A novel technique for pulmonary endarterectomy in the presence of patent coronary artery bypass grafts

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Abstract

Pulmonary endarterectomy (PEA) is the definitive surgical treatment for chronic thromboembolic pulmonary hypertension, with excellent short- and long-term results. PEA following previous coronary artery bypass graft surgery carries a risk of damage to patent grafts, as well as the risk of inadequate myocardial protection, especially when a patent pedicled internal thoracic artery graft is present. We report a technique where PEA may be safely and successfully accomplished ensuring adequate clearance of bilateral pulmonary thromboembolic disease via a right pulmonary arteriotomy, avoiding the patent bypass grafts overlying the pulmonary trunk, while ensuring adequate myocardial protection.

Keywords: Pulmonary hypertension • Endarterectomy • Thromboembolic disease • Pulmonary endarterectomy

INTRODUCTION

Pulmonary endarterectomy (PEA) is the definitive surgical treatment for chronic thromboembolic pulmonary hypertension (CTEPH), with excellent short- and long-term results [1, 2]. The most recent series reported in this journal have confirmed the benefits [3, 4]. Re-operative PEA may be performed with similar perioperative risk, although the improvement in pulmonary haemodynamics is not as satisfactory [5]. PEA has been performed following previous cardiac surgery, although outcomes have not been specifically reported. PEA following previous coronary artery bypass graft (CABG) surgery carries risks of damage to patent grafts, as well as the potential for inadequate myocardial protection, especially when a patent pedicled internal thoracic artery (ITA) graft is present. We report a technique where PEA can be safely performed in the presence of patent saphenous vein (SV) and ITA grafts.

CASES AND PROCEDURE

Three patients, who had previously undergone CABG 3–10 years ago, were diagnosed with CTEPH. All three patients had left internal thoracic artery to left anterior descending artery and two or three additional vein grafts to diagonal, obtuse marginal and right coronary territories. All had severe pulmonary hypertension with surgically treatable pulmonary thromboembolic pathology.

SV and ITA grafts were patent in all instances. Re-sternotomy was performed uneventfully, carefully preserving the SV grafts around the aorta and avoiding dissection around the left side of the heart to prevent damage to the ITA graft. The right atrium and aorta were carefully dissected free to allow establishment of cardiopulmonary bypass (CPB). A plane was developed by sharp dissection between the superior vena cava (SVC) and the aorta, between the SVC and the right pulmonary artery (RPA) and finally between the aorta and the RPA whilst cooling on CPB to 20°C (Fig. 1). Vents were positioned via the right superior pulmonary vein (RSPV) and the RPA (Fig. 2A). The area around the pulmonary trunk with overlying SV grafts and proximity to the ITA graft was not disturbed.

Right-sided endarterectomy

The RPA was exposed between the aorta and SVC and opened with a longitudinal arteriotomy (Fig. 1). The endarterectomy and clearance was performed as previously described [6]. When collateral flow was excessive and visualization became obscured, a cross clamp was applied to the ascending aorta, and the myocardium was perfused with 1 l of cold-blood cardioplegia administered via the aortic root into the SV grafts and the native coronary arteries. Following this, deep hypothermic circulatory arrest (DHCA) was commenced, thus ensuring the absence of ITA flow and retention of cardioplegia in the myocardium. Cessation of the circulation for 20 min enabled full clearance from the RPA. On completion of the right-sided dissection, CPB was re-established and the aortic cross clamp was removed to perfuse the myocardium. The patient was reperfused for a minimum period of 10 min.

Left-sided endarterectomy

The left pulmonary artery (LPA) dissection was performed via the RPA arteriotomy (Fig. 1), with the surgeon standing on the
patient's right side. The right arteriotomy was extended medially posterior to the aorta to achieve complete access to the LPA, with appropriate angulation of the operating table away from the surgeon, thereby providing excellent view into the left pulmonary circulation (Figs 1 and 2B). As soon as the cardioplegia delivery was completed, DHCA was commenced and the aortic cross-clamp was removed to allow the aorta to be fully retracted to the patient's left side. Excellent clearance was achieved bilaterally in all cases (Fig. 2C). The RPA arteriotomy was closed with continuous 5/0 polypropylene suture in two layers from either side.

The exposure of the LPA via the RPA was not as perfect as via the pulmonary trunk; however, in our experience of these three patients, it was adequate for full endarterectomy and the arrest times for left dissection were not prolonged and were less than for the right dissection (as usual); mean 21-min RPA, 19-min LPA. All patients made an uncomplicated recovery and were discharged home.

**DISCUSSION**

Patients presenting with CTEPH following previous CABG pose challenges. Re-sternotomy is more hazardous in patients with pulmonary hypertension and distended right-sided chambers. In addition, damage to patent grafts during sternal re-entry and dissection can cause myocardial ischaemia, which is poorly tolerated in patients with pulmonary hypertension and reduced cardiac output. Myocardial protection is made more difficult by the presence of patent pedicled ITA grafts. Most importantly, access to the LPA via the pulmonary trunk can be difficult because of the overlying left-sided SV grafts anteriorly and the ITA graft laterally.

By adopting a strategy of only dissecting around the right heart enough to establish CPB, and of gaining access to the whole pulmonary artery circulation via the RPA, dissection of the remaining pericardial adhesions and risk of damaging the grafts could be minimized. Good access to the LPA is achieved by a long arteriotomy in the RPA, which can be extended substantially posterior to the ascending aorta, and with appropriate angulation of the operating table, even basal segments of the left lower lobe are visualized. The technique was developed by chance in the first patient described here, and although it appears complex, it is actually simpler than dissecting out the whole heart and moving left-sided grafts. Grafts to the right coronary artery territory do not affect this or the standard approach.

A potential drawback is that this approach might not afford adequate visualization of the left side in every patient depending on body habitus. We feel that the standard operation is the optimal approach for patients undergoing first-time PEA and have reserved this approach only for patients with previous CABG with difficult adhesions. We achieved excellent exposure to both right and left pulmonary circulations in all three patients with good clearance of disease bilaterally. We therefore recommend this technique when faced with the difficult situation of PEA in the presence of patent SV and ITA grafts and dense pericardial adhesions.

**CONCLUSION**

In conclusion, we have described a unique method of performing complete PEA in both pulmonary arteries through a right pulmonary arteriotomy, avoiding potential damage to patent ITA and SV grafts in patients who have undergone previous CABG.
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**REFERENCES**


*Figure 2: The (A) operative set-up, (B) surgeon’s view of the interior of the LPA through the right pulmonary arteriotomy through which PEA was performed bilaterally and (C) completed endarterectomy specimen. AC: aortic cannula; IVCC: inferior vena caval cannula; SVCC: superior vena caval cannula; SVC: superior vena cava; RSPVV: right superior pulmonary vein vent; card: cardioplegia cannula in the aortic root; PAC: pulmonary arterial catheter; RPA: right pulmonary arteriotomy.*