Intraoperative management of failed single lung ventilation using a Fogarty balloon catheter through the open bronchus during off-pump left lung transplantation

Bandigowdanapalya Ramesh*, Anders Andreasson and John Dark

Department of Cardiopulmonary Transplantation, Freeman Hospital, High Heaton, Newcastle Upon Tyne, UK

* Corresponding author. Department of Cardiopulmonary Transplantation, Freeman Hospital, Freeman Road, High Heaton, Newcastle Upon Tyne NE7 7DN, UK. Tel: +44-191-2139577; fax: +44-191-2231439; e-mail: bc.ramesh@nuth.nhs.uk (B.C. Ramesh).

Received 19 September 2013; received in revised form 14 December 2013; accepted 26 December 2013

Abstract

The use of balloon catheters as an interventional procedure is well established in various fields of medicine. Failure of single lung ventilation (SLV) can add difficulty to open bronchus procedures, and could result in a life-threatening situation very quickly. Trying to achieve single lung ventilation by alternate methods is fraught with dangers, and use of urgent cardiopulmonary bypass is less desirable because of increased primary graft dysfunction and mortality. We describe a novel approach of using a Fogarty balloon catheter through the open bronchus to achieve SLV during off-pump left lung transplantation when conventional SLV failed.

Keywords: Airway • Surgery, complications • Transplantation, lung

INTRODUCTION

Although bilateral lung transplants have become the commonest procedure, the single lung transplant is still favoured in many centres for fibrotic disease. Performing single lung transplantation without cardiopulmonary bypass (CPB), under single lung ventilation (SLV), is the preferred approach in such a situation. SLV refers to mechanical separation of the two lungs to allow ventilation of only one lung to facilitate surgical access and to protect the ventilated lung. On the left side, SLV is usually achieved by right-sided double lumen tube (DLT). Placement is critical in patients with little respiratory reserve and very stiff lungs. On a number of occasions, there has been a loss of ventilation on opening the recipient bronchus. Rather than resort to CPB if airway control could not be achieved, we have devised an approach using an occlusive balloon. The following case illustrates the approach.

PROCEDURE

A 45-year old male underwent left off-pump single lung transplantation for end-stage pulmonary fibrosis by conventional posterolateral thoracotomy using a standard DLT for lung isolation. The position and function of the DLT was confirmed before and after positioning the patient in right lateral position. Standard left posterolateral thoracotomy was performed through the fifth intercostal space. Recipient pneumonectomy was completed in a sequential manner by securely ligating and dividing the left pulmonary artery and pulmonary vein branches, and by dividing the left main bronchus.

As soon as the bronchus was divided, a large air leak was noted with dissemination of anaesthetic gasses into the operating field resulting in a sudden desaturation episode along with haemodynamic compromise. The left main bronchus was occluded temporarily by the surgeon’s finger until haemodynamic stability was restored. On inspection through the operative field, the bronchial balloon of the DLT was found to be inflated and the position of the DLT was confirmed by bronchoscopy. Measures to reposition the DLT, including reflation of the bronchial and tracheal balloons, failed to achieve effective SLV.

TECHNIQUE

A size 10 Fogarty balloon catheter was placed retrogradely into the left main bronchus through the operative field by the surgeon and the balloon was kept inflated to achieve airway control and to prevent air leakage (Fig. 1). The donor lung was then prepared for implantation. There is always adequate length of left main bronchus to allow balloon inflation without compromising position of the suture line (Fig. 2).

After preparation of the donor hilum, the bronchial anastomosis was done first. In the small pleural cavity of the fibrotic recipient, we have found it easier to start the suture line at the mid-point of the cartilaginous bronchus, with the lung lying anteriorly over the mediastinum. Suture lines are lead around each end of the cartilaginous portion, and then tied. A second suture from each end closes the membranous portion, meeting in the middle. The Fogarty balloon catheter was brought out through this posterior suture line, which was left untied.
The pulmonary artery and left atrial cuff anastomoses are completed in a standard fashion. Size 4.0 polypropylene (Prolene™) sutures were used for construction of all three anastomoses. After deairing, and initial reperfusion, the Fogarty balloon was deflated and easily removed through the untied posterior bronchial suture line. Once tied, the airway was checked for integrity and the operation completed.

This manoeuvre has been used on number of occasions. Airway control was always achieved, and there was no problem withdrawing the catheter at the end. There was no anastomotic leak, either during intraoperative or during postoperative period.

**DISCUSSION**

Conventionally, SLV is achieved by using a DLT or bronchial blockers (BBs) during single lung transplantation with thoracotomy incision. The scope of use for Fogarty catheters is ever expanding in various fields of medicine. Initial use of the catheter for embolectomy has been extended to thoracic anaesthesia and surgery, and also for tamponading exsanguinating haemorrhage such as inaccessible major vascular injury, large cardiac injury and deep solid organ parenchymal bleeding [1–7].

In our case, the SLV failed midway through the operation despite the DLT being in position with an inflated balloon. This was completely unexpected and inexplicable. This was most likely due to continual leak around the balloon in the enlarged airways of patients with end-stage fibrotic disease. Unfortunately, we failed to recognize the severely enlarged airways prior to the occurrence of the ventilation problem during surgery. Careful study of the preoperative bronchial computerised tomography (CT) morphology is recommended to anticipate and prevent this unusual SLV problem. Repositioning under fiberoptic bronchoscopy and reinflation of the balloon with additional volume was not successful in providing adequate SLV.

Although there is a plethora of evidence of Fogarty catheter use in the literature as a BB, there is no reported evidence of its retrograde use through the open bronchus in the operating field in an emergency situation to secure differential lung ventilation. Conventional ways of securing SLV midway through the operation are time consuming and could therefore be hazardous. The use of emergency cardiopulmonary bypass (CPB) in such situations increases the risk of primary graft dysfunction (PGD) as evidenced by multiple studies. In multivariate models, the use of CPB has shown to be an independent risk factor for PGD and was associated with increased 90-day and 1-year mortality [8]. The use of venoarterial extracorporeal membrane oxygenation could be a less invasive alternative to conventional CPB, but its role has not been fully evaluated in lung transplantation, particularly regarding the effect on PGD and mortality.

**CONCLUSION**

We conclude that the intraoperative use of a Fogarty balloon catheter is a fast, safe, effective and reproducible simple innovative technique to deal with an unexpected SLV failure midway through open bronchial thoracic surgery on the left side. Unfortunately, this simple innovative procedure might not be suitable for right single lung transplantation due to the very short right main bronchus. Careful study of morphology of enlarged airways on CT imaging could prevent failed ventilation complications during lung transplantation.

**Conflict of interest:** none declared.

**REFERENCES**


eComment. Re: Intraoperative management of failed single lung ventilation using a Fogarty balloon catheter through the open bronchus during off-pump left lung transplantation

Authors: Souvik Maitra, Sulagna Bhattacharjee and Sugata Pal
AIMS, New Delhi, India
doi: 10.1093/icvts/ivu045
© The Author 2014. Published by Oxford University Press on behalf of the European Association for Cardio-Thoracic Surgery. All rights reserved.

We have read the article by Ramesh and colleagues with great interest [1]. The authors have managed the case in an innovative way, saving the life of the patient. However, we would like to discuss a few things about this case.

The authors mentioned the sudden failure of the double lumen tube (DLT); however, the quality of lung isolation just after thoracotomy has not been mentioned. Was the left lung deflated at the time of pneumonectomy? In the authors’ opinion, the failure of single lung ventilation was ‘most likely due to continual leak around the balloon in the enlarged airways of patients with end-stage fibrotic disease’. They do not mention the size of the DLT and how they selected that size.

The method of choosing the optimum size DLT for lung separation is a debatable issue. Kim et al. [2] recently found that there is no direct relationship between the length and diameter of the main bronchi and the height of the patients. Marked individual variability [3] contributes to the fallacies of selecting a proper size DLT on the basis of age and sex. Hannallah et al. [4] believe that the optimal left DLT size for a particular patient is defined as the largest tube that will fit in the left bronchus with only a small air leak detectable when the cuff is deflated. We think that a preoperative computed tomography scan (CT) must have been done and it can give an idea about the bronchial diameter. et al. [1] also proposed that 3D images be used to determine the size of the main bronchi. We should remember that the use of a Fogarty catheter in this scenario is only a rescue method. The bronchial diameter must be determined in such cases to select the optimum size DLT.

Finally, we wish to thank the authors for highlighting an excellent off-label use of a common device available in the operating room and hope in the near future that the Fogarty catheter will have a place in every thoracic anaesthesiologist’s emergency cart.

Conflict of interest: none declared.

References


eResponse. Re: Intraoperative management of failed single lung ventilation using a Fogarty balloon catheter through the open bronchus during off-pump left lung transplantation

Authors: Bandipowdanjalya Ramesh
Cardiopulmonary Transplantation, Freeman Hospital, Newcastle, UK
doi: 10.1093/icvts/ivu060
© The Author 2014. Published by Oxford University Press on behalf of the European Association for Cardio-Thoracic Surgery. All rights reserved.

We are very thankful to Maitra et al. for their invaluable and educative comments. We fully agree with their critical analysis of our publication. We would like to clarify some of the questions that are raised by their team.

The quality of lung isolation after thoracotomy was checked as a standard protocol and was found to be good. However, it is our practice to perform most of the dissection during recipient pneumonectomy without collapsing the lung. Small fibrotic lungs did not pose any problem in this regard.

We noticed the problem of big air leak only after division of the left main bronchus. The big and distorted airways in fibrotic lungs with possible mismatch of the double lumen tube (DLT), combined with slight displacement of the original position of DLT while dissecting the bronchus, might be the reason for this life-threatening mishap in our case. Our anaesthetists used a standard size DLT as per the size of the patient. Unfortunately, our team failed to study the computed tomography (CT) bronchial anatomy before selecting the appropriate size of DLT. Hence, we recommend the routine study of CT bronchial anatomy with possible 3D reconstruction, to select the appropriate size of DLT during off-pump left single lung transplantation.

Our aim was to highlight the use of this simple well known device and technique to tide over similar crisis during intrathoracic open bronchus surgery, by the operating surgeon, if possible. I am sure, the Fogarty balloon catheter finds its role in many innovative ways, particularly in the field of critical medicine.

Conflict of interest: none declared.

References