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A clinical case

Clinical Impact of Remote Ischemic Preconditioning on Myocardial Injury and Postoperative Delirium in a High-Risk Geriatric Patient Undergoing Orthopedic Surgery: A Case Report

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Abstract

Remote ischemic preconditioning (RIPC) is considered a method for reducing ischemia-reperfusion injury during surgical interventions. Although large randomized trials in non-cardiac surgery have not demonstrated convincing clinical benefits, individual studies may suggest their potential value.

We present a case report of a female patient undergoing elective orthopedic surgery, in whom RIPC was performed immediately after the induction of anesthesia. Postoperatively, troponin I levels remained within normal limits on days 1, 2, and 3, with no clinical or electrocardiographic signs of myocardial injury. A transient episode of delirium was noted on the first postoperative day; however, after treatment, the patient's condition quickly recovered, and she remained oriented and communicative. Renal function remained stable.

This clinical case illustrates the clinical use of RIPC in a high-risk cardiac patient. The observed stable troponin levels and favorable postoperative course are consistent with the hypothesis of a possible protective effect of RIPC. However, these observations are descriptive in nature and highlight the need for further prospective studies to evaluate the potential effectiveness of this technique and identify patient groups that may benefit most from it.

Keywords: remote ischemic preconditioning, non-cardiac surgery, troponin, myocardial injury, delirium.

1. Introduction

Coronary heart disease (CHD) and its most severe form, myocardial infarction, remain one of the leading causes of death and disability worldwide. According to the World Health Organization, cardiovascular diseases account for up to 32% of all deaths, highlighting the need to develop effective prevention and cardioprotection methods [1]. Despite the development of pharmacological and interventional approaches, a significant proportion of patients, particularly in the geriatric group, continue to experience complications associated with myocardial ischemia and reperfusion injury in the perioperative period [2]. The development of delirium often worsens the prognosis, increasing the patient's stay in the intensive care unit [3].

Remote ischemic preconditioning (RIPC) is a non-invasive technique that involves inducing short-term ischemia and subsequent reperfusion of a limb to activate the body's systemic defense mechanisms. This method was initially proposed for the prevention of ischemic myocardial injury during cardiac surgery, however, in recent years, interest in RIPC has also increased significantly in non-cardiac surgery. Recent randomized controlled trials have not revealed a clear clinical effect [4]. However, observations of individual cases may indicate the effectiveness of the method in certain patient groups [5].

In recent years, attention to delirium as a common complication in elderly patients has increased. Research indicates that delirium is linked to endothelial dysfunction, systemic inflammation, and microcirculatory impairment, which are pathogenetically similar to the mechanisms affected by RIPC [6]. Evidence is emerging that RIPC can reduce the incidence of postoperative delirium and improve cerebral perfusion [7,8].

This case suggests a potential role for RIPC in the prevention of cardiac injury and delirium in geriatric patients. The objective of this observation was to evaluate the potential efficacy of RIPC in preventing cardiac injury and postoperative delirium in geriatric patients. This case report conforms to the CARE guidelines and the EQUATOR network.

2. Clinical Case Description

Patient Information

Past medical history: A 65-year-old female patient with a significant cardiovascular history. In March 2021, she suffered a myocardial infarction; percutaneous coronary intervention (PCI) was not performed in the acute phase. In June 2022, post-infarction cardiosclerosis was diagnosed, and PCI with stenting of the anterior interventricular artery was performed as planned. The patient's comorbidities include ischemic heart disease, chronic heart failure stage IIA, functional class III according to the NYHA classification, stage III hypertension with very high cardiovascular risk (risk IV), and type 2 diabetes mellitus.

Recent medical history: The patient was hospitalized for elective surgery due to chronic pain and limited mobility in the right shoulder. Her medical history revealed a shoulder injury in February 2020 and surgery in March 2020. Surgeries for a non-union fracture (pseudarthrosis) of the humerus were performed in August 2020 and February 2021.

Her allergy and gynecological history are unremarkable.

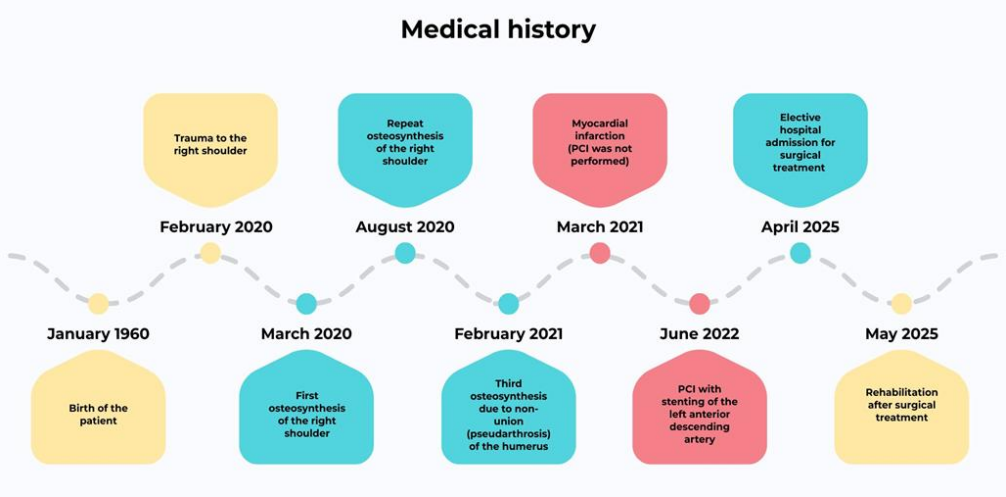

Figure 1 - Patient's medical history

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Clinical Findings

The patient's general condition was satisfactory. The skin and visible mucous membranes were normal in color. The patient was oriented and ambulated independently.

Neurological status: Consciousness was clear. No focal neurological symptoms were detected. Localized pain was noted upon palpation in the projection of the middle third of the right humerus. No neurovascular disorders were detected in the upper or lower extremities.

Respiratory system: Vesicular breathing, no wheezing. Respiratory rate was 18 per minute. Percussion revealed clear lung sounds. SpO_2 was 96-97%.

Cardiovascular system: Hemodynamics were stable. Heart sounds were clear and rhythmic. Heart rate was 76 per minute. Blood pressure was 125/84 mmHg.

Abdominal organs: The tongue was clean and moist. The abdomen is soft and painless on palpation. The liver and spleen are not enlarged. The percussion sensation is negative on both sides.

Local status: Examination of the right shoulder region reveals postoperative scars on the lateral surface without signs of inflammation. Palpation reveals tenderness over the middle third of the right humerus. Movement in the right shoulder joint is painless and limited: flexion 90°, extension 160°, abduction 20°.

Diagnostic Assessment

Laboratory results upon admission were within normal limits. Blood chemistry, coagulation profile, and urinalysis remained within normal limits before and after surgery. Coagulation parameters were maintained within the target normal coagulation range with anticoagulant therapy (Nadroparin Calcium (2850 IU anti-Xa/0.3 ml once daily).

Instrumental tests included:

ECG: Sinus rhythm with a heart rate of 74 beats per minute. Horizontal electrical axis. Cicatricial changes in the anteroseptal wall of the left ventricle.

Echocardiogram: Aortic root thickening. Cavity dimensions within age-appropriate limits. No structural heart valve pathology was detected. Left ventricular diastolic dysfunction. Minimal mitral valve contractility. pulmonary artery regurgitation. Global myocardial contractility was 55-57%. At the time of the study, hypokinesis of the interventricular septum (IVS) at the apex of up to 4 segments was observed.

Respiratory examination and fluorography also revealed no abnormalities.

During the examination an EGD revealed chronic superficial gastritis.

Ultrasound of the lower extremity veins showed normal venous patency, and no thrombosis was detected.

Diagnosis

Based on the patient's medical history, laboratory, and instrumental studies, the following diagnosis was made: Primary: Fracture nonunion (pseudoarthrosis). (Pseudarthrosis of the middle third of the right humerus.) Associated conditions: coronary artery disease (CAD), chronic heart failure (CHF IIa, NYHA FC III), stage III hypertension (CVD risk IV), post-infarction cardiosclerosis (as of June 13, 2022), condition after stenting of the left anterior ventricular artery (as of June 13, 2022), and type 2 diabetes mellitus.

The decision was made to perform surgery—removal of the fixing structures and repeat osteosynthesis with bone grafting.

Preoperative risk was assessed as ASA III, RCRI index ≥ 2, which corresponds to an increased risk of developing cardiac complications.

Anesthesia and RIPC Protocol

On the second day of hospitalization, after obtaining prior informed consent, the RIPC procedure was performed immediately after induction of general anesthesia and before surgery. A cuff was applied to the left arm, creating a pressure of 200 mmHg. Three 5-minute ischemia cycles were performed, each alternating with 5-minute reperfusion periods.

Induction was performed with sodium thiopental at a dose of 3.5 mg/kg, and anesthesia was maintained with inhalational sevoflurane with a minimum alveolar concentration (MAC) of 0.8–1.0. Perineural block was not performed. Fentanyl was used as a systemic analgesic intraoperatively. Muscle relaxants used were suxamethonium chloride at a dose of 100 mg for induction and pipecuronium bromide at a dose of 4 mg for maintenance.

Epinephrine was infused at a rate of 0.06-0.08 mcg/kg/min to support hemodynamics. Inotropic support was administered briefly intraoperatively to support a downward trend in blood pressure and was discontinued once hemodynamic parameters stabilized. Fluid therapy consisted of 1500 ml of 0.9% sodium chloride solution.

After surgery, the patient was transferred to the intensive care unit for observation, where she remained for 24 hours. Further treatment was then continued according to the underlying disease profile.

Surgical Treatment

The surgery lasted 3 hours and 20 minutes. Intraoperative blood loss was 300 ml. Prophylactic antibacterial therapy consisted of cefazolin 1000 mg intravenously.

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Postoperative Period

The hemoglobin level was 95 g/L on the first postoperative day, 85.5 g/L on the second day, and 89.6 g/L at discharge. No decrease in hemoglobin below 80 g/L was observed. There were no indications for blood transfusion.

Antibacterial therapy with cefazolin 1000 mg intravenously twice daily was continued. On the first postoperative day, the patient also received postoperative analgesia in the form of narcotic analgesics: promedol 20 mg intramuscularly three times daily. Subsequently, pain relief was maintained with NSAIDs: ketoprofen 100 mg intramuscularly twice daily, metamizole sodium 1000 mg intramuscularly once daily.

To prevent thromboembolic complications postoperatively, the patient was prescribed low-molecular-weight heparin (Nadroparin Calcium 2850 IU anti-Xa/0.3 ml) once daily for 10 days. To prevent stress ulcers, the patient took the proton pump inhibitor omeprazole 40 mg once daily for 7 days. As part of her rehabilitation, she underwent active kinesitherapy of the upper limb once daily for 3 days.

Follow-Up and Outcomes

High-sensitivity troponin I levels show a gradual decline and stability, with all values within the normal range. No signs of acute or ongoing myocardial injury were detected.

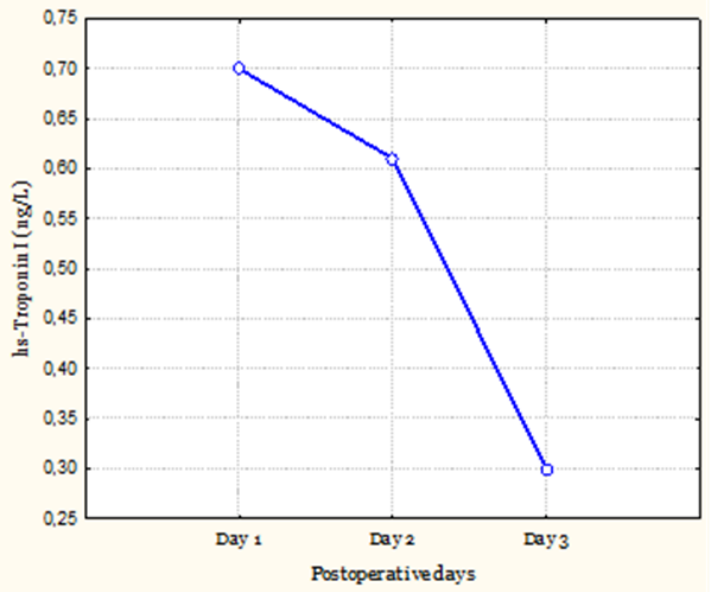

Figure 2 - Dynamics of troponin levels within 3 days after surgery.

Postoperative ECG: Sinus rhythm with a heart rate of 82 beats per minute. Horizontal electrical axis. Cicatricial changes in the anteroseptal wall of the left ventricle.

No signs of myocardial damage were detected during the three-day postoperative period.

Renal function: creatinine level preoperatively was 100 μmol/L; on the second postoperative day, it was 67 μmol/L. No signs of acute kidney injury were detected. Urine output remained within normal limits. Diuretic therapy was not administered.

Table 1 - Dynamics of neurocognitive status

Day	Mini-Mental State Examination (MMSE)	Confusion Assessment Method for Intensive Care Unit (CAM-ICU)	Richmond Agitation-Sedation Scale (RASS)	Result
Preoperative	30	Delirium absent	0	negative
Postoperative day 1	25	Delirium present	+2	positive
Postoperative day 2	29	Delirium absent	0	negative

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According to a dynamic clinical and psychometric assessment in the preoperative period, the patient maintained an intact cognitive status, with scores on the scales consistent with the absence of delirium.

On the first day after surgery, a transient development of postoperative delirium was detected, confirmed by a decrease in total scores on the cognitive scales and positive delirium screening results on all assessment tools used. The clinical picture included manifestations meeting diagnostic criteria for delirium, including psychomotor agitation and attention deficits. To manage delirium, sedation with dexmedetomidine was administered as a continuous infusion at a dose of 0.2–0.7 mcg/kg/h without a loading dose. No other antipsychotic medications were administered prior to the administration of dexmedetomidine. The initial clinical effects (reduction in agitation and anxiety) were observed within the first two hours of treatment initiation. A significant reduction in the severity of postoperative delirium occurred after 8 hours. With the therapy administered, a significant improvement in the patient's condition was noted as early as the following day.

By the second postoperative day, complete regression of delirium symptoms was observed: cognitive test scores returned to baseline values, delirium screening results became negative, and no clinical signs of disorientation, fluctuations in consciousness, attention deficits, perceptual disturbances, or behavioral abnormalities were detected. No recurrences of delirium were observed during follow-up.

Thus, the early postoperative period was characterized by a brief episode of postoperative delirium followed by full recovery of cognitive function and the absence of residual neurocognitive impairment. Furthermore, the patient's follow-up showed no signs of myocardial damage or purulent-septic complications, as confirmed by stable clinical and laboratory parameters.

The patient was discharged on the 13th postoperative day in satisfactory condition, indicating a favorable clinical outcome.

Written informed consent for publication of this case report was obtained from the patient.

4. Discussion

RIPC is a promising organ protection method based on the phenomenon of tissue cross-adaptation to ischemic stress. In the presented clinical situation, the use of RIPC was accompanied by favorable dynamics of biochemical markers of myocardial injury and a stable clinical course without signs of complications.

According to the literature, the effect of preconditioning depends on a number of factors:

1. Protocol – 3–4 cycles of 5 minutes of ischemia/reperfusion at a pressure ≥ 200 mmHg are considered optimal [9].

2. Patient age and comorbidities – elderly patients and those with baseline endothelial dysfunction benefit the most [10].

3. Anesthetics – inhalational agents such as sevoflurane potentiate the effect of RIPC, unlike propofol, which neutralizes it [11].

In the present case, postoperative troponin I levels were not accompanied by clinical signs of myocardial injury. However, the patient experienced a transient episode of postoperative delirium on the first postoperative day, which completely resolved within 24 hours and was not accompanied by persistent neurocognitive impairment. No signs of renal impairment were observed during the follow-up period.

Given the relatively stable course and favorable outcome, the use of RIPC in this case can be considered a clinical trial requiring further evaluation in controlled trials. This case does not allow conclusions to be drawn regarding the effectiveness of the technique or its recommendation as a component of standard preoperative preparation.

Several factors could have potentially influenced the observed clinical results. First, given publications indicating a possible inhibitory effect of propofol on RIPC signaling pathways, a decision was made to use sodium thiopental instead of propofol for induction [12]. There is also evidence that delayed RIPC protocols may improve outcomes in other organs, such as the kidneys [13]. Finally, RIPC is associated with improved postoperative cognitive function, suggesting possible neuroprotective effects beyond its cardioprotective action [14]. However, in our clinical case, we observed a transient episode of postoperative delirium, which provides impetus for further research in this area.

The results are consistent with recent publications, which have noted a decrease in cardiac complication rates in patients who underwent RIPC before undergoing non-cardiac surgery [15].

However, several limitations should be noted. The lack of preoperative troponin I testing significantly limits the interpretation of postoperative dynamics, as it is impossible to determine the direction of changes relative to baseline. The patient's age (65 years), which

falls within the lower end of the elderly patient category, may have contributed to an underestimation of the risk of postoperative delirium and should be considered a limitation. Furthermore, the results are based on a single patient and cannot be generalized. Studies on a larger sample are needed to confirm the findings.

5. Conclusions

This clinical case illustrates the use of RIPC in the perioperative management of a high-risk cardiac patient undergoing orthopedic surgery. The observed clinical results, including the absence of a significant increase in troponin, are consistent with previously expressed hypotheses regarding the potential cardioprotective effect of this technique. However, this isolated case does not allow conclusions to be drawn regarding the effectiveness of RIPC or to establish a causal relationship between the intervention and clinical outcomes.

Despite the potential neuroprotective effects of RIPC discussed in the literature, a transient episode of postoperative delirium was observed in this case, further highlighting the complexity of interpreting neurocognitive outcomes and the need for further controlled studies.

Therefore, this case should be considered a descriptive clinical observation that generates a hypothesis, but not proof of the technique's effectiveness. Further research is needed to standardize protocols and identify patient categories that benefit most from this technique.

Conflict of Interest. The authors declare no conflict of interest.

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Author Contributions. Conceptualization - A.K.; methodology - A.K., A.O; validation - G.L; formal analysis - A.K.; investigation - G.L., A.K.; resources - S.S., A.K.; data curation - S.S., A.O.; writing – original draft preparation - S.S.; writing – review and editing - A.K., A.O.; visualization - S.S.; supervision - G.L, A.O.; project administration - A.K.

All authors have read and agreed to the published version of the manuscript.

AI Declaration. The authors declare that no generative AI or AI-assisted technologies were utilized to create, write, or alter any portion of the submitted work.

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Ортопедиялық араласудан кейінгі кардиальды қаупі жоғары гериатриялық науқаста миокард зақымдалуына және отадан кейінгі делирийге қашықтықтан ишемиялық прекондициялаудың клиникалық әсері: Клиникалық жағдай

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Түйіндеме

Қашықтықтан ишемиялық прекондициялау (ҚИП) ота кезінде ишемия-реперфузиялық зақымдануды азайту әдісі ретінде зерттелуде. Жүрек хирургиясынан тыс жерлерде жүргізілген үлкен рандомизацияланған зерттеулер сенімді клиникалық пайдасын көрсетпесе де, жеке өзге жағдайлар оның құндылығын көрсетуі мүмкін.

Біз жоспарлы ортопедиялық отадан өткен және анестезия индукциясынан кейін бірден ҚИП жасалған науқастың клиникалық жағдайын ұсынамыз. Науқаста отадан кейін тропонин I деңгейі 1, 2 және 3-ші күндері қалыпты шектерде қалды және миокард зақымдануының клиникалық немесе электрокардиографиялық

белгілері байқалмады. Отадан кейінгі бірінші күні делирийдің өтпелі эпизоды байқалды. Дегенмен, емдеуден кейін оның жағдайы тез қалпына келді, науқаспен қарым-қатынас толықтай сақталып, бағдарлы болып қалды. Бүйрек қызметі тұрақты болып сақталды. Іріңді-септикалық асқынулар байқалмады.

Бұл клиникалық жағдай жоғары қауіпті науқастарда ҚИП кардиопротекторлық және даулы нейропротекторлық әсерлерінің ықтималдығын көрсетеді және осы әдіске ең сезімтал науқастардың кіші топтарын анықтау үшін қосымша зерттеулер жүргізу қажеттілігін көрсетеді.

Түйін сөздер: қашықтықтан ишемиялық прекондициялау, жүректен тыс хирургия, тропонин, миокард зақымдалуы, делирий.

Клиническое влияние дистанционного ишемического прекондиционирования на миокардиальное повреждение и послеоперационный делирий у гериатрического пациента с высоким кардиальным риском, перенесшего ортопедическое вмешательство: Клинический случай

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Резюме

Дистанционное ишемическое прекондиционирование (ДИП) рассматривается как метод снижения ишемически-реперфузионного повреждения во время хирургических вмешательств. Несмотря на то, что крупные рандомизированные исследования в некардиальной хирургии не показали убедительных клинических преимуществ, отдельные случаи могут указывать на его потенциальную ценность.

Мы представляем клинический случай с пациенткой, перенесшей плановую ортопедическую операцию, которой *ДИП* было выполнено сразу после индукции анестезии. В послеоперационном периоде уровень тропонина I на 1, 2 и 3 сутки оставался в пределах нормы и последовательно снижался, без клинических и электрокардиографических признаков повреждения миокарда. В первые сутки после операции был отмечен транзиторный эпизод делирия. Однако после проведенной терапии состояние быстро восстановилось, пациентка оставалась ориентирована, контакт с ней сохранялся. Функция почек оставалась стабильной. Не наблюдалось гнойно-септических осложнений.

Этот клинический случай демонстрирует возможный кардиопротективный и спорный нейропротективный эффект *ДИП* у пациентов высокого риска и подчеркивает необходимость дальнейших исследований для выявления подгрупп больных, наиболее чувствительных к данной методике.

Ключевые слова: дистанционное ишемическое прекондиционирование, некардиальная хирургия, тропонин, миокардиальное повреждение, делирий.

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