Pulmonary thromboendarterectomy for chronic thromboembolic pulmonary hypertension

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Considerable progress has been made in the diagnosis and management of acute pulmonary thromboembolism (PTE) but there are few data about the true incidence, early mortality, and long term progress of this condition. Recurrent PTE or incomplete resolution of the initial event leading to the development of secondary pulmonary hypertension is even less well understood. In the UK the diagnosis of chronic thromboembolic pulmonary hypertension (CTEPH) remains infrequently considered and even less frequently confirmed. Many physicians remain unaware that the condition is potentially curable by corrective operation and rely on transplantation or palliative medical management.

The incidence of acute pulmonary embolism (PE) in the USA has been estimated at between 300 000 and 650 000 symptomatic events per year.[1–3] This ranks venous thromboembolism as the third most common cardiovascular disorder after coronary artery disease and stroke.[4] Reported mortality rates for PE have varied from 2% to 25% with the net result in the USA being between 50 000 and 200 000 deaths per year.[5–7] However, this number may be an underestimate of the actual morbidity and mortality resulting from PE. Routine necropsy studies have found grossly identifiable clot in up to 30% of cases and microscopic evidence of recent or old thromboemboli in over 50%.[8 9] Other studies have shown the diagnosis of acute pulmonary embolism to be unsuspected in 70–80% of patients in whom it was the principal cause of death.[10 11] How accurately these data reflect the current position is unclear since modern diagnostic algorithms and approaches to treatment will undoubtedly alter these figures.

For many patients who survive acute PE the natural history is one of total or near total resolution of emboli without significant residual occlusion. In a recent study from France, however,[12] 52% of patients with a diagnosed and treated acute central PE were shown to have persisting endovascular abnormalities at 11 months (incomplete resolution of clot in 39% and chronic thromboembolic changes in 13%). Additionally, recurrent PE is estimated to occur in 4–23% of patients.[5–7 13]

Chronic thromboembolic pulmonary hypertension is the result of incomplete clot lysis with subsequent organisation resulting in its adherence to the vessel wall. Recanalisation may restore some blood flow through the obstructed vessel lumen but this is often insufficient to allow normal flow rates. Progressive pulmonary hypertension, right ventricular failure, and death often ensue. The reason for this sequence of events is unclear. It is possible that the natural clearing mechanisms are overcome by the nature, extent, or location of the embolus. It is thought that less than 10% of this group will demonstrate the presence of a procoagulant factor,[14] and studies have failed to show any consistent abnormality in the fibrinolytic cascade or the pulmonary vascular endothelium. It is estimated that 1–5% of patients who suffer a PTE will develop CTEPH,[15] and it is not expected that current therapeutic advances will appreciably influence this incidence.

Preoperative assessment

Progressive exertional dyspnoea and exercise intolerance are common to all patients and usually prompt the individuals to seek medical advice. Other symptoms include cough, pre-syncope and palpitations. Haemoptysis is uncommon. Syncope is associated with severe disease, representing either a severely compromised cardiac output and/or dysrhythmias. Physical examination can be unremarkable in the early stages of the disease but with time signs of pulmonary hypertension and right heart failure develop. Early symptoms are frequently attributed to other aetiologies such as coronary artery disease or left ventricular dysfunction and respiratory disorders such as asthma and chronic obstructive pulmonary disease (COPD). The diagnosis of CTEPH is not usually considered until the patient has experienced a significant diagnostic delay and, sadly, this delay has not decreased in recent years—a fact that highlights the importance of considering pulmonary vascular disease in any patient with dyspnoea of uncertain aetiology.

Differentiation of CTEPH from other forms of pulmonary hypertension can be difficult and referral to a specialist centre with experience in the diagnosis and management of pulmonary vascular disorders is advisable. Once a diagnosis of pulmonary hypertension has been made it is vital to establish whether thromboemboli are the actual cause, and to this end ventilation/perfusion scanning and spiral CT angiograms may be helpful.[16]

Specific evaluation includes right heart catheterisation to document right sided pressures and function, and pulmonary angiography to assess operability. Patients who are symptomatic with unremarkable haemodynamics at rest often show severe increases of pulmonary artery pressures and right heart dysfunction on exercise. In experienced hands, pulmonary angiography is safe with selective power injections of non-ionic contrast media. The existence of concomitant cardiac disease necessitates specific investigation including coronary angiography, but is not in itself a reason to exclude patients from consideration for surgical intervention. Finally, all patients are assessed for the need for the placement of an inferior vena caval filter preoperatively.

Surgery: pulmonary thromboendarterectomy

Surgery for CTEPH has evolved considerably over recent years. The first pulmonary thromboendarterectomy was performed in 1957 and to date there have been approximately 1000 procedures performed worldwide. The operation involves a bilateral approach via a median sternotomy utilising cardiopulmonary bypass. Brief periods of circulatory arrest are required to improve operative exposure, thus ensuring adequate removal of the chronic thromboembolic material. An endarterectomy plane is raised centrally in each of the main pulmonary arteries and then followed distally reaching subsegmental levels. A typical operative specimen is shown in fig 1. The right atrium is opened and inspected for evidence of an atrial septal defect, which should be closed if present (25% of patients). During systemic rewarming additional procedures such as valve replacement or coronary artery bypass may be performed if necessary.

The pulmonary artery pressures are commonly reduced immediately after surgery and decrease further over the next 48 hours. The cardiac index usually shows immediate

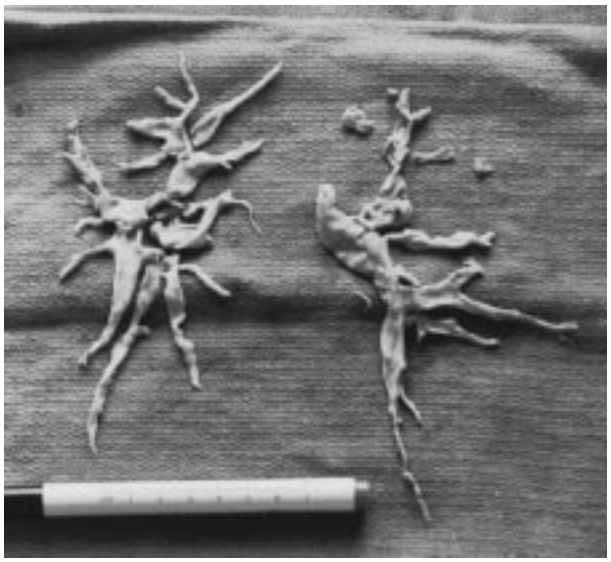

Figure 1 A typical specimen obtained at pulmonary thromboendarterectomy.

improvement compared with the preoperative state. Up to 20% of patients may experience reperfusion pulmonary oedema. This becomes clinically significant in around 10% of patients and causes death in 1–2%. Ventilation/perfusion mismatch occurs when endarterectomised segments experiencing injury on reperfusion become perfused following removal of the obstructing thrombus. Severe abnormalities of gas exchange are managed with continued ventilation, with or without the use of nitric oxide. All patients are anticoagulated for life with warfarin.

Results of surgery

CTEPH is the only form of pulmonary hypertension for which there is a surgical operation other than lung transplantation. With best medical treatment the five year survival for patients with a mean pulmonary artery pressure of >50 mm Hg complicating pulmonary embolism is only 10%.[17] At the University of California, San Diego Medical Centre (UCSD)—the unit with the largest experience of this procedure—the operative mortality for pulmonary thromboendarterectomy is around 7% (personal communication) which compares favourably with lung transplantation. Operative mortality is usually related to an incorrect diagnosis of CTEPH, an incomplete endarterectomy having been performed, or the occurrence of fulminant reperfusion pulmonary oedema.

Long term results of PTE document persistent haemodynamic and functional improvement. Reduction in pulmonary vascular resistance is sustained and right ventricular remodelling is marked with resolution of tricuspid regurgitation and right heart failure. Whereas preoperatively 95% of the patients at UCSD were in NYHA functional class III–IV, postoperatively 95% are in class I–II. The results of transplantation are less predictable, require long term immunosuppression, and are not sustained beyond five years for a significant proportion of patients.

Conclusions

It is clear that chronic thromboembolic disease has a significant incidence and yet the diagnosis of CTEPH is made infrequently. Pulmonary thromboendarterectomy offers a potential surgical cure for CTEPH and is the surgical procedure of choice for patients with this condition. It has a perioperative mortality which compares favourably with lung transplantation and long term benefits which exceed those of both long term medical treatment and transplantation. Life expectancy is improved for patients with pulmonary artery pressures in excess of 50 mm Hg. The full benefit of surgery will only be realised as early diagnosis and intervention become more commonplace. Early recognition of this group of patients is pivotal in improving the outcome from CTEPH. Early referral to a centre specialising in the management of pulmonary hypertension and with the necessary operative experience will allow timely intervention, resulting in improved operative mortality and long term outcome.

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