Myocardium protection against ischemic-reperfusion injury by nitric oxide supplied to the extracorporeal circulation line during cardiopulmonary bypass (experimental study)

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Aim The study was designed to assess the efficiency of exogenous nitric oxide supply to the extracorporeal circulation line for myocardial protection against ischemic-reperfusion injury in acute myocardial infarction simulation during cardiopulmonary bypass in the experiment.

Methods To conduct this prospective pilot study, 20 male rabbits “Soviet chinchilla” weighing 3–3.5 kg were used. Acute ischemia was simulated in rabbits (n = 20) with subsequent myocardial reperfusion. All animals were anesthetized and mechanically ventilated through a nasotracheal tube. The experiment included occlusion of the left coronary artery by its clamping with a ligature for 45 min with subsequent reperfusion for 120 min during cardiopulmonary bypass. All animals were divided into 2 equal groups:

- 10 rabbits received nitric oxide supply to the extracorporeal circulation line in a dose of 40 ppm throughout the entire cardiopulmonary bypass period (the main group);
- 10 rabbits made up the control group.

The ratio of the infarction area to the risk area was determined, and the quantity and nature of ventricular arrhythmias were accessed.

Results It was established that nitric oxide supply through the extracorporeal circulation line during cardiopulmonary bypass had a pronounced infarct-limiting effect, the infarct area to the risk area ratio decreased by 15% as compared to the control group, $p = 0.0002$. There was also a significant antiarrhythmic effect. A lesser quantity of polytopic and polymorphic ventricular extrasystoles were observed in the main group during periods of ischemia and reperfusion ($p = 0.003$ and $p = 0.012$). A statistically significant decrease in the venoarterial gradient of the partial pressure of carbon dioxide in the main group was associated with an increase in the urine flow rate amounting to 1.4 [1.3; 1.5] ml/kg/h in the main group and 1.15 [1; 1.3] ml/kg/h in the control group, $p = 0.013$.

Conclusion The data obtained during the experiment demonstrate the presence of cardioprotective properties of nitric oxide delivered to the extracorporeal circulation line when simulating myocardial ischemic-reperfusion injury. These properties manifest themselves as a 15% decrease of the infarction zone-risk area ratio, a fewer number of arrhythmias and improvement of tissue perfusion during cardiopulmonary bypass. Intraoperative myocardial protection by nitric oxide in patients operated with cardiopulmonary bypass should be the object of further clinical research.

Nitric oxide delivery into the extracorporeal circulation line and its impact on arrhythmia occurrence during ischemia and reperfusion

Phase	Arrhythmia	Main group	Control group	p
10 min of ischemia	no ventricular arrhythmia or rare polytopic ventricular extra systole	5 (50%)	6 (60%)	0.5
10 min of ischemia	polytopic and polymorphic ventricular extra systole	2 (20%)	9 (90%)	0.003
10 min of ischemia	ventricular fibrillation	0	1 (10%)	0.5
35 min of ischemia	no ventricular arrhythmia or rare polytopic ventricular extra systole	5 (50%)	6 (60%)	0.5
35 min of ischemia	polytopic and polymorphic ventricular extra systole	1 (10%)	7 (70%)	0.001
35 min of ischemia	ventricular fibrillation	1 (10%)	1 (10%)	1
45 min of reperfusion	no ventricular arrhythmia or rare polytopic ventricular extra systole	5 (50%)	4 (40%)	0.5
45 min of reperfusion	polytopic and polymorphic ventricular extra systole	2 (20%)	8 (80%)	0.012
45 min of reperfusion	ventricular fibrillation	0	4 (40%)	0.04

Pearson Chi-Square test was used. Data are presented as n (%)

Infarction zone-risk area ratio, the data are presented in % as Me [25; 75]. Mann – Whitney test was used; $p = 0.0002$