

## Postoperative Pain-Related Morbidity: Video-Assisted Thoracic Surgery Versus Thoracotomy

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One hundred thirty-eight consecutive, nonrandomized patients, with equivalent demographic and preoperative physiologic parameters, underwent either a video-assisted thoracic surgical (VATS) approach ( $n = 81$ ) or a limited lateral thoracotomy (LLT) approach ( $n = 57$ ) to accomplish pulmonary resection for peripheral lung lesions ( $\leq 3$  cm in diameter). Wedge resection was done in 74 VATS patients and 19 LLT patients. Seven patients underwent VATS lobectomy and 38 patients had lobectomy performed through an LLT. Pain was quantitated by postoperative narcotic requirements, the need for intercostal/epidural analgesia, and patient perception of pain index scoring. Shoulder and pulmonary function (forced expiratory volume in 1 second) were measured preoperatively, 3 days postoperatively, and at 3 weeks of follow-up. Patients undergoing VATS experienced significantly less postoperative pain. No patients undergo-

ing VATS required intercostal block/epidural analgesia; 31 LLT patients (54%) required this treatment for breakthrough pain ( $p = 0.001$ ). Narcotic requirements were less ( $p = 0.05$ ) among VATS patients, which correlated with lower perception of pain index after operation for VATS patients. Shoulder girdle strength was equally impaired at day 3, but function was more improved in VATS patients at 3 weeks ( $p = 0.01$ ). Patients undergoing wedge resection alone by LLT had greater impairment in early (day 3) pulmonary function (forced expiratory volume in 1 second) ( $p = 0.002$ ); this difference from VATS was not sustained at 3 weeks. Video-assisted thoracic surgery is associated with reduced pain, shoulder dysfunction, and early pulmonary impairment compared with LLT for select patients requiring pulmonary resection.

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Recent reports in the literature have emphasized the clinical perception of reduced postoperative morbidity associated with video-assisted thoracic surgical (VATS) approaches for a wide variety of intrathoracic pathologic processes [1-17]. Despite these authors' enthusiasm with the VATS approach, there has been little objective documentation of the relative benefits of this approach compared with open thoracotomy techniques. We undertook this study to compare the early postoperative differences in "pain-related" morbidity between the VATS approach to pulmonary resection and lung resection accomplished through a limited lateral thoracotomy (LLT) approach.

### Material and Methods

#### Patient Cohorts

One hundred thirty-eight consecutive patients requiring pulmonary resection for peripheral lung lesions ( $\leq 3$  cm in diameter) between March and November 1992 were inducted into this study after informed consent had been obtained in accordance with the investigational review committees of all participating institutions. Pulmonary resection was accomplished using the VATS approach in 81 patients, and an LLT was used for pulmonary resection in the remaining 57 patients. There was no difference in mean age, sex, or preoperative pulmonary function between patients in the two groups (VATS versus LLT). Additionally, all patients in both groups had good functional status (ECOG 0-1).

The "limited lateral thoracotomies" performed were either totally muscle-sparing approaches ( $n = 52$ ) or lateral thoracotomies sparing the entire serratus anterior muscle and the bulk of the latissimus dorsi muscle ( $n = 5$ ) [18]. All VATS resections were accomplished as per the

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Table 1. Diagnoses

Diagnosis	Thoracotomy (n = 57)	VATS (n = 81)
Benign nodule	11	27
Benign infiltrate	3	21
Primary cancer	41	24
Metastatic cancer	2	9

VATS = video-assisted thoracic surgery.

techniques described in previous reports by us [1, 7, 9, 10, 12, 19].

Patients considered for this study fell into two broad categories. The first group consisted of patients identified with idiopathic pulmonary processes (nodules, infiltrates) requiring lesional biopsy to direct appropriate medical or surgical therapy. The other subset was made up of patients with known "primary" lung cancers being considered for "curative" pulmonary resection (Table 1).

The extent of pulmonary resection performed in both study cohorts (VATS versus LLT) was based on primary clinical concerns (pathology and functional status) rather than attempting to balance the number and variety of procedures in each group. In all, wedge excision was primarily used for pulmonary resection in 74 VATS patients and 19 LLT patients. All infiltrative pulmonary disease and pulmonary nodules confirmed by intraoperative frozen section pathologic analysis to be benign were managed with wedge resection alone (VATS, 48; LLT, 13). Furthermore, all metastatic pulmonary nodules approached in this series were managed by wedge resection alone. Finally, a smaller group of patients with known bronchogenic carcinoma having impaired cardiopulmonary reserve underwent wedge resection combined with intraoperative lymph node staging as a primary "compromise" treatment of their malignant condition (VATS, 17; LLT, 3).

Formal lobectomy was the resection performed in the remaining 45 patients in this study. Seven patients underwent VATS lobectomy, and 38 patients had lobectomy performed through a LLT.

Study Methods

All 138 patients inducted into this prospective, nonrandomized study underwent a uniform series of perioperative evaluations to assess the differential pain-related morbidity between either LLT or VATS approaches to pulmonary resection (wedge, lobectomy). On postoperative days 1 through 3, the following were measured:

- Visual analogue scale/pain perception index
- Analgesia requirements
- Patient-controlled analgesia
- Epidural/intercostal block
- Pulmonary function evaluation (day 3)
- Complication tabulation (hospital stay)

During the postoperative period at 3 to 4 weeks, the following were measured:

- Visual analogue scale/pain perception index
- Shoulder girdle function
- Pulmonary function
- Complication tabulation (total)

Pain was quantitated in the study cohorts as a function of postoperative narcotic requirements, the need for intercostal/epidural analgesia, and visual analogue scales as an index of the patient's perception of pain. Patients were asked to respond to a standard pain questionnaire at 8-hour intervals during the first 3 postoperative days and again at their return clinic visit (Fig 1). This postdischarge follow-up visit occurred between 3 to 4 weeks after operation. Intravenous narcotic administration, controlled by the patient, was the method of analgesic delivery for all patients during day 1 through day 3 postoperatively. Total narcotic dosage during this 3-day period was also quantitated. These patients also underwent a preoperative psychologic assessment (modified McGill pain questionnaire) to ensure that an equivalent psychological profile existed between patients approached by VATS or LLT [18].

Shoulder function was estimated by measuring the strength of the latissimus dorsi and serratus anterior muscle groups before operation in both patient cohorts with a standard dynamometer used by the physical therapy departments [18]. The shoulder function changes

Patient Initials \_\_\_\_\_ Patient Number \_\_\_\_\_ Surgery Date \_\_\_\_\_  
 Today's Date \_\_\_\_\_ Assessment Time \_\_\_\_\_ Location ICU Floor PreOP Yes No

**SHORT-FORM McGill PAIN QUESTIONNAIRE**  
 Ronald Melzack

(Place a check next to the number that best describes the intensity of your present pain level for each word.)

	NONE	MILD	MODERATE	SEVERE
TROUBING	0) _____	1) _____	2) _____	3) _____
SHOOTING	0) _____	1) _____	2) _____	3) _____
STABBING	0) _____	1) _____	2) _____	3) _____
SHARP	0) _____	1) _____	2) _____	3) _____
CRAMPING	0) _____	1) _____	2) _____	3) _____
GNAWING	0) _____	1) _____	2) _____	3) _____
HOT-BURNING	0) _____	1) _____	2) _____	3) _____
ACHING	0) _____	1) _____	2) _____	3) _____
HEAVY	0) _____	1) _____	2) _____	3) _____
TENDER	0) _____	1) _____	2) _____	3) _____
SPLITTING	0) _____	1) _____	2) _____	3) _____
TIRING-EXHAUSTING	0) _____	1) _____	2) _____	3) _____
SICKENING	0) _____	1) _____	2) _____	3) _____
FEARFUL	0) _____	1) _____	2) _____	3) _____
PUNISHING-CRUEL	0) _____	1) _____	2) _____	3) _____

1. PLEASE MAKE A MARK ON THE LINE BELOW THAT BEST DESCRIBES THE INTENSITY OF YOUR PAIN.  
 2. PLEASE GIVE A NUMBER NUMBER BETWEEN 0 AND 10 THAT BEST DESCRIBES YOUR PAIN.  
 A ZERO (0) WOULD MEAN "NO PAIN" AND TEN (10) WOULD MEAN THE "WORST POSSIBLE PAIN".  
 PLEASE WRITE ONE NUMBER IN THE BOX BELOW:

[ ]

NO PAIN \_\_\_\_\_ WORST POSSIBLE PAIN

PPI: PRESENT PAIN INTENSITY (Check one line that describes your pain right now)

- 0 NO PAIN \_\_\_\_\_
- 1 MILD \_\_\_\_\_
- 2 DISCOMFORT \_\_\_\_\_
- 3 DISTRESSING \_\_\_\_\_
- 4 HORRIBLE \_\_\_\_\_
- 5 EXCRUCIATING \_\_\_\_\_

Fig 1. Patient questionnaire used during the postoperative period to assess postoperative pain (visual analogue scale/pain perception index) [18].

Table 2. Postoperative Morbidity

Morbidity	Thoracotomy	VATS
Death	0	0
Ventilator (>72 h)	2	1
Atelectasis (requiring bronchoscopy)	3	0
Empyema	1	0
Air leak (>7 days)	8	4
Postop bleeding	1	0
Total	15	5 <sup>a</sup>

<sup>a</sup>  $p = 0.05$  versus thoracotomy.

VATS = video-assisted thoracic surgery.

after operation in the study cohorts was assessed at 3 days and 3 to 4 weeks postoperatively. These changes were expressed as a percentage of the patient's preoperative baseline shoulder strength values.

Pulmonary functional analysis was also assessed preoperatively, at the third postoperative day, and at the 3- to 4-week follow-up examination as described by us in an earlier report [18]. The length of postoperative hospital stay and the complications occurring in both the VATS and LLT approach groups were also quantitated. Statistical procedures used in this analysis consisted of the Mann-Whitney test for ordinal data, Fisher's exact probability test, and analysis of variance techniques for continuous data.

Video-assisted surgical (VATS) approaches and techniques used by us for pulmonary wedge resection are described in recent reviews in the literature [1, 7]. The specific techniques we used to accomplish VATS lobectomy are outlined in recent manuscripts by Kirby and colleagues [19] and Roviario and associates [20].

### Results

There were no deaths in either cohort, but postoperative morbidity was less in the VATS group (Table 2). The postoperative hospital stay of  $5.0 \pm 3.3$  days for VATS

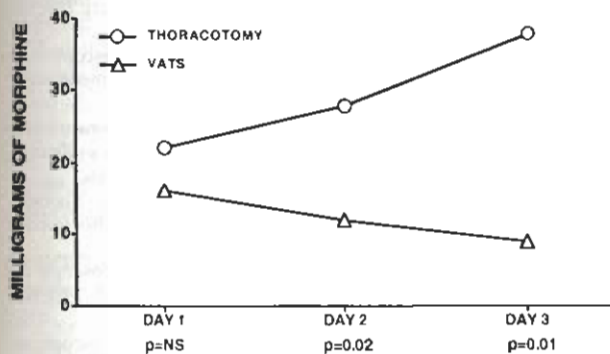


Fig 2. Patient-controlled intravenous morphine in milligrams required by each patient cohort (video-assisted thoracic surgery [VATS] versus left lateral thoracotomy) during the first 3 postoperative days of study. (NS = not significant.)

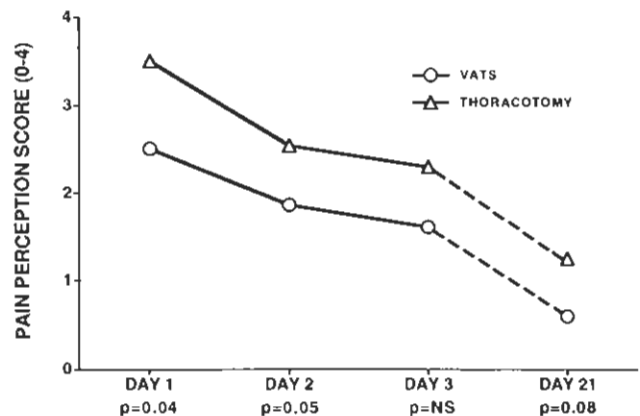


Fig 3. Average daily pain perception index score during the first 3 postoperative days and at postoperative day 21. (NS = not significant; VATS = video-assisted thoracic surgery.)

patients was also shorter ( $p = 0.01$ ) than that required for patients approached through LLT ( $7.5 \pm 4.7$  days).

The results of this study substantiate the impression that VATS patients experienced less postoperative discomfort compared with "open" thoracic surgical techniques [1-17]. No patient undergoing VATS required intercostal block or epidural analgesia to control postoperative pain; however, 31 LLT patients (54%) ( $p = 0.001$ ) required these adjunctive pain control measures during the postoperative period for pain unresponsive to patient-controlled analgesia. The total narcotic requirement was also less during the 3 days of patient-controlled narcotic analgesia among the VATS patients compared with the LLT group (Fig 2). This correlated with lower perceived pain scores in the VATS group throughout the postoperative period (Fig 3).

Shoulder girdle strength was equally impaired in both study groups at the postoperative day 3 assessment, but by 3 weeks after operation the VATS patients' function had nearly returned to their preoperative levels. The shoulder function of the LLT group, however, remained significantly impaired at the 3-week follow-up examination (Table 3). This shoulder dysfunction also correlated with increased perceived pain index among the LLT patients at the postdischarge follow-up visit (see Fig 3).

It would have been inappropriate to compare postoperative changes in pulmonary function between all patients in these study cohorts due to differences in the number of lobectomies performed between the VATS and LLT groups. We were, however, able to study pulmonary function differences (forced expiratory volume in 1 sec-

Table 3. Postoperative Shoulder Function (Percent of Preoperative Strength)

Day	Thoracotomy	VATS	p Value
Postop day 3	56%	59%	NS
Postop day 21	59%	85%	0.01

NS = not significant; VATS = video-assisted thoracic surgery.

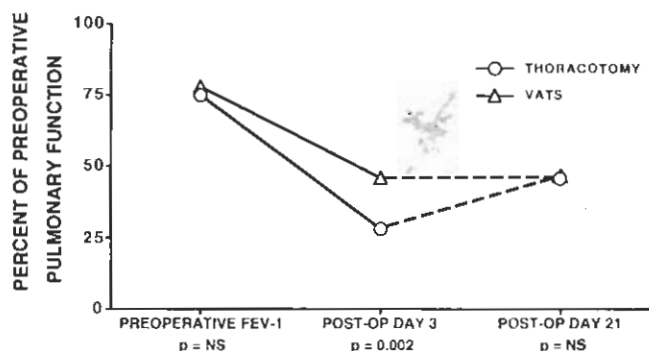


Fig 4. Differences in pulmonary function (forced expiratory volume in 1 second) from preoperative values seen between the video-assisted thoracic surgery (VATS) and left lateral thoracotomy patient cohorts undergoing wedge resection only. (NS = not significant.)

ond) between patients undergoing wedge resection alone by either the VATS or LLT approaches (Fig 4). This analysis revealed a greater reduction in pulmonary function on the third postoperative day among patients after LLT wedge resection compared with VATS wedge resection patients. These differences in forced expiratory volume in 1 second between VATS and LLT were not sustained at the 3-week evaluation. This suggests that the pulmonary functional impairment differences seen were related to increased early postoperative pain among the LLT patients.

### Comment

The primary goals of minimally invasive surgical techniques focus on reducing the operative morbidity associated with "classic" open surgical techniques. Video-assisted thoracic surgical approaches have been touted as providing the patient with this benefit of reduced operative morbidity [1-17]. There has, however, been little objective evidence supporting the opinion that a true reduction in pain-related morbidity occurs when the VATS approach is used for pulmonary resection.

Difficulty in objectifying pain is primarily responsible for the paucity of information regarding pain-related morbidity differences between VATS and open thoracic surgical approaches [18]. This clinical comparison demonstrated the advantages of reduced early postoperative pain, improved shoulder girdle function, reduced impairment in early postoperative pulmonary function, and shortened hospital stay for select patients requiring pulmonary resection when the VATS approach was used.

It is important to emphasize that the entire focus of this study was on surgical approach-related morbidity. Although it may be difficult, we urge the reader to try and segregate the concepts of overall postoperative morbidity and pain-related postoperative morbidity when they scrutinize the results of this study. This study focused on parameters evaluating postoperative pain and limitations in shoulder function after VATS or LLT. It would have been inappropriate to attempt to compare differences in overall postoperative morbidity between these groups as

there was a significant discrepancy in the extent of pulmonary resection performed (VATS versus LLT). Nonetheless, recent retrospective analyses that compared the differences in postoperative morbidity between pulmonary wedge resection done by VATS or LLT in subgroups of patients with more uniform lung pathology corroborated the findings of this study [9, 14]. Despite the results of this work and earlier studies, further documentation of the differential postoperative morbidity between VATS or LLT used for patient cohorts undergoing equivalent pulmonary resections will be desired.

The potential benefits of the VATS approach over open surgical techniques with regard to reducing the chronic postoperative morbidity of thoracic surgery remain to be defined [21, 22]. Further evaluation is also necessary to define the relative benefits of the VATS approach alone compared with LLT plus epidural analgesia in reducing the postoperative morbidity of major pulmonary resection [19, 20].

We are indebted to the nursing services and physical therapy teams of our thoracic surgical units for their conscientious contribution to this study. We also thank Frank D'Antonio, PhD, for his statistical support of this project.

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### DISCUSSION

DR K... giving... esting... a num... painful... prospe... rianus... racoto... Howev... presen... proced... thorac... group... functio... dissect... limited... a com... functio... be mo... I wa... think

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## DISCUSSION

**DR KEITH S. NAUNHEIM** (St. Louis, MO): Thanks so much for giving me the manuscript, Dr Landreneau. This is a very interesting and a timely project, specifically because there have been a number of claims that thoracoscopy is less invasive and less painful, and they have not yet really been addressed in a prospective or controlled fashion. The main thrust of your manuscript is the comparison of thoracoscopy and limited thoracotomy with regard to shoulder function and pain indices. However, it is important to note that the two groups that you presented in this study were not similar with regard to the procedure involved. Approximately 70% of the patients in the thoracotomy group had lobectomy versus 10% in the VATS group. So it is really not fair to compare morbidity or pulmonary functions or ventilatory compromise postoperatively. Have you dissected out that group of patients in the VATS group and in the limited thoracotomy group who had just wedge resection? I think a comparison of both morbidity and postoperative pulmonary function between those two subgroups or selected cohorts might be more valid.

I would like to congratulate you on an interesting talk, and I think we will be hearing more of this in the future.

**DR LANDRENEAU:** Doctor Naunheim, we have looked at the subset of patients who underwent pulmonary wedge resection by thoracotomy or by VATS. Interestingly, we found that at postoperative day 3, where pain was found to be the greatest, there was less impairment in pulmonary function in the VATS group compared with the thoracotomy group. At 3 to 4 weeks after operation there still remained some impairment in pulmonary function in both operative approach groups, but this sustained reduction in pulmonary function was equivalent.

I think that there may be some benefit with the VATS approach in preserving pulmonary function in the early postoperative period after pulmonary wedge resection. This may particularly be of benefit to the patient with significant preoperative pulmonary functional impairment. I encourage others to study the relative efficacy of VATS versus thoracotomy as experience with these endoscopic surgical techniques grows.

**DR DOUGLAS J. MATHISEN** (Boston, MA): In addition to the difference in the procedure, I think most people who would do a

wedge resection would not do the kind of incision that you have described with the retractors. Have you looked at very limited incisions that most people would do for a standard wedge resection, looking at the pain and the issues that you have looked at with VATS?

**DR LANDRENEAU:** We have not. We tried to standardize our open thoracotomy procedure, but we agree that this is another area that needs further investigation.

**DR WILLIAM H. WARREN** (Chicago, IL): This is a very nice report, Dr Landreneau. I am assuming that the epidural catheter was placed at the end of the procedure.

**DR LANDRENEAU:** No, it was placed by the anesthetic team. This usually was a single shot of epidural anesthesia if the patient-controlled analgesia was not working. And, in fact, we got some criticism on the front end of the study because we were not using epidural catheters in these patients. Some would say this is the standard of care for the management of postthoracotomy pain. We were trying to use the same study format used in Dr Hazelrigg's protocol presented at the meeting of the American Association for Thoracic Surgery a few years ago, in which he compared muscle sparing versus standard posterolateral thoracotomy with regard to postoperative pain and shoulder girdle function.

**DR WARREN:** Did you compare the amount of analgesic that was given in the patient-controlled analgesia pump in the two groups?

**DR LANDRENEAU:** Yes, our analysis of postoperative narcotic requirements between groups was based on total patient-controlled analgesia dosage during the first 3 postoperative days. As we have described, a significantly greater number of patients in the thoracotomy group had breakthrough pain on patient-controlled analgesia that required epidural analgesia. In addition to this supplemental epidural treatment, there still was a patient-controlled analgesia requirement difference overall between groups.