

Pulmonary thromboendarterectomy and pulmonary haemorrhage

Pulmonary thromboendarterectomy (PTE) surgery is the recommended treatment for patients with chronic thromboembolic pulmonary hypertension (CTEPH), with a perioperative mortality now less than 2% reported by major centres.^[1] However, devastating complications may occur, including pulmonary haemorrhage, reperfusion injury and right ventricular failure.^[2] Kanchi *et al* had presented three different management approaches to intrapulmonary haemorrhage and reperfusion injury during PTE surgery.^[3]

Massive intraoperative pulmonary haemorrhage with bleeding into the airway is a rare, but life-threatening complication of PTE surgery, with a reported incidence of 1-2%.^[4,5] It typically presents as cardiopulmonary bypass (CPB) flow is reduced and blood begins to flow through the pulmonary circulation. Immediate management includes restoration of full CPB to reduce blood flow through the pulmonary circulation. Prompt detection is essential to prevent contamination of the contralateral airway. Anaesthetic management involves lung isolation, which may be achieved with either a double-lumen endobronchial tube (DLT) or an endobronchial blocker (EBB). Weaning from CPB with a DLT and one-lung ventilation is challenging. Ventilation-perfusion mismatch and subsequent hypoxaemia result in an increase in pulmonary vascular resistance, creating a higher afterload for the impaired right ventricle. A DLT allows for suctioning of blood and potential differential lung ventilation but is suboptimal to promote tamponade of the bleeding bronchial segment. The advantage of an EBB is the ability to provide selective lobar blockade, which may better facilitate subsequent weaning from CPB, and assist in tamponade of the haemorrhage.^[6] The successful use of a DLT in combination with an EBB has been reported.^[7] Early identification of the site of haemorrhage is also critical. Using the “bubble” technique, during gentle ventilation, bubbles can be visualised arising from distal pulmonary branches to help identify the location of the breach.^[8] This may then allow surgical application of a haemostatic agent to control the bleeding. If surgical haemostasis is not possible, then short-term venoarterial (VA) extracorporeal membrane oxygenation (ECMO) is often employed to

decrease blood flow through the pulmonary circulation. Weaning from VA-ECMO occurs after bleeding into the airway has resolved.

Intrapulmonary haemorrhage from a bronchial collateral vessel presents a different challenge. Systemic-to-pulmonary arterial collaterals are common in CTEPH^[9] and bleeding from one or more of these bronchial collaterals may not be sufficiently reduced by maintaining extracorporeal circulation alone. Management options are limited. Lung isolation is again critical to prevent contralateral lung involvement and weaning from CPB with reversal of heparinisation may prove successful. However, continued haemorrhage into the airway requires further intervention: urgent pulmonary angiography and coil embolisation of the culprit collateral vessel can provide the solution.

Post-PTE reperfusion pulmonary oedema may occur in up to 20% of cases.^[10] It can occur immediately after weaning from CPB, but typically presents 24 – 48 hours after surgery. In its most severe form, veno-venous (VV) ECMO is warranted to provide adequate oxygenation for the patient. Weaning from VV-ECMO support is frequently successful and acceptable patient outcomes are reported by major centres.^[10]

In approaching the management of PTE pulmonary haemorrhage teamwork is key. Good communication between surgeon, anaesthetist and perfusionist during weaning from CPB is essential. Prompt diagnosis and early institution of the appropriate treatment pathway can be enhanced by management algorithms,^[3] potentially yielding successful patient outcomes.

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