



Coronary Bypass Surgery in Patients with Previous Pneumonectomy

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Abstract

INTRODUCTION: Severe pulmonary dysfunction is a commonly occurring post-operative complication following cardiac surgery. Resection of a lung causes major anatomical and physiological changes. Shift of the mediastinum and reduction in respiratory function following pneumonectomy makes cardiac surgery challenging not only for the surgeon but also for the anesthetist. The reported experience is sparse for patients with prior pneumonectomy who are undergoing surgery for ischemic or valvular heart disease. We report a case of cardiac surgery following pneumonectomy to highlight certain important features that we think are important while managing these patients.

CASE PRESENTATION: The patient was a 56-year-old male who had undergone extra-pericardial pneumonectomy 30 years earlier for tuberculosis of the left lung. Echocardiography showed a left ventricular function of 50%. His coronary angiogram revealed severe triple vessel disease. Pre-operative spirometry showed FVC 1.94 L (52% of predicted), FEV1 1.3 L (48% of predicted), and FEV1/FVC ratio 70%. The pre-operative workup of this patient included computerized tomography of the chest to assess distortion of intra-thoracic anatomy. To improve the pulmonary function, this patient was admitted 10 days before surgery for intensive chest physiotherapy and incentive spirometry. He underwent coronary artery bypass grafting (CABG) using cardiopulmonary bypass and antegrade cold blood cardioplegia. Internal thoracic artery was used to graft left anterior descending artery (LAD), saphenous vein (SVG) was used to graft posterolateral branch of the right coronary artery, and first diagonal and first obtuse marginal arteries. Access to arteries in the circumflex region was difficult due to shift of heart to the left side. The patient was weaned from the ventilator 14 h after and CPAP helmet was immediately applied for a period of 48 h continuously. After on, it was applied at intervals for 5 days. The subsequent recovery was slow but progressive and the patient was discharged on the 11th post-operative day in good conditions.

CONCLUSION: We conclude that with attention to the specific features of the pre-operative, intraoperative, and post-operative management, open heart procedures can be performed successfully on patients after pneumonectomy.

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Introduction

Severe pulmonary dysfunction is a commonly occurring post-operative complication following cardiac surgery. Resection of a lung causes major anatomical and physiological changes. Shift of the mediastinum and reduction in respiratory function following pneumonectomy makes cardiac surgery challenging not only for the surgeon but also for the anesthetologist. Open heart surgery is a frequent cause of pulmonary dysfunction. Usually, forced vital capacity decreases 70% in the first post-operative day of cardiac surgery and does not increase until the 10th post-operative day. This increase is only 30% of the previous forced vital capacity. These changes can be easily tolerated in patients with normal pulmonary reserves but after pneumonectomy, nearly 50% decrease of these reserves makes it harder to tolerate cardiac surgery [1], [2]. Pneumonectomy can lead to serious physiological, anatomical problems and can cause difficulty for a later open heart surgery. Pulmonary complications related to open heart surgery cannot be easily tolerated in patients with the previous pneumonectomy due to limited pulmonary functions and reserves [3], [4]. Pre-operative pulmonary physiotherapy

and bronchodilator treatment should be done to prepare the patient for post-operative respiratory problems. We would like to present a patient with a previous pneumonectomy who went through successful CABG (Coronary Artery Bypass Graft) surgery in our clinic.

Case Presentation

The patient was a 56-year-old male who had undergone extrapericardial pneumonectomy 30 years earlier for tuberculosis of the left lung. Echocardiography showed a left ventricular function of 50%. His coronary angiogram revealed severe triple vessel disease.

Pre-operative spirometry showed FVC 1.94 L (52% of predicted), FEV1 1.3 L (48% of predicted), and FEV1/FVC ratio 70%. The pre-operative workup of this patient included computerized tomography of the chest to assess distortion of intrathoracic anatomy. In an attempt to improve the pulmonary function, this patient was admitted 10 days before surgery for intensive chest physiotherapy and incentive spirometry.

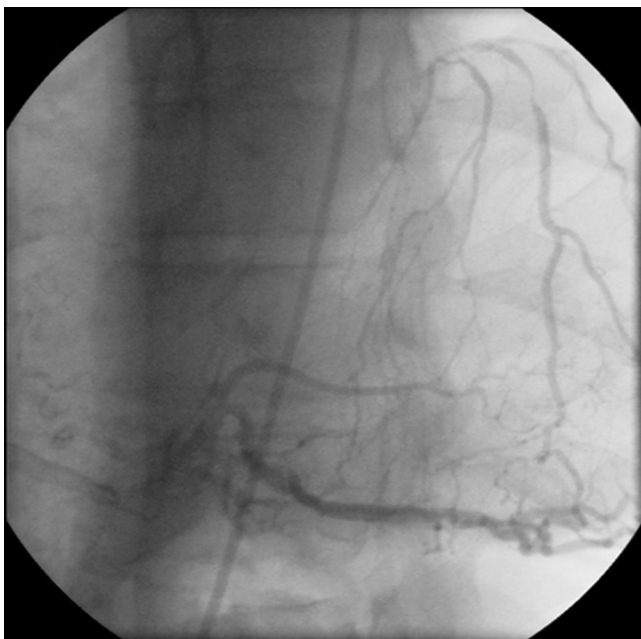
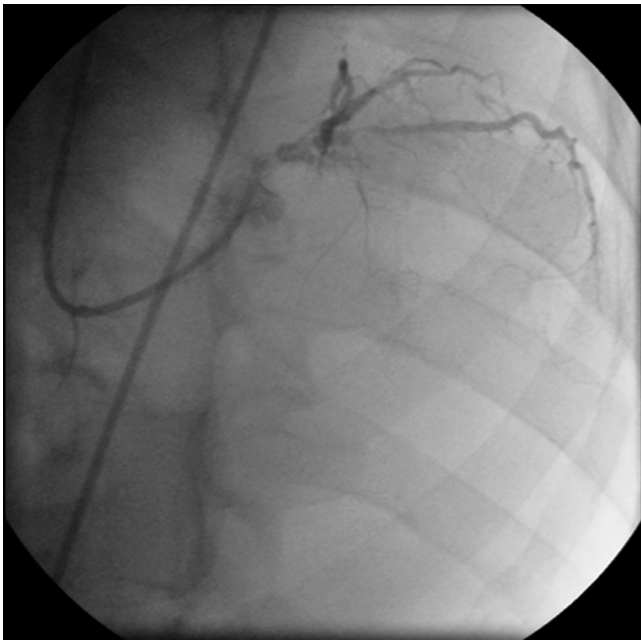


Figure 1: Coronary angiogram revealed severe triple vessel disease (upper and down)

A central venous catheter was placed in the right jugular vein. Endotracheal intubation was carried out noticing deviation of the trachea laterally. A full median sternotomy was made. The LIMA (Left Internal Mammalian Artery) was harvested with difficulty due to adhesions. The aorta and right atrium were displaced toward the left thorax. Cardiac apex was also very displaced laterally. The right atrial cannulation was done with the displacement of the cardiac structures, so the access to the femoral vein was not needed. Cardiopulmonary bypass was done with moderate systemic hypothermia (32°C). Cardiac arrest was obtained with antegrade cardioplegia administration. Topical cooling was also used. LIMA-LAD (Left Anterior Descending Artery) was performed and saphenous vein (SVG) was used to graft posterolateral branch of the right coronary artery, first diagonal, and first obtuse marginal arteries.

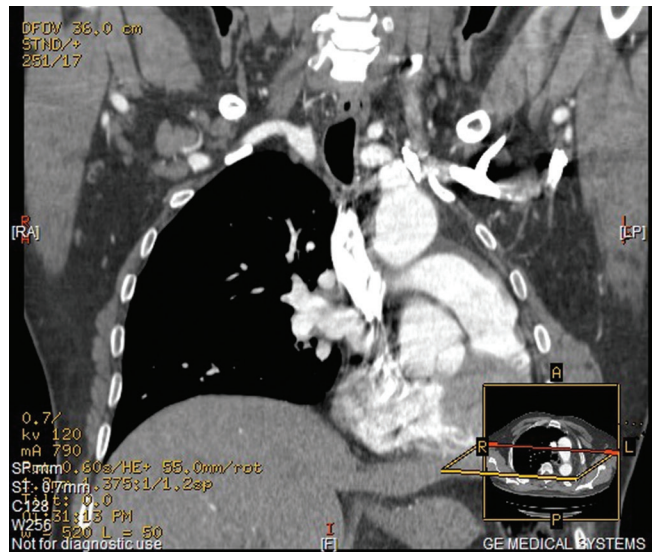
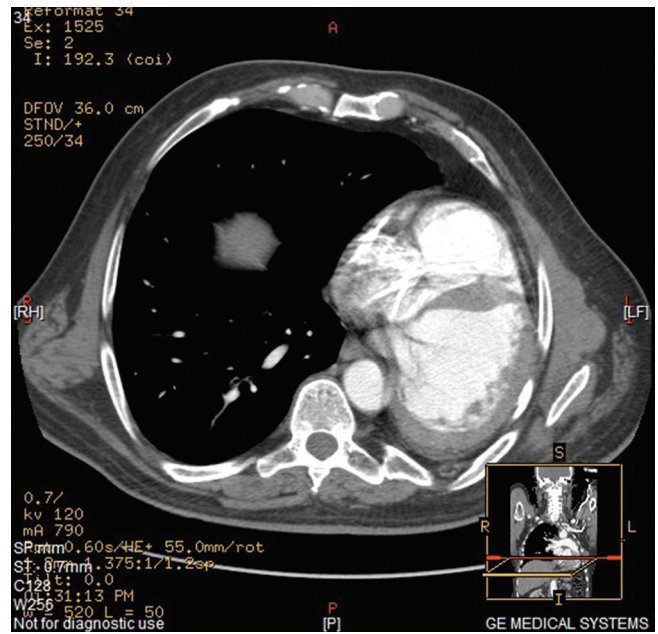


Figure 2: Computerised tomography of the chest to assess distortion of intra-thoracic anatomy (upper and down)

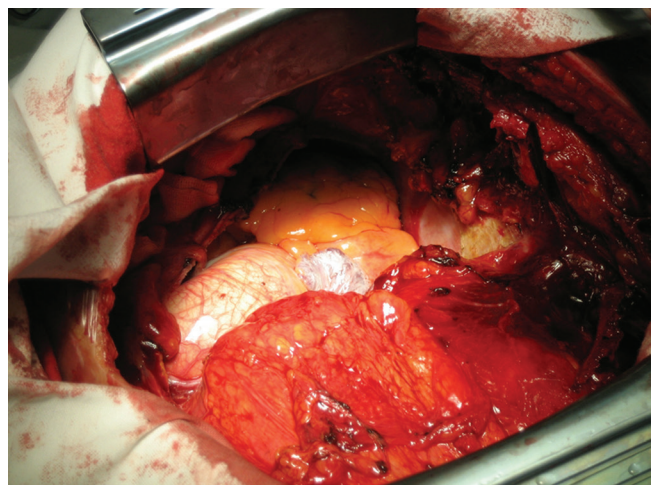


Figure 3: LIMA-LAD (Left Anterior Descending Artery) was performed and saphenous vein (SVG) was used to graft posterolateral branch of the right coronary artery

Access to arteries in the circumflex region was difficult due to shift of heart to the left side. The patient was weaned from the ventilator 14 h after and CPAP helmet was immediately applied for a period of 48 h continuously. After on, it was applied at intervals for 5 days. The subsequent recovery was slow but progressive and the patient was discharged on the 11th post-operative day in good conditions.

Discussion

After cardiac surgery, the lungs are at risk of injury and pulmonary dysfunction for multiple causes. Pulmonary complications in patients undergoing cardiac surgery can result from the absence of pulmonary blood flow during total cardiopulmonary bypass (CPB), as well as from alterations in chest wall mechanics due to the surgical incision. Activated leukocytes and their products incite an inflammatory response in the pulmonary vasculature, and the alveolar-capillary barrier becomes more permeable than normal. Macromolecules may enter the pulmonary interstitium and promote development of pulmonary edema [5], [6].

Although most patients undergoing coronary artery bypass graft (CABG) surgery can tolerate this pulmonary impairment, patients with borderline pulmonary reserve are at increased risk of post-operative pulmonary dysfunction and require special management during the operative period [7]. There is scarcity of data in the literature on the subject of cardiac surgery subsequent to previous pneumonectomy [3], [8]. We discuss our experience and review the literature on performing cardiac surgery following pneumonectomy to highlight technical and other features that need to be considered during management of these patients.

Following the pneumonectomy access to the heart is more difficult as heart not only shifts toward the side of pneumonectomy but also posteriorly due to loss of its anchor to pulmonary veins. The following right pneumonectomy, the left to right displacement of the mediastinum, occurs mostly by transfer with subsequent dextroposition of the heart and arrangement of the aortic arch in a frontal plane. On the contrary, after the left pneumonectomy right to left shift occurs mostly through rotation with the aortic arch arranged in the sagittal plane [9]. Severe distortion of mediastinal anatomy following pneumonectomy has been reported in the literature [10], [11], [12].

While performing the operation care has to be taken during sternotomy to avoid injury to the hyperinflated lung that often lies in close contact with posterior surface of the sternum. We encountered intrapericardial adhesions on the posterior surface of the heart in our first patient this, we believe, occurred due to intrapericardial technique used while performing pneumonectomy on this patient.

The following right pneumonectomy the shift of the heart in the right hemithorax can make access to the right atrium for establishing cardiopulmonary bypass (CPB) difficult. In their case report, Berrizbeitia *et al.* report difficulty that they encountered during cannulation of inferior vena cava (IVC) in a patient who had undergone right pneumonectomy [6]. The fixity of IVC at its hiatus in diaphragm prevents it from moving rightward resulting in acute angulation between the right atrium and the IVC. The venous cannulation to establish CPB may be achieved with more ease if operator stands on the left side of the patient. Another factor that needs to be considered in a patient who had previous right pneumonectomy is that, the right superior pulmonary vein is not available for venting therefore, alternative sites may have to be used.

The following left pneumonectomy access to arteries in the circumflex region becomes difficult due to shift of heart to the left side, this difficulty has also been reported by Medalion *et al.* [3]. We did not come across any report of off pump coronary artery bypass graft surgery (OPCAB) being performed on patients with the previous pneumonectomy, but we estimate that following left pneumonectomy, exposure of posterior surface of heart to graft circumflex coronary artery territory during an OPCAB procedure would be technically challenging.

We would like to highlight certain important points that need to be considered while choosing internal thoracic artery (ITA) as a conduit while performing CABG in these patients. The chest wall on the side of pneumonectomy becomes rigid; hence, spreading of sternal retractor leads to uneven spreading. ITA from the side of pneumonectomy is difficult to harvest. Pedicled ITA may not reach its targeted vessel due to displacement of heart; moreover, the ITA graft may become kinked by the hyperinflated lung. Various studies have shown that increased pain associated with ITA harvesting may be responsible for decreased post-operative pulmonary function [13], [14], [15]. This becomes more relevant in patients who already have compromised pulmonary function. Demirtas *et al.* have reported use of the left ITA to graft LAD in a patient who had left pneumonectomy in the past [15]. Their patient developed acute left heart failure on arrival to post-operative intensive care unit and required internal cardiac massage. Berrizbeitia *et al.* used SVG to graft LAD [8]. We did not use the ITA in our patient who had undergone left pneumonectomy.

There are important considerations for the anesthesiologist too, internal jugular vein cannulation can be difficult following pneumonectomy due to shift of the mediastinum. The care has to be taken to protect the single lung and sudden fluid overload can lead to pulmonary edema [10]. Early extubation is desirable to avoid risk of prolonged ventilation; external warming at the cessation of CPB; and on arrival to intensive care unit could facilitate early extubation. The use of

thoracic epidural analgesia improves pain control and facilitates easy expectoration and avoids many of the post-operative pulmonary complications [11], [14]. Similarly, intensive chest physiotherapy and early mobilization become more important in these patients to avoid atelectasis and risk of deep vein thrombosis. We utilized benefits of epidural analgesia and stressed on the early mobilization and chest physiotherapy in both our patients.

Conclusion

Patients in need of CABG surgery after pneumonectomy are an increased risk of morbidity. Bronchodilator treatment and respiratory physiotherapy are required before surgery. During intubation and surgical exposure, several difficulties may be encountered due to the displacement of the middle mediastinal structures after pneumonectomy especially for the institution of cardiopulmonary bypass, arterial, and venous cannulations.

We conclude that with attention to the specific features of the pre-operative, intraoperative, and post-operative management, open heart procedures can be performed successfully on patients after pneumonectomy.

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