LOBECTOMY—VIDEO-ASSISTED THORACIC SURGERY VERSUS MUSCLE-SPARING THORACOTOMY

A randomized trial

Video-assisted thoracic surgery has been adopted by some thoracic surgeons as the preferred approach over thoracotomy for many benign and malignant diseases of the chest. However, little concrete evidence exists to support this technique as the superior approach. This randomized study was carried out to define the advantages of video-assisted lobectomy over muscle-sparing thoracotomy and lobectomy. Sixty-one patients with presumed clinical stage I non-small-cell lung cancer were entered into the study. Each patient was randomized to muscle-sparing thoracotomy and lobectomy or video-assisted lobectomy. Six patients were excluded from the study either because final pathologic results revealed nonmalignant disease (3 patients) or because an attempted video-assisted lobectomy was converted to a thoracotomy. This left 30 patients in the thoracotomy group and 25 patients in the video-assisted group. No significant differences existed between the two groups in operating time, intraoperative blood loss, duration of chest tube drainage, or length of hospital stay. Significantly more postoperative complications occurred in the thoracotomy group ($p < 0.5$), the majority of which were prolonged air leaks. Return to work time was not an issue because the majority of the patients were either retired or not working at the time of the operation. Only three patients had persistent postthoracotomy pain (thoracotomy, $n = 2$; video-assisted lobectomy, $n = 1$). We conclude that video-assisted lobectomy was not associated with a significant decrease in duration of chest tube drainage, length of hospital stay, postthoracotomy pain, or, in this group of patients, a faster recovery time and return to work. Video-assisted lobectomy continues to expose the patient to the risk of a major pulmonary resection being done in an essentially closed chest. These results illustrate the need for critical evaluation of video-assisted thoracic surgery before the procedure is accepted as a superior approach based on presumed and thus far unproved advantages. (J THORAC CARDIOVASC SURG 1995;109:997-1002)

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The recent introduction of video-assisted thoracic surgery (VATS) has allowed many procedures that previously required a thoracotomy to be performed by way of this "minimally invasive approach." Lung biopsy, wedge excision of pulmonary nodules, blebectomy and bullectomy, thymectomy, and resection of mediastinal tumors have now all been successfully and safely accomplished by a VATS approach.[1-7] However, little or no evidence exists that VATS offers these patients significant advantages over more "conventional" and time-proven approaches. Proponents of VATS have assumed that this less-invasive technique represents an improved approach with advantages for both the surgeon and patient. In some instances VATS represents a more- and not a less-invasive and complicated procedure, necessitating single lung ventilation, multiple thoracoports, and complex, expensive, and often inadequate instruments. Also, both the patient and the surgeon are interested in long-term control of disease, particularly malignant disease, and not short-term goals such as pain control and length of hospital stay.[8, 9] Last, because the majority of general thoracic surgical procedures involve ma-

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Table I. *Demography of 61 patients randomized into either MST or VATS lobectomy*

	MST	*VATS*
Patients	31	30
Mean age (yr)	62 ± 12	58 ± 9
Male/female	14:17	12:18

jor resections of either the lung or esophagus, VATS will have to be shown to be advantageous in these areas if it is ever to play more than a minor role in thoracic surgery.

The initial reports of VATS pulmonary lobectomy for malignant disease described the technique and demonstrated that a major pulmonary resection could be safely performed by way of a minimally invasive approach.[10-12] There are many potential advantages of VATS lobectomy over a standard thoracotomy and resection, but these generally assumed advantages have yet to be conclusively demonstrated. Therefore we designed a randomized trial to compare VATS lobectomy with muscle-sparing thoracotomy (MST) and lobectomy in an attempt to define the specific advantages or disadvantages of these two approaches.

Patients and methods

Between October 1991 and December 1993, 61 patients with confirmed or what preoperatively was thought to be stage I (T1 N0, T2 N0) non-small-cell lung carcinoma were randomized into either MST lobectomy or VATS lobectomy (Table I). Preoperative studies included hemogram, SMA-16, electrocardiogram, computed tomographic scan of the chest, arterial blood gases, and pulmonary function testing. In most instances patients also underwent investigation to rule out extrathoracic spread of disease including a bone scan and computed tomographic scan of the head and abdomen. Each patient was believed to be a good operative risk for a pulmonary lobectomy.

At the time of the operation, the patients were randomized to undergo either of two procedures: lobectomy through an MST (31 patients) or lobectomy by means of VATS (30 patients). Because of the known inaccuracy of computed tomographic scan in staging mediastinal lymph nodes, 52 patients (Table II) also had a staging mediastinoscopy and, where indicated, anterior mediastinotomy in an attempt to ensure uniform pathologic staging of the two groups.[13-16] None of these 52 patients had N2 disease.

Patients randomized to the MST group had a posterolateral thoracotomy performed through the fourth or fifth intercostal space, preserving both the serratus anterior and latissimus dorsi muscles. The mediastinum was then carefully reevaluated and restaged by biopsy of additional mediastinal lymph nodes and frozen section analysis. The average total number of lymph nodes sampled in each group is shown in Table II. A complete and potentially curative lobectomy was then performed by standard thoracic surgical techniques. Complete mediastinal lymph node dissection was not performed in either of the two groups.

Table II. *Number of mediastinoscopies performed in each group and average total number of lymph nodes from which biopsies were taken at mediastinoscopy and thoracotomy*

	MST	*VATS*
Mediastinoscopy	28/30	24/25
Total number of nodes sampled for biopsy	9.3 ± 4.3	9.5 ± 3.6

Patients randomized to the VATS group had a lobectomy performed by means of techniques previously described, which included a 6 to 8 cm "access" thoracotomy through which standard thoracic instruments were introduced without rib spreading.[10-12] Hilar dissection was performed in a manner similar to that used in the MST group with individual transection of the bronchovascular components. Mass stapling of the lobar hilum, the so-called *SIS lobectomy,*[17] was not performed. In each case the mediastinum was restaged thoracoscopically so that lobectomy represented a complete and potentially curative resection.

Results

One patient in the MST group and two patients in the VATS group proved to have nonmalignant disease at the time of the operation and were therefore excluded from the study (Fig. 1). Three additional patients in the VATS group required conversion to MST because of difficulty in safely dissecting either the interlobar pulmonary artery or incomplete fissures and were therefore not included in the final analysis. This left a total of 30 patients in the MST group and 25 patients in the VATS group for comparison. Anatomic distribution of the primary cancers and pathologic cell type are shown in Tables III and IV.

No significant differences ($p > 0.05$) were detected between the MST and VATS groups in operative time (175 ± 93 minutes versus 161 ± 61 minutes), intraoperative complications, or blood loss (Table V). In the MST group a bronchial tear occurred in one patient during dissection but was repaired without sequelae. Postoperatively there were again no significant differences ($p > 0.05$) between the two groups in duration of chest tube drainage or length of hospital stay (Table VI). The average duration of chest tube drainage was 6.5 ± 4.8 days for the MST group compared with 4.6 ± 3.3 days for the VATS group. Average duration of

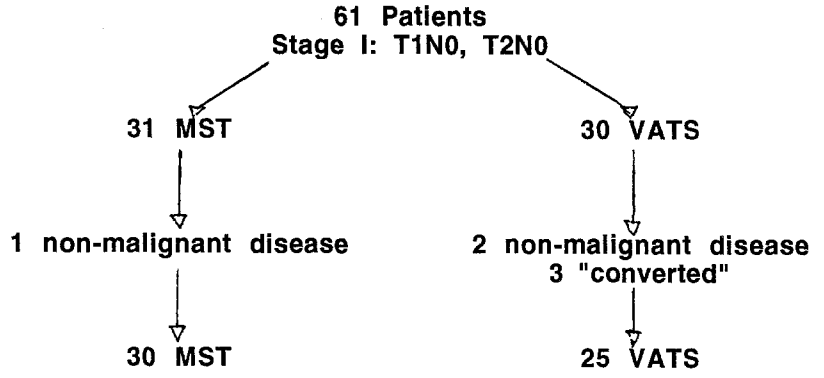

Fig. 1. Of 61 patients randomized, 6 were excluded from the study for the reasons shown, leaving 30 patients in the MST group and 25 in the VATS group.

Table III. *Anatomic distribution of the primary cancers and lobectomies performed*

	MST	*VATS*
Right upper lobe	7	6
Right lower lobe	11	3
Right middle lobe	1	5
Left upper lobe	6	6
Left lower lobe	5	5

Table IV. *Pathologic cell type in the two groups of patients*

	MST	*VATS*
Squamous cell	11	9
Adenocarcinoma	13	13
Large cell	5	3
Carcinoid	1	0

Table V. *Comparison of operating room time, intraoperative complications and blood loss, costs, and the number of patients in the VATS lobectomy group who required MST*

	MST	*VATS*
Operating room time (min)	175 ± 93	161 ± 61
Converted to MST	—	3
Intraoperative complications	1	0
Blood loss		
<250 ml	25	21
250-500 ml	2	4
>500 ml	3	0

Table VI. *Comparison of the two groups in terms of length of chest tube drainage, length of hospital stay, and incidence of postthoracotomy pain*

	MST	*VATS*
Chest tube drainage (days)	6.5 ± 4.8	4.6 ± 3.3
Length of hospital stay (days)	8.3 ± 5.7	7.1 ± 5.5
Postthoracotomy pain	2	1

hospital stay was 8.3 ± 5.7 days for the MST group compared with 7.1 ± 5.5 days for the VATS group.

Significantly more postoperative complications occurred in the MST group than in the VATS group: sixteen versus six ($p < 0.05$). Prolonged air leak was defined as lasting longer than 7 days; it occurred in eight patients in the MST group and lasted an average of 10.8 ± 3.2 days. Three patients in the VATS group had prolonged air leaks that lasted an average of 9.6 ± 1.1 days (no significant difference). The other complications were a pulmonary embolism in a patient treated by VATS and *Clostridium difficile* colitis in a patient treated by MST.

The clinical and pathologic stages of the two groups were compared. The stage of disease was reassessed as stage II (8 patients) or stage IIIA (3 patients) in 11 of the 30 patients in the MST group. In 5 of the 25 (20%) patients in the VATS group the disease was restaged as either stage II (4 patients) or stage IIIA (1 patient).

The average length of follow-up was 13 months with three patients dying: one at 6 months of a ruptured abdominal aortic aneurysm, one at 10 months of cancer of the gallbladder, and one at 15 months of metastatic lung cancer. The remaining patients remain alive and well without evidence of recurrent disease.

The overall incidence of disabling postthoracotomy pain was again not significantly different between the two groups (MST, $n = 2$; VATS, $n = 1$). The return to work time was not an accurate differ-

entiating factor between the two groups because the majority of patients were either not working or retired at the time of the operation.

Discussion

VATS represents an appealing new option for the management of many diseases that previously required a thoracotomy. Advantages of VATS such as decreased pain, shortened hospital stay, and a faster return to work are often presumed but, in most instances, await confirmation by clinical trials directly comparing VATS to conventional techniques. Even if such studies demonstrate that VATS does indeed have initial short-term advantages, thoracic surgeons are still, in most instances, concerned with long-term control of the underlying disease and in particular with the local control and cure of cancer. Clearly there is a need to precisely define both the early advantages of VATS and its long-term equivalency to presently accepted thoracic procedures and survival figures.

The effectiveness of thoracoscopy as a diagnostic tool in pleural and mediastinal diseases has been amply described.[18-20] VATS need not replace simple optical thoracoscopy in the diagnosis and management of many benign and malignant diseases involving the pleura, mediastinum, or chest wall. In contrast to VATS, optical thoracoscopy is less invasive, necessitating one skin incision, and can often be performed with local anesthesia. Single lung ventilation is usually not required, and, in an era of cost containment, the fewer elaborate instruments makes it a more economical procedure.

Because of the associated 10% false negative rate associated with mediastinoscopy in detecting the presence of N2 disease that is subsequently discovered at thoracotomy, consideration has been given to replacing mediastinoscopy with VATS as a staging procedure for bronchogenic carcinoma. Surgeons have argued that VATS will allow biopsy specimens to be obtained from areas that are inaccessible to the mediastinoscope. Mediastinoscopy is a proved, safe, and reasonably accurate method for staging bronchogenic carcinoma. Data have not yet been presented comparing the sensitivity and overall accuracy of VATS to mediastinoscopy. VATS represents a more invasive, complicated, and costly procedure than cervical mediastinoscopy, which is expeditiously performed through one incision without the need for single lung ventilation. To fully stage a patient's mediastinum by means of VATS requires multiple skin incisions, single lung ventilation, and a great deal more time and costly instrumentation. That VATS may be a more sensitive and accurate staging procedure than mediastinoscopy remains to be demonstrated.

Most thoracotomies are performed for malignant disease. In this study and in others, VATS lobectomy has been shown to be a safe and technically feasible operation in the setting of early stage I and II non-small-cell lung cancer. We have been unable to demonstrate significant short-term advantages of VATS in terms of length of stay, return to work, or significantly decreased postoperative pain as compared with MST. Certainly the management of hemorrhage during any major pulmonary resection remains of concern, especially when the procedure is done in an essentially closed chest. Last, insufficient time has elapsed to report on the 5-year survival of patients after VATS lobectomy, the ultimate criterion in the management of lung cancer.

This study is illustrative of the many controversies surrounding VATS procedures in general. The potential short-term advantages of any VATS procedure should not be accepted as fact without further evidence. Mass stapling of the lobar bronchovascular pedicle does not allow for the node dissection routinely performed during anatomic lobectomy and may adversely influence long-term survival. In the final analysis, potential short-term benefit or the surgeon's ability to perform a VATS procedure is of little value to the patients if the goal of long-term cure is compromised.

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Discussion

Dr. Joseph LoCicero III *(Boston, Mass.).* Dr. Kirby, thank you for updating the information you presented a year ago. Now you have a randomized series presenting some very detailed information.

I would like to ask you specifically about your randomization of patients. There are three centers involved in this randomized study and you have 55 patients. These are three very busy centers, and less than 60 patients in this report were actually randomized. These are fairly highly selected. Maybe you could give us more information about your selection criteria.

Second, three patients in the VATS group were converted to MST. I assume these patients were randomized before they arrived in the operating room, or at the time of operation, to one procedure or the other. Would it have made a difference had you randomized the patients after confirmation of your ability to perform a VATS procedure?

Next, did your patients know what procedure was going to be used before they were anesthetized?

Dr. Kirby. Our selection criteria were strict, limiting potential study patients to those with clinical stage I non-small-cell lung cancer without any evidence of obvious mediastinal adenopathy on computed tomographic scans of the chest. Despite patients being accrued from three large institutions, only 61 patients were ultimately entered over a 2-year period. All patients were informed that they would be randomized into either MST and lobectomy or VATS lobectomy.

The fact that we excluded from analysis those patients who were converted from a VATS lobectomy to an MST does not alter our results in any way. In fact, excluding these patients whose operating room time was prolonged because two separate approaches were required would bias our study in favor of the VATS lobectomy group, if any bias occurred.

Dr. Ralph J. Lewis *(New Brunswick, N.J.).* I would like to make a few comments on the randomized study. According to some statisticians, when a randomized trial is used for a surgical procedure, results can vary because of an inherent subjectivity and inability to do a true double blind study, problems related to legal or ethical issues, patient cooperation, and even surgeons' skills and experience. And, of course, the irreversibility of the surgical procedure has a profound impact.

Any of these factors can have a significant effect on the outcome. Actually the same randomized trial, when repeated by different investigators, has given different results. Some statisticians have argued that a valid randomized trial should not and probably could not be done during the evolutionary phase of a surgical procedure, when the skills, experience, techniques, philosophies, even surgical biases of the surgeons are constantly changing.

I realize that the participants in this report are all very experienced and skillful VATS surgeons, but even they have minimal experience with VATS lobectomy when compared with their enormous skill and experience with open lobectomy. I think the numbers may be too small and it may be too early to try to draw definite conclusions.

About 1½ years ago I maintained that the technique developed for open lobectomy was not suitable for VATS. I still believe that and I have abandoned the isolation ligation technique for VATS lobectomy. Thus I am pleasantly surprised to hear that what I consider a suboptimal procedure, isolation ligation for VATS, with only meager experience on the part of the surgeons, seems to be holding its own against the vast experience you all have for open lobectomy.

I have one other comment. I have not found the muscle-sparing incision to be helpful for my patients, but

I have found the bone-sparing incision of VATS to be very beneficial.

I have just one question, Dr. Kirby. In the past you mentioned that you used a rib spreader on occasion when doing a VATS lobectomy. I am wondering if, in reality, you are comparing a true open lobectomy thoracotomy with a minithoracotomy lobectomy instead of a VATS lobectomy.

Dr. Kirby. In terms of the validity of our study, we believed strongly that a randomized trial was scientifically the best method of demonstrating any advantages or disadvantages of these two surgical approaches.

We believe strongly that our patients having VATS lobectomy were in no way comparable to those having MST in terms of the degree of rib spreading. In a VATS lobectomy each surgeon, to the best of his ability, avoided any spreading of the intercostal space until the end of the procedure and then only if it was necessary to remove the specimen. Even in these instances spreading of the intercostal space was minimal and not comparable to the MST group. Some of the resections were actually completed entirely thoracoscopically with a minithoracotomy only being made at the end of the procedure to remove the specimen.

Last, in terms of our operative technique, we abide by the time-honored technique of individual ligation and transection of the bronchovascular components. We do not believe in altering accepted and time-proven operative techniques simply to accommodate a surgical approach without further evidence of its safety or equivalence. Most surgeons in this audience would look aghast if at the time of a thoracotomy a large stapling device was simply placed across the hilum and fired. Unfortunately, mass stapling is an example of the end justifying the means.