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ORIGINAL ARTICLE

Protective role of single versus multiple remote ischemic preconditioning in elective percutaneous coronary interventions

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Abstract *Aim:* To compare single cycle remote ischemic preconditioning (single RIPC) to multiple cycles RIPC in attenuating cardiac myonecrosis and reducing MACE after elective PCI.
Methods and results: 150 consecutive patients undergoing elective PCI were studied. Mean age was 54.5 ± 7.2 years and 42(28%) patients were females. 100 patients received RIPC (each cycle of RIPC was 5 min of inflation followed by 5 min of deflation), 50 by multiple cycles RIPC (group A), and 50 with single cycle RIPC (group B), while 50 patients did not receive RIPC (group C, control) before PCI. Myocardial ischemia during PCI, indicated by ST-segment deviation, was less in RIPC patients (31(31%) vs. 25(50%) patients, $p = 0.023$, 0.48 ± 0.81 mm vs. 0.96 ± 1.2 mm, $p = 0.004$; respectively), a difference that was similar when subgroups were compared to control (group A: 15, group B: 16, group C: 25 patients, $p = 0.075$, and group A: 0.46 ± 0.76, group B: 0.5 ± 0.86, group C:0.96 ± 1.2 mm, $p = 0.015$), with no difference between groups A and B. Myonecrosis, indicated by mean cTnI at 24 h after PCI, was lower in RIPC (0.043 ± 0.033, 0.06 ± 0.048 ng/ml, $p = 0.01$), higher in the control than subgroups (group A: 0.043 ± 0.034, group B: 0.042 ± 0.33, and group C: 0.06 ± 0.048 ng/ml, $p = 0.002$), again with no difference between groups A and B. At 3 months, there was a trend toward lower MACE, which was significant for acute coronary syndrome, in all the RIPC groups.
Conclusion: Single-cycle RIPC can be an alternative to multiple-RIPC for protective effects after elective PCI, however single RIPC requires less time in the busy PCI setting.

1. Introduction

Ischemic preconditioning (IPC), was shown to reduce the extent of myocardial infarction (MI), and to attenuate ischemia/reperfusion injury (IR).[1–4] Later, it was found that myocardial infarction (MI) size can be reduced if IPC

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was applied to a distant organ before myocardial ischemia, an extension that was called remote IPC (RIPC).[5–8]

Troponin release is an accurate marker of myocyte necrosis, used in many studies to prove the benefit of IPC in decreasing infarct size. However, elective percutaneous coronary intervention (PCI) is also associated with troponin release in approximately one third of the cases,[9,10] which is associated with subsequent cardiovascular events.[11]

A recent study showed that RIPC reduces PCI-related cTnI release and appears to reduce subsequent cardiovascular events.[12] In that study, RIPC was done by repeated cycles of ischemia in the upper limb done by a blood pressure cuff inflation for 5 min, interrupted by 5 min of cuff deflation.

In this study we aim to test the hypothesis that RIPC by single cycle of blood pressure cuff inflation is similar to that by multiple cycles of blood pressure cuff inflations in reducing cTnI after elective PCI compared to controls.

2. Methods

2.1. Identification and recruitment of patients

We included patients with significant coronary artery stenosis suitable for PCI (i.e. not three vessel disease or other complex lesion anatomy which are not suitable for PCI), documented by previous coronary angiography, referred for elective PCI in Ain Shams University Hospital and National Heart Institute (NHI), Cairo, Egypt. Patients were excluded if their level of cardiac troponin I (cTnI) before PCI was elevated (corresponding >0.04 ng/ml in the measurement assay used), or if they were on nicorandil or glibenclamide use (preconditioning-mimetic and preconditioning-blocking medication, respectively).[12–14]

The local ethics committee of both institutions approved the study and randomization protocol, and all patients gave written informed consents.

2.2. Procedural interventions

2.2.1. Remote IPC and control interventions

All RIPC studies were done in the cardiac catheterization laboratory, on table, and before starting the PCI procedure. Patients randomized to have RIPC had a blood pressure cuff placed around their non-dominant upper arm. In group A, the cuff was inflated in three cycles each to 200-mmHg pressure for 5 min, followed by 5 min of deflation, to allow reperfusion. In group B patients had only one cycle of inflation and deflation. In the control group (group C), patients had a similar cuff placed around the upper arm, but it was not inflated. Thereafter, all patients underwent PCI by an interventionist blinded to the study allocation.

2.2.2. Percutaneous coronary intervention

PCI was started once the cuff was removed after the last cycle of inflation in group A, and after removal of the cuff in groups B and C with a time window between removal of the cuff and the first balloon inflation that did not exceed 15 min. PCI was performed via a femoral arterial approach with 6F or 7F

Table 1 Basic demographic, clinical and angiographic data for all patients and subgroups.

	All patients (n = 150)	Group A (n = 50)	Group B (n = 50)	Group C (n = 50)	p-Value
Age (years)	54.5 ± 7.2	54.1 ± 7.4	54.0 ± 5.9	55.3 ± 8.3	.645
Sex (m/f) n(%)	108(72)/42(28)	35(70)/15(30)	38(76)/12(24)	35(70)/15(30)	0.743
Risk factors n(%)					
DM	79(53)	28(56)	25(50)	26(52)	0.829
HTN	88(59)	25(50)	29(58)	34(68)	0.187
DLP	9(6)	4(8)	0(0)	5(10)	0.084
SM	81(54)	25(50)	31(62)	25(50)	0.381
Family history	34(23)	11(22)	13(26)	10(20)	0.766
Mean blood pressure (mmHg)	97.6 ± 9.9	97.2 ± 10.5	95.8 ± 9.6	99.7 ± 9.5	0.133
Heart rate (beat/minute)	85.9 ± 5.8	86.6 ± 6.8	85 ± 5.7	86 ± 4.7	0.375
Medications n(%)					
B-blockers	133(89)	42(84)	47(94)	44(88)	0.284
ACEI	100(67)	34(68)	30(60)	36(72)	0.432
Statins	85(57)	30(60)	28(56)	27(54)	0.827
Killip class (I/II) n(%)	128(85)/22(15)	43(86)/7(14)	40(80)/10(20)	45(90)/5(10)	0.363
Presentation cTnI (ng/ml)[a]	0.024 ± 0.005	0.024 ± 0.005	0.025 ± 0.005	0.022 ± 0.005	0.246
Number of diseased vessels					0.862
Single vessel	115(77)	39(78)	39(78)	37(74)	
Two vessels	35(23)	11(22)	11(22)	13(26)	
Diseased vessels					
LAD	94(63)	33(66)	30(60)	31(62)	0.819
LCX	27(18)	5(10)	12(24)	10(20)	0.172
RCA	44(29)	15(30)	12(24)	17(34)	0.543
Others	23(15)	10(20)	7(14)	6(12)	0.513
Number of significant lesions	193	65	63	65	
AHA class (A/B/C)	146/44/3	50/15/0	51/12/0	45/17/3	0.125
Number of lesions per patient	1.29 ± 0.45	1.3 ± 0.46	1.26 ± 0.44	1.30.46	0.880
% of stenosis	84.4 ± 7.7	82.2 ± 14.3	85.9 ± 7.6	85.1 ± 7.7	0.111

[a] Presentation cTnI was available as a continuous variable in 98 cases (35 in group A, 38 in group B, and 25 in group C) because values in the remaining cases were so low to be detected by the measuring device.