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Pulmonary Embolism Caused by Tourniquets in the Lower Extremities Treated with ECMO – A Case Report

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ABSTRACT

Background: Using tourniquets in the lower extremities can increase the incidence of deep vein thrombosis (DVT). Acute large-area pulmonary embolism (APE) occurs in severe cases, and it is fatal to most patients. Acute large-area pulmonary embolism causes haemodynamic instability, right heart failure, and circulatory failure.

Case presentation: A 47-year-old female patient was subjected to spinal anaesthesia for a comminuted fracture of the tibia and fibula of the left lower limb. After the tourniquet was released during the operation, she had sudden hypotension and lost consciousness. Thus, ECMO was used to support patient circulation. With ECMO-assisted CT examination, she was diagnosed to have a pulmonary embolism. On the next day, she was subjected to a bilateral pulmonary embolism and embolectomy. Lastly, she was transferred to the general ward and discharged smoothly.

Conclusions: Patients undergoing fracture surgery should be wary of APE caused by the loss of DVT after the release of tourniquets. ECMO, as a rapid and effective temporary life support intervention, provides effective cardiopulmonary support and new treatment plans. It also saves time for further treatment of patients with high-risk APE.

INTRODUCTION

Background: In orthopaedic surgery, lower extremity tourniquets often are used to achieve a bloodless operation area and reduce operation time [Cai 2019]. However, using tourniquets in the lower extremities can increase the incidence of deep vein thrombosis. Acute large-area pulmonary embolism occurs in severe cases, and it is fatal to most patients [Yi 2014; Bogdan 2018]. Acute large-area pulmonary embolism refers to a large embolism that causes haemodynamic instability, right heart failure, and circulatory failure. The pathogenetic condition of patients with acute large-area pulmonary embolism is dangerous. If a patient fails to receive timely diagnosis and treatment, he or she will lose the opportunity for further treatment. As an effective cardiopulmonary support treatment, ECMO can provide effective circulatory support for patients with right heart failure, maintain systemic circulation perfusion, and save time for further diagnosis and treatment [Grant 2021]. In our case, ECMO combined with surgical pulmonary artery embolization was applied to treat a patient with large-area pulmonary embolism caused by tourniquets used on the lower extremities successfully.

Ethics approval and consent to participate: Informed consent was obtained from the patient and the hospital ethics committee.

CASE PRESENTATION

A 47-year-old female patient was admitted to the hospital because of a traffic accident. Multiple soft-group contusions were observed throughout her body, followed by increased abdominal wall muscle tension, obvious tenderness, obvious swelling and deformity of the left lower limb, untouched dorsal artery, and signs of shock. CT showed splenic rupture. She was diagnosed to have (1) spleen rupture, (2) comminuted fracture of the left lower limb tibia and fibula, and (3) haemorrhagic shock. In the emergency department, laparotomy and splenectomy successfully were performed. After the operation, she was transferred to the intensive care unit

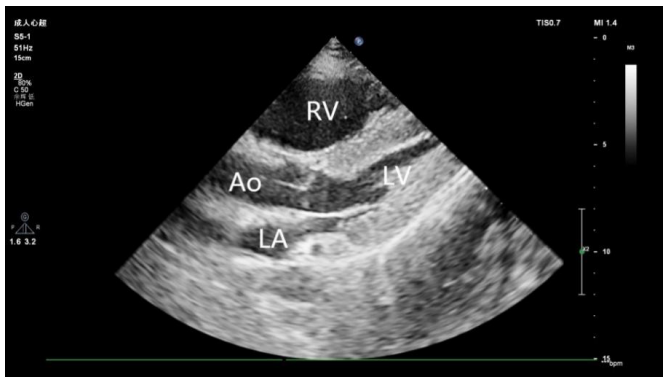

Figure 1.

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(ICU). After 13 days of treatment, her vital signs were stable. Then, she was operated on her left lower limb for curing the tibiofibular fracture again.

Spinal anaesthesia was performed after the venous channel was opened, and 0.5% of 15 mg of ropivacaine was given. The level of anaesthesia was T10. After her vital signs were stable, the operation began, and a pneumatic electric tourniquet was applied to the left lower limb. After 60 min, the tourniquet was released and loosened. The patient had sudden dyspnoea, drop in blood pressure, rapid heart rate, decreased finger pulse oxygen, and a change in consciousness 5 min after the tourniquet. The operation was stopped for emergency treatment. Face mask pressurization and oxygen therapy immediately were given; furthermore, tracheal intubation and mechanical ventilation, 0.2 μg/kg·min epinephrine, 0.2 μg/kg·min norepinephrine, and blood volume supplement were administered. Her blood pressure was 46/15 mmHg, and pulse oxygen saturation was 75%. Extra-thoracic heart compression was performed for cardiopulmonary resuscitation (CPR). Ultrasound examination was conducted, and bedside heart colour Doppler ultrasound indicated an enlarged right ventricle and an under-filled left ventricle, suggesting the possibility of pulmonary embolism. After 15 min of CPR, the patient still had difficulty resuming effective spontaneous circulation, and haemodynamics were extremely unstable. Right femoral arteriovenous catheterization was conducted to establish veno-artery ECMO (VA ECMO), and heparin sodium (1 mg/kg) was used for whole-body heparinisation. A 17 Fr (Medtronic) arterial cannulation was placed in the right femoral artery, a 19 Fr (Medtronic) intravenous cannulation was placed in the femoral vein implantation, and an 8 Fr terminal reperfusion catheter was inserted at the distal end of the artery. After 25 min of CPR, the ECMO cycle was established, the ECMO flow rate was 3 L/min, the blood pressure was 120/63 mmHg, and the pulse oxygen saturation was 100%.

The patient's haemodynamics kept stable after ECMO assistance, and the CTA examination on the pulmonary artery showed extensive embolism in the terminal segments of the main pulmonary artery and the upper and lower pulmonary artery branches. (Figure 2) The next day, bilateral pulmonary artery incision and embolectomy were performed. During the operation, a large number of thrombi in the main pulmonary artery blocked the pulmonary vascular bed. After the thrombi were removed, the pulmonary artery incision was sutured. (Figure 3) The re-examination of the pulmonary artery CTA on the first postoperative day indicated that the scope of pulmonary embolism was reduced. The cardiac colour Doppler ultrasound indicated normal cardiac function and stable vital signs. ECMO assistance was gradually removed. On the 6th day after the operation, the patient's oxygenation was normal, and her respiratory function returned to normal. After her tracheal tube was removed, she successfully was transferred to the general ward on the 14th day after the operation. The patient successfully was treated.

DISCUSSION AND CONCLUSIONS

In orthopaedic surgery, lower extremity tourniquets often are used to achieve a bloodless operation area and reduce operation time [Cai 2019]. Prolonged operation under the tourniquet caused the local swelling of lower extremities and blood stasis. When tourniquets were released momentarily, a large amount of blood quickly entered the affected limb, and the DVT easily fell off and entered the circulatory and respiratory systems, along with blood. Parmet et al. [Parmet 1998] found that the incidence rate of DVT with tourniquet is 5.33 times higher than that of DVT without a tourniquet. Some studies have shown that the number of dropped-off thrombus is significantly related to the time when a tourniquet is used [Siao 2015]. Preoperative anticoagulation is an important means to reduce deep vein thrombosis. In this case, the patient was subjected to splenectomy because of haemorrhagic shock due to a traffic accident. The patient was not

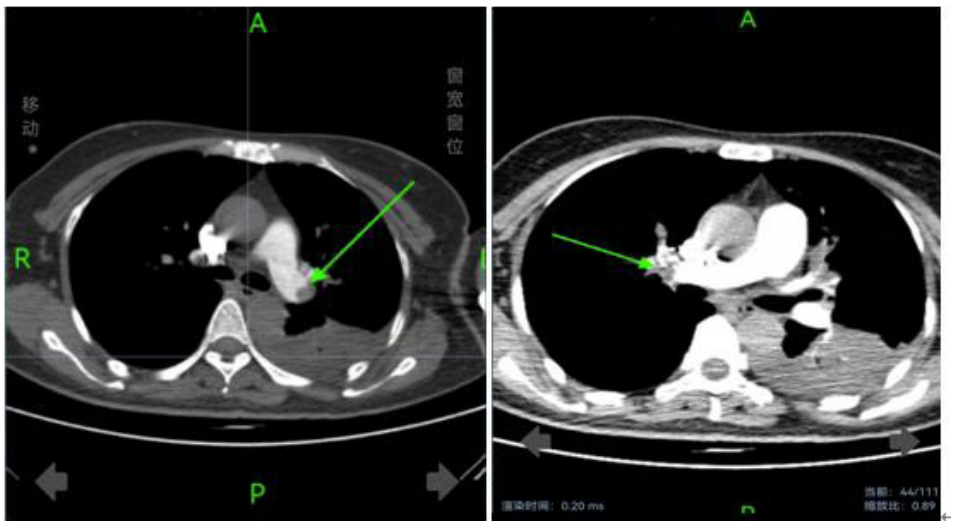

Figure 2.

Figure 3.

anticoagulated to avoid bleeding. There was no preoperative evaluation of deep vein embolism in the lower extremities, which might be an important cause of thrombosis.

ECMO can provide rapid and effective respiratory and circulatory support for patients with large-area pulmonary embolism with extremely unstable haemodynamics and shorten the time for further treatment of pulmonary embolism. The size of pulmonary vascular infarction affects the severity of changes in haemodynamics and respiratory function. Small pulmonary embolism may have no obvious clinical symptoms. When the infarct size exceeds 30%–50%, patients may have obvious haemodynamic changes [Siao 2015]. High-risk APE should be actively treated to reverse the condition, including drug-induced thrombolysis, percutaneous catheter intervention for thrombolysis or thrombectomy, and surgical pulmonary artery incision for thrombectomy [Martinez 2020]. Pulmonary embolectomy poses a lower risk of cardiac death than thrombolysis does [Martinez 2020]. Pulmonary embolectomy is the first-line therapy, especially for large-area pulmonary embolism [QiMin 2020].

In summary, patients undergoing fracture surgery should be wary of APE caused by the loss of DVT after the release of tourniquets. ECMO, as a rapid and effective temporary life support intervention, provides effective cardiopulmonary support and new treatment plans. It also saves time for further treatment of patients with high-risk APE.

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