

# Delayed Chest Closure With Skin Approximation After Lung Transplant in Oversized Graft

Prashant N. Mohite, Anton Sabashnikov, Aron-Frederik Popov, Mohamed Zeriouh, Javid Fatullayev, Massimo Capoccia, Mohamed Amrani, Martin Carby, André R. Simon

## Abstract

**Closure of the chest after lung transplant in cases of oversized grafts is often difficult. Lung volume reduction and delayed closure of the chest with Bogota bag are the only options available in such situations. Here, we propose to keep the sternum and intercostal spaces open and approximate skin over it. Once lung function improves and reperfusion-related edema recovers, the chest can be closed.**

**Key words:** Donor-recipient matching, Oversized lung graft, Reperfusion-related edema

## Introduction

An oversized lung allograft, as estimated by a donor-to-recipient-predicted total lung capacity ratio of > 1.0, is associated with improved long-term survival after lung transplant without an increase in posttransplant complications.<sup>1,2</sup> Therefore, surgeons are inclined toward oversizing when donor-recipient matching. The lungs after procurement tend to be less compliant and edematous (“wet”), owing to the effect of donor brain death, “pulmonoplegia” flush, handling during procurement and inflammation due to cold storage, and ischemia-reperfusion injury. For these reasons, and especially for oversized allografts, it is often difficult to close the chest after lung transplant. Such attempts may cause hemodynamic instability and desaturation from ventilation due to compartment-like syndrome in the chest.<sup>3</sup> Lung volume reduction and delayed chest closure are the

only treatment options in such situations. Lung volume reduction allows immediate chest closure but bears the risk of prolonged air leak, infection and empyema, and decreased vital capacity. Delayed chest closure may be achieved by leaving the chest open and/or stitching Esmarch bandage (a type of tourniquet) or Bogota bag over the incision.<sup>4,5</sup> An open chest in the postoperative period would significantly affect airway pressures needed to achieve an expected tidal volume.<sup>3</sup> During mechanical ventilation, the Bogota bag or Esmarch bandage may be sucked in during expiratory phase and blown out during inspiratory phase, affecting tidal volume and the effective gas exchange. In addition, blood may accumulate under the bag or bandage and leak out through the stitches. Here, we investigated a different approach for this situation.

## Technique

The technique described here is utilized when the chest cannot be closed after lung transplant without hemodynamic compromise due to an oversized allograft. The sternum and the intercostal spaces on both sides are left unapproximated. The skin along with the subcutaneous tissue on the chest wall is undermined for 2 to 3 inches over the pectoralis major muscle fascia with diathermy. This skin flap is then pulled over the oversized lungs, open intercostal spaces, and the disconnected sternal ends (Figure 1). If there is tension over the skin flap, big bite vertical mattress sutures may be helpful. Timing to close the chest mainly depends on improvement of pulmonary edema as shown by radiography, improvement of gas exchange, and hemodynamic stability, which usually ensues 24 to 48 hours after surgery (Figure 2). In a study by Force and associates, they reported 5 days as mean time to close the chest.<sup>3</sup> After this interval, the disconnected sternal ends are

*From the Department of Cardiothoracic Transplantation and Mechanical Circulatory Support, Royal Brompton & Harefield NHS Foundation Trust, Harefield, London, United Kingdom*

*Acknowledgements:* This work was not supported by any source of funding. The authors have no conflicts of interest or disclosures to declare.

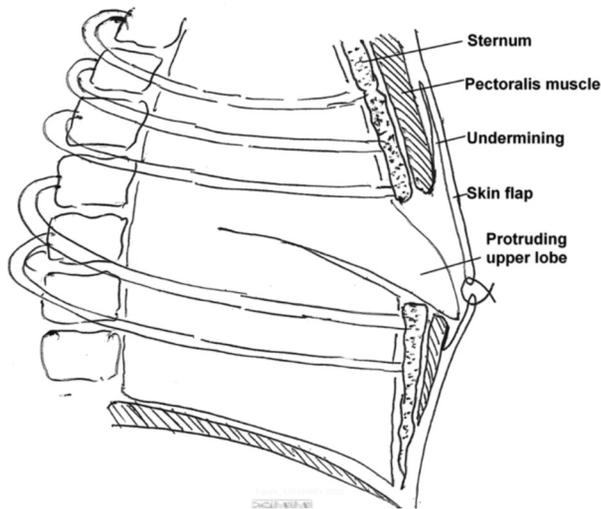
*Corresponding author:* Anton Sabashnikov, Harefield Hospital, Middlesex, London, UB9 6JH, United Kingdom

*Phone:* +44 74 4669 9360 *E-mail:* a.sabashnikov@rbht.nhs.uk

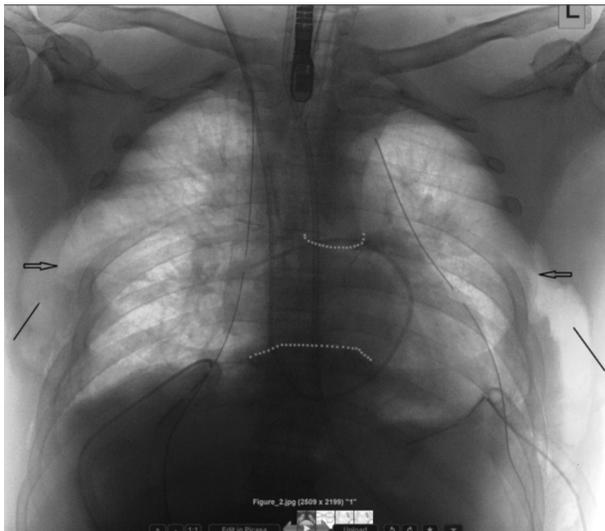
*Experimental and Clinical Transplantation (2018) 1: 107-109*

approximated with stainless steel wires, the intercostal spaces are approximated with thick polyester suture, and the chest is closed in a conventional layered manner.

**Figure 1.** Illustration of Undermined Skin Flap and Skin Approximation



**Figure 2.** Radiography of Open Chest With Lungs Bulging Out



Arrows denote protruding lung margin; solid lines denote subcutaneous air; dotted lines denote edges of unapproximated sternum.

We have used this technique in 2 patients and achieved delayed chest closure within 48 hours and 6 days. For these 2 patients, the donor and recipient characteristics and outcomes after lung transplant are presented in Table 1.

## Discussion

Delayed chest closure after lung transplant by relieving pressure on heart and lungs improves tidal

**Table 1.** Donor and Recipient Characteristics and Lung Transplant Outcomes in 2 Patients

	Patient 1	Patient 2
<b>Recipient</b>		
Age, y	46	24
Sex	Female	Male
Height, cm	165	172
Weight, kg	70	54
TLC, L	5.1	6.7
Diagnosis	Emphysema	Cystic fibrosis
<b>Donor</b>		
Age, y	57	55
Sex	Female	Male
Height, cm	167	177
Weight, kg	45	77
TLC, L	5.2	7
Donation	Brain dead	Brain dead
PO <sub>2</sub> /FIO <sub>2</sub>	300	402
Total ischemic time, min	631	786
<b>Outcome</b>		
On/off pump	On	On
Delayed closure time, d	6	2
Mechanical ventilation, d	27	4
Intensive care unit stay, d	42	7
Hospital stay, d	62	20
1-year survival	Alive	Alive
Recipient FVC, L (% of predicted)	2.4 (75%)	3.2 (64%)
Recipient FEV1, L (% of predicted)	79 (92%)	71 (85%)

**Abbreviations:** FEV1, forced expiratory flow in the first second of expiration; FIO<sub>2</sub>, fraction of inspired oxygen; FVC, forced vital capacity; PO<sub>2</sub>, partial pressure of oxygen; TLC, total lung capacity

volume without affecting the airway pressure and improves biventricular function, exerting less positive end-expiratory pressure.<sup>4</sup> It releases compartment pressure over the lungs and at the same time keeps the lungs confined to a certain extent. It not only allows sufficient time for improving lung function and resolving edema but also prominently avoids lung volume reduction or at least quantity of the lung reduction.<sup>5</sup> This technique may also potentially avoid use of extracorporeal life support, especially with oversized grafts with primary graft dysfunction, by stabilizing hemodynamic status and improving gas exchange.<sup>4</sup> The skin closure technique described here is not only cost effective but also avoids leaking of blood and soaking of dressing and offers an aesthetic look. The skin closure may have some tamponade effect, which helps formation and stabilization of clots compared with Esmarch bandage cover, which has a tendency to bulge out and move with breathing. Compared with an open chest or chest covered with Esmarch bandage, the skin closure provides firmness and stability. However, precaution must be taken while shifting and rolling these patients, as an unapproximated sternum leaves the body with spine as a main support. The dressing should be labeled as “open chest” in bold letters so that adequate support will be utilized while moving the patient.

## References

1. Eberlein M, Reed RM, Permutt S, et al. Parameters of donor-recipient size mismatch and survival after bilateral lung transplantation. *J Heart Lung Transplant*. 2012;31(11):1207-1213.
2. Eberlein M, Arnaoutakis GJ, Yarmus L, et al. The effect of lung size mismatch on complications and resource utilization after bilateral lung transplantation. *J Heart Lung Transplant*. 2012;31(5):492-500.
3. Dezube R, Arnaoutakis GJ, Reed RM, et al. The effect of lung-size mismatch on mechanical ventilation tidal volumes after bilateral lung transplantation. *Interact Cardiovasc Thorac Surg*. 2013;16(3):275-281.
4. Force SD, Miller DL, Pelaez A, et al. Outcomes of delayed chest closure after bilateral lung transplantation. *Ann Thorac Surg*. 2006;81(6):2020-2024.
5. Inoue M, Minami M, Ichikawa H, et al. Extracorporeal membrane oxygenation with direct central cannulation followed by delayed chest closure for graft dysfunction after lung transplantation: report of two cases with pulmonary arterial hypertension. *J Thorac Cardiovasc Surg*. 2007;133(6):1680-1681.