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Remote ischemic preconditioning in patients undergoing coronary bypass grafting following acute coronary syndrome without ST elevation

Kardioprotektivni efekat udaljenog ishemijskog prekondicioniranja tokom hirurške revaskularizacije miokarda kod bolesnika sa akutnim koronarnim sindromom bez elevacije ST segmenta

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Abstract

Background/Aim. A protection of heart and other organs from ischemic-reperfusion injuries can be provided by remote ischemic preconditioning (RIPC) by brief episodes of ischemia and reperfusion in distant tissues. The aim of this study was to assess effects of RIPC on early outcomes in patients underwent coronary bypass surgery (CABG) following acute coronary syndrome without persistent ST segment elevation (NSTEMI ACS). **Methods.** This trial included 42 patients randomized into two groups: the group 1 received RIPC and the group 2 was without RIPC (control group). Pre-, intra- and postoperative parameters were compared but primary endpoint was myocardial injury reflected as value of troponin I measured preoperatively and 1, 6, 12, 24, 48 and 72 h postoperatively. The secondary endpoints were hemodynamic parameters, blood loss, intensive care unit stay, mortality etc. **Results.** The groups 1 and 2 were similar in preoperative characteristics including age, New York Heart Association (NYHA) class, EuroSCORE II, left ventricular ejection fraction. The only significant difference between groups was for triple vessel coronary disease with dominance in the RIPC group [20 (100%) vs. 17 (77.3%), $p = 0.049$]. Cardiopulmonary bypass time [mean (± standard deviation): 83.0 (22.9) vs. 67.0 (17.4) minutes, $p = 0.015$], cross clamp time [57.9 (15.4) vs. 44.3 (14.3) minutes, $p = 0.005$] and number of conduits [median (25–75th percentile): 23.5(3–4) vs. 3(2–3), $p = 0.002$] were different. Other intra- and postoperative variables did not differ between groups. There were no differences in C reactive protein levels and postoperative hemodynamic parameters. Average troponin values in all time points revealed no significant differences between groups ($p_{0h} = 0.740$, $p_{1h} = 0.212$, $p_{6h} = 0.504$, $p_{12h} = 0.597$, $p_{24h} = 0.562$, $p_{48h} = 0.465$ and $p_{72h} = 0.715$, respectively). Furthermore, there were no significant differences in adverse events, hospital stay and mortality between groups. **Conclusion.** Treatment with RIPC during CABG following NSTEMI ACS did not provide better myocardial protection and hemodynamics characteristics but further larger randomized studies are needed t. prove its real value.

Key words:
coronary artery bypass; ischemic preconditioning, myocardial; myocardial revascularization; non-st elevated myocardial infarction; troponon i; treatment outcome.

Apstrakt

Uvod/Cilj. Zaštita srca i drugih organa od ishemijsko-reperfuzonih oštećenja može biti obezbeđena udaljenim ishemijskim prekondicioniranjem (*remote ischemic preconditioning* – RIPC) sa kratkim epizodama ishemije i reperfuzije u udaljenim tkivima. Cilj rada bio je da se utvrdi efekat RIPC na rane rezultate hirurške revaskularizacije miokarda kod bolesnika sa akutnim koronarnim sindromom bez elevacije ST segmenta. **Metode.** Studijom su bila obuhvaćena 42 bolesnika koji su bili randomizovani u dve grupe: grupu 1 koja je bila tretirana sa RIPC i grupu 2 bez RIPC (kontrolna grupa). Poređeni su pre-, intra- i postoperativni parametri, ali je glavni cilj bio miokardna lezija koja se odražava kroz vrednosti koncentracije troponina I merenih preoperativno i 1, 6, 12, 24, 48 i 72 sata postoperativno. Analizirani su vredno-

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sti hemodinamskih parametara, krvarenje, vreme lečenja u jedinici intenzivne nege, mortalitet i ostalo. **Rezultati.** Grupe 1 i 2 bile su slične po preoperativnim karakteristikama, kao što su životna dob, *New York Heart Association* (NYHA) klasa, EuroSCORE II i ejekciona frakcija leve komore. Jedina razlika među grupama bila je u zastupljenosti trosudovne koronarne bolesti sa dominacijom u RIPC grupi [20 (100%) vs. 17 (77,3%), p = 0,049]. Vreme kardiopulmonalnog bajpasa [srednja vrednost (± standardna devijacija): 83,0 (22,9) vs. 67,0 (17,4) minuta, p = 0,015], vreme kleme na aorti [57,9 (15,4) vs. 44,3 (14,3) minuta, p = 0,005] i broj graftova [medijan (25–75. percentil): 3,5 (3–4) vs. 3 (2–3), p = 0,002] bili su različiti. Ostale intra- i postoperativne varijable se nisu razlikovale među grupama. Nije bilo razlike u vrednostima C reaktivnog proteina i postoperativnih hemodinamskih parametara. Srednje vrednosti troponina u svim ispitivanim vremenskim intervalima nisu pokazale značajnu razliku među grupama (p_{0h} = 0,740, p_{1h} = 0,212, p_{6h} = 0,504, p_{12h} = 0,597, p_{24h} = 0,562, p_{48h} = 0,465 i p_{72h} = 0,715). Takođe, nije bilo značajne razlike u pojavi neželjenih događaja, dužini trajanja bolničkog lečenja i mortalitetu između grupa. **Zaključak.** Primena RIPC tokom hirurške revaskularizacije miokarda kod bolesnika sa akutnim korornarnim sindromom bez elevacije ST segmenta ne obezbeđuje bolju miokardnu zaštitu i hemodinamske kararkteristike, ali su neophodne veće randomizovane studije da bi se dokazao pravi efekat RIPC.

Ključne reči:
aortokoronarno premošćavanje; miokard, prekondicioniranje, ishemijsko; miokard, revaskularizacija; infarkt miokarda bez st elevacije; troponin i; lečenje, ishod.

Introduction

Remote ischemic preconditioning (RIPC) by brief episodes of ischemia and reperfusion in distant tissues can provide protection of heart and other organs from ischemic-reperfusion injuries [1–3]. Perioperative myocardial necrosis during cardiac surgery is predominantly caused by myocardial protection failure and is associated with increased morbidity and mortality [4]. It has been shown that RIPC can attenuate cardiomyocyte injury [4]. Cardioprotection methods are important to avoid post-ischemic myocardial dysfunctions which appeared during coronary artery bypass grafting (CABG) and are reflected by cardiac troponin (cTn) release. Previous studies have proved that RIPC has cardioprotective effect with reduced release of cTn levels during cardiac surgery and can improve better clinical outcomes [4]. Acute coronary syndrome (ACS) is clinical presentation of coronary artery disease and includes unstable angina (UA), non ST-segment elevation myocardial infarction (NSTEMI) and ST-segment elevation myocardial infarction (STEMI) [5]. Majority of patients with NSTE-ACS are treated with percutaneous coronary interventions (PCI) but about 10% of them require surgical revascularization (CABG) [6]. In this group of high risk patients is difficult to balance between ischemic-reperfusion injuries and bleeding complications in relation to the timing of surgery [5]. In addition to an urgent revascularization which carries a certain risk, acute myocardial ischemia is an additional risk factor for adverse events in postoperative course. Previous investigations have shown the effect of RIPC on myocardial protection during CABG [1, 3, 7] and adult valve surgery [8, 9], abdominal aortic surgery [10] and congenital heart surgery [2].

The aim of the present randomized, prospective, feasibility study was to reveal whether or not RIPC provides additional myocardial protection to standard cardioplegic techniques during CABG following NSTEMI ACS. For these reasons we analyzed cTn levels, hemodynamic parameters and compared outcome of surgical procedure by analyzing postoperative major complications.

Methods

This prospective, randomized, pilot, single-center study was conducted between June 2016 and November 2017. The study protocol was approved by the local Ethics Committee. All patients provided written informed consent for participation in the trial. Eligible patients were adults with ACS NSTEMI with chest pain and electrocardiogram (ECG) abnormalities required urgent CABG. Patients were randomized using previously generated randomization list in computer software PASS 11.0. Efron`s biased coin algorithm with 1:1 allocation ratio was used for randomization list generation. Forty-four eligible patients were included and randomized but two patients from the RIPC group were excluded from trial. In the first case, iatrogenic aortic dissection occurred during CABG and procedure was extended into ascending aortic reconstruction concomitant with CABG. In the second case, the patient was hemodynamic unstable after induction of general anesthesia and intra aortic balloon pump was inserted preoperatively. A total of 42 patients were divided into two groups: the RIPC group (3 cycles of 5 min right upper arm ischemia by inflation of a blood pressure cuff to 200 mmHg and 5 min of reperfusion) and the control group (cuff was uninflated around right upper arm for 30 min) after induction of anesthesia [11]. Our protocol was modified and cuff was inflated on right upper arm because we harvested left radial artery as conduit in some cases. Anesthesiologists who applied the RIPC protocol were not blinded but they were not involved in data collection and interpretation. All other participants in trial, including patients, were blinded.

Patient selection

Patients were included in the study if they had ACS NSTEMI unsuitable for percutaneous treatment but required CABG on the current admission. All of them were designated for urgent isolated CABG according to clinical and coronary angiographic findings recruited with cardiospecific enzymes levels. Exclusion criteria were: elective CABG, ad-

ditional valve surgery, poor left ventricular function (left ventriculkar ejection fraction < 25%), redo surgery, peripheral upper limbs occlusive vascular disease, off pump surgery, simultaneous carotid endarterectomy, acute or chronic infections, autoimmune diseases, hepatic dysfunction and recent pulmonary embolism or myocardial infarction or PCI or any other reasons for increased preoperative cTnI concentration.

Perioperative management

Premedication consisted of atropine (0.5 mg), midazolam (0.1 mg/kg) and morphine (4 mg) intramuscularly. Anesthesia was induced with midazolam (0.3–0.4 mg/kg), fentanyl (10–15 μg/kg) and rocuronium (0.6 mg/kg), and maintained with sevoflurane (minimum alveolar concentration 0.5–1.2 % atm) or with propofol and continuous infusion of fentanyl (1.5 μg/kg/h). After induction of anesthesia pulmonary artery catheter (HANDS-OFF Thermodilution Catheter, Arrow International Inc, Reading, PA) was inserted. Moderate hypothermic cardiopulmonary bypass (32°C) was established through cannulation of the ascending aorta and right atrium. Then RIPC was applied as aforementioned above or blood pressure cuff was remained uninflated. Surgical revascularization was performed through median sternotomy. Both internal thoracic arteries, radial artery and saphenous veins were used as conduits. Heparin was administered to achieve an activated coagulation time above 400 seconds. Membrane oxygenation (INSPIRE™ SORIN, Sorin Group Italia) and roller pump (Stockert SORIN S5, Sorin Group Italia) were used. Nonpulsatile flow on cardiopulmonary bypass (CPB) was maintained at 2.2–2.4 L/ (min/m^2), and perfusion pressure between 50 mmHg and 70 mmHg. Cardioplegic arrest was achieved by anterograde administration of cold blood cardioplegia (4 °C). Proximal graft anastomoses were performed with total single clamp or partial side clamping of the ascending aorta. After rewarming to 36.7–37 °C, weaning from CPB was supported by inotropic drugs. Systemic anticoagulation was reversed by protamine sulphate according to a standard protocol (1 mg/300 IU of heparin). A standard protocol for early postoperative care in an intensive care unit (ICU) was followed.

Data collection

The primary endpoint was to assess the perioperative myocardial injury reflected as cTnI concentration levels during first 72 h after CABG. Venous blood samples for measurement of cTnI concentrations were collected prior to surgery and 1, 6, 12, 24, 48 and 72 h after surgery. Concentrations of cTnI were measured using a specific two-side immunoassay (Access 2® Backman Coulter, USA). The reference range was 0–0.04 ng/mL. cTnI values above 0.1 ng/mL were considered as abnormal. Venous blood samples for measurement of creatine kinase (CK) and its muscle-brain (MB) isoform (CK-MB), C-reactive protein (CRP) and white blood cells (Le) count were collected prior to the surgery and 24 h after surgery. Serum CRP and CK-MB concentrations were determined by turbidometry with the UniCelD × C600® analyzer (Beckman Coulter USA). CRP concentrations below 5.0 mg/L and CK-MB concentrations 0–25 IU/L were considered to be within the reference range. Hemodynamic measurements in the form of cardiac output (CO), mean arterial pressure (ARP), pulmonary capillary wedge pressure (PCWP) and cardiac index (CI) were performed prior to surgery and 1, 6, 12, 24 h after surgery and in minority of cases 48h and 72 h after surgery. Arterial blood samples for pH, lactate and glucose concentrations measurements were obtained prior to surgery and 24 h postoperatively. Perioperative myocardial infarction, new onset of atrial fibrillation, cerebrovascular adverse events, infections, renal functions, mechanical ventilation time, ICU and hospital stay and intrahospital mortality were recorded.

Statistical analysis

Results are presented as count (percent), mean (± standard deviation) or median (25–75th percentile), depending on data type and distribution. The *t*-test, Mann-Whitney *U* test, Pearson χ^2 test and Fisher's Exact test were used to assess significant differences between groups. The Linear mix model and General linear model were used to evaluate differences between groups regarding blood parameters in follow-up period. All *p*-values less than 0.05 were considered significant. All data were analyzed using the SPSS 20.0 (IBM corp.) and R for Windows 3.3.0 (CRAN project).

Results

Study included 42 patients, 20 in the RIPC group (47.62%) and 22 in the control group (52.38%). Average age of all participants was 64.8 ± 9.2 years, minimum 43 and maximum 79 years. Majority of participants were males, n = 38 (84.4%). Comparisons between examined groups regarding basic characteristics of participants are presented in Table 1.

As shown in Table 1, patients had similar basic characteristics including age, gender, body mass index (BMI), NYHA class and EuroSCORE. Distribution of risk factors was almost identical across groups. Cardiovascular characteristics of patients were also very similar in both groups. The only significant difference between groups was for triple vessel coronary disease with its dominance in the RIPC group. Additionally, from the patients treated with dual antiplatelet therapy (DAPT) preoperatively, 3 (25%) of the patients from 12 (60%) in the RIPC group were operated within 24 h and 2 (13.3%) of 15 (68.2%) of the patients from the control group were operated within 24 h ($p = 0.628$).

We performed coronary angiography in the RIPC group within 24 h in 8 (40%) of the patients and in 12 (60%) of the patients more than 72 h before surgery. In the control group coronary angiography was done within 24 h in 5 (22.7%) of the patients, in 1 (4.5%) patient between 1 and 3 days and in 16 (72.7%) of the patients more than 72 h before surgery ($p = 0.326$). Preoperatively, elevated cTnI concentrations in the RIPC group was present in 11 (55.0%) of the patients and in 11 (50.0%) of the patients in the control group ($p = 0.746$).

Table 1

Basic characteristics of patients in examined groups

Paremeter	RIPC (n = 20)	Control (n = 22)	*p*-value
Age (years), mean (± SD)	64.3 (11.0)	65.4 (7.6)	0.728[a]
Gender (male), n (%)	17 (85)	18 (81.8)	1.000[c]
BMI, mean (± SD)	27.1 (3.2)	28.6 (3.8)	0.193[a]
NYHA class III–IV, n (%)	10 (50)	12 (54.5)	0.768[b]
Euroscore II, median (25–75th percentile)	3.36 (1.40–5.30)	2.1 (1.34–3.73)	0.413[d]
Ever smoker, n (%)	15 (75)	16 (72.7)	0.867[b]
Hypertension, n (%)	17 (85)	20 (90.9)	0.656[c]
Hypercholesterolaemia, n (%)	18 (90)	20 (90.9)	1.000[c]
Diabetes mellitus, n (%)	10 (50)	13 (59.1)	0.554[b]
Peripheral vascular disease, n (%)	3 (15)	2 (9.1)	0.656[c]
Carotid artery stenosis (> 75%), n (%)	4 (20)	1 (4.5)	0.174[c]
Previous myocardial infarction, n (%)	8 (40)	12 (54.5)	0.346[b]
Triple vessel coronary disease, n (%)	20 (100)	17 (77.3)	0.049[c]
Left main coronary disease (> 50%), n (%)	10 (50)	11 (50)	1.000[b]
Left ventricular EF (%), mean (± SD)	42.5 (6.6)	40.9 (8.1)	0.488[a]
Hospital stay before CABG (days), median (25–75th percentile)	4.5 (1–6.5)	5 (0–8)	0.484[d]
Medication, n (%)			
DAPT	12 (60)	15 (68.2)	0.580[a]
beta blockers	19 (95.5)	21 (95.5)	1.000[c]
ACE inhibitors	14 (70.0)	18 (81.8)	0.477[c]
oral nitrates	6 (30.0)	9 (40.9)	0.461[a]

RIPC – remote ischemic preconditioning: BMI – body mass index; NYHA – New York Heart Association; EF – ejection fraction; CABG – coronary artery bypass graft; DAPT – dual antiplatelet therapy; ACE – angiotensin converting enzyme; SD – standard deviation.
[a]*t* test; [b]Pearson χ^2 test; [c]Fisher's Exact test; [d]Mann-Whitney *U* test.

Operative and postoperative parameters in examined groups are presented in Table 2. As shown in Table 2, the RIPC group had significantly higher CPB time, aortic cross clamp time and number of conduits. Other operative parameters showed no significant differences between groups. It was obvious that some parameters had higher percentages in the RIPC group than in the control one, however with no statistical significance, probably due to small sample size. None of the participants had infection and only one patient died after surgery.

All patients were examined regarding CK-MB and CRP values before and 24 h after surgery. Median values with 25–75th percentiles in both examined groups are presented in Table 3. Delta values represent differences between 24 h postoperative and preoperative values. There were no significant differences between groups in preoperative, postoperative or delta CK-MB and CRP values. Median values were very similar in both groups with rather higher values in the control group, except for CRP postoperative levels.

Table 2

Operative and postoperative parameters in examined groups

Parameter	RIPC (n = 20)	Control (n = 22)	*p*-value
CPB time (min), mean (± SD)	83.0 (22.9)	67.0 (17.4)	0.015[a]
Aortic cross clamp time (min), mean (± SD)	57.9 (15.4)	44.3 (14.3)	0.005[a]
Number of conduits, median (25–75th percentile)	3.5 (3–4)	3 (2–3)	0.002[d]
Inotropes > 12 h, n (%)	13 (65)	9 (40.9)	0.118[b]
MV time (min), median (25–75th percentile)	12.5 (10–15)	13.5 (11–16)	0.503[d]
Atrial fibrillation, n (%)	7 (35)	3 (13.6)	0.152[c]
Drainage (mL), median (25–75th percentile)	650 (400–1375)	600 (450–700)	0.313[d]
Reintervention, n (%)	2 (10)	1 (4.5)	0.598[c]
Respiratory insufficiency, n (%)	3 (15)	2 (9.1)	0.656[c]
Infection, n (%)	0	0	–
ICU stay (days), median (25–75th percentile)	2 (1–5)	2 (2–4)	0.767[d]
Postoperative hospital stay (days), median (25–75th percentile)	7 (6.5–16.5)	7 (6–8)	0.405[d]
Mortality, n (%)	1 (5)	0	0.476[c]

RIPC – remote ischemic preconditioning; CPB – cardiopulmonary bypass; MV – mechanical ventilation; ICU – intensive care unit; SD – standard deviation.
[a]*t* test; [b]Pearson χ^2 test; [c]Fisher's Exact test; [d]Mann-Whitney U test.

Table 3

CK-MB and CRP in examined groups before and after the surgery

Parameter	RIPC (n = 20)	Control (n = 22)	*p*-value*
CK-MB (IU/L)			
preoperative	11.1 (8.8–17.1)	13.2 (10.4–16.8)	0.242
24 h postoperative	24.5 (19.0–58.9)	38.8 (25.1–57.4)	0.314
delta CK-MB	13.5 (3.6–36.6)	17.3 (10.5–40.5)	0.465
CRP (mg/L)			
preoperative	4.25 (3.10–9.75)	5.25 (1.30–10.80)	0.870
24 h postoperative	139.5 (111.8–178.5)	134.1 (89.9–175.3)	0.724
delta CRP	127.4 (107.4–168.5)	131.2 (88.9–159.3)	0.782

***Note*: Results are presented as median (25–75th percentile).**
RIPC – remote ischemic preconditioning; CK-MB – creatin kinase-muscle, brain isoform; CRP – C reactive protein.
***Mann-Whitney *U* test.**

cTn values were examined in seven time points. Average values in all time points revealed no significant differences between groups (p_0 = 0.740, p_1 = 0.212, p_6 = 0.504, p_{12} = 0.597, p_{24} = 0.562, p_{48} = 0.465 and p_{72} = 0.715, respectively). Delta troponin was calculated as difference between 72 h cTn and baseline cTn. Comparing results between groups, we did not obtain significant differences regarding delta cTn (0.46 ± 1.96 vs. 0.08 ± 2.59 ng/mL; p = 0.696). Using linear mixed model, we also obtained no significant differences between groups regarding mean troponin values during follow up (p = 0.816). Troponin mean values with 95% confidence intervals are presented in Figure 1. The cTnI reached a peak level at 6 h in the RIPC group while the maximum cTnT level was reached at 24 h in the control group; this trend did not reach statistical significance.

Beside troponin, following parameters were examined during follow- up in five time points (baseline, 1 h, 6 h, 12 h and 24 h after surgery): CO, ART, PCWP, CI and mixed venous oxygen saturation (SVO2). In time points 48 h and 72 h, only several patients have measurements and therefore we excluded these measurements from further analysis. Using general linear model, we did not obtain significant influence of RIPC vs. control on CO, ART, PCWP, CI and SVO2 parameters (p = 0.490, p = 0.943, p = 0.208, p = 0.422 and p = 0.594, respectively). When comparing differences between groups in each time point, we did not obtain any significant difference regarding examined parameters except PCWP in baseline (RIPC vs. baseline, p = 0.027). Listed parameters except SVO2 are presented in Figure 2.

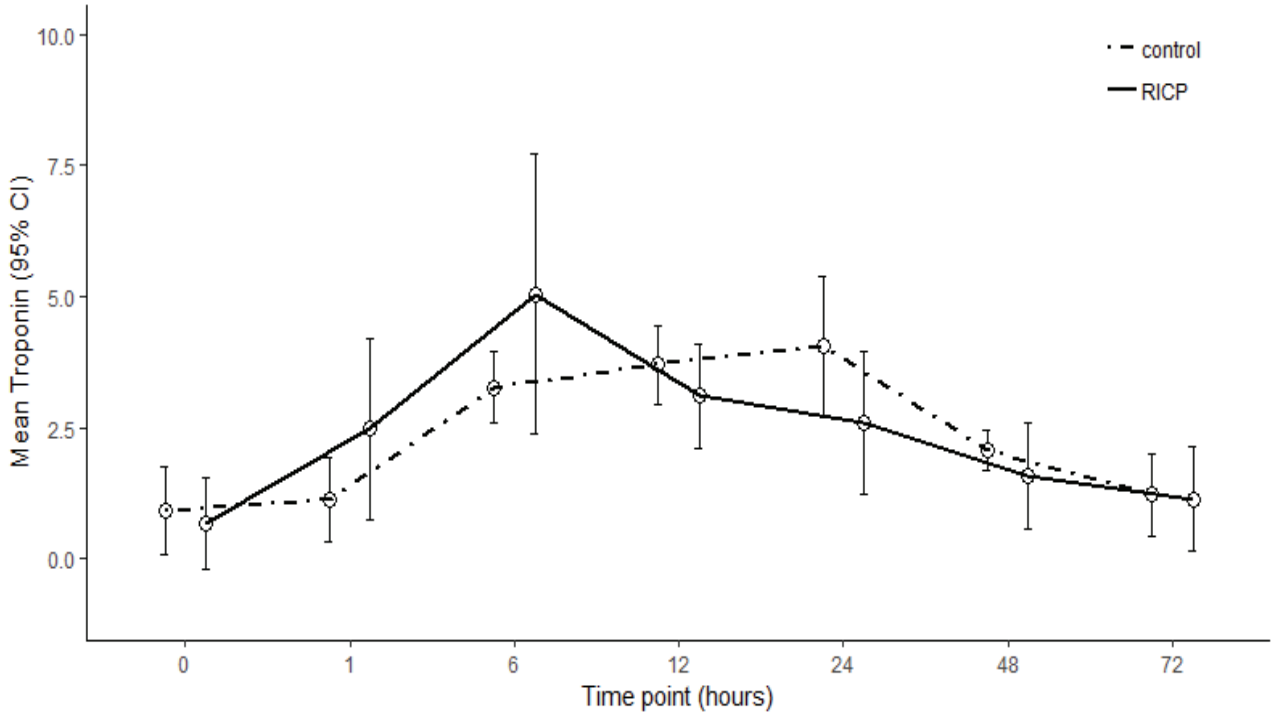

Fig. 1 – Troponin values (in ng/mL) during follow-up in examined groups.
RIPC – remote ischemic preconditioning; CI – confidence interval.

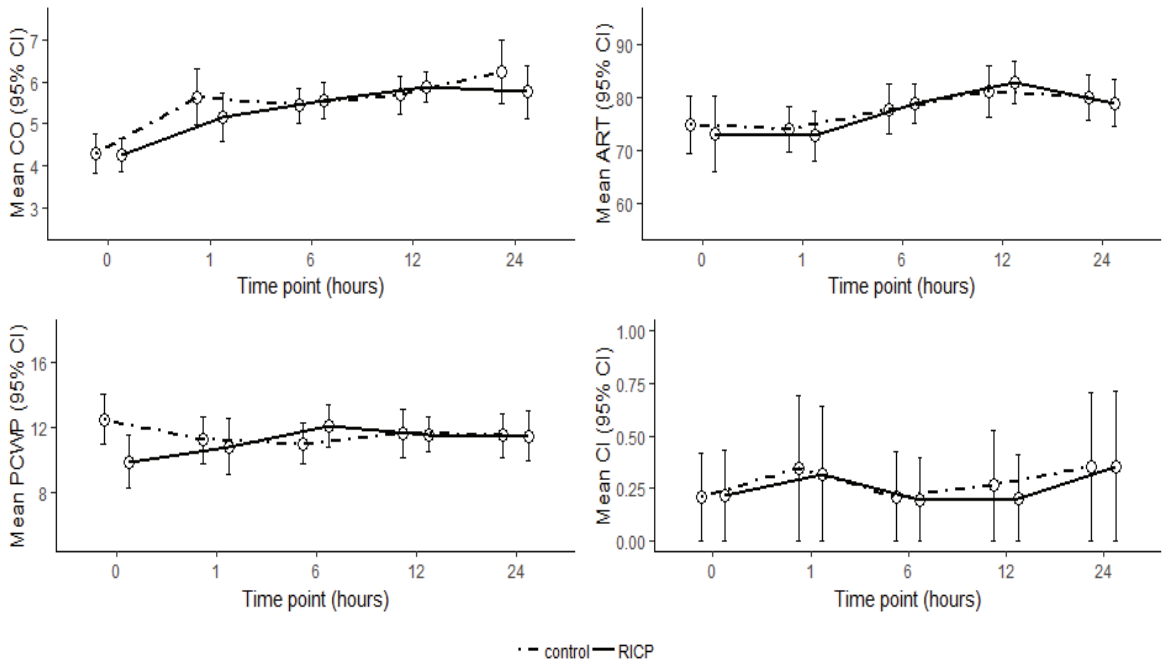

Fig. 2 – CO (L/min), ART (mmHg), PCWP (mmHg) and CI values in examined groups during follow-up. CO – cardiac output; ART – mean arterial pressure; PCWP – pulmonary capillary wedge pressure; CI – cardiac index. RIPC – remote ischemic preconditioning; CI – confidence interval.

Discussion

Our study was, to our knowledge, the first randomized prospective trial that assessed cardioprotective effect of RIPC in high risk patients undergoing CABG in NSTEMI ACS. In recent years, there has been an increasing interest in cardioprotective effect of RIPC during cardiac surgery, however results still remain controversial. Two large prospective, randomized trials that included patients with high EuroSCORE and combined procedures (CABG with valve or ascending aorta replacement) showed that RIPC did not reduce perioperative major adverse cardiac and cerebral events [12, 13]. Majority of previous investigations excluded urgent patients, thus proved that RIPC enhanced myocardial protection during elective CABG [1–3]. Our trial involved patients with NSTEMI ACS, with high risk of perioperative major adverse events and did not reveal beneficial cardioprotective effect of RIPC. Rahman et all. [14] included elective and urgent (NSTEMI ACS within 30 days) adult patients undergoing CABG but without patients who had angina within 48 h of surgery. All our patients were operated in next 24 h of NSTEMI ACS onset on the current admission. Only few studies included high risk cardiac surgery patients but did not prove that RIPC reduced cTnT, acute kidney injury or ICU support requirements [14–16]. In our trial, preoperative data were different between groups only in total amount of triple vessel coronary disease (all patients in the RIPC group) and it reflects on significant difference in CPB time, aortic clamp time and number of conduits. We performed coronary angiography within 24 h at the day of admission and before surgery in 8 patients in the RIPC group and in 5 patients in the control group, without statistical difference. All other patients in both groups were examined more than 3 days before surgery (except 1 patient from the control group who was examined between 1 and 3 days) and were admitted at hospital for elective CABG, carotid or abdominal aortic surgery but developed ACS NSTEMI while waiting for surgery. Ghosh and Galiñanes [17] investigated RIPC effects in CABG with or without CPB and revealed that RIPC had additional cardioprotective effect in beating heart surgery but not in "on pump" surgery because CPB induces preconditioning by itself [17]. We also believe that this difference in preoperative data had no impact on cTnI release. Furthermore, we observed the peak cTnI level at 6 h in the RIPC group while the maximum cTnI level in the control group was reached at 24 h. This observation suggest that RIPC may play a role in faster recovery from reperfusion injury after on-pump CABG. In line with our findings, several studies showed that RIPC reduced myocardial injury in patients undergoing CABG with cold blood cardioplegia [8] and crystalloid cardioplegic arrest [18]. In our trial, cardioplegic arrest was achieved by anterograde administration of cold blood cardioplegia in all cases, however we did not reveal additional cardioprotective effect. Results from our study demonstrated that postoperative hemodynamics characteristics and ICU inotropic support requirements did not differ between groups. Also, RIPC did not reduce mechanical ventilation time, ICU or postoperative hospital stay, mortality remained lower in the control group but without significant difference. Finally, only one death occurred in the RIPC group due to an acute kidney injury but small number of major adverse events could induce wrong conclusion.

These data were achieved on limited number of patients. Small sample size was main obstacle to extract any strong conclusion. Our study did not include patients with triple vessel coronary disease because we tried to establish whether all consecutive patients in our tertiary healthcare center undergoing urgent CABG surgery could profit from RIPC. We focused on surgical findings but disregarded preoperative anesthetic medication standardization. Although, it is hard to achieve homogeneous patient cohort, we hope our further investigation will give some firm conclusions.

Conclusion

Although limited by a small sample size, our results showed that RIPC in urgent high risk patients with NSTEMI ACS undergoing CABG did not reduce cTnI release, did not improve hemodynamics characteristics and did not improve early postoperative clinical outcomes. However, further multicenter, randomized trials are mandatory before assessing the real value of RIPC cardioprotective effects.

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