Off-Pump Bilateral Lung Transplantation via Median Sternotomy: A Novel Approach With Potential Benefits

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The clamshell incision is the standard approach for bilateral lung transplantation. There is limited experience with bilateral lung transplantation via median sternotomy, and the use of cardiopulmonary bypass seems to be mandatory in all cases while accepting the potential disadvantages of the extracorporeal circulation. We describe a novel approach for bilateral lung transplantation as an off-pump technique via median sternotomy. This approach has the potential to combine the advantages of median sternotomy with less postoperative pain, better chest wall function, and reduced risk of primary graft dysfunction and bleeding complications.

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The clamshell incision is currently the standard approach for bilateral lung transplantation worldwide. Despite its advantage of creating excellent exposure, it is an extremely invasive approach that causes severe postoperative pain and impairment of chest stability and respiratory mechanics. Wound complications with sternal overriding present a further disadvantage of this approach [1].

Bilateral lung transplantation via anterior thoracotomies with preservation of sternum was described by Meyers and colleagues [2] as an alternative to clamshell incision with some advantages [3]. Median sternotomy presents a further alternative for bilateral lung transplantation [1, 4, 5] with encouraging postoperative results regarding pain and functional recovery [1]. However, the use of extracorporeal support seems to be mandatory in these limited series, mainly because of the technical challenges posed by left-sided anastomoses. Our aim was to assess the technical feasibility of an off-pump bilateral lung transplantation via median sternotomy and its impact on postoperative outcome.

Technique

A median sternotomy was performed in a 36-year-old female patient with cystic fibrosis, and the pericardium was opened in the midline with retraction stitches at the pericardial edges. After opening the pleura, the right hilum was exposed by traction of pericardial sutures to the opposite site. After pneumonectomy of the native lung, the pericardium was opened circumferentially around the hilum with attention to the phrenic nerve, and the

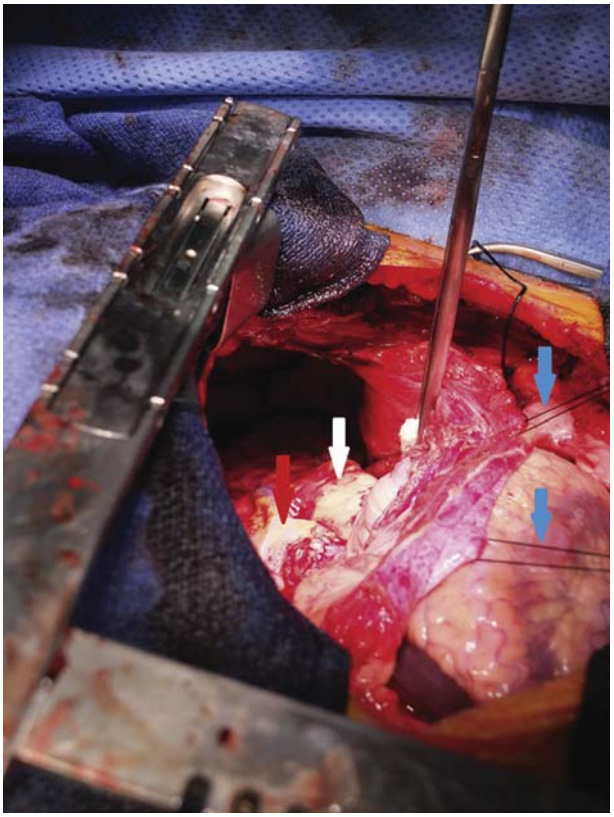

Fig 1. By traction of pericardial sutures (blue arrows) to the opposite site the right hilum was exposed and the bronchial, pulmonary arterial (white arrow) and left atrial (red arrow) anastomoses were completed without any problems.

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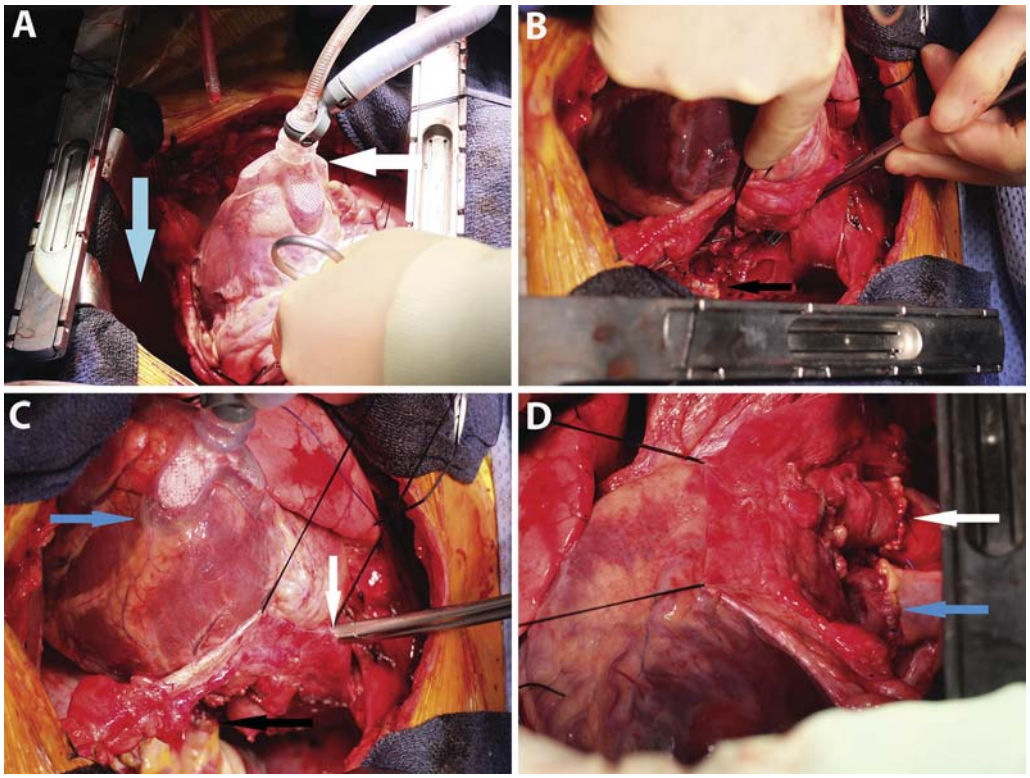

Fig 2. (A) The use of an apical heart suction device (white arrow) provides a better exposure of the left hilum (blue arrow). (B) Bronchial anastomosis (black arrow) completed first on the left side. (C) While the heart was still dislocated with the apical heart suction device (blue arrow), the left atrium was clamped intrapericardially (white arrow) to create sufficient space to perform the left atrial anastomosis (black arrow). (D) Completed pulmonary arterial (white arrow) and left atrial (blue arrow) anastomoses on the left side.

bronchial, arterial, and atrial stumps were mobilized further. After bronchial anastomosis with 4-0 monofilament nonabsorbable polypropylene as running suture, 5000 IE heparin was given and the pulmonary arterial stump and atrial cuff were clamped. First, the atrial cuff and then pulmonary arterial anastomosis were completed with 4-0 and 5-0 monofilament nonabsorbable polypropylene suture, respectively. After antegrade and retrograde deairing over suture lines, both anastomoses were completed (Fig 1), and controlled ventilation and reperfusion of the right donor lung was started gradually. After reperfusion for 10–15 minutes, right single-lung ventilation was started. After opening of the left pleura, the heart was dislocated using a suction device (Medtronic Starfish 2; Dublin, Ireland) on the apex of the left ventricle (Fig 2A) to provide better exposure of the left hilum. After pneumonectomy of the native lung, the left donor lung was implanted similarly to the right side (Figs 2B–2D). Controlled reperfusion and ventilation of the left donor lung was commenced, and hemostasis was secured. Four 28-French chest drains were placed apically and basally, with 2 drains on each side, using epigastric area as an insertion site to avoid intercostal pain. Sternotomy incision was closed in the standard manner with both grafts showing excellent compliance and gas exchange. The total procedure time was 5 hours, 48 minutes. The estimated blood loss was 860 mL. The ischemic times were 5 hours, 18 minutes on the right side and 6 hours, 32 minutes on the left side.

The patient was extubated 8 hours after the operation and was transferred on the second postoperative day to the normal ward. The apical drains could be removed on the second postoperative day and the basal ones on the seventh. The pain control was much easier compared with patients with bilateral thoracotomies. After an uneventful hospital stay with superb mobilization, she was discharged home on postoperative day 24.

Comment

The clamshell incision is the most commonly used approach for bilateral lung transplantation. It provides an excellent exposure, but there are a number of disadvantages, such as severe postoperative pain, impaired chest stability, and respiratory mechanics owing to division of transverse sternum and respiratory muscles, thus resulting in slow postoperative recovery and poor early functional performance. Wound complications related to sternal closure are also a problem in these patients.

The less invasive alternative to clamshell incision is the sternum-sparing, bilateral anterior thoracotomy that was first described by Meyer and colleagues [2]. This approach not only avoids the sternal complications; it also

provides better respiratory function in the early postoperative period [3].

Median sternotomy presents an additional alternative for bilateral lung transplantation, although there is limited published research on this approach. In a study by Macchiarini and colleagues [1], the clamshell incision resulted in more postoperative deformity, chronic pain, and impaired function compared with median sternotomy [1]. Dark [4] reported on shorter ventilation times and intensive therapy unit stays in patients who underwent transplantation via median sternotomy. Bates and colleagues [5] described bilateral lung transplantation via median sternotomy with the routine use of cardiopulmonary bypass to be a safe and feasible approach.

Despite these obvious advantages of median sternotomy, including rapid chest opening and closure, less postoperative pain, superior postoperative respiratory mechanics, and faster postoperative recovery, there are also some limitations, such as limited access to posterior mediastinum, difficult dissection of native lungs with severe adhesions, and supposed mandatory use of extracorporeal support owing to difficult access to the left-sided hilum.

Although the role of the off-pump technique on overall outcome is still controversial in the lung transplantation, there is clear evidence that the use of cardiopulmonary bypass is associated with increased risk of primary graft dysfunction [6]. The use of extracorporeal support in lung transplantation can be mandatory in patients with severe underlying disease whenever single-lung ventilation cannot be tolerated or in patients with severe pulmonary hypertension owing to intraoperative hemodynamic problems. Occasionally, difficult exposure of the left hilum can require the use of extracorporeal support for decompression and luxation of the heart. In 2006, Lau and colleagues [7] described three occasions of the use of an apical heart suction device for exposure of left hilum in lung transplantation to avoid cardiopulmonary bypass, with anterolateral thoracotomies or clamshell incision as surgical access.

Based on our literature review, this is the first reported off-pump bilateral lung transplantation via median sternotomy to date. This novel approach seems to combine the potential advantages of median sternotomy with less postoperative pain and better chest wall function while using an off-pump technique with reduced risk of primary graft dysfunction and bleeding complications and encouraging postoperative outcomes. Limited access to the posterior mediastinum and dense adhesions could be potential limitations of this access. Further experience is needed to assess the technical feasibility in different scenarios and the reproducibility of this superb postoperative outcome.

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