CARDIOTHORACIC TRANSPLANTATION

BILATERAL SEQUENTIAL LUNG TRANSPLANTATION WITHOUT STERNAL DIVISION ELIMINATES POSTTRANSPLANTATION STERNAL COMPLICATIONS

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Objective: The objective of this study was to assess the efficacy and safety of an alternative surgical incision for bilateral sequential lung transplantation. The vast majority of these operations worldwide have been performed through an anterolateral thoracosternotomy known as the “clamshell” incision. Recently, we have undertaken most of these operations through bilateral anterolateral thoracotomies without sternal division. **Methods:** Our medical center performed 262 bilateral sequential single lung transplantations from 1989 to April 1998. Between July 1996 and April 1998 we performed 69 bilateral sequential single lung transplantations on 68 recipients with 52 transplantations being conducted without initial sternal division. We retrospectively reviewed the results of these operations to assess the safety of the altered exposure and the efficacy in avoiding sternal wound complications such as malunion, dehiscence, osteomyelitis, and migrating hardware. Comparison was made to a historical control group composed of the last 50 patients in whom the full clamshell incision was used. **Results:** Of the 68 patients who underwent transplantations, 52 patients underwent the initial exploratory procedure without sternal division. Two patients required emergency sternal division for institution of cardiopulmonary bypass to control life-threatening bleeding. Eleven of 68 patients were placed on bypass electively to permit transplantation, and the lack of a sternotomy in 8 patients did not present an obstacle to ascending aortic and right atrial cannulation. There were no wound healing complications in the 50 patients for whom the sternum was left intact. In a historical control group of 50 patients who underwent transplantation with sternal division, 34% experienced morbidity or mild disability as a direct result of poor sternal healing. **Conclusions:** We conclude that bilateral anterolateral thoracotomy without sternal division is a safe approach that allows adequate exposure without the risk of commonly observed problems with sternal healing. (J Thorac Cardiovasc Surg 1999;117:358-64)

Since bilateral isolated lung transplantation was introduced, the ideal operative approach has evolved continuously.^{1,2} Initially, en bloc double lung replacement required a median sternotomy, a tracheal

anastomosis, and full cardiopulmonary bypass (CPB).³ Tracheal anastomotic complications were commonly observed and often fatal. This poor tracheal healing led to the gradual transformation of the operation to

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Fig 1. The skin incision runs along the inframammary crease and crosses the sternum at the level of the fourth intercostal space. The intercostal incision is made along the upper surface of the fifth rib. The costal cartilage of the fourth rib (shaded area) is resected to allow upward mobility of the fourth rib with retraction. (From Meyers BF, Patterson GA. Technical aspects of adult lung transplantation. *Semin Thorac Cardiovasc Surg* 1998;10:1-9. Published with permission of W.B. Saunders Company.)

include bilateral bronchial anastomoses, performed through a median sternotomy with the anastomoses accomplished in the “interaorticocaval space.”⁴ The shift of the airway anastomosis from the trachea to the main stem bronchi improved anastomotic healing, but the anterior midline approach hampered access to the posterior mediastinum and made CPB necessary for the atrial anastomosis. In 1990, we reported our initial experience with bilateral sequential lung transplantation through bilateral anterior thoracotomies with a joining transverse sternotomy, then referred to as a “cross-bow approach.”⁵ This approach allowed superior exposure of the pleural space and posterior mediastinum. It also gave suitable anterolateral exposure for performance of the left atrial anastomosis on both sides. From the start of bilateral sequential lung transplantation at our institution in October 1989 through July 1996, we performed 193 bilateral lung transplantations. Most of these procedures were performed as

Fig 2. The surgeon's view shows a Finochietto chest retractor used to spread the ribs vertically, with a Balfour retractor in place, with one jaw on the sternum and one jaw on the muscle and skin of the lateral chest. The intercostal muscle division is carried far more lateral and posterior than the skin incision to maximize rib spreading. The combined effect of these 2 retractors typically results in excellent exposure without sternal division. (From Meyers BF, Patterson GA. Technical aspects of adult lung transplantation. *Semin Thorac Cardiovasc Surg* 1998;10:1-9. Published with permission of W.B. Saunders Company.)

sequential operations through the so-called “clamshell” or “cross-bow” thoracosternotomy. The high prevalence of sternal wound complications observed in our patients led us to explore an alternative approach that avoids sternal division.

In July 1996 we began to use bilateral anterolateral thoracotomies without sternal division in selected patients. As our comfort with this exposure increased, we applied this sternum-sparing approach to an increasing number of patients and now use this approach routinely. This report documents our experience during this period of development.

Methods

In July 1996, we began to omit the transverse sternotomy from the clamshell incision used for bilateral lung transplantation. The alteration from our previous standard surgical approach was performed on a case-by-case basis and was not part of an a priori plan to randomize patients to 1 of 2 treatment groups. If a patient's anatomy was judged inappropriate for a sternum-sparing clamshell incision, a standard incision was performed or an alternative incision was selected that addressed the unique needs of the individual patient. After a

Table I. Morbidity and mortality rates of bilateral lung transplantation, comparing sternum-sparing clamshell incision with full clamshell incision

Complication	Sternum-sparing clamshell (n = 52)			Full clamshell (n = 50)			P value*
	No.	%	CL	No.	%	CL	
60-Day deaths (%)	2	4	1.3-9	3	6	3-12	.5
CPB	8	15	10-22	15	30	23-38	.06
Stroke	2	4	1.3-9	3	6	3-12	.5
Major sternal complications†	0	0	0-4	4	8	4-14	.05
Any sternal healing problem‡	0	0	0-4	17	34	27-42	< .0001

CL, 70% confidence limits.

*By Fisher's exact test.

†Sternal dehiscence or deep sternal wound infection requiring operative debridement and sternal rewiring.

‡Includes, in addition to major complications, operative removal of migrating hardware, with the patient receiving general or local anesthetic; persistent complaints of sternal pain with motion, deformity, or erythema; or sternal wound infection requiring antibiotic therapy but not surgical debridement.

gradual transition period, it became evident that most patients could be treated safely and effectively without sternal division. We retrospectively reviewed the results of our last 69 consecutive bilateral lung transplantations performed between July 1996 and April 1998. These operations included 52 cases in which the sternum was not initially divided. The results are reported, and the technical details regarding sternum-sparing clamshell incision are described.

To provide a basis for comparison, we studied the outcome of the last 50 patients for whom we used a full clamshell incision with transverse sternal division. These 50 patients underwent 51 bilateral transplantations over the time period ranging from April 1995 to December 1997. Outpatient charts, inpatient records, office notes, and serial chest radiographs were studied with specific attention to operative complications and postoperative wound problems. We contacted patients by telephone to learn whether any unrecorded interventions had occurred as a result of the sternal closure. Patients were also asked about symptoms referable to sternal override or nonunion. This historical control group gives a rough estimate of the frequency and severity of sternal wound healing complications in our patient population.

Operative technique. Our current operative techniques have been recently described elsewhere in detail.⁶ In brief, the patient is positioned supine with all extremities padded and the arms tucked in at the patient's side. In our initial experience, the skin incision for this modified incision was identical to that performed for the full clamshell. Recently, however, we have refrained from dividing the skin over the sternum as our comfort with this exposure has increased. Typically, the fourth intercostal space is entered, and the internal thoracic artery is ligated and divided bilaterally. The fourth rib is shingled anteriorly by resecting 1 cm of the costal cartilage at the sternal border (Fig 1). More mobility is obtained by dividing intercostal muscle from within the pleural space to the paraspinal muscles. Two mechanical retractors are placed in this thoracotomy, one at a 90-degree angle from the other one to provide optimal exposure (Fig 2). Should additional access to the thorax become necessary during the conduct of the operation, the sternum is easily divided transversely at the fourth intercostal space, and the entire

chest opened via a clamshell incision. With the exception of the small modification of the access incision, the operation is substantially the same as that previously reported.⁵ When the clamshell or the sternum-sparing clamshell incision has been used, the patient remains in the supine position throughout both transplantations, and the operating table is tilted right and left to maximize exposure. On occasion, because of unique circumstances in an individual patient, we have performed bilateral posterolateral thoracotomies or combinations of posterolateral and anterolateral thoracotomies. This has been specifically necessary when the heart is shifted to the left or when the left pleural space is reduced in size, thereby limiting access to the left hilum from an anterior incision.

Results

Bilateral sequential lung transplantation was performed 69 times in 68 patients during the period of observation. The diagnoses of the recipients of these bilateral sequential single lung transplantations include the following: chronic obstructive pulmonary disease, 27 recipients; α -1 antitrypsin deficiency, 12 recipients; cystic fibrosis, 15 recipients; bronchiectasis, 7 recipients; idiopathic pulmonary fibrosis, 3 recipients; primary pulmonary hypertension, 2 recipients; obliterative bronchiolitis (retransplantation), 1 recipient; silicosis, 1 recipient; and acute graft failure (retransplantation), 1 recipient. The retransplantation operations included one late retransplantation in a patient who had undergone transplantation 5 years earlier, and one acute retransplantation in the only patient who underwent operation twice during the course of this study. Fourteen of these operations were performed through a standard clamshell incision because of anticipated difficult dissection, the expectation that CPB would be required, or the need to perform a concomitant repair of a cardiac defect. Three operations were performed through completely separate thoracotomies; sequential bilateral posterolateral thoracotomies were

used in the patient requiring late retransplantation; and the combination of left posterolateral thoracotomy with right anterolateral thoracotomy was used in 2 patients with pronounced leftward mediastinal shift. Two patients were initially approached through a sternum-sparing clamshell incision that was converted on an emergency basis to a full clamshell incision for improved exposure in response to an operative mishap. The remaining 50 patients underwent transplantation through the sternum-sparing clamshell incision. The 52 cases in which the sternum-sparing approach was initially attempted are compared with our historical control group, consisting of the last 50 patients receiving full clamshell exposure for bilateral transplantation (Table I).

There were no intraoperative deaths in either group. The 60-day mortality rate for the sternum-sparing group was 2 of 52 patients (4%) as compared with 3 of 50 patients (6%) for the historical controls. Eight of the 52 patients (15%) who underwent the sternum-sparing procedure required the support of CPB, and 15 of the patients (30%) in the clamshell control group required CPB. Two patients (4%) in the sternum-sparing group required emergency conversion to a full clamshell incision during the conduct of the operation. These two patients were eventually noted to have experienced perioperative strokes and are discussed in detail later. Three patients (6%) in the historical control group were noted to have had strokes, but all 3 patients were successfully discharged from the hospital without major disability.

No patients in the sternum-sparing group experienced complications related to the closure or healing of the sternum. Four of the historical patients (8%) required major sternal intervention consisting of sternal debridement and rewiring, while receiving general anesthetic, for major sternal dehiscence or deep sternal wound infection. Six additional patients (12%) underwent a total of 7 minor procedures, some under general anesthesia, to extract migrating Kirschner wires or pins. Seven patients (14%) were evaluated and treated nonoperatively for problems specifically related to the sternal closure such as prolonged sternal pain necessitating medication, sternal wound infection necessitating antibiotics but not debridement, or sternal override producing motion and discomfort. There was no evidence of sternum-related problems in 33 of 50 patients (66%) in the historical control group.

Thirty-one patients in the historical control group, with a mean and median follow-up of 2.5 years, were interviewed by telephone. The reasons for inability to participate in the interview included death (13 patients), return to a foreign country (3 patients), or current hospitaliza-

tion (3 patients). Four of the 31 patients interviewed (13%) reported late instability at the sternal closure, and 5 of 31 patients (16%) had deformity at the sternum.

In the patients initially undergoing exploration through a sternum-sparing approach, 2 patients required emergency sternal division for control of hemorrhage and institution of CPB. One such patient requiring emergency bypass was a 59-year-old man with bronchiectasis. The first pneumonectomy and graft implantation on the right side was accomplished through a sternum-sparing anterior thoracotomy without incident despite dense pleural adhesions. The left lung was extracted, and the graft was implanted, but bleeding at the atrial suture line required additional repair sutures. Despite these efforts, bleeding at this site worsened to the degree that the hilar vascular clamps were reapplied. The bleeding recurred after additional sutures and unclamping. The sternum was transected, and the patient was placed on CPB. The patient eventually required a 29-minute period of fibrillatory arrest on full bypass to secure hemostasis at the anastomosis. The rest of the operation was notable for a severe coagulopathy. Six hours later the patient underwent a reexploratory procedure for bleeding. Subsequently the patient was noted to have a severe neurologic deficit and died of sepsis on postoperative day 17.

Another patient who underwent the sternum-sparing clamshell procedure and who required emergency sternal division and CPB was a 51-year-old man with α -1 antitrypsin deficiency emphysema. During implantation of the first lung on the left side through a sternum-sparing anterior thoracotomy, difficult exposure was encountered during the performance of the left atrial anastomosis. During retraction of the heart with a metal retractor, the recipient left atrial cuff was lacerated medial to the left atrial clamp, and the patient bled profusely. Manual compression slowed the bleeding while the sternum was divided transversely, and the patient was placed on bypass. Despite expeditious cannulation and massive transfusion, the patient had a sustained period of hypotension and bradycardia. The left atrial anastomosis, repair of the atrial tear, and right lung transplantation were completed while the patient was on bypass. After the operation, the patient was found to have had a severe neurologic injury and died on postoperative day 17 after a cardiac arrest during a physical therapy session.

Discussion

The clamshell incision has existed for several decades under various names. Kortz⁷ described it in detail in 1958, stating that "a bilateral transsternal thoracotomy affords optimal access to the heart and great

vessels, and is of particular value in experimental surgery because it simulates the technical exposure employed in human patients during most intracardiac and pericardiac operations." The authors' use of the clamshell incision for bilateral lung transplantation began in the late 1980s on the advice of Hermes Grillo,⁸ who occasionally used bilateral anterior thoracotomies with transverse sternal division for resection and reconstruction of the distal trachea and bilateral main stem bronchi. The superiority of this approach over median sternotomy for lung transplantation was clear, particularly in the improved access that it allowed to the posterior mediastinum. The clamshell incision was quickly adopted for bilateral lung replacement, and the specific technique was popularized by the Washington University group.⁵ Other applications for this wide exposure have emerged, such as the work described by Bains and colleagues⁹ at Memorial Sloan-Kettering Cancer Center. They described their use of the full clamshell incision in 71 patients and a hemi-clamshell incision in 19 patients. The operations were performed for bilateral pulmonary metastases, primary mediastinal tumors, and lung tumors with mediastinal extension. The Memorial Sloan-Kettering group reported a single wound infection and no cases of sternal override, postoperative ventilatory support, or perioperative death. They maintain that the full clamshell incision offers excellent exposure with minimal morbidity and that the hypothetical concern of sternal override is eliminated by the use of heavy-gauge Kirschner wires or Steinmann pins in the sternal closure. No mention is made in their report about the length of time the patients were followed up after the operation.

In many instances, the sternum has been closed only with 2 or 3 loops of stainless steel sternal wire. Although that is generally satisfactory to prevent distraction of the ends, there is a tendency toward angulation and anterior displacement of the distal sternum; a translational movement that is not prevented by the sternal wires. This has resulted in a problem referred to as "sternal override," which has been encountered in many of our early patients and has been described by others in the literature.¹⁰ Although the Memorial Sloan-Kettering group did not encounter this complication, it is possible that the debilitated state of the lung transplant recipients and the routine use of postoperative corticosteroids have contributed to poor sternal healing in this specific population of patients. Brown and associates¹¹ report a prevalence of 36% for sternal disruption in transverse bilateral thoracosternotomy for lung transplantation in their institution, and they cite disruption rates of 20% to 60% at institutions worldwide.

The solution to sternal override has been the addition of coaxial stabilization: either long, thin Kirschner wires or short, stout Steinmann pins, placed within the cancellous bone of the sternum to eliminate sternal override and translational movement at the bony closure. The problem we have seen with such wires is their tendency to migrate. We have removed numerous wires from many patients after the discovery of their migration from the sternum to various locations in the body. Such retrievals have required interventions ranging from a local anesthetic to liberate a wire eroding through the anterior chest wall to a general anesthetic and a laparoscopic procedure to remove a Kirschner wire from the pouch of Douglas. An additional serious problem is that of deep sternal wound infection in the patient after transverse sternotomy. We have encountered this problem in several patients, and it has required operative and bedside wound debridement with additional antibiotics and a prolonged hospital stay. The estimated prevalence for all sternal closure complications in our historical control group is 34%, a figure that is certainly an underestimate. Lung transplant recipients in our program spend a short period of observation in the local area before returning to their geographic home. Once the recipients have left our area, it is quite probable that late complications, especially minor ones, are taken care of locally and never reported to us. It is our contention that all such complications can be avoided by avoiding sternal division.

If the point of abandoning an accepted operative practice is to decrease the risk of morbidity and decrease the length of the operation and the anesthetic, one must consider what additional new risks are introduced by the proposed changes. Has the safety of the operation been compromised in an effort to make the incision smaller or less "invasive?" With regard to our patients, we experienced 2 episodes of life-threatening bleeding in patients in whom the initial exploratory procedure was through the sternum-sparing incision. In these 2 cases, one could postulate that the slightly poorer exposure of the left atrial anastomosis contributed directly or indirectly to each patient's complicated postoperative course and eventual death. It is impossible to know whether the outcome of these patients would have been different had the exploratory procedure been conducted through a standard clamshell incision. It is worth noting that the left hilar dissection in general, and the left atrial anastomosis in specific, is the "Achilles heel" of any anterior exposure, including the full clamshell incision. It is precisely for that reason, and because of the experience gained in the 2 patients with complications, that a different approach

was taken for the patients judged to be at higher risk for difficulty at the left hilum.

We therefore conclude that sternal division is not routinely necessary for bilateral sequential lung transplantation and that the sternum-sparing clamshell approach provides safe exposure of both pulmonary hila and the pleural spaces without the additional risks of morbidity incurred with sternal division. When sternal division is required in selected cases, we advocate heavy-gauge Steinmann pins over Kirschner wires given the increased propensity of the latter to migrate. In rare selected cases, we also advocate modified approaches such as a combined left posterolateral and right anterior thoracotomy to optimize the left hilar exposure without the need for either sternal division or for a separate positioning, preparing, and draping.

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Discussion

Dr Douglas J. Mathisen (*Boston, Mass*). The most remarkable thing about this paper is the example it sets. This is especially important for the young surgeons in the audience. We are all aware of the numerous contributions that the

authors have made in the field of lung transplantation. It is often the case that people who do a procedure and who have made numerous contributions to the field become complacent, develop tunnel vision to what they are doing, and do not reanalyze and critically evaluate their procedures and treatments. This has never been the case with these surgeons. Even something as routine as the surgical incision has been evaluated, and they have tried to find a better way to do this. I think it is an example of something we should all strive to do in our own work.

I do have a couple of questions. What was the actual incidence of complications with the transsternal approach? Are there any lessons that you have learned about transecting the sternum that might avoid some of these problems? Please restate the contraindications to this bilateral approach that you have suggested without transecting the sternum. Do you have any thoughts about the impact on respiratory mechanics of this incision? Does preservation of the sternum preserve respiratory mechanics, making patients easier to wean?

Finally, do you have a subjective sense of the differences in pain experienced by the patients. Oftentimes that is a difficult factor to analyze, but I wondered if you had any sense about that?

Dr Meyers. We do not have an ability to quantitate the actual incidence of these complications. It is in the memory of the senior surgeons on the paper that migration of the sternal wires was quite frequent and sternal override was also frequent. The deep sternal wound infection was a rare complication, probably limited to just 2 or 3 patients in the last few years. Because this was a retrospective study and because most of the treatment was either observation in the case of sternal override or a bedside procedure or a clinic-based procedure that did not generate an operative note, I do not have an actual number for you on frequency of hardware migration.

As far as lessons learned and contraindications, I do know that in looking back to the patients in whom we resorted to a full clamshell incision during this period of observation, certain trends emerge.

First of all, when there is a concomitant heart operation to be done in a patient with a known atrial septal defect or a patent foramen ovale, we have gone with the full clamshell incision. There were patients who had had multiple lung biopsies and a patient with pulmonary fibrosis and particularly dense adhesions in whom exploration was initially done through a clamshell incision. We had 1 patient in whom a bilateral lung volume reduction operation had been done a few years before, and the exploratory procedure used for that patient was the full clamshell incision.

The other subgroups that are worth special handling are patients in whom the heart is nearly completely in the left hemithorax, making an anterior approach at the left atrial anastomosis quite hazardous. As I mentioned, we have encountered that twice in recent experience, and to avoid the negative consequences of implanting the second lung with the recipient in the decubitus position with the newly implanted lung on the lower side, we have taken to doing the

left side first with a posterolateral incision and the right side in an anterior approach.

As far as the impact on pain and respiratory mechanics, I do not believe there will be any. The skin incision is just as large, and the only difference in the actual division of tissue is just that couple of centimeters of sternal bone. I do not think that would make any difference on their pain or respiratory mechanics.

Dr Clifford W. Barlow (*Stanford, Calif*). We have had to remove sternal wires for minor discomfort following the clamshell incision, but we have never had major problems. Do you have more specific information on the "major" complications your patients experienced? It seems unfortunate that the two patients who bled both subsequently died. How much time do you think you wasted with poor exposure, while deciding whether to undertake sternal division?

Dr Meyers. The answer lies somewhere in how much time we used in deciding to divide the sternum, because the actual division of the sternum took very little time once the decision was made to do so. But I would just mention that both of those 2 complications occurred in the very early portion of our experience, the eighth and the sixteenth patients of the 52 patients in whom that approach was attempted. Since then, 11 months and 40 operations have passed without any repeat of a serious operative complication with this approach.

Dr Thomas M. Egan (*Chapel Hill, NC*). You are substituting division of costal cartilage for division of the sternum, because normally we do not divide costal cartilage or resect costal cartilage to do a clamshell incision. Have you had any problems with costochondritis?

The second point I wanted to make is that we too are getting tired of removing wires, so we have stopped using wires. We put the sternum together now with No. 5 Ethibond suture (Ethicon, Inc, Somerville, NJ), and it eventually will dissolve. I do not think we are going to have problems with wires anymore. I do not know whether we are going to have more problems with nonunion. However, it is not the nonunion that most patients object to, it is the movement of the wire and its irritation of the overlying skin.

Dr Meyers. There were no cases of costochondritis in the period described.

Dr Walter Klepetko (*Vienna, Austria*). After discussions with Dr Patterson, we started prospectively to investigate this approach with 2 anterior thoracotomies in the bilateral lung transplantation setting. We performed 13 procedures in 6 weeks. Four patients had cystic fibrosis with significant adhesions; 9 patients had chronic obstructive pulmonary disease, 4 of whom had a history of earlier lung volume reduction operation.

In general these have been very satisfying procedures. We had no intraoperative complications, 100% 3-month survival, and even the difference in cold ischemic time between the second and the first lung was shorter than in a comparable group of patients operated by a clamshell incision before.

When we compared vital capacity in the early postoperative period with that of the patients who received a clamshell

incision, the patients with the minimal invasive approach had a much better vital capacity than the patients who received clamshell incision.

I did not completely understand why you do a skin incision above the sternum at all. I think you could easily spare the skin there because wound infection could easily occur in those cachectic patients as well.

Second, I am not sure, do you transect the thoracic artery in those patients or do you try to keep that intact, because this is important for healing of that particular region as well?

What is your attitude for patients who have a small volume of the chest, like fibrotic patients? Would you have a similar approach in those patients?

Dr Meyers. I would comment first on the skin incision. We took steps in the beginning to minimize the time to conversion if it were necessary, and therefore we carried out the entire skin incision and divided the thoracic arteries to prepare the sternum for division if it were to become necessary. The 2 incidences in the early portion of our experience that caused us to have to convert quickly reinforced that habit, and it was only recently that I heard from Dr Cooper that he had omitted the skin bridge in a recent patient. The general tendency had been to prepare everything for a full clamshell incision with the exception of the bone division.

The only special circumstances that we took with patients with small chest volumes were, again, in the 2 patients who had small chest volumes and large hearts, mostly on the left side, and we shied away from the minimalist approach in those patients and did a full thoracotomy on the left side.

Dr Klepetko. Do you keep the thoracic artery intact or not?

Dr Meyers. We have been dividing it routinely. Again, I think that is still reinforced by the recent memory of the cases where we had to convert quickly and did not want to waste time finding and dividing the artery.

Dr Ali Rahman (*Manchester, England*). We have been using the clamshell incision quite frequently, and, like Dr Barlow and others, we did not have many in the way of complications that you mentioned. We use Ethibond suture in younger patients and children.

I wonder whether you are trading one complication with another. In other words, for example, was the bleeding from the atria caused by difficulty of access and did you have any bronchial complications or any other complications relating to limited access?

Dr Meyers. I do not believe that we have had any bronchial complications because of limitation of access. With this incision, the ability to expose the bronchus on both sides is essentially identical to that with the full clamshell incision. You may be right in saying that by shifting from one procedure to another, we exchange one set of complications for another, but as we become more comfortable with this incision, our comfort level in the left atrial anastomosis and our ability to distinguish the good candidate from the poorer candidate seems to be improving, given that we have had 40 consecutive operations without any major complication.