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Case Report

Surgical Management of Acute Right Heart Failure Induced by Massive Pulmonary Embolism: Lessons from a Case Report

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Abstract

Massive pulmonary embolism is uncommon in children and adolescents but may cause abrupt right ventricular pressure overload, circulatory collapse and cardiac arrest. We report a 15-year-old boy admitted with femoral deep-vein thrombosis who developed sudden cardiac arrest after more than four days of low-molecular-weight heparin treatment. During prolonged cardiopulmonary resuscitation, transoesophageal echocardiography demonstrated a large thrombus at the pulmonary artery bifurcation and severe right ventricular dysfunction. Computed tomographic pulmonary angiography was not feasible because of the patient's instability. Systemic thrombolysis was not administered; the team proceeded directly to emergency open pulmonary embolectomy with femoral cannulation and cardiopulmonary bypass. Large thromboembolic fragments were extracted from the central pulmonary arterial circulation, permitting initial separation from bypass and transfer to intensive care on substantial inotropic support. Approximately 12 hours later, recurrent right ventricular failure progressed to refractory cardiogenic shock and death. Venoarterial extracorporeal membrane oxygenation and right ventricular assist devices were unavailable at the treating institution. This case illustrates both the potential for immediate mechanical reperfusion during cardiac arrest and the challenge of persistent postoperative right ventricular dysfunction when advanced circulatory support is inaccessible.

Keywords: *adolescent; pulmonary embolism; cardiac arrest; surgical pulmonary embolectomy; right ventricular failure; mechanical circulatory support*

Introduction

Acute pulmonary embolism (PE) is less frequent in paediatric than in adult populations, but high-risk PE can rapidly become fatal through acute obstruction of the pulmonary vascular bed, abrupt elevation of right ventricular (RV) afterload and impaired left ventricular filling. Management is especially challenging in children because evidence for reperfusion strategies is limited and decisions often require individualised multidisciplinary assessment. In patients with profound instability or cardiac arrest, prompt identification of a reversible obstructive cause and timely reperfusion are central priorities. We describe emergency open surgical pulmonary embolectomy in an adolescent with cardiac arrest and subsequent refractory postoperative RV failure in a centre without access to advanced mechanical circulatory support. [1,2]

Case Presentation

A 15-year-old male patient was hospitalised in a cardiovascular unit with femoral deep-vein thrombosis and had received low-molecular-weight heparin for more than four days. During hospitalisation he developed sudden cardiac arrest. Cardiopulmonary resuscitation (CPR) was initiated, and he was transferred to intensive care and intubated during ongoing resuscitation. Despite prolonged CPR, approaching one hour, and pharmacological circulatory support, sustained spontaneous haemodynamic recovery was not achieved.

Emergency transoesophageal echocardiography identified a large saddle-shaped thrombus at the bifurcation of the main pulmonary artery, together with findings of severe RV dysfunction. Because of the ongoing arrest and extreme haemodynamic instability, computed tomographic pulmonary angiography could not be obtained. Systemic thrombolysis was not administered: in the context of ongoing resuscitation, the treating team elected to proceed directly to emergency surgical reperfusion. This was a case-specific treatment decision, not an assertion that cardiac arrest is itself an absolute contraindication to thrombolysis.

Emergency femoral cannulation was performed during ongoing external chest compressions, enabling initiation of cardiopulmonary bypass (CPB) while cardiopulmonary resuscitation was in progress. Under CPB support, the pulmonary artery was opened and open surgical pulmonary embolectomy was performed on the beating heart, without cardioplegic arrest. Large thromboembolic masses were removed from the pulmonary arterial circulation (Figure 1). Following extraction, haemodynamic conditions initially improved sufficiently to allow separation from CPB. The patient was transferred to intensive care on substantial inotropic support and anticoagulation.

Approximately 12 hours after surgery, the patient developed recurrent severe RV failure despite intensive pharmacological support. Progressive haemodynamic deterioration culminated in refractory cardiogenic shock and death. Venoarterial extracorporeal membrane oxygenation (VA-ECMO) and dedicated right ventricular assist devices (RVADs) were not available at the treating institution, limiting options for rescue mechanical circulatory support.



Figure 1. Pulmonary thromboembolic material removed during emergency open surgical embolectomy. Photograph obtained intraoperatively after extraction. The anatomical origin of individual fragments cannot be determined from the photograph alone.

Discussion

This case illustrates the rapid progression from venous thromboembolism to obstructive shock and cardiac arrest in an adolescent. Acute PE imposes a sudden increase in pulmonary vascular resistance, which may cause RV dilatation, reduced RV coronary perfusion, interventricular septal shift and diminished systemic output. Even after central obstruction is relieved, RV dysfunction can persist because of antecedent ischaemia, reperfusion injury, residual distal thromboembolic burden or the systemic consequences of prolonged low-flow circulation. The present case does not provide sufficient data to determine which mechanisms dominated the postoperative deterioration. [1]

Bedside transoesophageal echocardiography played a decisive diagnostic role during resuscitation. It permitted recognition of central thromboembolic obstruction and severe RV dysfunction when transport for computed tomography was impractical. Although cross-sectional imaging remains important when feasible, it should not delay time-critical treatment in a patient undergoing active resuscitation when a compelling diagnosis has been established by bedside assessment. [2]

Reperfusion options for high-risk PE include systemic thrombolysis, catheter-based therapies and surgical embolectomy, depending on clinical circumstances, local expertise and resources. In this patient, systemic thrombolysis was not used because the team proceeded directly to open surgery during ongoing cardiac arrest. Importantly, cardiac arrest associated with suspected PE is not, by itself, a categorical contraindication to thrombolysis; thrombolysis may be considered during resuscitation according to applicable guidance and individual risk–benefit assessment. The clinical record available for this report does not establish any additional bleeding contraindication. [3]

Emergency cannulation during active chest compressions allowed CPB to be established without waiting for return of spontaneous circulation. Pulmonary arteriotomy and direct extraction of thromboembolic material were undertaken on the beating heart under CPB support. Although this approach achieved immediate mechanical reperfusion and initial haemodynamic stabilisation, it did not result in sustained RV recovery. Following prolonged resuscitation and severe obstructive shock, recurrent RV failure developed postoperatively. The case illustrates the distinction between successful removal of central obstruction and recovery from the physiological consequences of massive PE. [4]

VA-ECMO may provide temporary cardiopulmonary support in selected patients with PE-related arrest or refractory RV failure, either as a bridge to reperfusion or as support during recovery. RVAD support is another potential option in specialised settings, although its applicability depends on the clinical situation and local expertise. Neither modality was available at our institution. This lack of access was an important therapeutic limitation, but the present single case cannot establish whether mechanical support would have changed the outcome. The report underscores the need for early multidisciplinary escalation, timely reperfusion and systems of care capable of providing or coordinating advanced support for selected critically ill adolescents. [5]

Conclusion

High-risk pulmonary embolism should be considered in adolescents with known venous thrombosis who develop sudden circulatory collapse. During cardiac arrest, bedside echocardiography can facilitate rapid recognition of central PE and guide emergency treatment when computed tomography is not feasible. Open pulmonary embolectomy can achieve immediate reperfusion, but persistent or recurrent RV failure may remain fatal. Access to advanced mechanical circulatory support is an important consideration in the organisation of care for such patients.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Consent for publication

Written consent from parent(s).

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