivessel lesion	31 (50 %)	29 (14,2 %)	P < 0.001
The number of occlusions	37 (59,7%)	68 (33%)	P = 0.01
The length of stented segment (mm)	25,3 ± 5,8	18,6 ± 7	P < 0.001
Double antiplatelet therapy at least 1 day before PCI	14 (22,6%)	117 (57,3%)	P < 0.001
Double antiplatelet therapy after PCI	46 (74,2%)	199 (97,5%)	P < 0.001

Table 5.

Factor analysis by extraction (Varimax rotation method with Kaiser normalization).

	Component				
	1	2	3	4	5
Age	-,361	,142	-,103	,344	,728
Gender	,206	-,139	,161	-,208	,839
Ejection fraction	,216	,713	-,024	,381	-,132
ACS	,726	,073	,126	-,052	-,026
Occlusion of the coronary artery	,063	,131	,758	-,140	,041
Intake of Clopidogrel during the PCI	-,032	-,013	,022	,927	,005
Multivessel lesion	-,125	-,100	,784	,158	,032
Long stenosis	,136	-,854	-,058	,214	-,056
Compliance with recommendations on Clopidogrel intake	-,818	,069	,240	-,036	-,025
Explained dispersion 73.42%					

We have also found an increased risk of stent thrombosis development in the presence of combination of such factors as male sex and age older than 60, as well as multivessel disease and occlusion of coronary artery. Herewith we could not demonstrate the influence of diabetes mellitus on stent thrombosis.

Among the causes associated with the coronary artery lesion a significant relationship has been revealed between the number of coronary occlusions and the incidence of stent thrombosis (59.7% of occlusions in the main group vs. 33% in the control group, p=0.01). We could confirm the data about the correlation between the length of stented segment and the incidence of thrombosis: the stented segments in the main group were significantly longer: 25.3 ± 5.8 mm and 18.6 ± 7 mm, respectively , $p < 0.001$. As we can see from Table 5, we could demonstrate an increased risk of stent thrombosis in the presence of coronary artery occlusion combined with multivessel coronary disease.

We could not demonstrate the influence of factors associated with the intervention technique on the development of stent thrombosis. PCI was a 100% successful in all cases, residual stenosis was less than 10%, the blood flow was TIMI 3. In our opinion, the above factors excluded an incomplete stent expansion, presence of slow-reflow/no-reflow phenomena and marginal dissections at the edges of implanted stent.

At the same time, our study has showed an extremely important role of double antiplatelet therapy after the PCI. More than 25% of patients were not compliant with the received recommendations on the regimen and the duration of Clopidogrel's intake.

CONCLUSION

The most important factors increasing the risk of stent thrombosis are: acute coronary syndrome, multivessel coronary disease, decreased LV ejection fraction, baseline occlusion of the coronary arteries, long (>25 mm) stented segment of the coronary artery, as well as cessation of double antiplatelet therapy after endovascular intervention. Combination of male sex and age older than 60, as well as coronary artery occlusion in the presence of multivessel coronary disease are additional predictors of stent thrombosis.

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Problems of Endovascular Myocardial Revascularization in Patients after Kidney Transplantation

I.G. Riadovoy, A.B. Mironkov, B.L. Mironkov, G.R. Babayan, M.G. Gontuar, V.V. Chestukhin*
Shumakov Research Center of Transplantology and Artificial Organs, Moscow, Russia

We have studied the causes inhibiting the optimal use of endovascular methods of myocardial revascularization in patients with CAD after kidney transplantation. Technical particularities and difficulties of myocardial revascularization were studied in 42 kidney transplant recipients. We discuss the methods helping to overcome of these problems.
Keywords: *coronary angioplasty, kidney transplantation, contrast agent.*

INTRODUCTION

During the last years the number of renal transplantations in Russia has been steadily increasing and in 2009 exceeded 1000. Meanwhile 5-years survival of recipients with functioning kidney transplant (KT) was over 70 % (1), that is, technical problems of renal transplantation in Russia are essentially solved. However lately another serious problem, namely – heart diseases – has arisen in these patients and is coming to the fore. It has been shown that the incidence of coronary artery disease (CAD) in KT recipients (14-20%) is 3 to 5-fold higher that in general population (2,3,9,10,11). In general population this rate does not exceed 5% (5,9). Heart problems are responsible for up to 36-48% of lethal cases (11,12). According to some authors, 10-years survival in KT recipients with CAD after endovascular myocardial revascularization is higher than in similar patients undergoing only pharmacological therapy (75% vs. 39%) (3). It would seem that the effectiveness of endovascular therapy (EVT) of CAD in KT recipients (as well as in general population with CAD) is obvious, however we could not find any publications on this subject in Russian medical literature, besides our own articles.

The purpose of our work was to analyze the factors, limiting endovascular myocardial revascularization, and the causes complicating this procedure in KT recipients with CAD, as well as to demonstrate the possibilities to overcome these causes.

MATERIAL AND METHODS OF STUDY

The study comprised the data of examination and treatment of 42 recipients of kidney transplant (RKT) who underwent coronary angioplasty in the period from 1999 through 2008 (31 men and 11 women, aged from 43 to 68 years; mean - 54,5±7,3 years). Time interval between kidney transplantation and angioplasty varied from several weeks to 15 years. The transplant's function was evaluated on the base of clinical, biochemical and instrumental data before angioplasty, as well as within the first 48 hours and in 12 months after it. Prior to angioplasty the function of kidney transplant in all patients was stable, as assessed by blood creatinine values (Table 1).

Some patients had a long history of CAD before and after KT. The severity of CAD was evidenced by the fact that 66% of patients had a history of AMI, 76% had III and IV class angina, which is suggestive of marked coronary disease (Table 2).

The patients have been investigated in accordance with the program generally accepted in the practice of cardiac surgery (ECG, EchoCG, stress-test, coronary angiography, as well as clinical and laboratory examination). Coronary angioplasty with optimal stenting was performed in all patients.

The presence of angiographically and clinically significant coronary stenosis served as indication for coronary stenting. Repeated cardiological examination was performed in 24-48 hours and in 12 months after angioplasty.

ANGIOGRAPHIC CHARACTERISTICS OF PATIENTS

Coronary atherosclerosis was characterized by a combination of proximal stenoses and diffuse calcification of the small coronary vessels. Angiography has revealed three-vessel coronary disease in 22 patients, two-vessel disease – in 11. In 16 patients (38%) coronary stenosis was associated with arterial occlusions, in 24 cases (57%) – with diffuse lesions of the small coronary vessels, manifested by delayed distribution and washing out of the contrast medium in all coronary branches. Besides, marked tortuosity of distal coronary arteries was seen. Marked calcification, manifested as radiopaque inclusions in proximal and middle segments of the coronary arteries was found in 52% of patients. The combination of the above types of the coronary lesions was seen in the majority of cases (Table 3).

* Address for correspondence:
Dr. Ivan Riadovoy
Dept. of X-ray diagnostics and endovascular methods of treatment of the Shumakov Research Center for Transplantology and Artificial Organs
Russia, 123182, Moscow, ul. Schukinskaya,1 .
Tel. +7 903 670-54-61
e-mail: ryadovoy@pochta.ru.
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Table 1.

Characteristics of patients.

	N=42
Age (years)	54,5±7,3
Sex, males (%)	81%
Baseline blood creatinine (μmol/l)	162,5 ± 60,8
Time after kidney transplantation (months)	86,1±54,4
Duration of programmed dialysis before kidney transplantation (months)	20,1±19,6

Table 2.

Patients' distribution by functional class of angina (Canadian classification).

	N=42	%
Class II	10	24%
Class III	28	67%
Class IV	2	4,8%
Unstable angina	1	2,4%
AMI	1	2,4%

Table 3.

Coronary lesions in KT recipients.

	N=42	%
Two-vessel disease	11	26%
Three-vessel disease	22	52%
Left main coronary artery disease	3	7%
Occlusion of a single CA	16	38%
Occlusion of two CA	1	2,3%
Marked calcification of CA	22	52%
Diffuse coronary lesions	24	57%

PARTICULARITIES OF EVT IN CAD PATIENTS WITH KT.

In total, 56 endovascular procedures have been performed in 42 patients. Repeated interventions have been performed in 25% of cases, and one half of them was related to restenosis in previously stented segments (BMS in all cases), and another half – with progressing atherosclerosis in other segments of the coronary bed (Table 4)

In total, the interventions have been performed in 68 coronary arteries. In all, 85 bare metal stents and 19 drug-eluting stents have been implanted. The latter were used mainly in patients with diabetes mellitus, as well as for bifurcation stenting and in long lesions of the small arteries.

Average number of stents per one patient was 2,47. All significant stenoses have been stented (Table 5).

Recanalization has been successful in 11 of 17 chronic total occlusions of the coronary arteries (65%).

IN-HOSPITAL COMPLICATIONS

Despite severe, multiple, diffuse coronary lesions with marked calcification, in our series there were no cases of death or arterial rupture leading to emergency CABG. However in 10 of 58 endovascular interventions we have faced marked dissections of the coronary arteries. Five of them were accompanied by acute arterial thrombosis, that has been treated by subsequent adequate stenting of the damaged segments and administration of IIb/IIIa platelet receptors blockers (Monafram, 5 mg per 20 kg of body mass). The "no-reflow" syndrome leading to AMI developed in one case.

Non-cardiac complications were encountered in 5 patients (8,9%). In all cases these were false aneurysms in the area of femoral puncture, which got thrombosed after prolonged manual compression. In one case the procedure had to be stopped because of increasing arterial bleeding from the site of femoral arterial puncture. This was stopped by manual compression after the removal of introducer (Table 6).

DYNAMICS OF CLINICAL CONDITION OF PATIENTS

Clinical improvement, decreasing functional class of angina (in average by more than 1 class, from 2.65±0,53 to 1,5±0,61), increasing physical tolerance have been observed in 97,6% of KT recipients.

DISCUSSION

Endovascular management in KT recipients was first applied in our clinic in 1999. An extremely severe CAD non-responding to pharmacological therapy made it necessary to perform coronary angioplasty. Despite clear clinical effect and absence of compli-

Table 4.

Quantitative characteristics of angioplasty procedures.

Total number of angioplasty procedures	56
Primary procedures	42
Re-interventions for in-stent stenosis	7
Re-interventions for «de novo» lesions	7

Table 5.

Characteristics of performed coronary stenting procedures.

	N=42
Average stent's length (mm)	18,7±6,7
Average diameter (mm)	3,12±0,34
Average number of stents used during one procedure	1,85
Average number of stents per one patient	2,47
Total number of stents	104
DES (n)	19
Coronary bifurcation stenting (n)	25
Stenting of the left main coronary artery	3
Average angioplasty duration (min.)	85,3±23,9
Average volume of contrast medium per one procedure (ml)	495,5±186,7 (от 200 мл до 1200 мл)

Table 6.

Angioplasty-related complications in patients with KT.

Mortality	0
AMI	1
ACE	0
Transplant dysfunction	0
Coronary dissection	10
Acute coronary thrombosis	5
False aneurysm of the femoral artery	5

ACE – acute cerebrovascular event

cations, during the next 2-3 years the use of endovascular methods for the treatment of CAD in KT recipients was still considered as something extraordinary.

Unreasonably rare use of invasive methods for diagnosis and management of CAD can be attributed to the following causes:

- excessive fear of contrast-induced nephropathy (CIN) on the part of nephrologists. CIN is typical for chronic renal disease (10-40% of cases of serious renal dysfunction after coronary angioplasty or angiography), but probably is associated also with kidney transplantation (6).

- late reference of RKT to cardiologist, as the frequency of asymptomatic CAD in such patients is 2,5-3-fold higher than in general population (27% vs. 11%) (7). Besides, the specificity of ECG signs – T wave inversion, ST elevation – in such patients is attenuated due to myocardial hypertrophy, anemia, metabolic disturbances, diabetes, etc. These factors play an important role in decreasing the possibilities of making CAD diagnosis prior to kidney transplantation, and probably persist in a certain measure after it (8)

Late referral to endovascular therapy leads to progressing of the changes in the coronary arteries and to the increase of the rate of MI, which complicates the treatment and decreases its effectiveness.

We believe that the evaluation of immediate and long-term influence of the contrast agents on the KT's function presented in our previous work is very important. Our experience has shown the absence of clinically significant disturbances of kidney transplant's function in all 42 patients undergoing endovascular treatment, independently of the type of contrast agent, its volume (200 to 1200 ml) and baseline degree of KT's dysfunction (4). These results afford ground for recommending more early and extensive use of EVT in kidney transplant recipients with CAD.

Our results are in agreement with the data according to which coronary atheroscelrosis in RKT is characterized by early development of marked calcification. These morphological features cause significant technical difficulties during EVT and results in more frequent development of complications in comparison with general population of patients with CAD (13).

Among these complications one should firstly name high propensity to marked dissections of the coronary arteries. In order to prevent this compli-

cation development and progressing during stenosis predilatation it is reasonable to use small balloon catheters (up to 2 mm). This, on the one hand, gives the possibility for optimal vessel dilatation to prepare it for stenting, and, on the other hand – for minimizing coronary artery dissection. If "direct" stenting is feasible, it is reasonable to use this method as it is less traumatic.

Besides, massive calcification of the stenosis-inducing plaque necessitates the use of special instruments (high-pressure balloon catheters or cutting balloons) for dilatation.

Rather high rate of acute coronary arterial thrombosis (5%), makes it necessary to use the inhibitors of IIb/IIIa platelet receptors (Monafram).

The difficulties of stent advancement to the site of implantation, related to arterial tortuosity, narrow lumen, rugosity of the inner surface (when the lumen seems to be large enough, but it is difficult to advance the guide) or the presence of markedly dissected sites, suppose the use of certain special tricks for stent delivery.

The easiest way to solve the problem of stent delivery is to insert an adjunctive guidewire with higher support. This guidewire straightens the arterial bends impeding stent advancement and "makes a path" for the stent. Probably, it minimizes stent's contacts with the arterial wall.

If this proves to be insufficient we use another technique. A balloon catheter is advanced through the second guidewire up to the difficult segment of the artery, while the stent is placed at the guide-catheter's tip inside the first guidewire. Then we inflate and deflate the balloon catheter, thus dilating the lumen and compressing the damaged elements of the vessel. After that the catheter is left at the same place within the arterial lumen, and the flattened balloon covers a part of the inner arterial surface; due to it the stent can be advanced with less resistance. After that the balloon catheter is removed, and the stent is implanted. This method is rather cumbersome and is used rarely, but in difficult cases it can be effective.

Our experience with the patients with chronic renal failure suggests, that if stent advancement proves difficult, in some cases it is reasonable to start not from the distal segment of the artery, as it is usually done, but from the proximal segment. It provides easier advancement of the next stent. If stent delivery into the target segment is impossible, we believe it reasonable to implant it in the maximally attainable site. As a rule, after it the next stent can be successfully delivered to the target segment.

If preprocedural information suggest eventual technical problems we prefer to use shorter, low-profile and more flexible stents.

In some cases we plan a two-step endovascular procedure. At the first step we perform the main task, then basing on the results of clinical, functional and instrumental examinations we decide on the reasonability of performing the second step.

Thus, myocardial revascularization in RKT is associated with much greater technical problems in comparison with general population of patients with CAD. All arising problems can be solved with the use of a wide range of the newest instruments.

The effectiveness of treatment is confirmed by the improvement of clinical condition of patients evaluated by functional class dynamics, and the increase of their working capacity.

CONCLUSION

1. Endovascular therapy is a rather effective method for the treatment of CAD in kidney transplant recipients. However it requires a large repertoire of modern instruments and medications. In some cases stepped approach is reasonable.

2. The safety of method and the absence of data on clinically significant negative impact of contrast media on the function of KT allows to recommend wider use of invasive diagnostic and therapeutic methods for the management of these patients at the early stages of CAD.

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Stenting of Chronic Occlusions of the Internal Carotid Artery

A.V. Khripun, M.V. Malevanny, Ya.V. Kulikovskikh, A.V. Kramarenko, M.T. Akbasheva, E.P. Fomenko, Z.Yu. Zaypulaeva*
Regional Vascular Center of the Rostov-on-Don Regional Clinical Hospital, Rostov-on-Don, Russia

Despite pharmacological therapy, the annual risk of stroke in the presence of chronic occlusion of the internal carotid artery (ICA) is as high as 30%. Open surgical correction of this pathology is associated with low rate of success or is low effective. Endovascular interventions have demonstrated their effectiveness and safety in the restoration of physiological cerebral blood flow in this category of patients. We have analyzed 7 cases of stenting of chronic occlusions of the ICA in patients with the history of acute cerebrovascular events (ACE) 6,8±3,1 months prior to hospitalization. Successful recanalization and stenting of chronic occlusion of the ICA with the restoration of TICI-3 blood flow was achieved in 100%. There were no new transient ischemic attacks (TIA) or ischemic strokes during the follow-up period. The data obtained with the use of functional neuroimaging techniques suggest the improvement of brain perfusion.
Keywords: *chronic occlusion of the internal carotid artery, stenting.*

Purposes: to evaluate the feasibility, the effectiveness and the safety of stenting of chronic occlusions of the ICA.

Background: annual risk of stroke in patients with occluded ICA is 5-7%. In the presence of decreased cerebrovascular reserve the risk of stroke achieves 30% despite pharmacological therapy. Open surgical correction of this pathology is associated with low rate of success or is low effective. Endovascular interventions aimed at the restoration of physiological cerebral blood flow have proved their effectiveness and safety in this category of patients.

Methods: we have analyzed 7 cases of stenting of chronic occlusions of the ICA. All patients had a history of ischemic ACE in ipsilateral hemisphere 6,8±3,1 months prior to hospitalization. In all cases chronic occlusion was accompanied by unstable neurological symptoms. All patients underwent recanalization and stenting of chronic occlusion of the ICA. The results of endovascular intervention were assessed by the presence of clinical symptoms, National Institute of Health Stroke Scale (NIHSS), modified Rankin scale. Stents' patency and the presence / absence of restenosis were determined using the data of ultrasound triplex scanning and transcranial duplex scanning. Prior to the discharge cerebral perfusion in all patients was evaluated using SPECT or perfusion CT.

Results: successful recanalization and stenting of chronic occlusion of the ICA with the restoration of TICI-3 blood flow was achieved in 100%. During the follow-up period there were no new TIA or ischemic strokes. A tendency for the decrease of neurological deficit severity as assessed by NIHSS and for the restoration of functional independency of patients was observed in early postoperative period. The data of functional neuroimaging suggested the improvement of brain perfusion. Ultrasound examination carried out at day 30 after the procedure showed that all stents were patent without signs of restenosis.

Conclusions: the stenting of chronic occlusions of the ICA in a certain group of patients is feasible and safe. Large randomized trials are necessary for the determination of clinical effectiveness and indications for recanalization of chronic occlusions of the ICA.

ABBREVIATIONS:

ICA – internal carotid artery
MCA – middle cerebral artery
TIA – transient ischemic attack
SPECT – single-photon emission computed tomography
TCDS – transcranial duplex scanning
USTS – ultrasound triplex scanning
CT – computed tomography
ACE – acute cerebrovascular event
NIHSS – National Institute of Health Stroke Scale
mRS – modified Rankin scale

To date the stenting of carotid arteries is accepted as an effective and safe alternative to carotid endarterectomy (1, 2). However it is seldom performed for carotid arterial occusions, except for the cases of acute ischemic cerebrovascular events (3). Despite all technical achievements of carotid revascularization, the progress in the management of chronic occlusions of the carotid arteries is not impressive. We present our first experience with the stenting of chronic occlusions of the carotid arteries.

* Address for correspondence:
Dr. Mikhail Malevanny
Russia, 344082, Rostov-on-Don, ul M. Gorkogo 11/43, apt. 57
e-mail: doctorm@mail.ru
Tel. +7-863-218-94-18
Cell +7-928-296-27-50
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MATERIAL AND METHODS

In 2010 in the Regional Vascular Center of the Rostov-on-Don Regional Clinical Hospital 7 patients underwent recanalization and stenting of chronic occlusions of the carotid arteries. Mean age of patients was 64,6±4,7 years. Five of them (71,4%) were males. All patients had a history of ischemic ACE in ipsilateral hemisphere 6,8±3,1 months prior to hospitalization. At admission neurological deficit assessed by NIHSS was 3,3±0,7, the degree of functional independency assessed by modified Rankin scale was 1,0±0,8. Chronic occlusion of the ICA was accompanied by unstable neurological symptoms: the deterioration of neurological status in 2 patients (28,6%), frequent recurrent TIA in 3 (42,9%), orthostatic TIA – in 1 (14,3%), headaches and amaurosis fugax at the side of occlusion in 1 (14,3%). The comorbidities included: diabetes mellitus in 1 (14,3%), arterial hypertension in 7 (100%), coronary disease – in 3 (42,9%) patients. Prior to the procedure all patients underwent the evaluation of brain perfusion with SPECT (4; 57,1%) or perfusion CT (3; 42,9%). The results of these studies allowed to reveal the ischemic foci in ipsilateral hemisphere.

Selective angiography of brachiocephalic arteries revealed occlusion of the cervical segment of the ICA 4 to 63 mm in length with retrograde opacification of the cervical segment of the ICA distal to the occlusion through the ophthalmic artery and the anterior communicating artery and/or antegrade opacification through vasa vasorum. Five (71,4%) patients had hemodynamically insignificant stenoses of the contralateral ICA. Two patients (28,6%) had contralateral ICA stenosis > 70%. The first step of the intervention in these patients consisted in stenting of the contralateral ICA, and recanalization and stenting of the ICA ipsilateral to the occlusion was performed as the second step.

All interventions were planned and performed under local anesthesia. Transfemoral approach was used in all cases. Only proximal protection MoMa Ultra (Invatec) was applied during recanalization and stenting in 6 (85,7%) patients. In 1 (14,3%) case the procedure was conducted with combined use of the system of proximal and distal brain protection. Carotid stent Cristallo Ideale (Invatec) was implanted in all patients. Two patients (28,6%) with long lesions received an additional coronary stent Multi-Link (Abbott Vascular). TICI-3 blood flow was obtained after the endovascular intervention in all patients.

One day before the procedure all patients received a loading dose of Clopidogrel (600 mg) and Aspirin (300 mg). After stenting the patients received the recommendations for life-long intake of Aspirin (100 mg daily) as well as of 75 mg of Clopidogrel daily for at least 3 months. During the procedure all patients received intravenous Heparin (5 000 – 10 000 U) for ACT maintenance within 200-250 sec.

The results of endovascular intervention were evaluated on the base of the presence clinical symptoms, neurological status was assessed using NIHSS at discharge and in 30 days; the degree of functional independency of the patients was evaluated using modified Rankin scale (mRS) in 30 days after the discharge. Stents' patency and the presence/absence of restenosis were evaluated on the basis of USTS and TCDS at discharge and in 30 days. Prior to the discharge, brain perfusion was assessed with SPECT or perfusion CT in all patients.

RESULTS

Successful recanalization and stenting of chronic occlusion of the ICA resulting in restoration of TICI-3 blood flow were achieved in 100% (7 patients). Mean duration of the procedure was 58,0±16,8 minutes. There were no cases of carotid artery perforation or contrast medium extravasation during the procedure. After the procedure 1 patient (14,3%) had bradycardia and hypotension, which resolved within 12 hours. In 24-48 hours after the procedure all patients underwent brain CT that did not reveal hemorrhagic foci.

During the follow-up period (59,7±13,5 days) there were no new TIA or ischemic strokes. According to ultrasound studies, in 30 days all stents were patent, without signs of restenosis.

The evaluation of neurological status did not reveal significant differences in NIHSS indices at admission (3,3±0,7), at discharge (2,4±0,9) and in 30 days after the procedure (0,9±0,7). This can be explained by small number of cases. However the observed tendency for the improvement of neurological status together with the absence of recurrent TIA or new strokes suggest the success of endovascular intervention. The indices of functional independency as assessed by modified Rankin scale were not significantly different at admission and in 30 days after the procedure, while a tendency for the improvement was seen.

Functional neuroimaging studies performed prior to the discharge in all patients revealed the improvement of perfusion in the ipsilateral as well as in contralateral hemispheres with the increase of cerebrovascular reserve.

CLINICAL CASE

The patient Z., female, aged 69, was admitted to the Regional Vascular Center of the Rostov-on-Don Regional Clinical Hospital with the complaints of frequent recurrent transient ischemic attacks in the territory of the right middle cerebral artery (MCA). She had a history of ACE in the territory of the right MCA 7 months prior to hospitalization. At admission her neurological status was assessed as NIHSS 2. The degree of functional independency assessed with modified Rankin scale = 1. USTS of the brachiocephalic arteries revealed an occlusion in the servical segment of the right ICA and a 30% stenosis in the proximal cervical segment of the left ICA. TCDS showed markedly decreased linear velocity indices of the blood flow in the right MCA with collateral

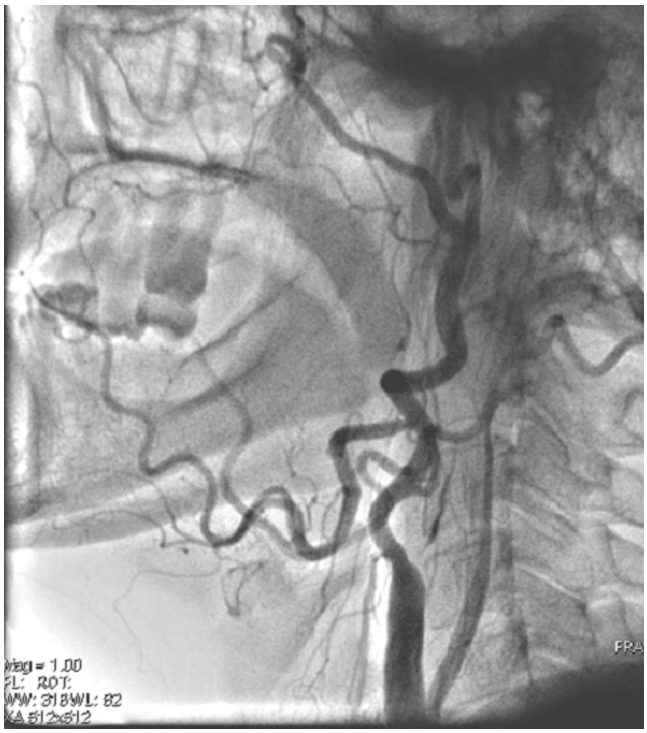

Fig. 1. Occlusion of the cervical segment of the right internal carotid artery.

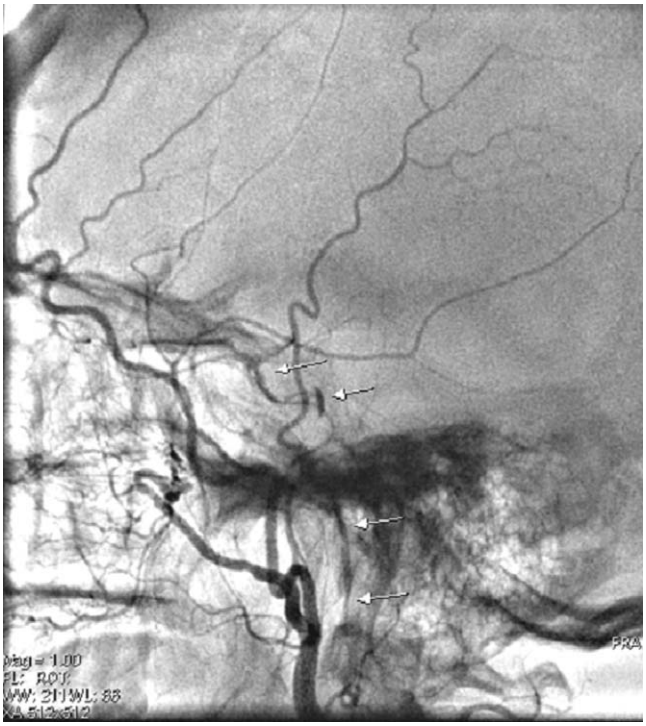

Fig.2. Retrograde opacification of the right internal carotid artery (arrows) through the ophthalmic artery.

blood flow. CT revealed a focus of previous ACE in the right hemisphere.

Selective angiography of the brachiocephalic arteries revealed a 4 mm long occlusion of the right ICA in the cervical segment (figure 1) with antegrade opacification of the ICA distal to the occlusion through vasa vasorum and retrograde opacification through the ophthalmic artery (figure 2). The left ICA was without hemodynamically significant stenoses, the right anterior and middle cerebral arteries opacified through the anterior communicating artery.

In view of frequent recurrent TIA in the right hemisphere and the presence of occlusion in the right ICA the patient underwent single-photon emission computed tomography for the evaluation of cerebral perfusion and cerebrovascular reserve. A large focus of ischemia with decreased cerebrovascular reserve was found in the right hemisphere(figure 3).

Taking into account symptomatic chronic occlusion of the right ICA, the presence of the distal bed and perfusion disturbances in the right hemisphere we decided to proceed with the intervention – recanalization and stenting of the right ICA.

Endovascular intervention was performed under local anesthesia through the right transfemoral approach. A system including coronary guidewire PT2 (Boston Scientific) and coronary balloon catheter 1,5-10 mm was advanced to the area of occlusion in the ICA with the use of proximal protection MoMa Ultra (Invatec). Recanalization with the guidewire and predilatation of the occluded area were performed. The retrograde blood flow was obtained. 40 ml of blood were aspirated, no sediment was found in the filter. Angiography revealed a long stenosis in the cervical segment of the right ICA. A carotid stent Cristallo Ideale 6-8 x 40 mm (Invatec) (figure 4) and a coronary stent Multi-Link (Abbott Vascular) (figure 5) were implanted in the long stenosis area. Control angiography showed antegrade opacification of the right ICA, the anterior and the middle cerebral arteries, the blood flow TICI-3 (figures 6 and 7). SPECT of the brain, performed prior to the discharge, demonstrated improved perfusion in the right hemisphere (figure 8).

DISCUSSION

According to Flaherty et al., the rate of symptomatic chronic occlusion of the ICA is 6 per 100 000, and these data are only approximate, as many patients with TIA do not apply for medical care, and some patients with stroke or TIA are not submitted to the imaging of the carotid arteries (4). The same authors believe that about 15% of all strokes are due to the occlusion of the carotid arteries (4). The rate of asymptomatic occlusion of the ICA is unknown.

Annual risk of recurrent stroke in the presence of occluded ICA is as high as 5-7%, with the rate of stroke in the territory of the occluded ICA is 2-6% (5-7). Moreover, in patients with chronic occlusion of the ICA and decreased cerebrovascular reserve the risk of recurrent stroke is significantly higher – up to 30% per year (5,7-9). The risk of stroke persists despite standard double antiplatelet therapy (7).

Clinical picture of occlusion of the ICA varies from totally asymptomatic to severe disabling stroke and death (10). Neurological symptoms in patients with chronic occlusion of the ICA can arise in the situations when brain perfusion is decreased: abrupt uprising from the lying or sitting position (orthostatic TIA), post-

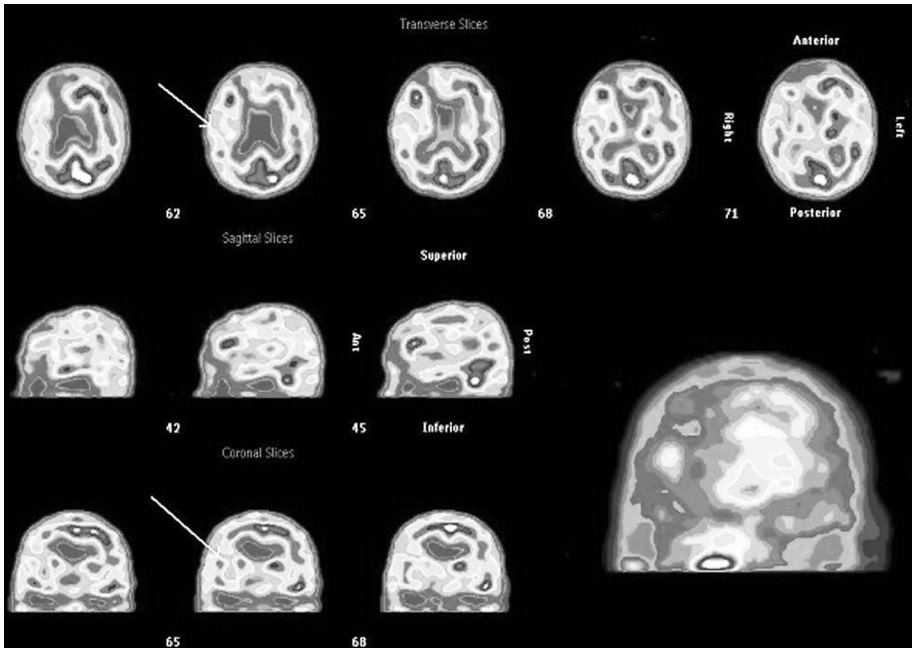

Fig. 3. Single-photon emission computed tomography of the brain of patient Z. prior to endovascular intervention (the arrow marks the ischemic focus in the right hemisphere).

prandial hypotension, blood loss or fluid loss, in physical load and heart failure (10,11). Repeated involuntary movements of one or both ipsilateral extremities that frequently are interpreted as manifestation of epilepsy, represent in fact a rare manifestation of cerebral hemodynamics disturbances in patients with chronic occlusion of the ICA (10-12). Meanwhile the EEC does not demonstrate any epileptiform activity (10,13,14). Some patients develop atypical headaches as a result of forming collateral circulation (10). Collateral blood flow in the branches of the external carotid artery in patients with occlusion of the ICA can cause pulsation in the area of the mandibular angle, brow and cheek (15). The presence of an episode of transient sight loss in one eye (amaurosis fugax) is highly suggestive of the ICA lesion proximal to the ophthalmic artery (10). Despite the fact that amaurosis fugax is a symptom of acute retinal ischemia most commonly caused by embolization from the ICA, the syndrome of chronic ocular ischemia can develop in 4 to18% of patients with occlusion or critical stenosis of the ICA (16). In such case the patients complain of progressive sight loss (16). The occlusion of the ICA also can be manifested by episodes of syncope (17). According to one hypothesis, chronic cerebral ischemia caused by the occlusion of the ICA can lead to dementia (18).

In the presence of chronic occlusion of the ICA cerebral and retinal ischemia can be caused by embolism, insufficient perfusion or both (10). The source of embolism can be proximal stump of the occluded ICA as well as atherosclerotic plaques in the common or external carotid arteries (10). In such case the embolism occurs through the collaterals of the external carotid artery (10). This mechanism can be confirmed by the fact of total cessation of symptoms after the exclusion of the proximal stump of the ICA from the circulation and antiplatelet therapy (10,19). Besides, there is a possibility of embolism development from the distal segment of the occluded ICA (5). However due to the absent antegrade flow in such case the risk of embolism can not be high (20). The insufficiency of cerebral blood flow plays the main role in the pathogenesis of ischemia in patients with the occlusion of the ICA (10,11,20-22). In the presence of chronic occlusion of the ICA the brain perfusion is maintained by collateral circulation, whose insufficiency can contribute to hemodynamic disturbances (10). The studies with the use of functional neuroimaging methods, such as PET and SPECT, have demonstrated that disturbed brain perfusion in the presence of chronic ischemia of the ICA is an independent factor for future TIA and/or strokes (10,23). The occlusion of the ICA is often associated with borderline areas' infarctions, resulting from cerebral perfusion insufficiency (10,24). Besides, both mechanisms can act in the same patient (10,25). At the same time, according to animal studies, in case of embolism the size of stroke is significantly increased in the presence of associated insufficiency of the cerebral blood flow (26).

Carotid endarterectomy is a preventive measure against stroke in patients with the stenosis of the ICA, but in cases of occlusion of the ICA the rate of successful open surgery is only 34% because of technical problems (27). Theoretically, extra-intracranial bypass grafting can improve cerebral blood flow in patients with the occlusion of the ICA, but it proved to be ineffective in decreasing the incidence of stroke in comparison with pharmacological therapy (28). Low effectiveness of open interventions has switched the attention to the strategy of reinforcement of collateral blood flow by the way of stenting of the external or common carotid arteries, contralateral ICA, or vertebral arteries, depending on the source of collaterals. However up to now there are no randomized trials supporting this practice (10, 11).

The papers demonstrating the effectiveness and safety of stenting in acute occlusions of the ICA can be found in the world literature (29). Recent publications describe successful endovascular interventions in chronically occluded carotid arteries (20-22).

Our small clinical series demonstrate the feasibility and the effectiveness of endovascular recanalization with subsequent stenting in certain patients with chronic occlusions of the ICA. Our main criteria of patients' selection for endovascular intervention were:

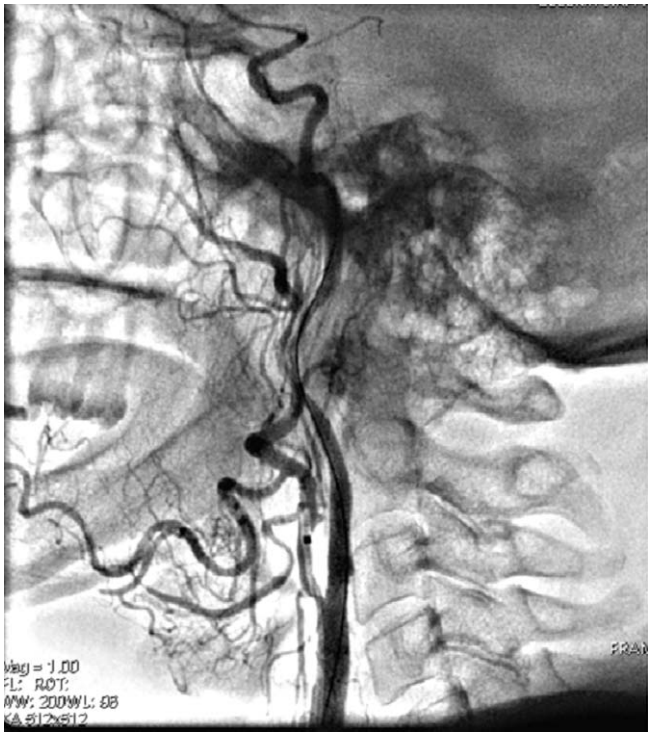

Fig. 4. The right internal carotid artery after the implantation of a carotid stent: a stenosis can be seen in the cervical segment distal to the stent.

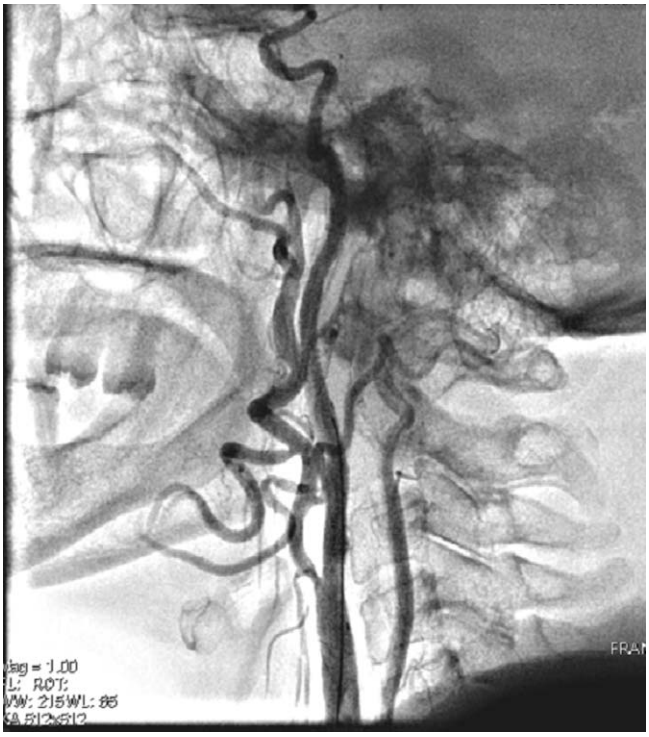

Fig. 5. The right internal carotid artery after endovascular intervention.

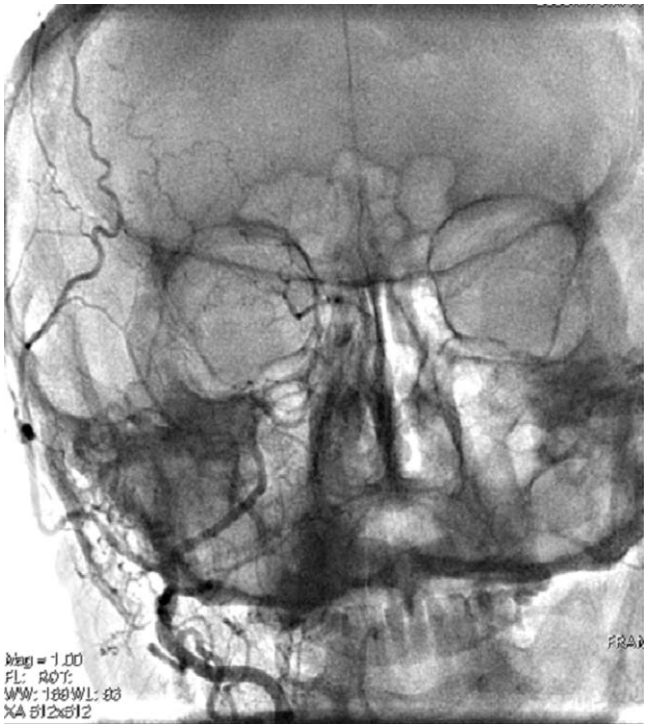

Fig. 6. Selective angiography of the right internal carotid artery before and after endovascular intervention. Antegrade opacification of the intracranial segment of the right ICA, the anterior and the middle cerebral arteries are absent.

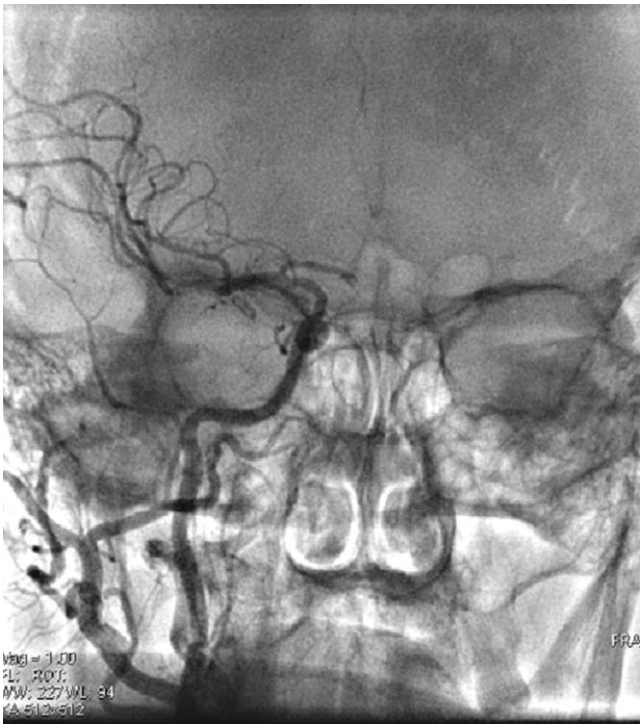

Fig. 7. Selective angiography of the right common carotid artery after endovascular intervention.

1) unstable neurological status or progressive neurological deficit in the territory of the occluded ICA in the settings of adequate conservative therapy, 2) the ischemia of ipsilateral hemisphere confirmed by SPECT or perfusion CT, and 3) the opacification of the cervical segment of the ICA distal to the occlusion, which, according to literature data, is a good predictor of successful recanalization (22). If this opacification of the cervical segment is absent, the eventual success of endovascular revascularization is doubtful, but in the

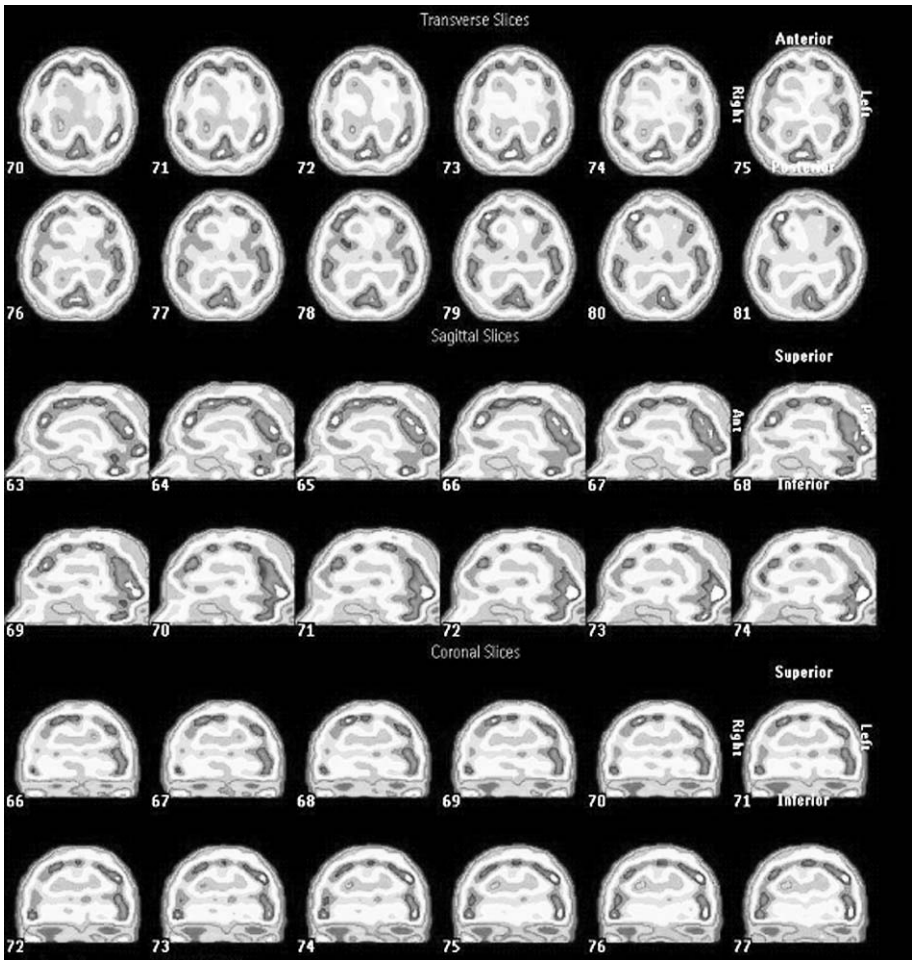

Fig. 8. Single-photon emission computed tomography of the brain of patient Z. after endovascular intervention. The perfusion in the right hemisphere is improved.

presence of such opacification the revascularization is feasible in a properly selected cohort of patients.

In our practice the opacification of the cervical segment of the ICA distal to the occlusion has been revealed by selective angiography of brachiocephalic arteries in 24% of cases. It allowed us to consider it feasible to perform a successful endovascular correction of this pathology with the restoration of adequate antegrade blood flow. It is worth noting that the presence of a patent distal segment in patients with diagnosed occlusion of the ICA has been revealed only by selective angiography of brachiocephalic arteries. Ultrasound studies and CT-angiography were less informative in the evaluation of the ICA bed distal to the occlusion, probably, because of technical difficulties of imaging of a low-velocity arterial blood flow and insufficient specialists' awareness of the possibility of surgical correction of this pathology.

Endovascular correction of chronic occlusion of the ICA are associated with the risk of distal embolism, dissection or perforation of the carotid artery (21,22). We have used the system of proximal protection MoMa Ultra (Invatec) in all 7 patients. In one case after recanalization, predilatation and obtention of retrograde blood flow, macroscopic sediment from the aspirated blood has been found at the filter. In this case we decided to use an additional distal protection system Accunet (Abbott Vascular).

The incidence of stenosis after the stenting of chronically occluded carotid arteries is unknown (22). The data obtained after stenting of chronically occluded subclavian arteries suggest that the incidence of restenosis in such high-flow vessels is low (30).

The revascularization of critical stenoses of the carotid arteries is always associated with the risk of hypoperfusion syndrome (22). The risk of its development after stenting of chronic occlusions of the ICA is unknown, but it has been proved that the patients with decreased cerebrovascular reserve are at higher risk for hypoperfusion syndrome (21,22,31). In order to prevent perioperative hypoperfusion syndrome we have tried to maintain systolic pressure at 100-140 mm Hg.

The risk of hypoperfusion syndrome also increases in the presence of critical contralateral stenosis (32). Two of our patients had hemodynamically significant lesions of contralateral ICA. The first step of correction in these patients consisted in the stenting of hemodynamically significant stenosis of contralateral ICA in order to eliminate TIA due to improved cerebral perfusion. The improvement of neurological status was temporary. SPECT of the brain confirmed hemisphere ischemia at the side of occlusion, and the patients were offered the second step of correction.

CONCLUSION

Small number of cases, the use of such traditional control end-points as new TIA or stroke, are not sufficient for full-value demonstration of the effectiveness of these endovascular interventions. Our small clinical series show that such interventions are feasible and safe. It is very important to properly select patients who will receive the biggest benefit from this kind of treatment. In the future it will be necessary to conduct large prospective randomized trials with the evaluation of functional neurocognitive changes for the determination of clinical effectiveness and indications for recanalization of chronic occlusions of the ICA.

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Evaluation of the Probability of Single-Vessel Coronary Disease in Patients with Acute Coronary Syndrome without ST-Elevation

N.V. Solovieva[1], N.N. Burova[2], T.D. Glebovskaya[1], N.A. Mikhalchikova[1]*
1 – Almazov Federal Heart, Blood and Endocrinology Center of the Ministry of Healthcare and Social Development of Russia, St. Petersburg;
2 – Consultative and Diagnostic Center with Out-Patient Department of the Administration of the President of RF, Moscow, Russia.

Randomized clinical trials have shown that standard invasive technique of treatment improves early and late prognosis in patients with acute coronary syndrome without ST-elevation (non-STEACS). 9 to 21% of patients with acute coronary syndrome require myocardial revascularization by the way of aortocoronary bypass grafting during their first admission. We have established a group of signs determining reliably high probability of detecting single-vessel coronary disease: no history of coronary artery disease and arterial hypertension, absence of chronic heart failure prior to non-STEACS development, low risk as assessed by GRACE score. The highest probability of single-vessel coronary disease was noted in patients with new-onset angina, without heart failure and with preserved myocardial contractility.
Key words: *acute coronary syndrome, coronary angiography, single-vessel coronary disease*

Purpose. To establish the group of signs determining a reliably high probability of diagnosis of single-vessel coronary disease.

Background. The prediction of the volume of coronary lesions in patients with acute forms of coronary artery disease (CAD), including those with acute coronary syndrome without ST-elevation (non-STEACS), is extremely important for differentiated approach to the admission of patients in medical institutions with different level of organization and methodological readiness.

Material and methods. We have examined 102 patients with non-STEACS at high risk for cardiovascular complications. Coronary angiography has been performed in all patients within the first 72 hours after the admission. On the basis of its results, 50 patients with single-vessel coronary disease (SVCD) were assigned to group I, and 52 patients with multivessel disease (MVD) – to group II (control).

Results. We have established a group of signs determining a reliably high relative chance for the detection of SVCD:

1. Clinical signs: age ≤ 50 years; no symptoms of CAD, no history of arterial hypertension; absence of chronic heart failure prior to the development of non-STEACS symptoms; new-onset angina in the beginning of non-STEACS ; absence of acute heart failure during non-STEACS ; low GRACE score.
2. Laboratory signs: isolated triglyceridemia.
3. Instrumental signs: absence of repolarization changes on ECG; left atrial size prior to EchoCG ≤40 mm; normal myocardial contractility; absence of diastolic dysfunction of the left ventricle.

The probability of SVCD in patients with new-onset angina in the absence of echocardiographic signs of diastolic dysfunction was 81%. SVCD was maximally probable in patients with new-onset angina, no clinical signs of heart failure and normal myocardial contractility.

Conclusions. We have established the signs determining the high probability of single-vessel coronary disease in patients with non-STEACS at high risk of cardiovascular complications.

Randomized clinical trials have shown that standard invasive tactics of treatment in patients with acute coronary syndrome without ST-elevation (non-STEACS) improves early and late prognosis. 9 to 21% of patients with acute coronary syndrome require myocardial revascularization by the way of aortocoronary bypass grafting during their first admission. We have established a group of signs determining reliably high probability of detecting single-vessel coronary disease: no history of coronary artery disease and arterial hypertension, absence of chronic heart failure prior to non-STEACS development, low risk as assessed by GRACE score. The highest probability of single-vessel coronary disease was noted in patients with new-onset angina, without heart failure and with preserved myocardial contractility.

* Address for correspondence:
Dr. Natalia Solovieva.
Russia, 194354, St. Petersburg,
Severny prospekt, 8, bld. 1, apt. 181.
Tel: +7 921 323 40 44
E-mail: phroska@mail.ru
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ABBREVIATIONS

AH – arterial hypertension
CAD – coronary artery disease
MI – myocardial infarction
CAG – coronary angiography
ACS – acute coronary syndrome
Non-STEACS – acute coronary syndrome without ST-elevation
CHF – chronic heart failure
ECG – electrocardiography
CI – confidential Interval
OR – odds ratio

At the beginning of the 21st century coronary artery disease (CAD) still is one of the thrilling problems of cardiology. This is related to high prevalence of the disease, the decreasing quality of life of patients, high indices of the loss of working capacity and of mortality (1 - 3).

Most life-threatening complications in patients with CAD are associated with acute forms of the disease (4 - 6). The patients with a history of acute coronary syndrome (ACS), including myocardial infarction (MI), are at high risk of reinfarctions, arrhythmias, heart failure, sudden death (7 - 9).

According to J.S. Birkhead et al. (2004) the annual rate of hospitalization for ACS without ST elevation (non-STEACS) is 3 per 1000 of population (10). On the average, in-hospital mortality among patients with non-STEACS in Europe is 5%, by 6 months it reaches 13%, and in 4 years increases two-fold (11 - 15).

The results of numerous randomized clinical trials have shown that standard invasive tactics of treatment decrease the number of coronary ischemic events in high-risk patients, mainly due to the decrease of the rate of recurrent severe myocardial ischemia, readmissions and TLR, thus improving early and long-term prognosis (16 - 24).

Coronary angiography (CAG) reveals single-vessel coronary disease in 30 – 38% and multivessel coronary disease – in 44-59% of patients with ACS (16, 25). Hemodynamically significant (>50%) stenosis of the left main coronary artery is found in 4% to 8% of patients. Diffuse atherosclerotic infiltration of the coronary arteries without significant stenosis of the lumen is revealed in 10 – 20% of patients with ACS (26). The choice of the method and the determination of the volume of revascularization in based on the results of CAG. In 2010 in Russian Federation there were about 140 cathlabs dealing with cardiovascular diseases (2). Meanwhile the hospitals with endovascular facilities often have no technical possibilities to perform open interventions on the coronary arteries, and the percent of patients with non-STEACS in whom myocardial revascularization by CABG is indicated during the first admission, varies from 9 to 21% (27 - 33).

The prediction of the volume of coronary involvement in patients with acute forms of CAD, including those with non-STEACS , seems necessary in view of differentiated approach to patients' admission into the hospitals with different level of organization and methodological readiness.

MATERIAL AND METHODS

102 consecutive patients with non-STEACS who underwent CAG within the first 72 hours after the admission to Almazov Federal Heart, Blood and Endocrinology Center, have been examined and included in our study. None of them had a history of CAG and/or myocardial revascularzation. On the basis of angiographic examination of the coronary vessels the patients have been divided into two groups. Group I (the main group) comprised 50 patients with hemodynamically significant stenosis (>50% of the vessel's diameter) of one coronary artery (40 men and 10 women; mean age 52,00±10,51 years). Group II (the control group) comprised 52 patients with hemodynamically significant stenoses of two and more coronary arteries (40 men and 12 women; mean age 60,14±8,52 years). All patients have been examined in conformity with the same protocol. In order to verify the form of non-STEACS, we evaluated clinical, biochemical, electrocardiographical and echocardiographical data within the first 24 hours after the onset of the disease.

We have analyzed history and clinical data, the results of laboratory studies and instrumental investigations. The risk of unfavorable outcome and MI was evaluated using GRACE score at admission and in dynamics; we also have evaluated the presence of clinical criteria of high and very high risk of MI and/or death.

Statistical processing of the obtained data was performed using "Statistika 6.0" and SPSS software. The criterion of statistical significance was set at $p \leq 0,05$. The factors, significant for the prediction of single-vessel coronary disease in patients with non-STEACS , have been determined in two stages. At first we have selected the signs associated with reliably high odds ratio (OR) of the detection of hemodynamically significant atherosclerotic process in one coronary artery. At the second stage of the study the predictive value of the selected signs has been evaluated and the probability of correct prognosis has been determined.

RESULTS

The diagnosis of non-STEMI was made in 22 patients from Gr. I and in 26 patients from Gr II (p=0,55). Progressive angina has been revealed in 13 patients from the main group and in 25 from the control group (p=0,02); the new-onset angina has been noted in 15 patients from Gr. I and in one patient from Gr. II (p<0,01). In Gr. I coronary angiography has been performed on the average in 15,60±13,00 hours, in the control group – in 16,39±14,88 hours after the admission to the ICU (p=0,78).

The analysis of the age of patients revealed, that 24 patients from Gr. I were aged ≤50 years, while in Gr. II there were only 7 patients of similar age (p<0,01).

Table 1.

The indices of the probability of correct prediction of single-vessel coronary disease

Sign	OR	Probability of correct prognosis
Age ≤ 50 years	5,93 (95%CI 2,25–15,66)	0,68
Absence of CAD	21,33 (95%CI 6,61–68,88)	0,78
Absence of AH	4,69 (95%CI 1,69–13,09)	0,64
New-onset angina in the beginning of non-STEACS	21,86 (95%CI 2,76-173,13)	0,65
Absence of CHF prior to the development of non-STEACS	11,43 (95%CI 4,27–30,56)	0,76
Absence of the signs of acute heart failure in the presence of non-STEACS	14,47 (95% CI 1,82–116,69)	0,59
Normal repolarization on ECG	5,76 (95%CI 1,95 – 17,04)	0,65
Isolated triglyceridemia	9,71 (95%CI 1,17–80,80)	0,58
Left atrium ≤40 mm	2,85 (95%CI 1,23 – 6,55)	0,62
Normal ejection fraction	11,49 (95%CI 3,16 – 41,75)	0,68
No signs of diastolic dysfunction	5 (95%CI 2,12 – 11,79)	0,41
GRACE score ≤108	10,15 (95%CI 3,99 – 25,79)	0,76

In patients with non-STEACS aged ≤50 years, the OR of single-vessel coronary disease was reliably high – 5,93 (95%CI 2,25–15,66). Meanwhile in patients over 50 years the OR of significant single-vessel disease was low (OR=0,17; 95%CI 0,44–0,06).

Prior to the inclusion in the study the signs of CAD were significantly less common in patients from Gr. I than in the control group (32 and 4 patients, respectively; p<0,01). The OR of single-vessel coronary disease in patients with no signs of CAD in history was 21,33 (95%CI 6,61–68,88), and in patients with such signs it was reliably low – 0,05 (95%CI 0,15–0,02).

The OR of single-vessel coronary disease in patients without arterial hypertension (AH) was 4,69 (95%CI 1,69–13,09). In the presence of AH (31 patients from Gr. I and 46 from Gr. II) the OR of single-vessel coronary disease was reliably low 0,21 (95%CI 0,59–0,08); p<0,01.

Patients with new-onset unstable angina preceding ACS had a reliably high OR of single-vessel coronary disease; it was noted in 30% of patients from Gr. I and in 1,9% from Gr. II (p<0,01); OR=21,86 (95%CI 2,76-173,13).

Before the development of the first signs of non-STEACS, 32 patients from Gr.I and 7 patients from Gr. II (p<0,01) had no signs of chronic heart failure (CHF). The OR of single-vessel coronary disease in these patients was high - 11,43 (95%CI 4,27–30,56).

The analysis of clinical presentation of non-STEACS allowed to state, that the patients from Gr. I had no signs of acute heart failure in the presence of non-STEACS , while in Gr. II such signs have been noted in 11 patients (p<0,01). The OR of single-vessel coronary disease in the absence of the signs of acute heart failure during non-STEACS development was reliably high (14,47; 95%CI 1,82–116,69). In patients with the signs of acute heart failure in the presence of non-STEACS the OR of significant stenosis of only one coronary artery was low, and the difference was statistically significant (OR=0,06; 95% CI 0,55–0,01).

Isolated triglyceridemia was significantly more common in Gr. I in comparison with the control group (8 and 1 patients, respectively; p=0,01). The OR of single-vessel coronary disease for this category of patients was 9,71 (95%CI 1,17–80,80).

The ECG did not revel repolarization changes in 19 patients with non-STEACS from Gr. I, while in Gr. II normal repolarization has been registered only in 5 cases (p<0,01). The OR of single-vessel coronary disease in patients with non-STEACS without repolarization changes on the ECG has been considered high – 5,76 (95%CI 1,95 – 17,04).

The analysis of EchoCG data allowed to determine significant differences in the compared groups on terms of the size of the left atrium and the indices of myocardial contractility. We have assessed the OR of single-vessel coronary disease depending on the values of the above-stated parameters. Left atrium was > 40 mm in 13 patients from Gr. I and in 26 from Gr. II (p=0,01). The OR of single-vessel coronary disease in these patients was 0,35 (95% CI 0,81–0,15), while the patients with non-STEACS and the diameter of the left atrium (as assessed by M-mode EchoCG) ≤40 мм the OR was reliably high – 2,85 (95%CI 1,23 – 6,55).

According to EchoCG data, at admission the majority of patients from Gr. I had normal LV contractility (94% patients). In Gr. II normal contractility was noted only in 57,69% of cases (p<0,01). The OR of single-vessel coronary disease in patients with non-STEACS and normal myocardial contractility was high – 11,49 (95%CI 3,16 – 41,75).

The incidence of diastolic LV dysfunction (assessed by EchoCG) in the compared groups also was different (20 patients in Gr. I and 40 in Gr. II; p<0,01). The OR of hemodynamically significant changes of only one coronary artery in this category of patients was reliably low (0,2; 95%CI 0,47 – 0,09), while in patients without signs of diastolic LV dysfunction this index was significantly higher (OR=5; 95%CI 2,12 – 11,79).

Low risk of cardiovascular complications assessed by GRACE score, was significantly more common in patients from Gr. I in comparison with the control group (34 and 9 patients, respectively; p<0,01), which was related to the high OR of single-vessel coronary disease. Thus, the low GRACE score corresponded to OR of single-vessel coronary disease =10,15 (95%CI 3,99 – 25,79).

Hence, we have established a group of signs determining a reliably high OR of single-vessel coronary disease:

Clinical signs: age ≤ 50 years; absent signs of CAD, history of AH; absent CHF prior to the development of the signs of non-STEACS; new-onset angina in the beginning of non-STEACS; absent signs of acute heart failure in the presence of low GRACE score.

Laboratory signs: isolated trigyceridemia.

Instrumental signs: absence of repolarization changes on ECG in the presence of non-STEACS ; left atrial size (assesed by M-mode EchoCG) ≤40 mm; normal myocardial contractility; absence of diastolic LV dysfunction.

The indices of the probability of correct diagnosis of single-vessel coronary disease are shown in Table 1. These data suggest, that the predictive value of the selected signs varies from 41 to 78%. The following signs had high predictive value (>75%): no history of CAD, absence of CHF prior to non-STEACS , low GRACE score (low risk of cardiovascular complications).

The analysis of various combinations of the selected signs for the evaluation of the probability of correct diagnosis of single-vessel coronary disease has established the combinations of signs allowing to improve diagnostic results. Thus, in patients with new-onset angina in the absence of EchoCG-signs of diastolic dysfunction the probability of single-vessel coronary disease was 81%. Single-vessel coronary disease was maximally probable (94%) in patients with new-onset angina, no clinical signs of heart failure and preserved myocardial contractility.

CONCLUSIONS

1. Patients with non-STEACS without history of CAD, in the absence of CHF prior to non-STEACS development, low GRACE score are at high probability to have single-vessel coronary disease.

2. Single-vessel coronary disease is maximally probable in patients with non-STEACS in the presence of new-onset angina, in the absence of clinical signs of heart failure and with preserved myocardial contractility.

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Rare Complication of Stenting of Extracranial Carotid Arteries with the Use of Distal Antiembolic Brain Protection Devices

Z.Kh. Shugushev[1], I.G. Uchkin[2], A.M. Zudin[1], A.G. Bagdasarian[2], S.K. Nasunova[1]*
1-Chair of Surgery of People's Friendship University of Russia, 2-Department of Vascular Surgery and Angiosexology of Research Center of the 1st Moscow Sechenov State Medical University, Department of Vascular Surgery №2, Department of Endovascular Diagnostics and Treatment, Semashko Central Clinical Hospital №2 of the JSC "Russian Railroads", Moscow, Russia

We describe a rare complication of carotid angioplasty and stenting with the use of a distal antiembolic protection device – the detachment of a "snare". In order to restore the lumen of the internal carotid artery and eliminate the deformation of stent the second stent has been implanted.
Keywords: *carotid stenosis, stenting, complication, antiembolic protection device*

ABBREVIATIONS

CAS – carotid angioplasty and stenting
APD – antiembolic protection device
ICA – internal carotid artery
BCA – brachiocephalic arteries
COPD – chronic obstructive pulmonary disease
DB – diagonal branch
CxB – circumflex branch
RCA – right coronary artery
LAD – left anterior descending artery

INTRODUCTION

The complications of carotid angioplasty and stenting are rather common (1). The emphasis on ischemic events seen in modern papers dedicated to the evaluation of CAS-related complications is justified (2). However in practice endovascular surgeons can face rare CAS-related complications requiring unusual approaches and presenting difficulties due to their low incidence. We present a case met in our practice.

CASE DESCRIPTION

Patient U., male, aged 54, has been admitted to the Department of Vascular Surgery №2 on April 07, 2010, with the diagnosis:

Stenotic atherosclerosis of the brachiocephalic arteries; asymptomatic bilateral significant stenoses of extracranial internal carotid arteries; 1st degree cerebrovascular insufficiency; ischemic heart disease; angina of effort class I; condition after stenting of the LAD (April 01, 2010); circulatory insufficiency class II; chronic obstructive pulmonary disease.

* Address for correspondence:
Dr. Arthur Bagdasarian
Russia, 107150, Moscow,
Ul. Losinoostrovskaya, 43.
Tel..: +7 499 160 55 24,
Cell: +7 903 507 15 66,
e-mail: in_vivo@bk.ru,
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The patient was transferred from the Department of Cardiology where he underwent stenting of the LAD. During examination a critical stenosis of the right internal carotid artery (ICA) and hemodynamically significant (up to 70%) stenosis of the left ICA where found. The patient was transferred to the Department of Vascular Surgery №2 for carotid revascularization.

After stenting of the LAD his angina of effort has stabilized (class I). The patient received Cardiomagnyl, Plavix, Enalapryl, Verospiron.

Carotid angiography revealed up to 70% stenosis and tortuosity of the right ICA.

Taking into account the presence of class II circulatory insufficiency, chronic obstructive pulmonary disease, bilateral carotid lesions, associated coronary lesions [the DB – subtotal ostial stenosis, the CxB – up to 50% stenosis at the border of the proximal and the middle segments, the small (< 2 mm) RCA arising from the posterior sinus, with 70% stenosis in the proximal segment and an extended 50% stenosis in the middle segment (right type of coronary circulation)], we decided to perform endovascular carotid revascularization. Despite the tortuosity of the right ICA, primary diagnostic angiography has shown a «convenient» linear segment of the ICA for the implantation of antiembolic protection device (APD). Besides, we have used a nitinol stent Cristallo, which, unlike chromium-cobalt stents, can better adapt to the anatomical features of carotid bifurcation and does not «enhance» the tortuosity.

On April 20, 2010 balloon angioplasty and stenting of the right ICA have been performed.

The patient received an infusion of 6 000 U of heparin (75 U/kg). A guiding sheath was inserted into the right common carotid artery. Angiography has been performed. A 60-70% stenosis with angiographic signs of calcification has been revealed in the distal segment of the common carotid artery, in the ostium and the proximal segment of the internal carotid artery; more distally, in the cervical segment of the right ICA a complete loop has been revealed (figures 1 и 2).

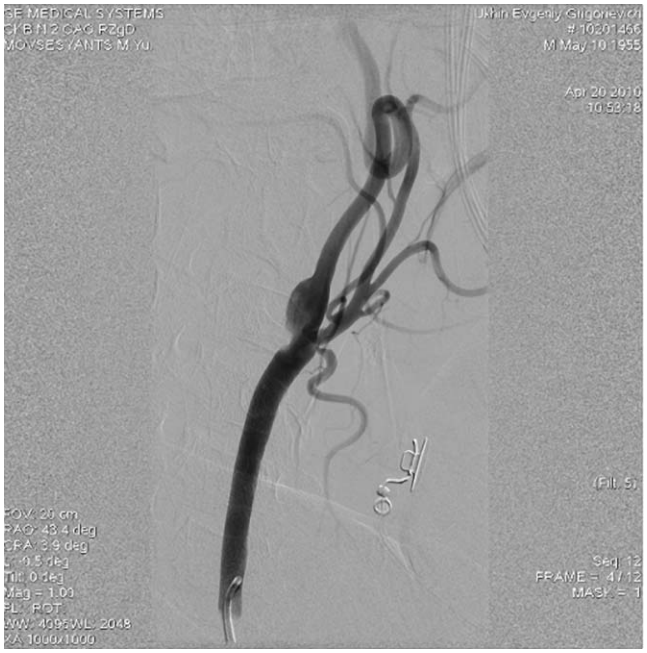

Figure 1. Bifurcation of the right common carotid artery (direct view)

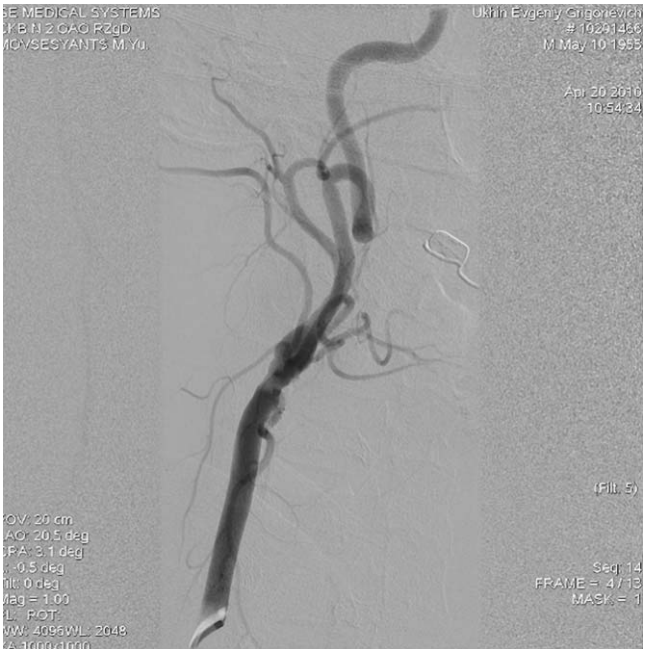

Figure 2. Bifurcation of the right common carotid artery (lateral view)

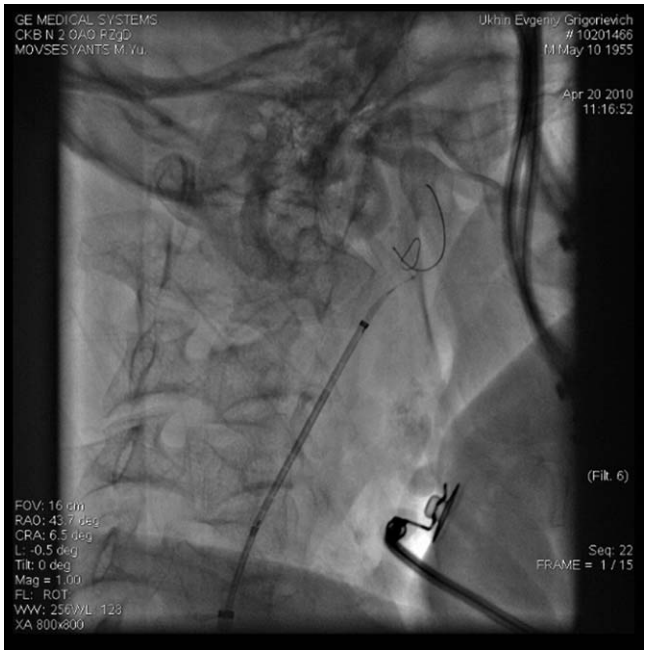

Figure 3. Implantation of the APD and positioning of the stent

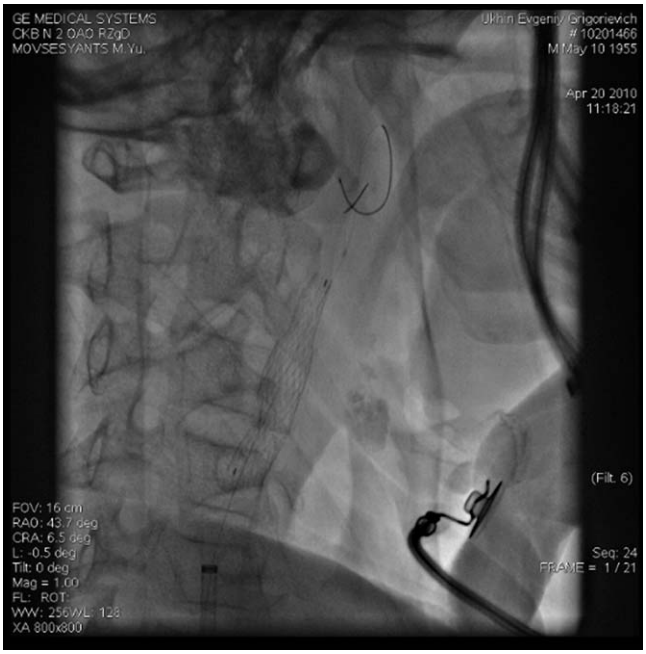

Figure 4. Implantation of Cristallo 6-9 x 40 mm stent in the CCA and the ICA. Stent deployment.

During CAS, the catheterization of the CCA, the implantation of the APD (figure 3), the stenting (figure 4), the post-dilatation of stent (figure 5) went uncomplicated.

During control angiography of the carotid artery bifurcation the detachment of the snare and the deformation of the distal end of stent have been revealed. The contrast ring of the snare could be seen at the mid-level of previously implanted stent, there were no stenoses in the ICA, the artery was patent (figure 6).

In order to eliminate stent deformation we decided to implant the second stent in the ICA, overlapping the distal end of the first stent.

For this purpose, an ATW guide was advanced into the lumen of the stented ICA and positioned in the loop of the right ICA (figure 7).

The second stent has been advanced and successfully implanted by this guidewire. An overlapping in-stent stenting using Cristallo stent 6-9 x 40 mm has been performed (figure 8).

Control angiography (figure 9) showed a totally deployed stent, the APD could be visualized at the site of

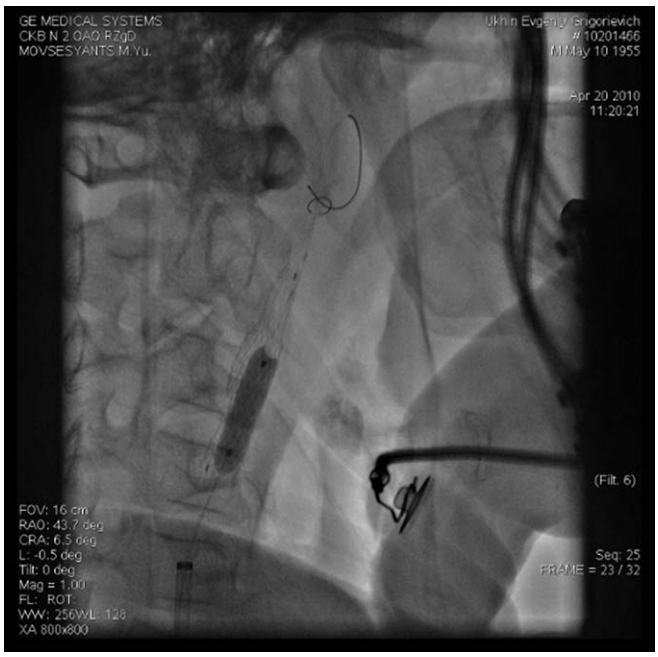

Figure 5. In-stent angioplasty with balloon catheters Ultra-soft 5,5 x 20 mm and Viatrac 6 x 15 mm. Post-dilatation of the stent

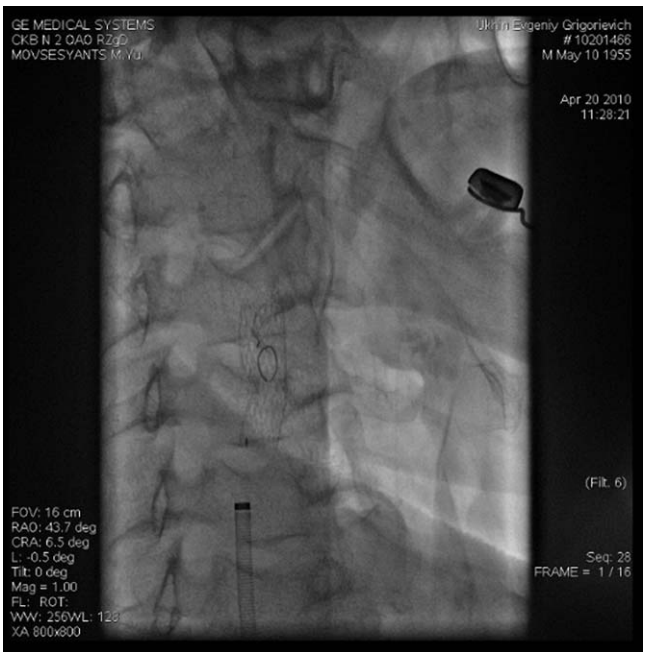

Figure 6. Detachment of the snare and deformation of the stent

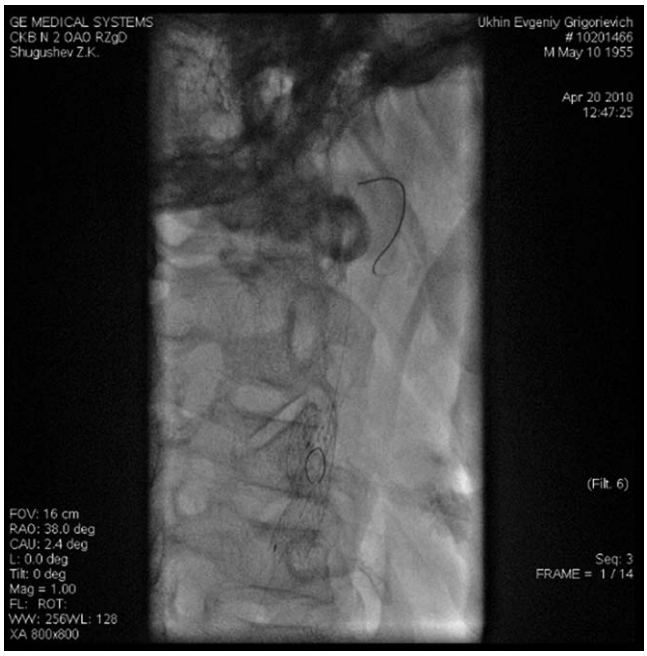

Figure 7. The guidewire is advanced through the stent

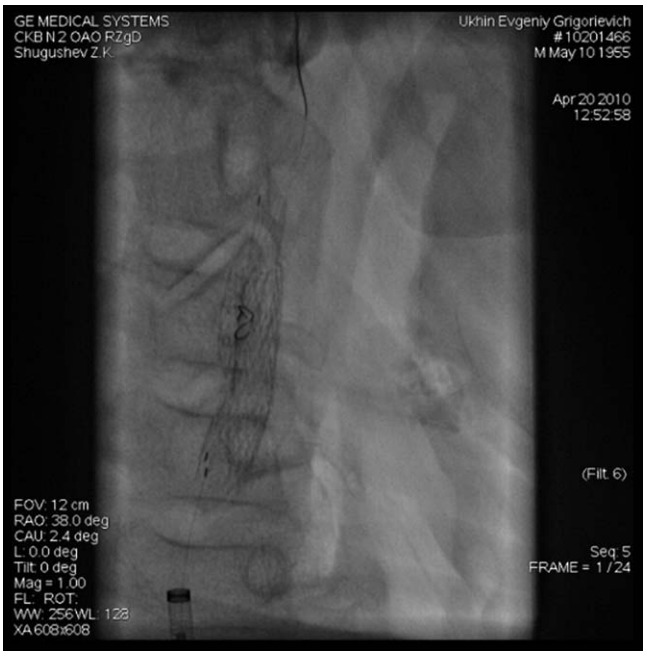

Figure 8. Second stent implantation

two stents' overlapping, there were no dissections, the arterial lumen was totally restored, there were no residual stenoses, the intracranial vessels were unchanged. The operation was terminated. The sheath was removed. The puncture site was sutured using PerClose device and a compression bandage was applied.

The patient has been followed for 8 months. During this period there were no ischemic neurological events in the territory of the stented artery, as well as of the contralateral ICA.

In 8 months after stenting of the right ICA the patient was admitted to the hospital for surgical treatment of the stenosis of the contralateral ICA.

Diagnostic contrast angiography of the BCA showed patent stented ICA, the stents in the right ICA are adequately implanted, there are no signs of restenosis. A stenosis of ~ 70% was revealed in the contralateral ICA (figures 10 and 11).

As conservative therapy conducted after stenting of the LAD led to the regress of the signs of circulatory insufficiency (up to class I), we could perform open revascularization of the left carotid artery. Postoperative recovery was uncomplicated.

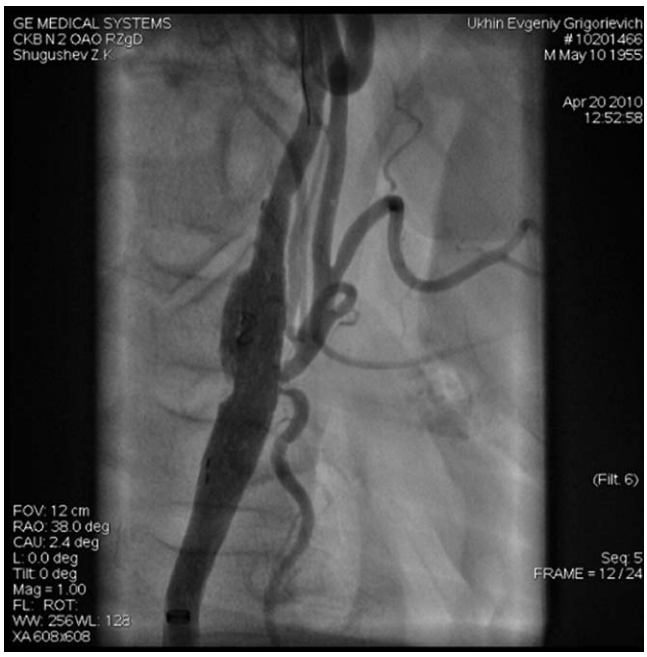

Figure 9. Control angiography

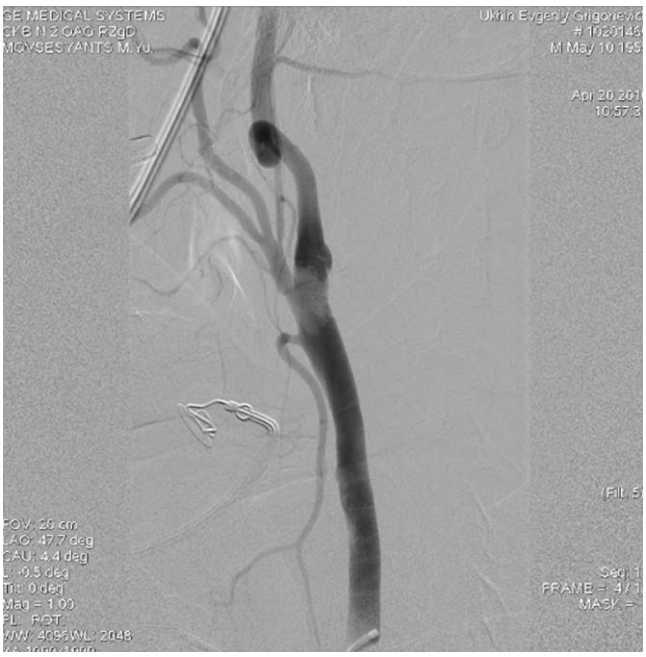

Figure 10. Bifurcation of the left common carotid artery (direct view)

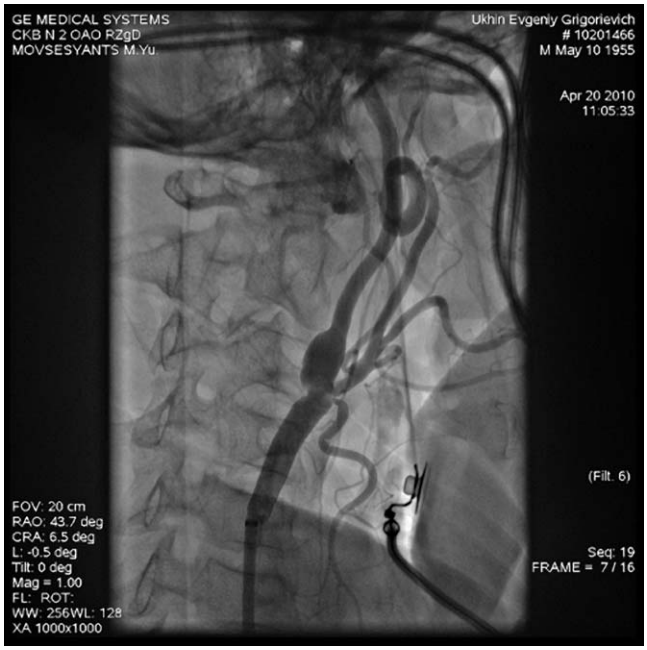

Figure 11. Bifurcation of the left common carotid artery (lateral view)

DISCUSSION AND CONCLUSION

We could not find any description of such complications and any data concerning their incidence in Russian or foreign literature.

When meeting such complication we faced one problem: How to restore normal patency of the artery – by open surgery or by endovascular itnervention?

The open operation allows to remove the stent and the APD. However despite this advantage such operation would necessitate endotracheal anesthesia and extended arteriotomy, thus significantly increasing the time of operation and creating additional risks for the patient. For this reason we decided to restore the ICA's patency using described technique. So, an unusual complication developed in our patient has required an unusual solution. This case can serve an example of tactics acceptable for such rare complications.

Endovascular Reduction of False Aneurysm of the Proper Hepatic Artery. A Clinical Case

A.I. Kvashin, S.A. Atamanov, A.V. Melnik, A.O. Bykov, A.A. Pomkin, M.G. Shirkin.*
Scientific Center of Reconstructive and Restorative Surgery, Irkutsk Regional Clinical Hospital, Irkutsk, Russia

False aneurysm of the proper hepatic artery (PHA) is a rare, life-threatening condition. It forms as a result of yatrogenic injury of the vessel during the operation in the pancreatoduodenal area, or of an abdominal trauma. It can be seen in patients with liver cancer who receive intraarterial transcatheter chemotherapy. We present a clinical case of a patient who received catheter regional chemotherapy. The diagnosis was made on the base of clinical examination, multihelix computed tomography (MHCT), angiographic study. Endovascular correction of the blood flow in the proper hepatic artery was performed using coil embolization of the false aneurysm's cavity under stent-assistance. During control MHCT the blood flow in the proper hepatic artery was not disturbed, the false aneurysmatic cavity did not opacify.
Our case proves that endovascular correction of false aneurysms in this location is highly effective, minimally traumatic and not associated with blood loss.
Keywords: *false aneurysm, stent, hepatic artery, regional chemotherapy.*

ABBREVIATIONS

PHA – proper hepatic artery.
MHCT – multihelix computed tomography
CT – computed tomography
RHC – regional hepatic chemotherapy
CT – celiac trunk
GDA – gastroduodenal artery

INTRODUCTION

Regional hepatic chemotherapy (RHC) as a method of palliative treatment of non-resectable liver cancer has been firstly applied in the 1960-ies (2,13). An infusion catheter is inserted into the gastroduodenal artery using a direct intraoperative puncture. The agents entering the hepatic blood flow produce a marked cytotoxic effect thus decreasing systemic manifestations of the disease (2). Being a dominating method of treatment of colorectal hepatic metastases, RHC has been widely used in the end of 20th century, which was in part related to the problem of liver transplantation (1,4,6,8,12,17,23,28). Along with its benefits this method has several disadvantages. The cases of thrombosis of the catheterized vessel, the episodes of sickness, vomiting and diarrhea have been described (5,14,27). Also RHC can be accompanied by cholangitis and liver abscesses (20). The development of false aneurysm of the proper hepatic artery (PHA) is a rare complication of PHC.

CLINICAL CASE

Patient P., female, aged 53, underwent the treatment in the department of purulent surgery of Irkutsk Regional Clinical Hospital in March 2011. Her main diagnosis was: cancer of the left hepatic lobe T4N1M1, 4th degree, 4th clinical group. The main disease has been complicated by hematic abscess of the omental sac and reactive left-sided pleuritis.

In August 2010 the patient underwent left-sided hemihepatectomy in the Regional oncological dispensary. She received several courses of intraarterial chemotherapy through a port device implanted in the gastroduodenal artery. In early 2011 she has applied twice in the oncological dispensary with the clinical signs of acute pancreatitis and has been successfully managed. In March 2011, after the latest course of chemotherapy she had another acute aggravation of pacreatitis with clinical symptoms of peritoneal abscess. The arterial port was removed from the GDA. Computed tomography of the abdominal area revealed a fluid-filled mass measuring 34 x 27 mm in the head of pancreas as well as a large volume of fluid in the omental sac. The patient has been transferred for further management to the department of purulent surgery of Irkutsk Regional Clinical Hospital with the diagnosis of acute destructive pancreatitis. Left pleural puncture performed at admission allowed evacuating 250 ml of serous fluid. Antibacterial and infusion therapy was prescribed and in order to choose further tactics of treatment MHCT has been scheduled. At day 2 after the admission the patient had an episode of intestinal bleeding. MCHT confirmed the state after left-sided hemihepatectomy and revealed hepatic cysts, caudal pancreonecrosis with the formation of parapancreatic sequestrum-containing abscess

* Address for correspondence:
Dr. Alexey Melnik.
Russia, 664000, Irkutsk, microdistrict Yubileyny 100,
Irkutsk regional clinical hospital, Department of Angiography.
E-mail: am78@bk.ru
Tel. +7 964 212 25 45
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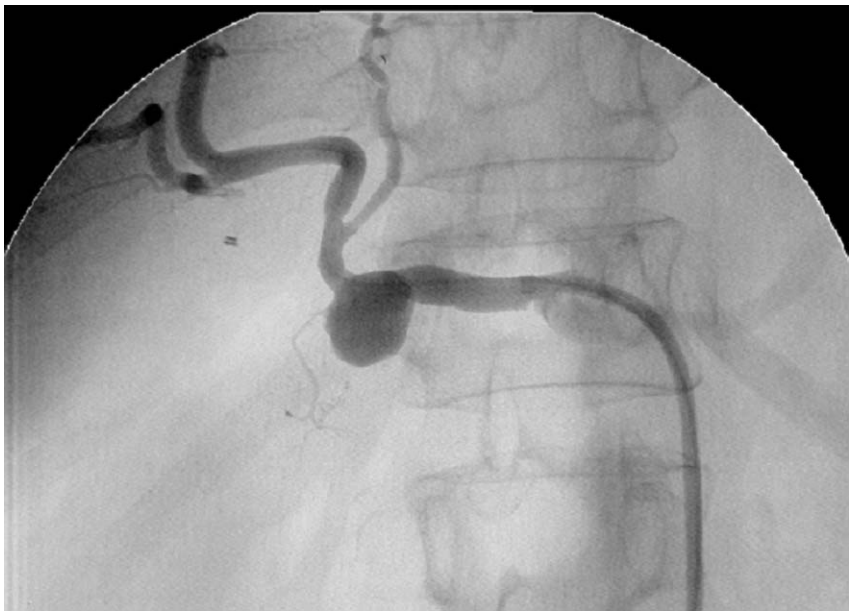

Fig. 1. Celiacography. False aneurysm of the proper hepatic artery.

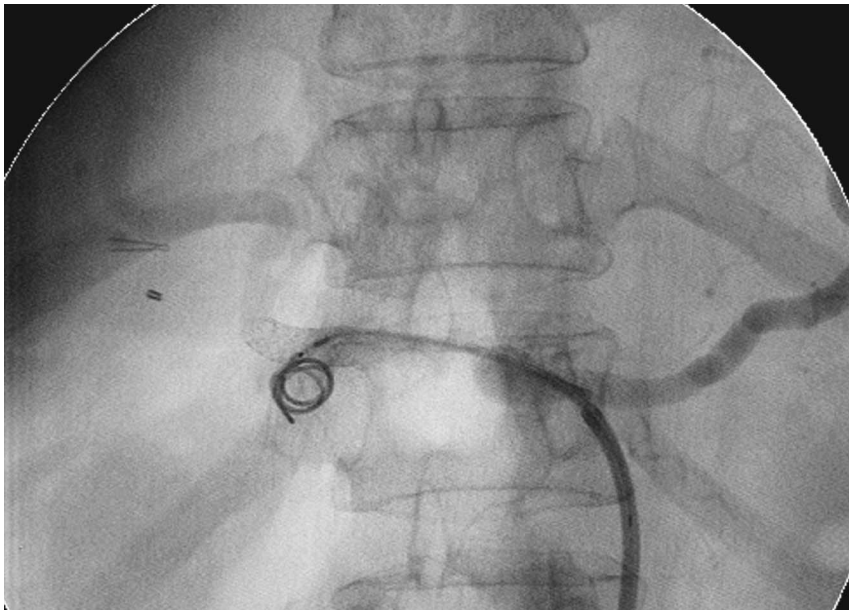

Fig. 2. Stage of coil embolization of the aneurysmatic cavity through the strut of the impalnted stent.

with the signs of bleeding, parapancreatic infiltrate, the cysts of the head of pancreas, left-sided small hydrothorax. Taking into account digestive bleeding we decided to perform angiographic examination of the celiac trunk pool. The approach was achieved through the right femoral artery. Celiacography and upper mesentericography in frontal view showed the origin of the celiac trunk at the level of the lower edge of Th-12. The branching was normal. A false aneurysm with turbulent intracavitary blood flow was revealed in the projection of the gastroduodenal artery (figure 1). The neck of the aneurysm = 12 mm, its diameter = 11x10 mm. The gastroduodenal artery could not be seen. There was good opacification of the right hepatic artery and fragmentary opacification of the left hepatic artery in the proximal segment; its distal branches could not be seen. The superior mesenteric artery was without pathological changes. In the presence of a wide neck of the false aneurysm and in the absence of a stent-graft of necessary size we decided to perform embolization of the aneurysmatic cavity under stent-assistance. A string-guide was advanced into the distal segment of the right hepatic artery. The stent Hippocampus (5.5-20) InvaTec was implanted into the aneurysm. Control angiography showed the stent covering the aneurysm's neck, while its cavity was filled through the stent struts. At the next stage a removable Flipper coil with 5 turns and the turn's diameter = 8 mm (COOK) was inserted into the aneurysm's lumen (figure 2). Control examination revealed partial filling of the aneurysm with markedly decelerated blood flow (figure 3). The blood flow in the major branches of the celiac trunk was not impaired. The intervention was terminated and the patient was transferred to the ICU. Postoperative period was uncomplicated. In 2 days the patient underwent control MHCT-angiography that revealed a patent stent in the hepatic artery. The false aneurysm could not be visualized, the opacified blood did not spread outside the hepatic artery (figure 4.).

The applied treatment contributed to the positive changes in the patient's condition, hyperemia was stopped, the palpable infiltrate in the abdomen decreased, the appetite as well as the general condition improved. The patient was discharged under the care of oncologist.

DISCUSSION

The formation of a false aneurysm of the common or proper hepatic artery after the insertion of an intraarterial catheter for prolonged chemotherapy has been described in world literature (7,11,12). False aneurysms of the hepatic arteries can be clinically silent up to the moment of rupture with the development of life-threatening digestive bleeding (26). There are descriptions of the rupture of false aneurysms in this location with the formation of fistulae into the biliary system, the intestinal tract, the omental sac

(13,16,18). Surgical intervention related to the placement of an intraarterial port is often associated with intimal trauma leading to vascular wall dissection. The aneurysm of hepatic arteries account for about 20% of all visceral aneurysms (15). Some 65% of them are prompt to rupture, which leads to death in 20% of cases (15,22). The symptoms of rupture include abdominal pain in case of retroperitoneal bleeding and hemobilia or melena in case of drainage into the gastrointestinal tract. Endovascular separation of the false aneurysm from the true vascular lumen is the priority trend in the treatment of this pathology (3,9,10,19,21,24,25).

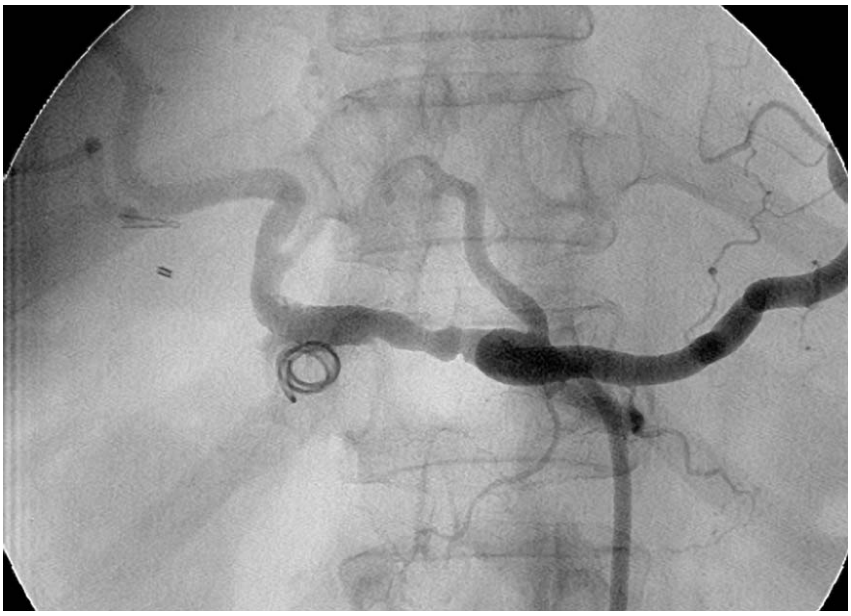

Fig. 3. At control celiacography the cavity of the false aneurysm is not opacified.

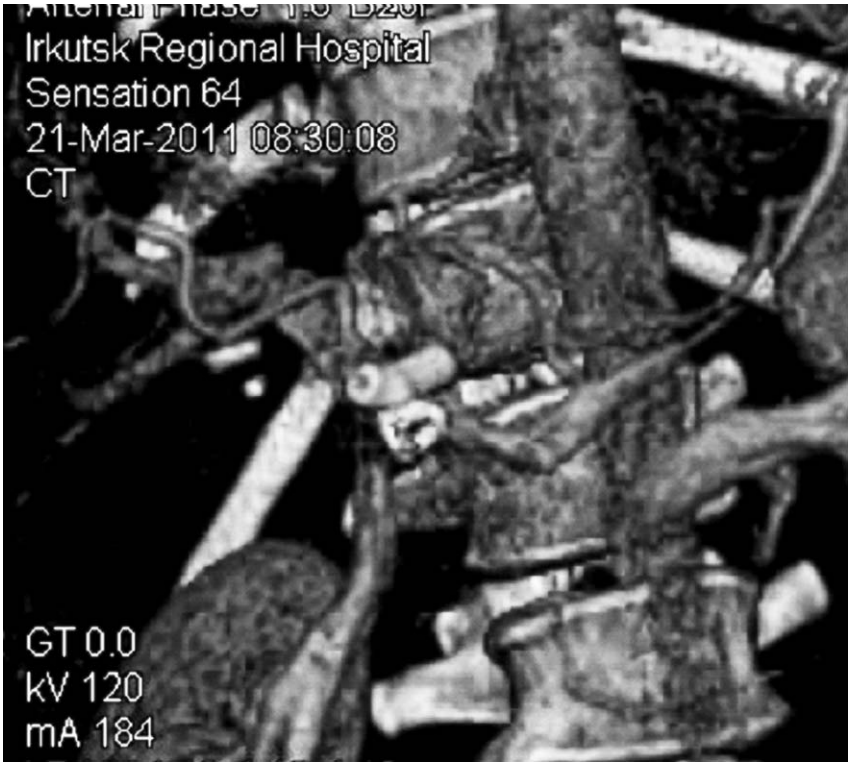

Fig. 4. MHCT-angiography of the celiac trunk. The stent in the proper hepatic artery is totally patent, there is no opacification of the false aneurysmatic cavity.

CONCLUSION

Regional chemotherapy applied for primary liver cancer can cause the development of false aneurysm at the site of catheter insertion. Endovascular separation of the false aneurysm's cavity from the arterial lumen is a minimally invasive, low-traumatic and highly effective method of treatment for this pathology. The feasibility of intravascular surgery in severely ill patients, the absence of blood loss and of deep anesthesia offer the possibility of wide use of this method.

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Coronary Bifurcation Stenoses: Problems and Prospects (a Review of Literature)

*Z.Kh.Shugushev[1,2], D.A. Maksimkin[1,2] *, Yu.V. Tarichko.*
Chair of Surgery with the Course of pediatric Surgery of the Peoples' Friendship University of Russia[1], Semashko Central Clinical Hospital №2[2], Moscow, Russia

The authors present the analysis of recent randomized trials, demonstrating the effectiveness of various drug-eluting stents in patients with coronary bifurcation stenoses and illustrate the main problems related to the choice of the optimal technique of stenting, the reasonability of routine use of intravascular ultrasound, the prevention of late stent thrombosis, as well as describe the prospects of endovascular treatment of patients with coronary bifurcation stenoses.
Keywords: *bifurcation stenoses, drug-eluting stents, intravascular ultrasound, antiplatelet therapy.*

The year 1977, when A Gruentzig (1) has suggested the idea of simultaneous inflation of two balloon catheters in the main and the side branches of coronary bifurcation should be considered as the year of the start of endovascular management of coronary bifurcation stenoses (CBS). In 1989 B. Meier (2) for the first time has used this technique in clinical practice. However it did not spread largely enough because of high rate of unsatisfactory results. The risk of side branch occlusion during balloon dilatation of the main artery was 14-33%, and the blood flow in the side branch was compromised in 27-41% of cases (3,4).

In most cases unsatisfactory results of balloon angioplasty of bifurcation stenoses are caused by the dislocation of the plaque's elements in the side branch ostium (the «snow-plough» effect), that makes it necessary to perform several balloon inflations, sometimes under high pressure (5,6). This, in its turn, can lead to the development of extensive intimal dissection in the main artery, as well as to the thrombosis and subsequent myocardial infarction (MI) (7).

The randomized trial TULIPE has shown that the angle of bifurcation is the most frequent predictor of the side branch occlusion, along with its diameter and the ostial type of the lesion (8). On the contrary, the DKCRUSH-1 trial has shown that the angle of bifurcation does not influence the rate of restenosis and cardiac events in the long-term after the intervention (9).

The eccentricity of the lesion in another unfavorable factor in the treatment of bifurcation stenoses (4, 6, 7). During balloon inflation, uneven distribution of effort due to this eccentricity causes overdistention of the free part of the vascular wall, thus inhibiting the formation of the plaque's intima disruption, and leads to elastic recoil of the artery. This is one of the main causes of a significant residual stenosis after balloon angioplasty (2, 4, 6, 10, 11).

Thus, a peculiar vicious circle is created: the dislocation of the plaque into the side branch ostium prevents its fragmentation and pressing into the deep layers of the artery, while the impact of multiple dilatations leads to overdistention of the free wall and then – to elastic recoil or to extensive intimal dissection (6).

Because of all above the leading place in the treatment of CBS went to surgical myocardial revascularization, while angioplasty has been performed in only 4-16% of such patients (12,13).

To date, balloon angioplasty as an independent method of treatment is virtually not used in patients with CBS, as it is considered as a high-risk intervention and does not allow to restore a full-value blood flow in both branches of the bifurcation.

STENTING OF CORONARY BIFURCATION STENOSES

The introduction of coronary stents into the clinical practice has given to reconsideration of the indications for endovascular myocardial revascularization in patients with CBS. According to various sources, immediate success of stenting is 89-99%, however the rate of repeated interventions in the long-term still remains high (3, 6, 12, 14-19).

J. Dens et al. (20) have noted 8% of restenoses in the group of patients after stenting of bifurcation stenoses, versus 26% in the group after balloon angioplasty ($p<0,05$). The rate of repeated revascularization was 12,5% and 16%, respectively ($p<0,05$), while the rate of cardiac events in both groups was not significantly different.

The introduction of drug-eluting stents (DES) led to cardinal improvement of the results of stenting for coronary bifurcation stenosis (14, 16, 18, 19, 22-34).

* Address for correspondence:
Dr. Daniil Maksimkin,
Chair of surgery of the PFUR,
Russia, 117198, Moscow, ul Miklukho-Maklaya, 8
Tel. +7 916 788 66 75
e-mail: danmed@bk.ru,
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Table 1.

Comparative analysis of the effectiveness of DES and BMS

Stent type	Trial	N of patients	Follow-up duration, months	Rate of cardiac events, %		Rate of restenosis, %		Target lesion revascularization, %	
				DES	BMS	DES	BMS	DES	BMS
Cypher	RAVEL [39]	238	6	6	29,3	0	26	0	26
				P < 0,0001		P < 0,0001		p < 0,0001	
	SIRIUS [28]	1101	9	7,1	18,9	3,2	35,4	4,1	16,6
				P < 0,0001		P < 0,0001		P < 0,0001	
Taxus	TAXUS IV [37]	1314	12	10,8	20,0	10,0	19,4	4,4	15,1
				P < 0,0001		P < 0,0001		P < 0,0001	
	TAXUS V [37]	1156	9	11,5	20,1	14,5	31,2	8,7	15,7
				P < 0,0001		P < 0,0001		P < 0,0001	
	TAXUS VI [40]	446	9	16,4	22,5	22,2	42,8	6,8	18,9
				P < 0,0001		P < 0,0001		P < 0,0001	
Endeavor	ENDEAVOR II [79]	1197	9	7,3	14,4	8,1	15,4	5,6	12,5
				P < 0,0001		P < 0,0001		P < 0,0001	
Xience V	SPIRIT I [32]	60	12	15,4	21,4	8,1	15,4	7,7	21,5
				P < 0,0001		P < 0,0001		P < 0,0001	

The most widely used DES are Sirolimus-eluting «Cypher» stent (Cordis, Johnson & Johnson, USA), Paclitaxel-eluting «Taxus» (Boston Scientific, USA) and Everolimus-eluting «Xience-V» stent (Abbott Vascular, USA) (27, 30, 31, 35, 36).

Long-term results of endovascular treatment of patients with CBS suggest that independently of the type of stent used, DES allow to decrease the rate of the main branch restenosis to 3-5%. However the rate of side branch restenosis, requiring repeated intervention is still rather high and often exceeds 20% (10, 14, 18, 19, 21-24,27,35,36).

The differentiated approach to the strategy of bifurcation stenting suggested in our studies and based on the identification of risk factors for PCI-related complications that develop with the use of DES (independently of the DES type) allowed to decrease the rate of side branch restenosis to 5,5% after provisional side branch stenting and to 2,9% after complete bifurcation stenting (p>0,05). Herewith restenosis of the main branch was absent. The rate of target lesion revascularization (TLR) was 5,5 and 5,8%, respectively (p>0,05) (32-34,37)

High effectiveness of DES in comparison with bare metal stents (BMS) has been shown in several large randomized trials (Table 1).

According to some authors, Sirolimus-eluting stents are the most effective in patients with CBS (10, 27, 28, 35, 40-43). Recent clinical trials have demonstrated high effectiveness of Everolimus-eluting stents, including in patients with diabetes mellitus. Meanwhile in 12 months after the intervention the diameter of the residual in-stent lumen as well as the frequency of cardiovascular complications were significantly better in the group of Everolimus-eluting stents (44-46).

Our results of comparison of the effectiveness and the safety of Sirolimus- and Paclitaxel-eluting stents did not show significant differences between these two generations of stents, with the restenosis rate of 4,5% in both groups (p>0,05). Late stent thromboses were observed in patients with Paclitaxel-eluting stents (2,3%), while in another group they were absent (p=0,8) (32-34, 37).

Thus, the available randomized trials demonstrate high effectiveness and safety of various generations of DES. To date these stents offer the possibility for a significant improvement of long-term results of endovascular treatment of CBS.

DES THROMBOSES AND THE WAYS OF THEIR PREVENTION

Certainly, drug-eluting stents have offered new options in the management of coronary bifurcation stenoses. However there is reverse side – these stents are highly susceptible to thrombosis, especially in case of cessation of antiplatelet therapy (47).

Stent thrombosis is a rather rare but serious complication leading in 70% of cases to myocardial infarction and in 31-45% of cases to death (47-49).

Traditionally stent thrombosis has been considered as a complication of coronary angioplasty developing within the first 30 days after the intervention. However the results of recent trials have demonstrated the relevance of the problem of late stent thrombosis. This thrombosis produces a significant impact on life expectancy and the quality of life after stenting.

Late stent thrombosis can occur within one year and according to recent publications – even within two years, after stenting. The most probable causes of late stent thrombosis one include technical problems occurring during stent implantation (incomplete stent adherence to the vascular wall, the presence of a marked residual stenosis, deformation and prolapse of the stent's elements into the lumen), as well as the deviations from antiplatelet therapy regimen (38, 48, 50, 51).

Recent consensus in the definition of stent thrombosis allows to make the diagnosis only after coronary angiography, in the presence of clinical signs of myocardial ischemia accompanied by ECG changes. As a result the number of documented stent thromboses decreased twofold (50).

The pathophysiology of stent thrombosis is still unclear. However, thrombosis is primarily associated with platelets activation and the release of gp IIb/IIIa receptors for binding with fibrinogen and platelet aggregation (52, 53).

The effectiveness of various combinations of acetylsalicylic acid (aspirin) with Ticlopidine and Clopidogrel, as well as low-molecular heparins for the prevention of stent thrombosis has been studied in numerous trials. The use of the first combination is limited by delayed start of action and the development of side effects, sometimes fatal (51-53).

According to the Guidelines of American Heat Association (AHA) the most effective for this purpose is the combination of acetylsalicylic acid and Clopidogrel, with loading dose of Clopidogrel of 300 mg two days prior to the intervention with subsequent intake of 75 mg daily. This regimen is optimal for the achievement of maximally quick start of action (54).

The duration of antiplatelet therapy after the intervention varies from 6 to 12 months, and sometimes the treatment can last for an indefinitely long period of time, depending on the severity of coronary lesion and the complexity of stenting (52, 54).

The most discouraging information concerns late DES thrombosis in cases of arbitrary premature cessation of antiplatelet therapy, which leads to 2-3-fold increase of infarct-related mortality (55, 56).

According to the available data, within the first 6 months after the intervention 28% of patients arbitrarily stop thienopyridines intake, while about 7% even do not start to take thienopyridines after endovascular intervention (55).

The data on cross (simultaneous) resistance to antiplatelet agents are of interest. Thus, the resistance to acetylsalicylic acid has been revealed in 12,7% and to Clopidogrel – in 24% of patients after endovascular intervention (57).

To date an alternative to Clopidogrel can be found in Prasugrel whose antiagregation effect is higher that this one of Clopidogrel. However it is associated with higher rate of unfavorable events in the form of massive bleeding. For this reason clinical trials aimed at the determination of optimal Prasugrel dosage are being conducted (58).

The TRITON-TIMI 38 trial has demonstrated the effectiveness of Ticagrepol (reversible inhibitor of P2Y12 receptors) in preventing late stent thrombosis and decreasing the rate of cardiovascular complications (59). In June 2010 a special committee of FDA has approved clinical use of Ticagrepol, and the results of recent trials on the effectiveness of antiplatelet therapy after endovascular interventions for complex coronary lesions, presented during EuroPCR-2011, have demonstrated the reasonability to add Tiocagrepol as a third agent to a commonly accepted antiplatelet therapy.

STRATEGY OF ENDOVASCULAR INTERVENTIONS IN PATIENTS WITH CORONARY BIFURCATION STENOSIS

From the viewpoint of endovascular management, coronary bifurcation stenoses are complex lesions. They account for 15 to 20% of all atherosclerotic coronary lesions (9, 14, 18, 19). Their complexity is caused primarily by the diversity of anatomical variants of bifurcations, as well as by hemodynamic changes occurring during angioplasty. This does not allow to use the same strategy of endovascular treatment in all patients with CBS (6,7,10,14,18,21,24,32-34,37).

The most important disadvantages of available techniques of bifurcation stenting are excessive local accumulation of metal in the stented artery due to stents overposition, as well as the breakage of polymer-drug coating during the procedure. All this can serve as a substrate for the development of restenosis and thrombosis in both branches of bifurcation, thus decreasing clinical effectiveness of bifurcation stenting in the long-term follow-up (35, 42).

To date the main strategy of endovascular treatment of most patients with true CBS is based on stent insertion in the main branch with subsequent dilatation of both branches using the technique of "kissing balloons" (provisional T-stenting), while the two stents technique is mainly used in patients with unsatisfactory clinical and angiographic results of provisional T-stenting (type D and F dissection, marked angina pain with negative ECG dynamics, blood flow < TIMI III in the side branch) (60-66). The use of DES in such cases allows to decrease the rate of reinterventions to 2-5,2 % (32-34, 37, 67-69).

However, some specialists still prefer complete bifurcation stenting. They explain their choice by low rate of cardiac events and side branch restenosis in the long term follow-up (70-73).

A. Assali et al. (16) have demonstrated that T-stenting is associated with higher rate of cardiovascular events and side branch restenosis in comparison with provisional T-stenting. Presumably, the risk factors contributing to the development of

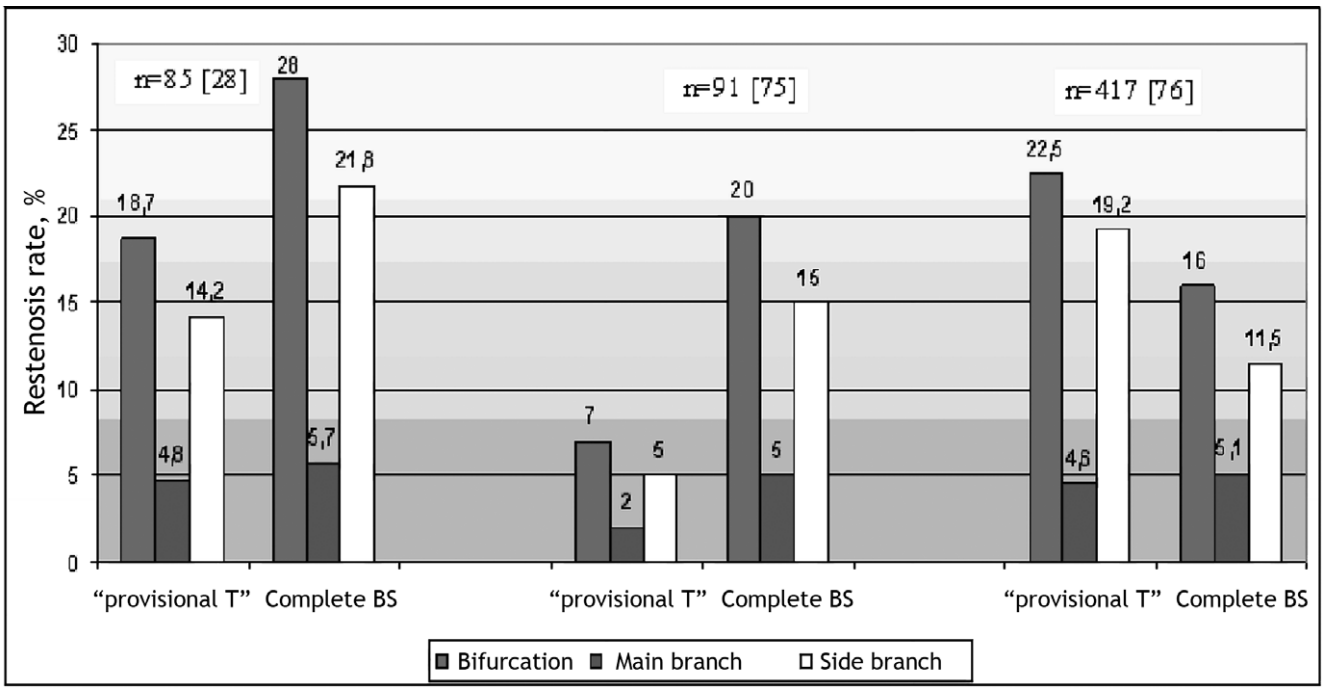

Fig.1. Comparative analysis of the rate of restenosis in the bifurcation branches with the use of one or two DES. BSt – bifurcation stenting

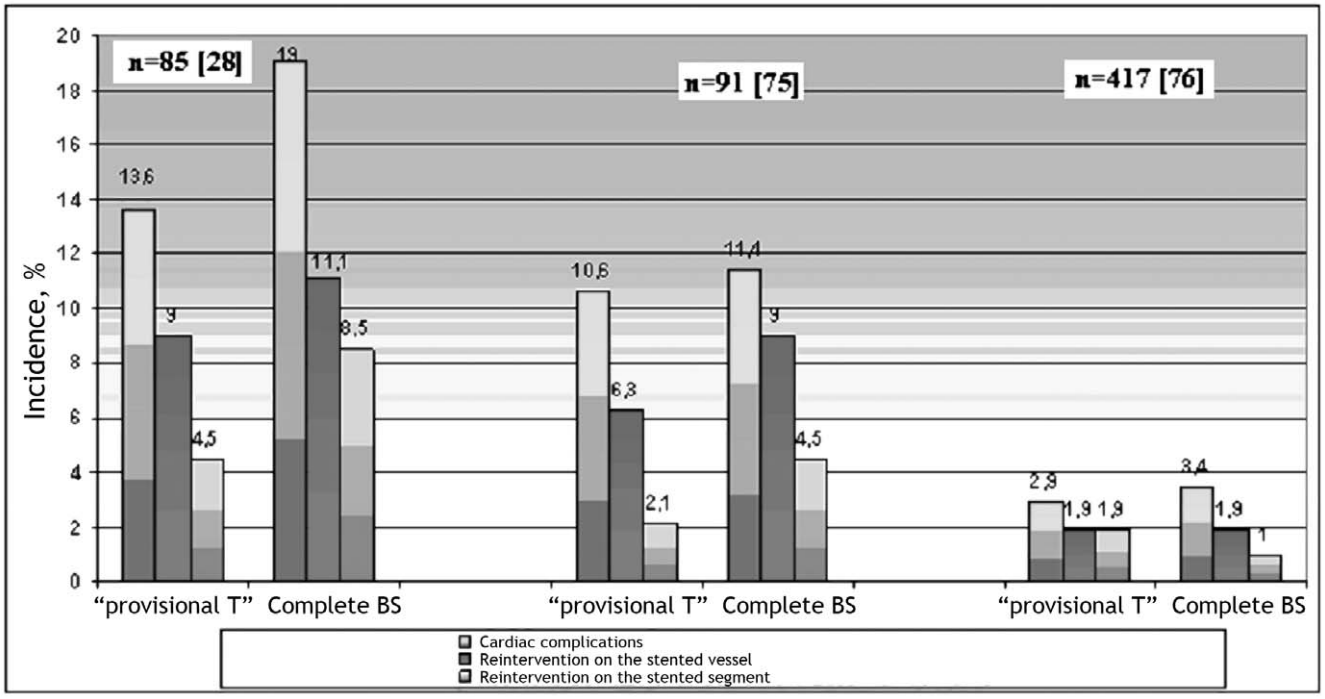

Fig. 2. Clinical and angiographic results of the the use of one or two DES in bifurcation stenosis. BSt – bifurcation stenting

these complications are excessive arterial tortuosity in the area of bifurcation, small diameter of the side branch, bifurcation angle >500, as well as high density of metal in the region of bifurcation ostium (14, 16, 21, 25, 73).

Basing on our own earlier studies we have recommended elective complete bifurcation stenting in patients with the following preoperative risk factors: bifurcation angle < 70 , length of side branch lesion >2,1 mm, high SYNTAX score, calcified lesion in the side branch, diabetes mellitus, side branch diameter >2,3 mm (32-34, 37).

The results of three large randomized trials of endovascular management of true CBS are available. It has been shown that the strategy of provisional T-stenting is associated with a tendency for higher rate of side branch restenosis and target lesion revascularization in comparison with complete

bifurcation stenting (28,75,76). However these differences are not significant (figs.1, 2).

Similar results were obtained in the CACTUS trial: the rate of side branch restenosis in the long term was comparable in the group of provisional T-stenting and complete stenting, 13,2 and 14,7%, respectively (p=0,9) (43).

The data of meta-analysis comprising 1145 patients also did not found any advantages of two-stents strategy of treatment of CBS neither in terms of side branch restenosis, nor in terms of the rate of cardiovascular complications (76).

Another meta-analysis (6 randomized trials comparing the effectiveness of various strategies of bifurcation stenting) has demonstrated that the risk of postoperative myocardial infarction after complete bifurcation stenting is twofold increased (p=0,007). Also it has been noted that the strategy of complete bifurcation stenting does not improve the prognosis after endovascular intervention (72).

Meanwhile 5-years results of Nordic Bifurcation Study have demonstrated low frequency of MI, that was not different with the use of single-stent and two-stent strategies – 3,4 and 6,4% (p=0,17), as well as the absence of differences in the rate of late stent thromboses and a tendency for its increase after the use of two-stent strategy (3,4 and 1,5%, respectively, p=0,33) (77).

The only available randomized trial DKCRUSH II has shown high effectiveness of two-stents strategy, given that the technique of "double kissing" crush stenting has been used. Herewith the rate of main and side branches restenosis after provisional T-stenting was 9,7 and 22,2%, respectively (p=0,036), and in the group of double kissing crush stenting - 3.8 and 4.9%, respectively ($p < 0.001$). The rate of cardiovascular complications in both group was similar (78).

IVUS IN PATIENTS WITH CBS

Despite coronary angiography being the "gold standard" for the diagnostics of vascular lesions, in patients with bifurcation stenoses it often gives idea on the severity of lesion. It can lead to diagnostic errors and unjustified stenting of heart arteries.

Intravascular diagnostic methods, such as IVUS and intravascular manometry are being used in clinical practice from 1989. These modern techniques of non-X-ray diagnostics are more informative than coronary angiography (79-81). For example, with the use of IVUS one can obtain tomographic (silhouette) image, directly visualize the lumen and measure its diameter and area. Due to high resolution this method gives the possibility for differential evaluation of the lesion (82-84). It allows to determine properly the size of stent and contributes to the optimization of the stenting procedure, which is of great importance for patients with bifurcation stenoses, multivessel disease, stenoses of the left main coronary artery (18, 24, 79, 83, 85). Nevertheless IVUS should be considered not as an alternative, but as an adjunction to coronary angiography (80).

The use of IVUS is limited as it provides only anatomical information. Hemodynamic significance and necessity of side branch stenting in patients with borderline coronary bifurcation stenoses (30-70%) can be assessed by intravascular manometry. It allows to determine the fractional flow reserve (FFR) – the ratio of distal average coronary blood pressure to proximal average coronary blood pressure (80, 86).

The comparison of the results of exercise testing with the results of intravascular manometry helped to determine the borderline value of FFR - 0,75. If this index is lower, the stenosis is defined as hemodynamically significant, while in FFR >0,75 coronary angioplasty does not improve the prognosis. The FFR in a normal coronary artery is 1,0. To date the borderline value of FFR has been augmented to 0,8 (87).

The 1,5-years results of randomized trial FAME, presented at European Congress of Cariology in 2009, have confirmed that coronary stenting performed with the account of FFR of the diseased vessel contributes to the improvement of prognosis. Absolute number of cardiovascular events (death, MI, re-interventions) decreased by 5,3% in comparison with the group of patients in whom FFR was not measured. It was also noted that the measurement of FFR allows to decrease care-related expenses, as one can avoid stenting of the lesions that do not cause ischemia. This is a rare case, when a new technology increases clinical effectiveness of the treatment while decreasing its costs (88). The results of 2 years-long follow-up are still suggestive of decreasing risk of death, MI and repeated revascularization in the group of patients with known FFR. Myocardial infarction caused by a stenosis that previously has been assessed as non-significant, developed only in 0,2% of patients in the FFR group, while the revascularization of a lesion that previously has been assessed as non-significant has been performed in only 3,2%. The evaluation of FFR leads to absolute decrease of complications risk by 4,5% (88).

In total, despite the fact that IVUS and intravascular manometry allows to determine accurately the severity of ostial side branch stenosis and the necessity of its stenting, routine use of these methods is reasonable in patients with borderline coronary bifurcation stenoses (84).

EFFECTIVENESS OF VARIOUS TECHNIQUES OF BIFURCATION STENTING

The widely used techniques of complete bifurcation stenting include T-stenting, V-stenting, crush stenting, mini-crush stenting, "culotte" stenting, as well as the technique of "double kissing" crush stenting (9, 10, 14, 18, 19, 70-72,78).

Long-term results of the use of crush and mini-crush techniques in patients with BCS have shown that the rate of side branch restenosis in 12 months after stenting is comparable with the rate after provisional

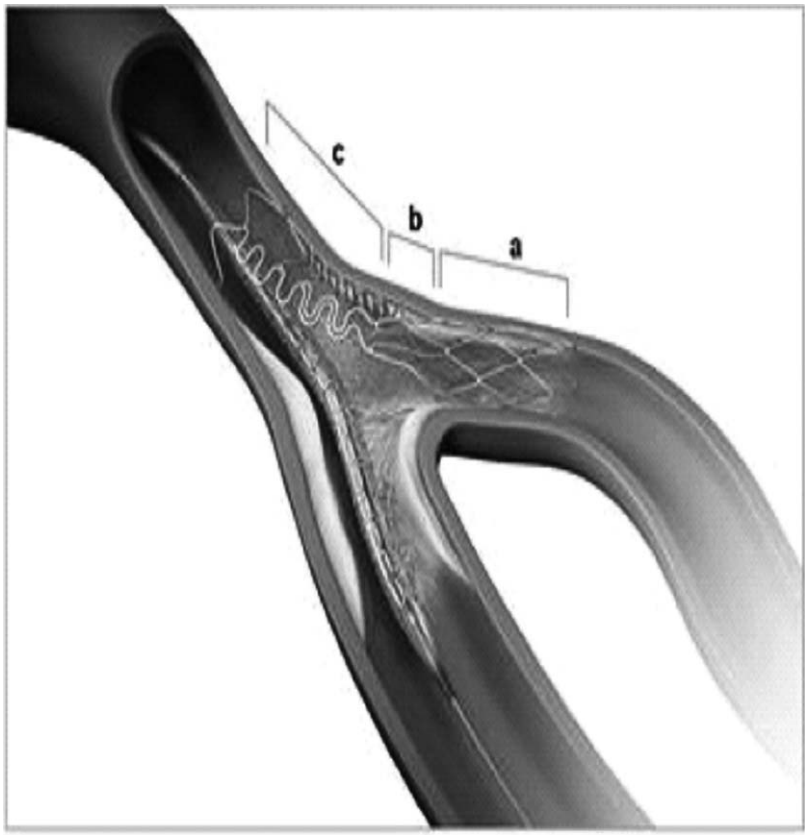

Fig. 3. Bifurcation stent TRYTON
a – side branch, b – zone of stents' overposition,
c- main branch

T- stenting and does not exceed 9% (p>0,05) (18, 25, 73, 89). However the results of crush stenting completed by both bifurcation branches dilatation with "kissing balloons" technique demonstrate a reliable decrease of the rate of target lesion revascularization (25, 70, 90).

According to some authors, crush stenting does not provide complete armoring of the bifurcation ostium and is associated with a high rate of late stent thromboses – up to 4,3% (47, 91).

Unlike crush-stenting, the "culotte" technique facilitate uniform covering of the bifurcation ostium and, along with the use of DES, contributes to the decrease of the rate of restenosis in the branches of bifurcation (73, 92). At the same time the rate of target lesion revascularization does not exceed 8,9%, and the rate of cardiovascular events is similar to the rate seen after provisional T-stenting (93).

T. Lefevre et al. (64) renounced the use of «culotte» technique in their practical work and explained this decision by the high rate of in-hospital cardiovascular complications – 37,5% in 7 days and 44,4% in 7 months after the procedure.

The technique of "double kissing" crush stenting is widely used in patients with complex anatomical variants of bifurcations. According to some authors, the rate of restenosis and cardiac events in the long-term after the intervention is 4,0 - 7,8% and 5,2 - 9,1%, respectively (9, 69).

One has to note that, independently of the technique used, it is recommended to finish any intervention in atherosclerotic lesion of coronary bifurcation by "kissing balloons" angioplasty. It contributes to the decrease of the rate of restenosis and target lesion revascularization, thus producing a significant impact on the long-term prognosis (3, 6, 8-10, 14, 18, 21-23).

On the contrary, recent randomized Nordic-Baltic Bifurcation Study III, comprising 477 patients has shown that routine use of "kissing" dilatation gives no advantages in the terms of cardiovascular complications in comparison with the patients who underwent only stenting of the main artery without final "kissing" dilatation. Herewith the duration of fluoroscopy and the amount of contrast medium was significantly lower in the later group. However it was noted that final "kissing" dilatation contributes to significant decrease of the rate of side branch restenosis in patients with true CBS (7,6 and 20%, respectively, in patients with and without final "kissing" dilatation, p=0,024)(94)

PROSPECTS OF ENDOVASCULAR MANAGEMENT OF CBS

The impossibility of creating an "ideal" geometric construction with the use of various techniques of bifurcation stenting, as well as the high frequency of side branch restenosis have provided the basis for the development of special bifurcation stents («Multi-Link Frontier», «SUDEGUARD», «SIDE KICK») and their introduction into the clinical practice (82).

The results of studies of the first generations of bifurcation stents have demonstrated the simplicity of their implantation, which contributed to the decrease of procedural time. However, the rate of restenosis in 3 and 5 years after the intervention was the same as after crush and T-stenting (95).

Later generations of bifurcation stents include «AXXESS», «TRYTON Side-Branch Stent», and «E-TRYTON 150» stents with biodegradable biolimus-eluting. With the use of these stents it is possible to perform simultaneous stenting of both bifurcation branches.

The first randomized trial TRYTON-LM aimed at the evaluation of safety and effectiveness of combined use of bifurcation stent «TRYTON» and «Xience Prime» stent has been started in the end of 2009. The stent is firstly implanted in the side branch, and then any available stent can be implanted in the main branch (fig. 3).

A third-generation Paclitaxel-eluting bifurcation stent «Nile Pax» (Minvasys, France) has received Conformity European (CE) Mark approval. This poly-

mer free stent is intended to decrease the intensity of inflammatory processes after the implantation.

Immediate and long-term results of the use of the later generations of bifurcation stents has been presented at EuroPCR-2011, however any of the cited trials did not reveal their evident advantages in comparison with single-stent techniques of bifurcation stenting. Besides, while implanting a bifurcation stent one admittedly plans the use of two-stents technique. A question arises: if the majority of the available studies did not show the advantages of two-stents techniques over the single-stent techniques, then is it reasonable to implant a special bifurcation stent?

Thus, the effectiveness of DES, independently of the type of stent used, is completely proven in patients with CBS. These stents have contributed to a significant improvement of long-term outcomes of endovascular intervention.

Numerous clinical trials did not evidence the advantages of two stents implantation over single-stent technique (provisional T- stenting), however some questions are still unsolved. Thus, for example, at present it is necessary to conduct a sufficient number of randomized trials aimed at the study of the effectiveness of special bifurcation stents and the perfection of the technique of their implantation. Also it is important to develop of a “single” algorithm based on differentiated approach to patients with CBS and mandatory preoperative detection of risk factors for the complications of endovascular interventions. Besides, further studies should determine the reasonability of routine use of IVUS and intravascular manometry in patients with CBS, as well as clear indications for complete bifurcation stenting.

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Irina CHERNYSHEVA

Congratulations and best wishes to the Deputy Director of Moscow City Center of Interventional Cardioangiology, Candidate of Medical Sciences, member of the Editorial Council of "International Journal of Interventional Cardioangiology" Irina Chernysheva on her jubilee!

After finishing Semashko Moscow Medical Stomatological Institute and residency Irina Chernyshev began her work in Moscow City Hospital N15. From 1986 through 2011 she was cardiologist, and then – head of the 6th Department of cardiology under the guidance of Prof. David G. Iosseliani. From September 2001 up to the present time she is Deputy Director for Clinical work in Moscow City Center of Interventional Cardioangiology. Her immediate tasks include the supervision of all clinical departments of the Center. Being a perfect physician, Irina Chernysheva knows all modern methods of diagnosis and treatment of coronary heart disease. She has participated in the organization of the service for emergency and elective management of patients with coronary heart disease, in the elaboration of guidelines for in-hospital treatment of patients with acute and chronic forms of coronary heart disease after PCI. Irina Chernysheva is the author of many scientific papers on endovascular interventions in patients with coronary heart disease, at present she is working on her Doctor thesis.

Dr. Chernysheva attends Russian and International scientific congresses and conferences dedicated to the problems of cardiology.

Due to her professional achievements, Dr. Chernysheva has been awarded the medal "Commemorating the 850-th anniversary of Moscow" and the Certificate of Merit of the Minister of Healthcare of Russia, a Commendation of the Head of the Department of healthcare of the city of Moscow. She is the Laureate of the Prize of the government of Moscow in the field of medicine, the Laureate of the Prize of Russian Federation in the field of science and technique, the Laureate of the Prize "Specialist of the Year-2011" in the nomination "Cardiology".

A high-class specialist, attentive and sensitive physician, excellent person, Irina Chernysheva is much regarded and liked by all those who know her.

The Editorial Board of "International Journal of Interventional Cardioangiology" wishes Irina Chernysheva a good health, a lot of happiness and new achievements in her scientific and clinical work!

Boris DOLGUSHIN

Professor Boris DOLGUSHIN, MD, Deputy-Director for scientific work of Blokhin Research Institute of Clinical Oncology, Corresponding Member of Russian Academy of Medical Sciences, Laureate of the Prize of government of RF in the field of science and technique turned 60 on February 15, 2012

Boris Dolgushin was born in the town of Tambov. His parents were physicians and originators of the most numerous medical dynasty in the Tambov region. Thirteen members of this family have dedicated their life to medicine, and among them there are 3 Honored Doctors of Russian Federation. In total, the working life of Dolgushin family is over 300 years!

In 1975 Boris Dolgushin has graduated from the Therapeutical faculty of the 2nd Moscow State Medical Institute named after Pirogov. His clinical residency and post-graduate education at Scientific Center of Oncology of the Academy of Medical Sciences of the USSR were aimed at the mastership of the specialty "oncology-radiology". In 1980 he defended his Candidate thesis on the subject "Angiographic diagnostics of secondary liver tumors", and after started his career in the Department of X-ray diagnostics of the Center. In 1989 Boris Dolgushin defended his Doctor thesis "Abdominal angiography in complex diagnostics of tumors in children". His subsequent working activity was inextricable connected to the Russian Scientific Center of Oncology, where he has made his way from the first steps in specialty to the summit of professional skills, from a newcomer physician to a generally accepted leader in the field of organization and clinical use of the methods of X-ray diagnostics and interventional radiological methods of treatment, from junior researcher to the position of the Head of the biggest special multi-profile service in Europe, possessing all modern means of X-ray diagnostics and interventional radiology – X-ray, ultrasound, radionuclide, endovascular and endoscopic. Due to his organizational and professional talent and innovative approach to the solution of imposed tasks, Boris Dolgushin succeeded in reorganization of the Center's departments responsible for X-ray visualization in oncology and unified them in a single service. After technical and technological re-equipment and preparation of highly skilled practical specialists and scientific staff this service is able to solve the most difficult problems of diagnostics and minimally invasive treatment in oncology, to develop medical science in conformity with the cal of the time. In 1998 Boris Dolgushin became the pioneer of filmless digital technology in our country. He organized the first special 12-beds unit of endovascular diagnostics and treatment for cancer patients and the first endoscopic department in our country, he pioneered the organization of working places for diagnostic oncologists who use various x-ray technologies unified on the basis of organ and systemic principles, the was one of the initiators and an active participant of the organization of the Center of Positron Emission Tomography at Blokhin Scientific Center of Oncology. At present Professor Boris Dolgushin is a head of the staff comprising 350 workers, among them 16 Professors and Doctors of sciences, over 20 Candidates of sciences; one half of this staff are specialists with university-level medical and technical education. Each day over 600 cancer patients undergoing examination and treatment in the service receive about 1,500 diagnostic investigations and therapeutic interventions.

Boris Dolgushin is a professor of the Chair of X-ray diagnostic, radiation therapy and medical physics of Russian Medical Academy of post-graduate education (this Chair has been created with his active participation). He is an active teacher and researcher, he has been the academic advisor of 7 Doctor and 22 Candidate theses, many of his students have gained the leading positions of profile services in special medical institutions in the city of Moscow and other cities of Russia and CIS countries. Boris Dolgushin is the author of over 250 scientific papers, 11 monographs, certificates of authorship and patents, he has elaborated and introduced into practice a large spectrum of innovative radiological techniques for the treatment of cancer of the liver and bile ducts, kidneys and ureter, respiratory, bone and digestive systems.

He has suggested low-impact technologies for the treatment of complications after thoracoabdominal interventions that have contributed to several-fold decrease of postoperative mortality.

The achievements of Boris Dolgushin in the fiend of practical, scientific and organizational activity are evident for professional society. He is member of Thesis Board, of the Scientific Council of Research Institute of Clinical Oncology, of the Joint Scientific Council of Blokhin Scientific Center of Oncology, member of the editorial boards of several journals, Chairman of Problem Commission "Diagnostic and interventional radiology" of the Scientific Council of Russian Academy of Medical Sciences and Ministry of healthcare and Social Development of Russia, Chairman of the section "Interventional oncology" of Moscow Society of Radiology, member of the Board of Russian Society of Interventional Cardioangiology, fellow of Russian, European and North-American Societies of Radiology, President of National Society of Interventional Oncoradiology.

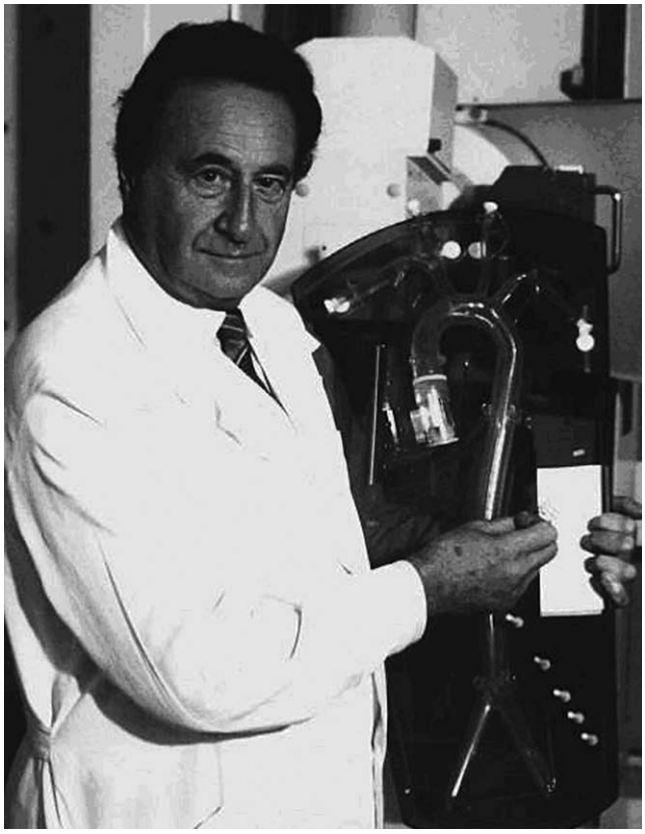
The conferment of title of Professor with a specialization in oncology (1997) and the election to the rank of Corresponding member of Russian Academy of Medical Sciences (2007) have been the most important milestones for Boris Dolgushin.

The merits of Professor Boris Dolgushin in the field of healthcare and medical science in Russia got a high appreciation from the state and professional society: he was awarded a medal "In memory of 850th anniversary of Moscow" (1997), a medal of the "Order of Merit for the Fatherland" of the 2nd degree (2002), he is Laureate of the Prize of Government of RF in the field of science and technique (2001), Laureate of the Prize named after N.Petrov for the best scientific research in oncology (2009).

The simple enumeration of Professor Dolgushin's achievements cannot give a complete idea of this physician, researcher, leader and person. Boris Dolgushin is equally demanding of his employees and of himself, and at the same time he is an amazingly kind, warm, amiable, nice and understanding person, colleague and friend. He has two sons – one of them follows his father's steps – and is a loving grandfather.

The friends, the colleagues and the Editorial Board of the Journal congratulate Professor Boris Dolgushin on his jubilee date, wish him a lot of health, a long and prosperous life, new successes in his active and fruitful work for the benefit of our country population, national healthcare and medical science!

Iosiph RABKIN



The eminent physician and scientist, Corresponding Member of Russian Academy of Medical Sciences, Academician of Russian Medico-Technical Academy, Laureate of the State Prize of the USSR, Honorary Fellow of the British Royal College of Radiologists, Honorary member of Cornell Medical Center (USA), of European Society of interventional radiology, as well of many scientific societies of other countries, named "ThePersona of the Year of America" (1997) awarded with the diploma and the medal "The Global Year of Excellence" by International Biographical center in Cambridge for world-renown achievements in medicine (2006), with the golden medal of A. Chizhevsky for his great contribution in the development of new medical technologies (2008) Iosiph Rabkin turned 85.

After finishing cum laude the feldsher college in Omsk in 1943 and Moscow Medical Institute in 1949, Iosiph Rabkin did his military service for six years. At first he was a military physician, and then has been moved to the position of a section chief in the military hospital. After army discharge he started his post-graduate education on roentgenology in the Central Institute of medical post-graduate education. In 1960 he has defended his Candidate (PhD), and in 4 years – his Doctor thesis. After that Iosiph Rabkin has worked under the guidance of eminent scientists, such as Corresponding Member of the Academy of Medical Sciences of the USSR I. Tager, Academician of Russian Academy of Medical Sciences E Meshalkin, Academician of Russian Academy of Sciences and of Russian Academy of Medical Sciences B. Petrovsky.

During 35 years Iosiph Rabkin has headed the Department of x-ray diagnosis and endovascular surgery in the All-Union Scientific Center of Surgery of the USSR Academy of Medical Sciences (today – Petrovsky Russian Scientific Center of Surgery).

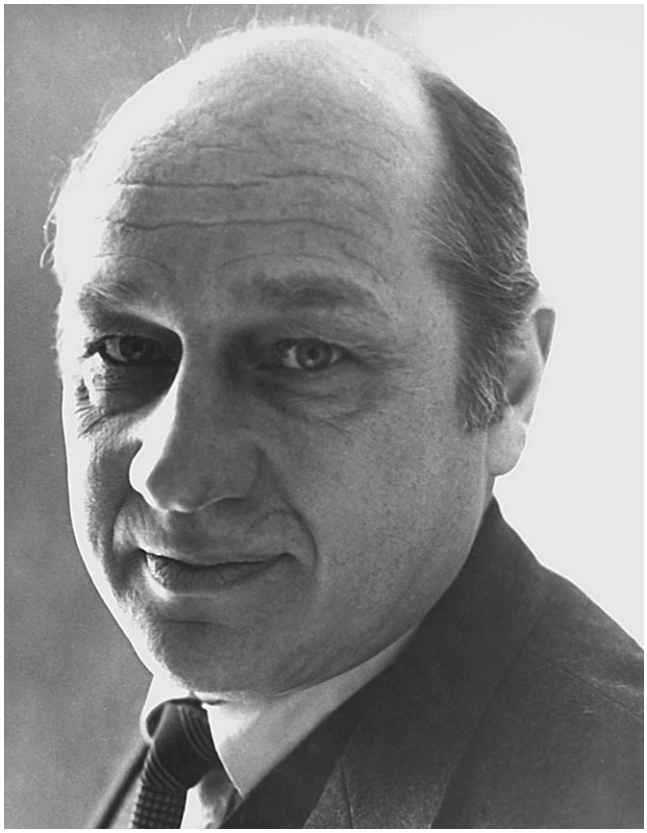
Professor Rabkin is rightfully named the pioneer in various fields of radiology. In 1976, he became the founder of a new trend in clinical medicine – endovascular surgery (interventional cardioangiology). In 1984, for the first time in the world he has performed endovascular, endobiliary and endoesophageal stenting with an original endograft (stent) made of nickeland titanium alloy. This stent got the name of "nitinol Rabkin endograft". He has performed original studies of endovascular hemostasis in pulmonary, gastrointestinal and uterine blleding, fundamental studies of visceral mircocircualtion using selective radionuclide administration in ischemic lung, liver and pancreas disease. Professor Rabkin has lectured and made presentations in America, England, China, Denmark, Norway, Portugal, Germany, Poland, Bulgaria, Romania, Czechoslovakia, Cuba, Hungary. He has performed operations in Bulgaria, Germany and Cuba. He has consulted and guided the preparation of 105 theses (23 Doctor and 82 Candidate), including 4 theses on endovascular surgery.

Professor Iosiph Rabkin is the author of 23 monographs, over 500 scientific papers and 16 inventions confirmed by patents and certificates of authorship. At present he lives in the USA, but does not break contacts with his homeland – he attends the conferences and congresses, publishes his papers in Russian journals, acts as opponent at theses' defenses, propagates the achievements of Russian medical science, maintains communication with Russian Academy of Medical Sciences.

The disciples of Professor Rabkin works in various Russian cities. Many of them became professors and are heading the centers, the departments, the laboratories of interventional radiology.

All disciples and colleagues of Professor Iosiph Rabkin, Russian Society of Interventional Cardioangiology, the Editorial Board of "International Journal of Interventional Cardioangiology" cordially congratulate him and wish him good health, happiness, new scientific discoveries and success.

Yury VOLYNSKY



The eminent physician and researcher, one of the pioneers of angiography and endovascular surgery in Russia, Professor Yury Volynsky turned 80.

In 1955, Yury Volynsky graduated cum laude the Riazan Medical institute named after Academician Ivan Pavlov. For 3 years he has worked as a surgeon in the regional hospital and performed hundreds of major operations. From 1958, scientific and practical activities of Yury Volynsky has been closely connected with Vishnevsky Institute of Surgery. Just in those times this Institutes has initiated active investigations and practical work on the mastering of cardiac surgery and the methods of extracorporeal circulation. Together with such well-known scientists, as V. Parin, P. Anokhin, V. Chernigovsky, L. Shik, V. Bourakovsky, Yury Volynsky has participated in experimental studies and heart operations.

Step by step the attention of Dr. Volynsky has been drawn to the conduction of intracardiac investigations. In 1960-63, Volynsky together with his colleagues has published many articles on the problems of catheterization and angiography in pulmonary and hepatic diseases, as well as on pathophysiology of extracorporeal circulation.

In 1961, Yury Volynsky together with G. Bykov became the pioneers of the use of transseptal cardiac puncture and platinum-hydrogen dilution method for the determination of intracardiac shunts and portal circulation in Russia. In the same time Dr. Volynsky participated in active innovative works on the use of information systems in medicine conducted under the guidance of Academicians A.Vishnevsky and I.Artobolevsky.

In 1963, Yury Volynsky has defended his Candidate thesis (Ph.D) on the peculiarities of intracardiac hemodynamcis in congenital heart diseases, and in 1969 – his Doctor thesis «Patterns of hemodynamics in heart defects and restrictive pericarditis». For many years his monograph «Changes of intracardiac hemodynamics in heart diseases» has been a leading manual for many specialists in this field.

In 1968, acting on the instructions of Academcian A. Vishnevsky, Dr. Volynsky has founded a laboratory for the studies of burn shock and remained its head until 1975. The laboratory conducted innovative research of hemodynamics and metabolism of burn shock and developed new methods of shock treatment. In late 1960-ies, Volynsky started to use heart catheterization technique for the study of the changes of hemodynamics during acceleration. The results of these studies have been published in 1970, in the journal “Space biology and medicine”.

In 1976, Yury Volynsky together with A. Vishnevsky, Jr., and F. Todua, has successfully performed the first embolization of bronchial arteries for stopping pulmonary bleeding in Russia. Volynsky and the staff of his department of endovascular surgery have used transcatheter technique and dilution methods for unique measurements of the volume of bronchial blood flow and bronchopulmonary bypass grafting in cardiac and pulmonary pathology. During the years to come Dr. Volynsky has conducted pioneering studies on the use of excimer laser for arterial recanalization, balloon dilatation of the stenosis of brachiocephalic trunk. In early 1980-ies, Yury Volynsky together with F.Todua founded the laboratory of computed tomography in the Institute of Surgery and was one the first in our country to perform diagnostic punctures of visceral organs under CT guidance.

In 1988, Yury Volynsky together with L. Kokov started to perform mitral balloon valvuloplasty with the use of transseptal puncture technique.

From 1995 through 1997, Yury Volynsky has been Deputy Director for scientific work in the Moscow City Center of Interventional Cardioangiology. Simultaneously he was the leading researcher of Research and Practical Center of Medical Radiology.

In the same time Yury Volynsky manifested an active interest towards the problems of telemedicine, participated in the development and introduction of IT systems in the practice of clinical medicine. He is heading the section on this problem at Public expert council of Moscow Douma.

In his multiprofile scientific work Yury Volynsky collaborates with the Research Institute of Transplantology and Artificial Organs, Priorov Central Institute of Traumatology and Orthopedics. Together with the group of programmers from the Lomonosov State University of Moscow he participated in the development and introduction of the method of roentgen-video-densitometry into the clinical practice.

In 2005, Prof. Volynsky has participated in the organization of angiographic service in the Institute of Stroke of the Russian State Medical Academy, and his disciple M. Kirillov is heading this service. In one year they have performed the first in Russia successful transarterial selective thrombolysis in ischemic stroke.

Professor Volynsky is the author of about 400 scientific papers, 5 monographs and 6 author's certificates. He has guided the defense of 26 Candidate theses, consulted 5 Doctor theses, he is member of the Editorial boards of "International Journal of Interventional Cardioangiology" and of the journal "Diagnostic and interventional radiology".

The Editorial board of "International Journal of Interventional Cardioangiology", the staff of Moscow City Center of Interventional Cardioangiology, the colleagues and friends congratulate Professor Yury Volynsky on his jubilee and wish him good health, endless energy and further successes in his scientific work.

Vladimir Avilov

Dr. Vladimir Avilov – a wonderful person, our colleague, employee of Moscow City Center of Interventional Cardioangiology – died suddenly on February 23, 2012, in his 60th year of life.

Dr. Avilov was born in Moscow on November 6, 1952. In 1976, he graduated the Faculty of Medicine and Biology of Russian State Medical University. The main part of his scientific and practical activities has been related to Bakoulev Scientific Center of Cardiovascular Surgery, where he defended his Candidate thesis. Vladimir Avilov was the author and co-author of numerous scientific publications on the problems of clinical enzymology .

From 1997, and up to the last day of his life Dr. Avilov has worked in the Clinical and Diagnostic laboratory of Moscow City Center of Interventional Cardioangiology. He made an invaluable contribution in the development of laboratory services, he has elaborated, introduced into the clinical practice and upgraded many new techniques, established a modern system of laboratory quality control. He was a great professional, attentive and compassionate person, a real life and soul of the whole staff.

The staff of Moscow City Center of Interventional Cardioangiology bewails the premature death of dear colleague and friend and presents sincere condolences to his family.