A minimally invasive incision for lung transplantation: antero-axillary approach

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Abstract

Increasing attention is being paid by cardiothoracic surgeons to performing cardiothoracic surgical procedures through less invasive approaches, including the use of limited skin incisions. A limited incisional approach is described that achieves full access to the entire chest cavity and the hilum, allows the use of standard operative instruments and techniques, permits rapid, easy initiation of cardiopulmonary bypass, and is easy to learn.

Key words: lung transplantation, minimally invasive approach.

Introduction

Although minimally invasive approaches to cardiothoracic surgical operations have become very popular in recent years [1, 2], there is little consensus on what constitutes a minimally invasive approach in lung transplantation. Features that have been mentioned include avoidance of cardiopulmonary bypass, avoidance of sternotomy, or limited incisions with standard operative techniques [3-5].

For bilateral lung transplantation, clamshell incision with transverse sternotomy is still preferred by most surgeons [3]. However, this approach has potential disadvantages, including the sternal wound healing problem in immunosuppressed patients and division of internal mammary arteries. The antero-lateral approach was described with sparing of the sternum [4]. Although this approach is less invasive compared to the clamshell approach, there are potential disadvantages, including the damage or removal of costal cartilages or the potential stretching or division of internal mammary arteries, and the incision can be seen from the front. A vertical axillary approach was also described [5], and its incision can be short, and cosmetically good, but there are also potential disadvantages, including the damage or removal of ribs, and the safety of the operation can be compromised in case emergency institution of cardiopulmonary bypass is necessary. In addition, it can be used only for single lung transplantation.

To provide a less invasive approach that allows a standard operation to be performed but with some of the advantages of limited incisions, I have developed a technique that allows for elimination of the potential disadvantages of other approaches and the performance of standard lung transplant procedures through a limited skin incision.

Technique

With the patient in a supine position, the arms lifted up and the hands fixed in front of the face (Fig. 1), a limited antero-axillary skin incision is made beginning at the junction of the anterior axillary line and the inframammary crease, extending towards the axilla along the crease and lateral to the pectoralis major muscle (Fig. 2). The incision is 8 to 12 cm in length. The subcutaneous tissues are divided and dissection is carried down to the chest wall. The appropriate intercostal space is identified bilaterally and entered.

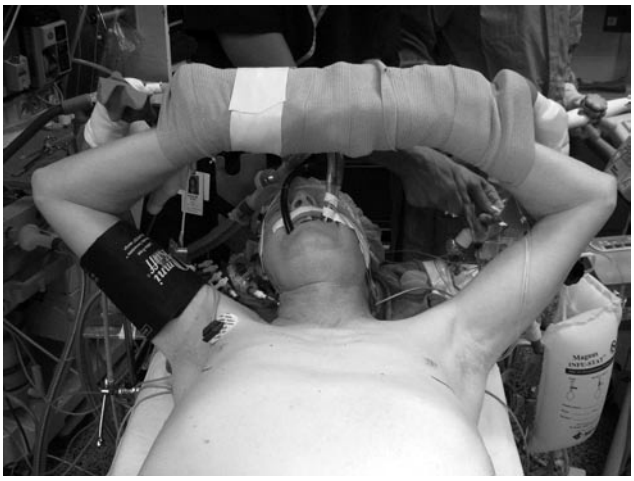

Fig. 1. Position for the antero-axillary approach

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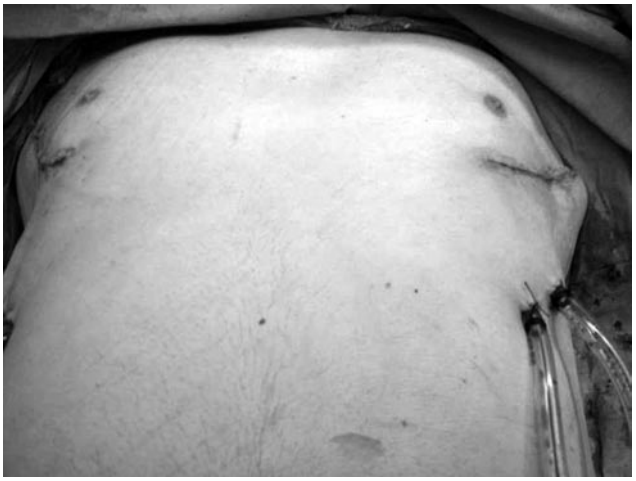

Fig. 2. Bilateral antero-axillary incisions

Usually the fifth intercostal space is good for emphysema patients who have a large chest cavity and the fourth is good for pulmonary fibrosis patients who have a small chest cavity. Intercostal muscles are divided from 1 cm lateral to the internal mammary artery and vein to 2 cm lateral to the sympathetic trunk to facilitate spreading of the ribs. The standard medium Finichetto spreader is placed in the middle of the dissected part of the ribs, providing adequate rib distraction without damaging or dividing the ribs. After the dissection of the adhesions between the lung and the parietal pleura, the hilum of the lung is dissected and the pulmonary artery and the superior and inferior pulmonary veins are isolated and taped bilaterally.

Standard pneumonectomies are performed in the usual fashion utilizing endo-GIA staplers for pulmonary arteries and veins once the donor procurement team comes back safely. After the donor lung is prepared at the back table, it is placed in the recipient chest cavity through the small opening of the thoracotomy. The opening provided by the 8 cm skin incision is perhaps at least required for explanting a native lung and inserting the donor lung through without injuries, indicating that 8 cm is the shortest skin incision possible for lung transplantation. The bronchial, pulmonary arterial and left atrial anastomoses are performed in the usual fashion. Of note, this antero-axillary approach provides better exposure of the hilum for the anastomoses compared to the posterolateral approach for a single lung transplantation (Fig. 3). Routine closure of the ribs with two absorbable stitches is accomplished. This approach is particularly beneficial for female patients who are interested in cosmetic appearance after surgery. The incision cannot be seen from the front or the back unless the patients lift their arms.

In case cardiopulmonary bypass needs to be started emergently, the incision is extended anteriorly along the divided intercostal space. If a right thoracotomy is performed, cannulation of the ascending aorta for arterial return, and the right atrium for venous drainage is easily accomplished (Fig. 4). If only left thoracotomy is performed, cannulation of the descending aorta and the main pulmonary artery is established for emergency cardiopulmonary bypass without difficulties.

Case

The patient was a 56-year-old man with end-stage emphysema. Bilateral antero-axillary incisions via the fifth intercostal space were carried out (Fig. 2). The adhesions due to prior pneumothorax, chest tubes and possible pleurodesis were quite dense bilaterally and were dissected out entirely through these short incisions. Sequential bilateral lung transplantation was performed without using cardiopulmonary bypass in the usual fashion. The ischemic time of the left lung was 303 minutes and the right 453 minutes. He left the operating room with oxygen saturation of 97%, FiO_2 of 25% and PEEP of 10 cmH_2O. Postoperatively, he was extubated on postoperative day #1, transferred to the floor on POD# 3, and discharged home on POD#11 on room air with clear lungs on a chest X-ray. His biopsy showed no acute cellular rejection on POD#14.

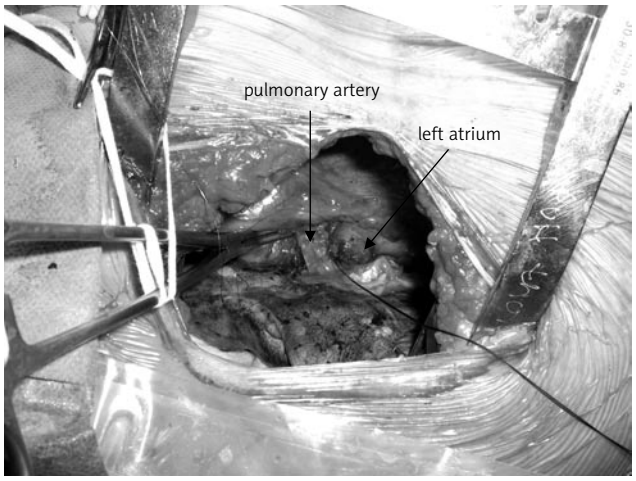

Fig. 3. Exposure of the hilum via the antero-axillary approach

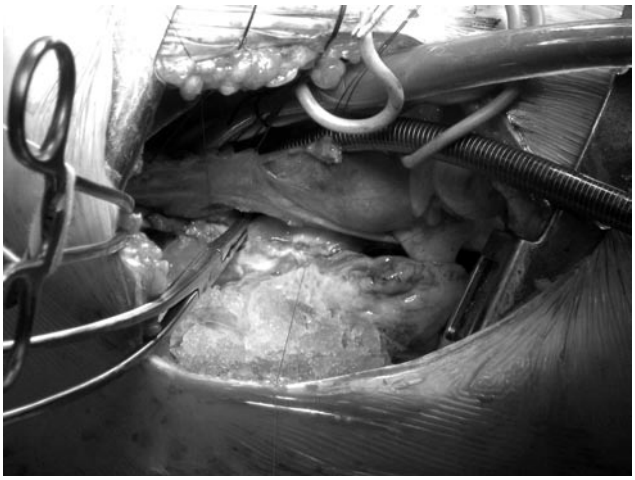

Fig. 4. Cannulation for cardiopulmonary bypass through the antero-axillary approach

Comment

I have started to use an anterior approach rather than a posterior approach for a single lung transplantation because the lumens of the recipient and donor bronchus, pulmonary artery and vein are visualized better for the anastomosis via the anterior thoracotomy than the posterior thoracotomy. I have also started to use the axillary extension rather than the lateral extension because the axillary extension is right above the intercostal space and therefore the skin, subcutaneous tissue and muscles obstruct the exposure less than the lateral extension, especially for obese patients. Then, I gradually shorten the incision, until I have reached a reasonable balance between incision size and exposure. I feel that an 8cm incision is the shortest possible incision to put donor lungs through without causing any injuries. Since January of 2007, I have used the described approach on 12 single lung transplants and 7 double lung transplants. There have been no intraoperative complications attributable to the incisional approach, no re-exploration for bleeding, and no wound complications. In patients with severe adhesions and patients who require immediate institution of cardiopulmonary bypass, enlargement of the skin incision is easily and quickly carried out. Theoretically patients should complain of less pain because of preservation of the sternum and the ribs, and subjectively patients do complain of less incisional pain and recover quicker. At follow-up this incision is especially satisfying to some patients because the incision can hardly be seen from the front or the back.

The primary goal of every surgeon is to do the right operation well. The standard clamshell incision has become the favored incision of lung transplant surgeons for several very good reasons: exposure to all contents of the entire anterior mediastinum and the bilateral chest cavity is possible so that the cardiopulmonary bypass is easily utilized through the ascending aorta and the right atrium, and the incision heals well in virtually all cases. Thus techniques that can preserve the benefits of this approach, such as the one described here, have some advantages. Some of the potential advantages of limited incisions are also met by this approach. The smaller skin incision does not allow excessive spreading of the ribs, thus avoiding potential disruption of the ribs or stretch injury to the internal mammary artery that can at times accompany too aggressive rib spreading. The patient is pleased to see only an 8- to 12-cm incision, which will actually shorten with healing. This approach avoids some of the problems associated with other minimal access approaches, namely costal cartilage damage or removal, internal mammary artery damage or ligation, and transverse sternotomy that can potentially cause healing problems especially in cachectic patients with severe osteoporosis on high dose of steroids. Compared to the vertical axillary approach in the 60-degree lateral position for single lung transplantation described by Pochettino and Bavaria, the safety of this approach is obvious – should something untoward occur during the operation, the surgeon need only extend the skin incision anteriorly to have better exposure to the heart, and if necessary, a standard sternotomy can be performed since the patient is in the supine position. In addition, this approach is applied not only for single lung transplantation but also for double lung transplantation without changing the position. Cardiopulmonary bypass can be utilized with normal cannulas and instruments (Fig. 4). Additionally, the technique is easy for every surgeon to learn. Initial use of this approach can begin with progressive shortening of the antero-lateral incisions, such as starting near the sternal-costal junction and ending at the axillary area, until the surgeon becomes comfortable making the incisions as short as described. At the same time, standard operative techniques are maintained.

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