OFF-PUMP CORONARY SURGERY: INFLUENCE OF ISOVOLEMIC HEMODILUTION ON EARLY CORONARY GRAFT PATENCY RATE.

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The contrast levels of intraoperative hemodilution are the most prominent differences between on-pump and off-pump coronary artery bypass grafting (CABG). It is well-recognized that the absolute values of graft transit-time flow measurement during on-pump surgery are higher in comparison to off-pump ones that is directly related to hemodilution level. This fact is the basis for the statement that the hemodilution is a useful background for off-pump surgery, and its absence may be the cause of the reduced off-pump early graft patency rate that some of the researchers have found when comparing on-pump to off-pump CABG. At the other hand, the clinical outcomes are not correlated with the values of flow measurements, and hemodilution may trigger the excessive endothelial activity leading to thrombogenesis.
We have attempted to clear up the influence of the hemodilution on the early graft patency rate during the off-pump surgery basing on the postoperative re-coronarography as the most reliable marker of the shunt patency.

Methods

Multi-vessel (three and more targeted vessels) coronary patients have been enrolled in two groups. Group I (n=57) included the patients that had undergone the off-pump CABG with the intraoperative hemodilution background (Hb –101.2±0.58 g/L; volume of blood removal – 15.2±0.16 ml/kg; volume of fluid to maintain isovolemia– 41.6± 0.65 ml/kg). The hemodilution wasn't used for the off-pump patients of Group II (n=45) (correspondingly 132.3±1.03 g/L; 0 ml/kg; 23.2±0.34 ml/kg). The preoperative and perioperative data, risk factors are shown in the Table 1 and 2. There are no significant differences between groups excluding the hemodilution variables. The targeted vessels features are shown in Table 3. There are no differences between groups in the kind of shunt material, degree of stenosis and revascularisated coronary territories. Sites of the proximal anastomoses were marked with radio-opaque markers. Re-coronarography was done on the 10-th postoperative day. There were 190 distal anastomoses in Group I (3.33 per patient) and 158 in Group II (3.51). The statistical comparative analysis of the groups and of the grafts as a whole included t-test, chi-square and bivariate correlation tests.

Table 1. Preoperative Clinical Data

Variable	Off-pump with hemodilution (n = 57), n (%)	Off-pump without hemodilution (n = 45), n (%)	*p* Value
History of MI[a]	48(84.2)	37(82.2)	0.650
Angina class			
1	5(8,8)	5(11.1)	0.762
2	18(31.6)	14(31.1)	
3	21(36.8)	16(35.6)	
4	13 (22.8)	10(22.2)	

NYHA class			
I	35(61.4)	28(62.3)	0.780
II	15(26.3)	11(24.4)	
III	7(12.3)	6(13.3)	
Coronary disease			
Three-vessel	36(63.2)	24(53.1)	0.634
Four vessel	19 (33.3)	18 (40.1)	
Five-vessel	2 (3.5)	2 (4.5)	
Six-vessel	0 (0.0)	1(2.3)	
Ejection fraction (%), mean ± SD	54.1±15.3	57.3±15.3	0.213
Distal anastomoses[a], mean ± SD	3.33±0.71	3.51±0.82	0.495
Distal arterial anastomoses, mean ± SD	1.93±0.64	2.50±0.55	0.706
Distal venous anastomoses, mean ± SD	1.40±0.82	1.01±0.68	0.429

MI = myocardial infarction; NYHA = New York Heart Association; SD = standard deviation.

Table 2. Risk factors and perioperative data

Variable	Off-Pump with hemodilution (n = 57), n (%)	Off-Pump without hemodilution (n = 45), n (%)	*p* Value
Age[a], mean ± SD	54.3±10.0	54.0±9.2	0.981
Gender M/F	55/2	43/2	1.000
BSA, mean ± SD	1.83±0.17	1.81±0.18	0.384
BMI, mean ± SD	26.9±4.5	26.8±4.3	0.896
Obesity	17(29.8)	11(24.2)	0.432
Smoking habits	25(43.9)	19(42.2)	1.000
Recent smoking	11(19.3)	9(20.0)	1.000
Systemic hypertension	19(33.3)	16(35.6)	0.638
Diabetes	8(14.0)	5(11.1)	0.191
Dyslipidemia	21(36.8)	17(37.8)	1.000
CVA	2(3.5)	1(2.2)	0.265

Peripheral vascular disease	6(10.5)	3(6.7)	0.847
Hemoglobin level (g/l)	101.2±0.58	132.3±1.03	<0.05
Blood removal (ml/kg)	15.2±0.16	0.0±0.00	<0.05
Fluid volume (ml/kg)	41.6±0.65	23.2±0.34	<0.05

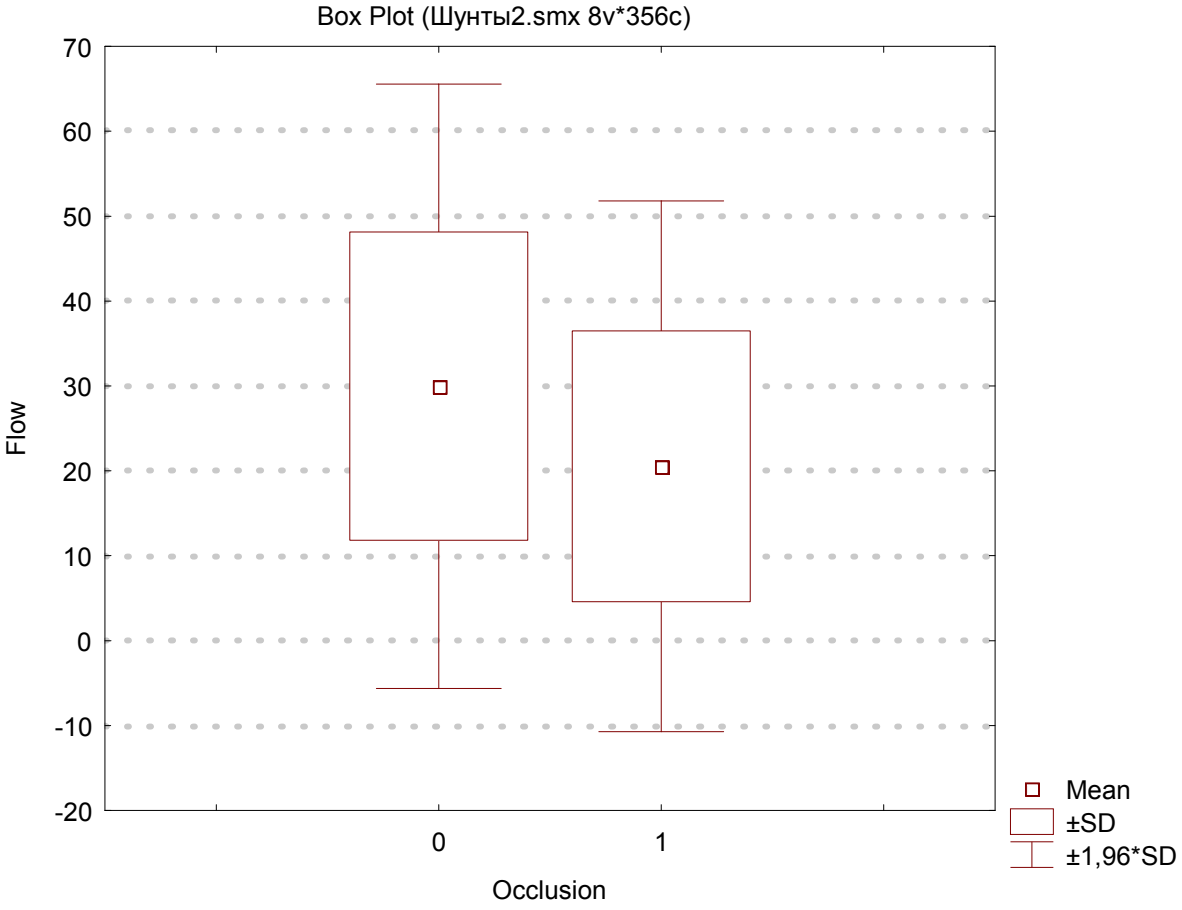
BMI = body mass index; BSA = body surface area;CVA = cerebrovascular accident; SD = standard deviation.

Table 3. Targeted Vessel Features

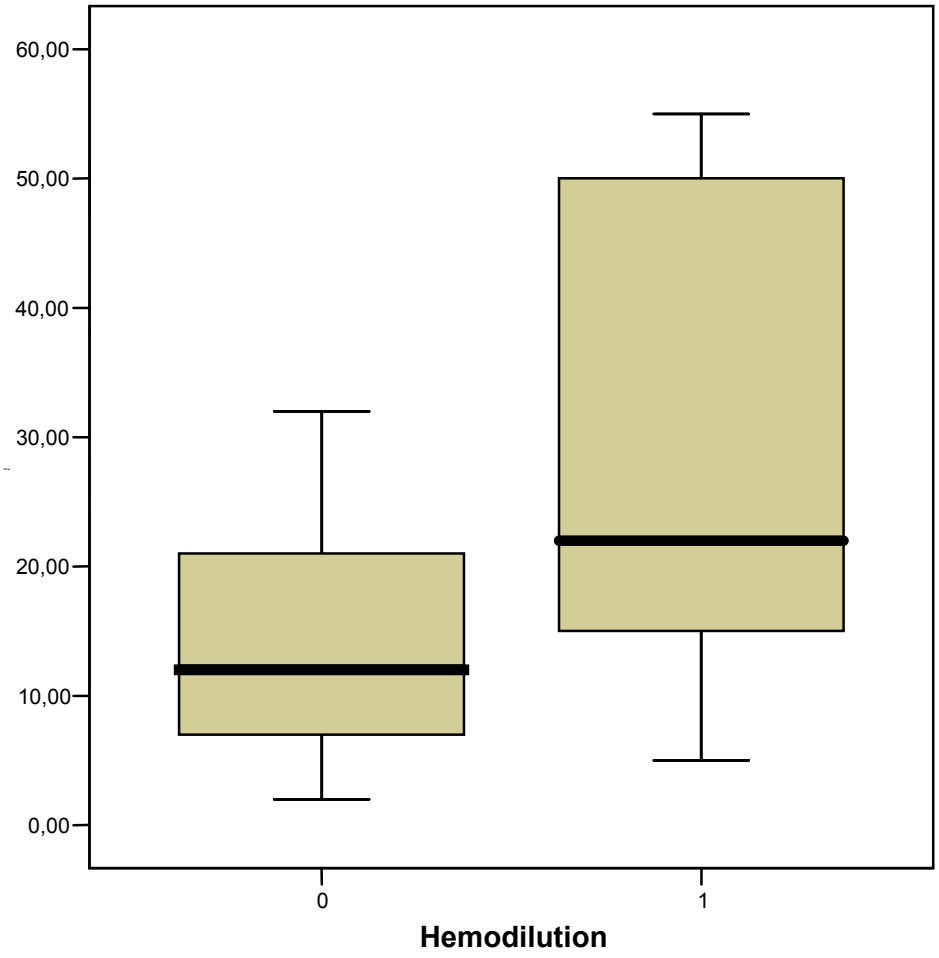
Variable	Off-pump with hemodilution(n = 190), n (%)	Off-pump without hemodilution (n = 158), n (%)	*p* Value[a]
Coronary artery grafted			
Left anterior descending artery	75(39.7)	63(39.3)	
Diagonal	16(7.9)	18(11.6)	
Obtuse marginal	56(29.6)	34(21.7)	0.076
Right coronary artery	18(9.5)	26(16.6)	
Posterior descending artery	25(13.3)	17(10.8)	
Proximal stenosis			
51–70%	26(13.7)	20(12.5)	
71–90%	84(44.0)	72(45.7)	NS
91–99%	37(19.6)	34(21.7)	
100%	43(22.7)	32(20.1)	
Left internal thoracic	70(36.6)	61(38.3)	0.234
Right internal thoracic	27(14.4)	25(16.1)	
Free internal thoracic	0(0.0)	4(2.5)	
Saphenous vein	93(49.0)	68(43.1)	

Results

There are 25 occluded grafts in Group I (13.16%±2.64) and 31 in Group II (19.6%±3.5; P>0.05). In the general number of the grafts, the mean value of the variable “graft flow” was significantly lower in occluded grafts to compare with patent grafts (P<0.05) (Figure 1).



The analysis of the variable “graft flow” among the occluded grafts in Group I (with hemodilution) and Group II (without hemodilution) showed more than twice difference (29.92±1.78 versus 13.61±2.48 ml·min^{-1}, P<0.05) (Figure 2).



This fact underlines that the individual values of graft flow measurement have limited predictive significance in the graft patency rate. However, in general, there is statistically significant relationship between variables “graft flow” and “graft occlusion” independently on hemodilution level.

At the same time, multivariate correlative analysis demonstrates that the variable “graft flow” strongly correlates with variables inherent to hemodilution (hemoglobin and hematocrit levels, volumes of blood removed and fluid loaded) (Table 1).

Table 1. The coefficients of correlation the variable “Graft flow” with the hemodilution and targeted vessel features variables.

	The variable “Graft flow"	P level
Hemoglobin level	- 0.302	0.01
Hematocrit level	- 0.303	0.01
Graft occlusion	- 0.158	0.01
Volume of blood removal	0.296	0.01
Degree of targeted vessel stenosis	0.325	0.01
Volumes fluid loading	0.169	0.01
Size of targeted vessel	0.307	0.01

In addition, the statistically significant relationship was found between the variable “graft occlusion” with the size and the degree of the stenosis of targeted vessel independently on the hemodilution level.

Intuitively, it seems to be possible that if the growth of the patients’ number continues, statistical significance in comparison group I and II in the term of “graft occlusion” will be achieved. Thus, the further study should be continued.

Conclusions:

1. The relationship between the variable “graft occlusion” and variables inherent to hemodilution is intermediated by the variable “graft flow” during the off-pump coronary artery surgery.
2. In our opinion, the acute isovolemic hemodilution is an obligatory intraoperative component of the off-pump CABG.