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Case Report

Successful Treatment of Pulmonary Embolism Causing Cardiac Arrests with Reteplase during Neurosurgery: A Case Report

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ABSTRACT

Pulmonary embolism can cause cardiac arrest. Fibrinolytic therapy and surgical embolectomy can be used to manage it. This case report presents the clinical course of a patient who experienced intraoperative cardiac arrest resulting from massive pulmonary embolism. The patient encountered three instances of cardiac arrest requiring 35 minutes of cardiopulmonary resuscitation. Subsequent treatment involved the administration of reteplase, a thrombolytic agent. Following resuscitation, the patient developed multiple organ dysfunction in the intensive care unit, necessitating the use of diverse medications. Successful resolution of organ dysfunction led to the patient's transfer to the neurosurgery department. This case highlights the complexities involved in managing pulmonary embolism-induced cardiac arrest and subsequent multiorgan dysfunction, emphasizing the significance of a multidisciplinary approach in the comprehensive care and treatment of these patients.

Introduction

Pulmonary embolism (PE) constitutes a reversible etiology of cardiac arrest, accounting for 5-6% of all in-hospital cardiac arrests. Treatment modalities include fibrinolytic therapy, surgical embolectomy, percutaneous mechanical thrombectomy, and extracorporeal membrane oxygenation (ECMO) [1]. In this report, we describe a case of a patient who experienced intraoperative massive PE, leading to cardiac arrest, and was managed with reteplase. The patient also developed multiple organ dysfunction syndrome (MODS) secondary to ischemia-reperfusion injury (IRI), which was effectively treated.

Case Report

A 45-year-old male patient presented with worsening lower back pain over the past two weeks accompanied by a decrease in lower extremity strength. No prior medical history or medication use was reported, and there was no smoking history. Physical examination results were unremarkable except for the weakened lower extremities. The patient's weight was 85 kg with a BMI of 27.75. MRI findings indicated spondylodiscitis, with changes in signal intensity at the 3rd and 4th lumbar levels.

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A patient underwent spinal surgery following routine pre-operative evaluations, which included a complete blood count, coagulation function, biochemical function of the liver and renal, chest X-ray, and electrocardiography (ECG). Despite having no pre-existing pathologies, the patient experienced a significant amount of bleeding (700 cc), injection fluid (1500 cc), and urine output (200 cc) during the three-hour operation. Shortly after the surgery concluded, the patient's End-tidal carbon dioxide (ETCO2) decreased, and they developed ventricular tachycardia while in a supine position. Immediate action was taken, including initiating chest compressions, administering Adrenaline in 1 mg boluses every 3 minutes, and delivering an electrical shock. It's important to note that these events occurred despite thorough pre-operative evaluations and monitoring, highlighting the unpredictable nature of medical procedures. Spontaneous circulation resumed after 10 minutes of performing cardiopulmonary resuscitation. Without delay, an arterial line was inserted into the patient's right radial artery, and an infusion of 20 mcg/min of adrenaline was initiated. Furthermore, due to the suspicion of a pulmonary embolism, a bolus of 5000 units of heparin was injected.

After 15 minutes, the patient experienced ventricular fibrillation (VF) and chest compressions were resumed. Adrenaline was administered every 5 minutes and one electrical shock was given. After 10 minutes, spontaneous circulation returned. Successful CPR was followed by inserting a central venous catheter into the patient's right jugular vein, administering an infusion of 20 mcg/min of adrenaline and a bolus of 5000 units of heparin. An arterial blood gas sample was taken which showed a pH of 7, PaCO2 of 80 mmHg, and an HCO3 of 17 mg/dl. Oxygen saturation (O2 Sat) and ETCO2 were 75% and 25%, respectively. To confirm the diagnosis of PE, Pulmonary CT angiography was carried out. Upon being taken back to the operating room, the patient experienced cardiac arrest caused by VF. CPR was immediately performed for 15 minutes, and the patient received an electric shock and 1 mg adrenaline every 5 minutes. Spontaneous circulation was restored after the 15-minute mark. After careful consideration of the evidence of massive filling defect at both pulmonary trunk and severe instability of vital signs, including low O2 Sat, the anesthetist in consultation with the cardiologist initiated rescue thrombolysis in the operating room. 10 IU of reteplase was administered over 10 minutes, followed by a further 10 IU over 45 minutes. After 2 hours of reteplase injection, the patient's O2 Sat increased significantly.

The patient was promptly transferred to the ICU and provided with ventilatory support in addition to noradrenaline and adrenaline infusion. On the first day of monitoring, USCOM analysis revealed a low cardiac index and DO2 levels, prompting the administration of dobutamine to address the concern.

The patient experienced gradual increases in creatinine, ALT, AST, and bilirubin levels, peaking at 3.66 mg/dl, 2456 unit/L, 4585 unit/L, and 7.63 mg/dl, respectively, alongside complete speech impairment. Following IRI, the patient was diagnosed with MODS. To reduce tissue damage, the patient received erythropoietin, melatonin, atorvastatin, colchicine, vitamin C, L-carnitine, and pentoxifylline in addition to norepinephrine and dobutamine infusions. The patient's liver enzymes, serum creatinine, and bilirubin levels gradually decreased, and on the fifth day of ICU admission, the patient was successfully extubated. By the tenth day of ICU admission, the patient was transferred to the neurosurgery ward and showed significant improvement in speaking with creatinine, ALT, AST, and bilirubin levels of 1.11 mg/dl, 36 unit/L, 37 unit/L, and 1.74 mg/dl, respectively.

Discussion

This case report highlights a complex scenario where a patient encountered a significant PE during surgery that resulted in cardiac arrest. The use of Reteplase, a drug that has only been recorded in one other instance for use during surgery, was a remarkable treatment option. In 2011, M. Wenk et al. shared the case of a 34-year-old woman who experienced an asystole cardiac arrest due to massive PE while undergoing an emergency cesarean delivery. The patient was thrombolysis with reteplase during successful cardiopulmonary resuscitation, which adds to the significance of this treatment approach [2].

According to the European Society of Cardiology (ESC), it is recommended to promptly administer intravenous anticoagulation with UFH, which includes a weight-based bolus injection, to patients suspected of having high-risk PE [3]. Despite the patient being administered a bolus of 5000 units of heparin and a continuous infusion of 1000 units/hour, two additional cardiac arrests were experienced. Systemic thrombolysis is the primary reperfusion treatment for high-risk PE patients. However, in cases where contraindications to thrombolysis exist, alternative treatments such as surgical pulmonary embolectomy or percutaneous catheter-directed treatment may be considered. Nevertheless, in the absence of these alternatives, thrombolytic injection becomes necessary to prevent death.

Only alteplase, streptokinase, and urokinase are approved thrombolytic agents for PE. Although reteplase has been studied, it is presently unapproved for acute PE treatment [4].

Although the patient's condition stabilized, they still experienced MODS as a result of IRI.

The term IRI describes functional and structural changes after blood flow restoration following ischemia. The process has two stages: cell energy depletion during ischemia and oxidative and microcirculatory stress, inflammation, and apoptosis during reperfusion [5].

The most effective way to prevent IRI is by reducing hypoperfusion [5]. In our patient, norepinephrine was prescribed to increase the mean arterial pressure above

65, protecting blood flow to vital organs, and dobutamine was prescribed to increase blood flow and oxygen delivery to the organs. Our patient with MODS received a variety of treatments including selenium, acetylcysteine, vitamin C, atorvastatin, erythropoietin, colchicine, pentoxifylline, L-carnitine, and melatonin.

Melatonin and its metabolites act as powerful antioxidants, protecting mitochondria from oxidant injury. Additionally, melatonin stimulates the synthesis of antioxidant enzymes and reduces the expression of harmful substances in various organs [6].

Experimental and clinical evidence clearly demonstrates the efficacy of statins in reducing the severity of IRI and inhibiting cellular responses, including the significant reduction of matrix metalloprotease secretion [7].

The study investigated vitamin C's role in IRI in clinical and preclinical settings. The IRI process causes oxidative stress and rapid depletion of body's vitamin C stores due to cellular consumption. This results in significantly reduced vitamin C levels in plasma following cardiac arrest and other critical illnesses. Vitamin C impairs the expression of nitric oxide synthetase, reducing plasma nitric oxide levels and counteracting vasoconstrictors' effects. This could maintain vascular resistance and possibly MAP [5].

Erythropoietin has been found to have a protective effect against tissue injury caused by IRI in various organs, including the brain, retina, heart, liver, kidney, lung, and intestine. This effect is attributed to its anti-apoptotic, antioxidative, and anti-inflammatory properties [8].

Pentoxifylline improved blood flow and reduced tissue damage and edema by suppressing leukocyte adhesion during reperfusion [9].

N-acetylcysteine is an efficient and safe antioxidant that scavenges free radicals without causing cellular toxicity due to its high thiol groups content [10].

L-carnitine increases the activity of antioxidant enzymes like glutathione peroxidase and catalase, and also binds metal ions that catalyze ROS production. This reduces the antioxidant effect and may decrease IRI [11].

A decrease in serum selenium concentrations occurs during systemic inflammation, which enhances the risks associated with these conditions. Selenium deficiency also decreases the antioxidant activity of glutathione peroxidases and thioredoxin reductase. Therefore, selenium deficiencies may contribute to IRI [12].

Colchicine, an anti-mitotic drug, has been shown to alleviate IRI in various tissues by decreasing the release of inflammatory cytokines, such as IL-1β, inhibiting the generation of leukotriene B4, modulating TNF-α function, decreasing neutrophil degranulation, and attenuating lipid peroxidation and stabilizing membranes [13].

Conclusion

If a perioperative pulmonary embolism leads to cardiac arrest, rescue thrombolysis could be a viable option. However, it is crucial to carefully evaluate the potential risk of massive bleeding. It is important to note that there is currently limited research on the effectiveness of reteplase in treating perioperative cardiac arrest, emphasizing the urgent need for further investigation in this area.

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