minimally invasive techniques

Early Postoperative Stress*

Video-Assisted Wedge Resection/Lobectomy vs Conventional Axillary Thoracotomy

Edda M. Tschernko, MD; Sabine Hofer, MD; Christian Biegelmayer, MD; Wilfried Wisser, MD; and Wolfram Haider, MD

Postoperative pain is a major cause of ineffective breathing after lung surgery, predisposing patients to hypoxemia. Because potent analgesics like opioids depress ventilation and other analgesic techniques are time-consuming, efficient postoperative pain therapy is difficult. Therefore, a less painful surgical approach could be beneficial. Forty-seven patients with diagnosis of a pulmonary nodule were prospectively studied. Patients were assigned to a video-assisted thoracic surgery (VATS) group (n=22) or a group undergoing axillary thoracotomy (n=25). Visual analogue scale (VAS) scores, plasma glucose levels, plasma epinephrine and plasma norepinephrine levels, as well as arterial oxygen (PaO₂) and carbon dioxide (PaCO₂) tension were determined the day before surgery, and 3, 15, 24, 48, and 72 h after surgery. Postoperative piritramide (a synthetic morphine compound) demand was recorded. VAS values were significantly lower (p<0.05) during the whole observation period in the VATS group. Significantly higher epinephrine levels were observed 3 and 15 h after surgery (267.4±28 vs 111.8±13 ng/L; p<0.01; and 176.6±46.5 vs 96±14.5 ng/L; p<0.05) in the thoracotomy group, whereas there was no significant difference in norepinephrine levels. Piritramide demand was significantly (p<0.05) reduced in the VATS group throughout the whole observation period. There was no difference in PaCO₂ values but PaO₂ values were higher in the VATS group over 72 h, with maximum differences occurring at 15 h after operation: 60.9±1.9 vs 49.2±2.4 mm Hg (p<0.01). In conclusion, the videoendoscopic approach is associated with less postoperative pain and better oxygenation than traditional surgical approaches. (CHEST 1996; 109:1636-42)

Key words: pain, postoperative; thoracoscopy; thoracotomy

Abbreviations: VAS=visual analogue scale; VATS=video-assisted thoracic surgery

Immediately after thoracotomy, peak inspiratory flow rates and timed forced expiratory volumes decrease to approximately 75% of preoperative values. This decrease is at least partially due to postoperative pain and ineffective breathing, which lead to hypoxemia. In a study in which preoperative effort-elicited spirometry was compared with values after surgery, differences of 15 to 20% were achieved when analgesia was effective.

Systemically administered opioids in doses sufficient to treat postoperative pain depress ventilation, reducing arterial oxygen tension by 20%, and are therefore only partially beneficial. Other analgesic techniques, such as thoracic epidurals, are time-consuming and require the attention of well-qualified staff. Epidural analgesia, which is said to be most effective for postoperative pain control after lung surgery, also carries the risk of severe complications, including respiratory depression, urinary retention, excessive nausea and vomiting, itching, hypotension, or unexpected somnolence. Thus, a less painful surgical approach such as video-assisted thoracic surgery (VATS) might be beneficial.
To our knowledge, conventional axillary thoracotomy has not been compared with a video-assisted endoscopic approach with respect to their effects on postoperative stress and oxygenation. We compared these two approaches in patients undergoing resection of a pulmonary nodule.

**Materials and Methods**

After approval by the institutional committee on human research and written informed consent had been obtained, 47 patients undergoing thoracotomy or segmental resection of a pulmonary nodule were studied. Patients were assigned to either the VATS procedure or conventional axillary thoracotomy (Table 1). Patients with coexisting diseases that might influence the pain score or the chemically determined stress parameters, such as diabetes mellitus, neurologic disorders, drug abuse, rethoracotomy, obesity, cachexia, or hypertension, were excluded from the study. The patients were all classified I (healthy patient) or II (mild systemic disease, no functional limitations) according to the American Society of Anesthesiologists.

**Pain/Stress Parameters**

All stress parameters were determined while patients were lying at rest. Chest physiotherapy took place only after questioning visual analogue scale (VAS) scores and blood samples were obtained. All patients provided VAS scores the day before surgery as well as 3, 15, 24, 48, and 72 h postoperatively. All other measurements were made at those time points as well.

Blood samples were drawn through a 17-gauge venous cannula that was inserted the day before operation and used no earlier than an hour after insertion to avoid elevation of catecholamine levels caused by the insertion. Blood samples were drawn to determine plasma epinephrine and plasma norepinephrine levels. Plasma was collected into chilled tubes containing EGTA (ethylene glycol-bis-[β-aminoethyl ether] N, N', N'-tetraacetic acid) and reduced glutathione. After collection, the blood was centrifuged using a centrifuge (Hettich Universal RF 30) at 3,000 U/min for 15 min. Plasma was collected and frozen to –70°C. Plasma catecholamines were analyzed by high-performance liquid chromatography with kits purchased (Chromsystems; Munich, Germany) and used according to the manufacturer’s suggestions. Briefly, samples were mixed with dihydroxybenzylamine for recovery estimations and were subsequently extracted with A1203. Eluted catecholamines were automatically injected and separated on a C18-silica column by high-performance liquid chromatography. The equipment was calibrated with standards for epinephrine, norepinephrine, dihydroxybenzylamine, and dopamine. Catecholamines were measured by an electrochemical detector (Pharmacia; Sweden). Data reduction of signals was performed by an integrator (Shimadzu). Precision of the method was determined by analysis of control samples from the manufacturer on different days (n=17) and coefficients of variation were calculated.

Arterial blood gases were drawn the day before operation via a single puncture of the radial artery; all subsequent samples were drawn via a 20-gauge arterial cannula inserted in the radial artery with Seldinger’s technique before induction of anesthesia and kept in place for 3 days. All blood gas values were determined while patients had been breathing room air for at least 15 min.

**Anesthesia**

All patients were premedicated orally with midazolam, 0.08 mg/kg, 90 min before induction of anesthesia. After standard monitors were applied, consisting of ECG, invasive BP measurement via the radial artery, and pulse oximetry, anesthesia was induced using thiopental (thiopentone), 5 mg/kg, and fentanyl, 3 μg/kg, as a standard. Vecuronium, 0.1 mg/kg, was used to facilitate intubation with a double-lumen endobronchial tube. One-third of this induction dose was repeated at the start of one-lung ventilation and every 40 min thereafter. Anesthesia was maintained with 0.8 to 1.1%. A fentanyl bolus of 2 μg/kg was administered whenever BP and/or heart rate rose 30% or more above the baseline value that was determined the day before operation.

Patients were ventilated via mask with 100% oxygen before intubation. Correct position of the endotracheal tube was verified by auscultation and fiberoptic bronchoscopy. Patients were ventilated with 100% O2 tidal volumes and frequency were adjusted to maintain PaCO2 between 35 and 40 mm Hg. Peak ventilatory pressures of no more than 35 cm H2O were accepted with double-lung ventilation. Ten minutes after one-lung ventilation began, arterial blood gases were measured and oxygen adjusted to keep PaO2 between 70 and 110 mm Hg.

All patients were operated on in the lateral decubitus position. IV infusion during surgery was restricted to isotonic saline solution. During the first hour, saline solution was infused at a rate of 5 mL/kg and thereafter at 2.5 mL/kg. At the end of operation, the upper lung was reinflated manually until all visible lung collapse had disappeared. All patients were extubated in the operating room. Before extubation, muscle relaxation was reversed by neostigmine, 2.5 mg, and glycopyrrolate, 0.6 mg.

**Technique of Operation**

Thoracotomy and VATS were performed with the patient placed in the lateral decubitus position. For axillary thoracotomy, skin incision began below the mamilla in the fourth intercostal space and ran posteriorly to the posterior axillary line. The latissimus dorsi was not dissected with this approach. In none of the cases was a rib resected. For VATS three incisions averaging 2.5 cm in length were required. The scope was inserted in the sixth or seventh intercostal space in the midaxillary line. The two other incisions were made in the third or fourth intercostal space in the anterior and posterior axillary line for insertion of devices and assisting instruments.

Lobectomy was performed in four patients of the thoracotomy group and in three patients of the VATS group. Removal of one pulmonary lobe according to its anatomic borders was performed in the thoracotomy and the VATS group. In the VATS group, one of the three incisions was enlarged to about 4 to 5 cm in length after resection of the lobe to remove the resected tissue from the thoracic cavity. The remaining 40 patients underwent wedge resection. The resection was performed extra-anatomically (irrespective of bron-

<table>
<thead>
<tr>
<th>Patient Data Preoperatively and Rate of Lobectomy to Wedge Resection*</th>
<th>Thoracotomy (n=25)</th>
<th>VATS (n=22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>57.2±3.0</td>
<td>58.0±2.8</td>
</tr>
<tr>
<td>Sex, M/F</td>
<td>16/9</td>
<td>13/9</td>
</tr>
<tr>
<td>Body weight, kg</td>
<td>65.2±2.0</td>
<td>67.4±2.2</td>
</tr>
<tr>
<td>VAS, cm</td>
<td>0.34±0.3</td>
<td>0.36±0.59</td>
</tr>
<tr>
<td>Serum epinephrine, ng/L</td>
<td>80.5±9.9</td>
<td>87.4±11.3</td>
</tr>
<tr>
<td>Serum norepinephrine, ng/L</td>
<td>210±35.6</td>
<td>176.3±30.1</td>
</tr>
<tr>
<td>PaO2, mm Hg</td>
<td>72.8±2.2</td>
<td>71.2±1.5</td>
</tr>
<tr>
<td>PaCO2, mm Hg</td>
<td>37.0±0.45</td>
<td>37.4±0.7</td>
</tr>
<tr>
<td>FVC, %</td>
<td>90.2±5.0</td>
<td>87.9±4.3</td>
</tr>
<tr>
<td>FEV1, %</td>
<td>85.7±3.5</td>
<td>83.6±3.7</td>
</tr>
<tr>
<td>Blood glucose, mg/dL</td>
<td>95.0±3.2</td>
<td>92.5±3.8</td>
</tr>
<tr>
<td>Lobectomy/wedge resection</td>
<td>4/21</td>
<td>3/19</td>
</tr>
</tbody>
</table>

*Values are mean±SEM.
chopulmonary segmentology) in both groups. The amount of lung tissue that was removed was equivalent to about one to two bronchopulmonary segments in both groups.

**Postoperative Analgesia**

For postoperative analgesia, the synthetic opioid piritramide (a diphenylpropylamine derivative) was administered subcutaneously following the normal ward routine, in which patients are given postoperative analgesics on demand for pain relief. Nurses gave injections subcutaneously as a bolus, using no more than 7.5 mg piritramide within 45 min. When signs of sedation appeared, such as ventilatory rate below 8/min or no response to verbal stimuli, no further injection was administered. No other analgesics were administered. (Piritramide is a diphenylpropylamine derivative that has potent analgesic effect [more potent than pethidine and morphine]. Piritramide is used preferably for postoperative analgesia, because its onset is fast [30 min] and the duration of action is 4 to 6 h, with the additional advantage of a therapeutic index three times as high as the index of pethidine. Side effects [nausea, vomiting, drowsiness] and contraindications are comparable to those of morphine. The most dangerous side effect caused only by overdosage is drowsiness and ventilatory depression. Average adults receive 7.5 to 15 mg as a starting dose, which can be repeated after 30 min if pain relief is not sufficient.)

**Postoperative Complications**

Postoperative complications were assessed during the hospital stay of each patient. In case of hospital readmission of one of those patients at a later time, we ascertained whether the readmission was for a postoperative complication or another reason.

**Assessment of Costs**

Average time of hospital stay after VATS and axillary thoracotomy were recorded. Costs per day on our ward as charged to the insurance were taken into account. Costs on personnel in the operating room and room costs were calculated for a time span of 90 min for both techniques as there was no significant difference in operating time.

**Statistical Analysis**

Data were analyzed with unpaired Student’s t test. Descriptive statistics are expressed as mean±SEM unless otherwise stipulated.

**Results**

**Patients**

No significant differences were noted with respect to age, blood glucose, plasma epinephrine, or plasma norepinephrine levels. PaO2, PaCO2, FVC, and FEV1 did not differ between groups at baseline (Table 1).

**Subjective Pain Measurements: VAS and Opioid (Piritramide) Demand**

Using a VAS, where 0 cm indicates no pain and 10 cm indicates the worst imaginable pain, the thoracotomy group showed statistically significant higher values (p<0.05) than the VATS group at 3, 15, 24, 48, and 72 h after surgery (Fig 1).

**Figure 1.** Time points: preop=24 h preoperatively; 3h=3 h postoperatively; 15h=15 h postoperatively; 24h=24 h postoperatively; 48h=48 h postoperatively; 72h=72 h postoperatively. VAS score: 0 cm indicating no pain at all and 10 cm indicating the worst imaginable pain. Asterisk=p<0.05; two asterisks=p<0.01.

**Figure 2.** Time points: 3h=3 h preoperatively, etc, as in Figure 1. Piritramide: additive analgesic demand, eg, 24h time point shows additive piritramide demand from 15 h postoperatively to 24 h postoperatively. Piritramide is a synthetic morphine compound with the advantage of being less respiratory depressive than morphine. Asterisk=p<0.05; two asterisks=p<0.01.

**Figure 3.** Time points: preop=24 h preoperatively; 3h=3 h postoperatively, etc, as in Figure 1. Note plasma epinephrine levels at the observation time points. Asterisk=p<0.05; two asterisks=p<0.01.
Piritramide demand as an indirect subjective pain indicator was significantly higher (p<0.05) at all observation time points in the thoracotomy group: 7.5±1.6 vs 1.3±0.6 mg (p<0.01) 3 h postoperatively; 16.1±2.2 vs 8.6±3 mg (p<0.05) 15 h after surgery; 13.3±2.4 vs 6.4±1.1 mg (p<0.01) 24 h after surgery; 15.8±1.5 vs 6.4±2.3 mg (p<0.01) 48 h postoperatively; and 9.2±1.7 vs 2.1±1.4 mg (p<0.01) 72 h postoperatively (Fig 2). These values were derived by adding up all administered piritramide doses from one observation time point to the following one.

**Blood Glucose Levels**

As a metabolic stress parameter, blood glucose levels were significantly higher in the thoracotomy group over 48 h postoperatively. Glucose levels returned to baseline values by 72 h after surgery. The 3-, 15-, 24-, 48-, and 72-h postoperative time points showed following values in the thoracotomy group compared with the VATS group: 160.7±8.9 vs 115±4.3 mg/dL (p<0.05), 152.5±18.2 vs 102.3±5.8 mg/dL (p<0.05), 153.3±16.1 vs 87±4.7 mg/dL (p<0.01), 112±3.4 vs 85.8±6.1 mg/dL (p<0.05), and finally 84±2.5 vs 87.5±3.7 mg/dL (not significant).

**Serum Catecholamine Levels**

Serum epinephrine level was significantly elevated at 3 and 15 h postoperatively in the thoracotomy group: 267.4±28 vs 111.8±12.7 ng/L (p<0.01) 3 h postoperatively and 176.6±46.5 vs 96±14.5 ng/L (p<0.05) 15 h postoperatively. No significant differences were noted at any other time points, despite the mean values in the conventional thoracotomy group being higher during the whole observation period (Fig 3).

As shown in Figure 4, mean values for norepinephrine in the thoracotomy group were higher during the whole observation period but no statistical difference was noted due to large SEMs.

**Arterial Oxygen and Carbon Dioxide Tension**

PaO_2 was significantly lower when patients were operated on conventionally 72 h after operation (Fig 5): 53.1±2.0 vs 64.1±1.9 mm Hg (p<0.01) 3 h postoperatively; 49.2±2.4 vs 60.9±1.9 mm Hg (p<0.01) 15 h postoperatively; 55.8±2.1 vs 64.0±2.7 mm Hg (p<0.01) 24 h postoperatively; 57.3±2.6 vs 65.0±1.7 mm Hg (p<0.01) 48 h after surgery; and 60.1±2.6 vs 67.1±2.4 mm Hg (p<0.05) 72 h after operation.

**Figure 4.** Time points: preop=24 h preoperatively; 3h=3 h postoperatively, etc, as in Figure 1. Note plasma norepinephrine levels at the observation time points. There was no significant difference between the groups over the whole observation period.

**Figure 5.** Time points: preop=24 h preoperatively; 3h=3 h postoperatively, etc, as in Figure 1. Note PaO_2 at the observation time points expressed in percent of the preoperative value. The preoperative value indicates 100%. Asterisk=p<0.05; two asterisks=p<0.01.

**Figure 6.** Time points: preop=24 h preoperatively; 3h=3 h postoperatively, etc, as in Figure 1. Note PaCO_2 at the observation time points.

Downloaded From: http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21733/ on 06/26/2017
No statistically significant difference was observed in PaCO₂ (Fig 6) between groups at any time.

**Conversion to Thoracotomy**

Twenty-five patients were initially enrolled in the VATS group, but only 22 patients could be successfully operated on with the technique. In two patients the technique had to be converted to axillary thoracotomy for completing the resection for malignancy. In one patient, major bleeding that could not be dealt with endoscopically led to conversion of technique. Those patients were excluded from the study.

**Postoperative Complications**

Postoperative complications are listed in Table 2. Radiologic signs of pneumonia, which were detected in two patients who underwent thoracotomy, did not lead to acute respiratory insufficiency and they could be treated sufficiently with antibiotics. None of the patients in the VATS group developed radiologic signs of pneumonia. One of the patients in the thoracotomy group developed angina pectoris with enzymatic and ECG signs of myocardial ischemia on the second postoperative day. This led to a detection of three-vessel coronary disease. This patient underwent a coronary artery bypass operation three months afterwards. No signs of myocardial ischemia could be observed in the VATS group. Subcutaneous emphysema was observed in four patients operated on with the VATS technique in comparison to one patient in the thoracotomy group. No treatment was necessary for this complication, but patient comfort was reduced. The only late complication we have seen to date is one patient who presented with intercostal nerve neuralgia 6 months after thoracotomy.

**Average Costs of Operation and Postoperative Hospital Stay**

As shown in detail in Table 3, costs of operation were higher for VATS than for conventional thoracotomy because of the costly stapling devices. Postoperative hospital stay was shorter in the VATS group, which led to lower total costs of operation and hospital stay for the VATS group, when compared with those having conventional axillary thoracotomy.

**Discussion**

In our prospective study comparing axillary thoracotomy with a VATS approach, we found that pain was reduced, patient comfort improved, and analgesic demand reduced during the first 72 h postoperatively when the VATS technique was chosen. Plasma epinephrine level was significantly higher 15 h after operation in the conventional thoracotomy group. Mean norepinephrine levels were higher in the thoracotomy group as well, but no statistical significance was observed. A major advantage of VATS noted was with respect to PaO₂ 72 h postoperatively. There was no effect on PaCO₂.

The markedly elevated epinephrine levels (stress indicator) found 15 h postoperatively in the thoracotomy group are similar to those other investigators have found in patients after lung surgery. As the time course of epinephrine elevation is different from the time course of postoperative pain, the elevation could be at least partially caused by influences other than postoperative pain, including intraoperative stress and tissue damage. A depletion of epinephrine stores could also be the cause of the different time course of epinephrine elevation and VAS scores. The markedly higher epinephrine levels indicate that VATS is less traumatic than thoracotomy.

Norepinephrine levels showed huge differences between patients. Mean values were higher in the thoracotomy group, but no statistically significant difference was reached with the number of patients we studied.

We found markedly higher PaO₂ during the first 72 h postoperatively in the VATS group. Since VAS scores were higher in the thoracotomy group despite increased administration of opioid, we conclude that

### Table 2—Postoperative Complications During Hospital Stay*

<table>
<thead>
<tr>
<th>Postoperative Complications</th>
<th>Thoracotomy (n=25)</th>
<th>VATS (n=22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia (clinical+radiologic signs)</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Acute respiratory failure ( reintubation necessary)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Myocardial ischemia (clinical+enzymatic + ECG signs)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Clinical signs of cerebral ischemia</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Subcutaneous emphysema</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Intercostal nerve neuralgia</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Early mortality (30 days postoperatively)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Exception: intercostal nerve neuralgia occurred 6 months after thoracotomy. All complications (except the intercostal nerve neuralgia) could be treated sufficiently.

### Table 3—Average Cost of Operation and Postoperative Hospital Stay per Operation

<table>
<thead>
<tr>
<th></th>
<th>Thoracotomy, $US</th>
<th>VATS, $US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel in operating room</td>
<td>215</td>
<td>215</td>
</tr>
<tr>
<td>Room costs (eg, light, heating)</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Narcosis (eg, medication, syringes)</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Material (eg, sutures, staplers)</td>
<td>170</td>
<td>579</td>
</tr>
<tr>
<td>Postoperative hospital stay</td>
<td>8,560</td>
<td>4,750</td>
</tr>
<tr>
<td>(Mean hospital stay) (9.2d)</td>
<td>(9.2d)</td>
<td>(5.1d)</td>
</tr>
<tr>
<td>Total</td>
<td>8,977</td>
<td>5,576</td>
</tr>
</tbody>
</table>
better oxygenation was due to reduced pain. Although some investigators have found no difference in FVC or FEV₁ when patients received optimal analgesia after lung and upper abdominal surgery, compared with control subjects, it is now commonly accepted that postoperative pain after thoracotomy causes ineffective breathing, which leads to hypoxemia in some patients. In adults, ventilatory depression is explained by alterations in mechanics of breathing induced by surgery and pain and by reflex changes in diaphragmatic function that are accentuated by pain. These different findings can be explained by the fact that pulmonary function testing reflects function only during a very short time period and is strongly dependent on patient cooperation.

Many techniques are used to control postoperative pain in patients who have undergone thoracic surgery, such as intercostal nerve blockade, thoracic epidurals, transcutaneous nerve stimulation, or cryoanalgesia, to improve patient comfort and reduce postoperative pulmonary complications. All of these techniques are time-consuming and carry the risk of severe side effects.

PaCO₂ did not differ significantly between groups. In normal subjects, as in the ones we selected for our study, CO₂ elimination continues efficiently for quite some time, even if tidal volumes are lower than usual. Nevertheless, it is possible to observe marked CO₂ elevations when patients suffer preoperatively from COPD.

In our study, the VATS technique had a positive effect on postoperative gas exchange despite little therapeutic effort and no side effects. As VATS is more frequently used in thoracic surgery, this less traumatic technique could be the method of first choice when thoracic surgery has to be performed on patients suffering from severe restrictive and/or obstructive pulmonary disease.

VATS cannot be used when tumors are large because of insufficient radicality and limited view of the operating field. In our study, technique conversion occurred three times because of the above-mentioned problems. A conversion rate of 20% is generally accepted.

Severe postoperative complications like pneumonia occurred in two patients after thoracotomy (one lobectomy and one wedge resection), whereas no such signs were noted in the VATS group. One patient who underwent thoracotomy for wedge resection developed myocardial ischemia on the basis of a three-vessel coronary disease, which was not registered before. Despite these facts, it is not possible to draw the conclusion that thoracotomy leads to severe complications more often than VATS on the basis of our data. Much larger patient numbers would be necessary for examination of the frequency and severity of postoperative complications, especially as in the patient collective we studied, relatively little lung tissue was removed, and patients selected for this study were preoperatively in good condition (American Society of Anesthesiologists class I or II). This is probably also the reason why no acute respiratory insufficiency was observed in 47 patients, which is otherwise present in 4.4%, when large patient numbers with bronchial carcinoma resection are studied.

Landreneau et al. studied 138 consecutive patients who underwent either a VATS approach (n=81) or a limited lateral thoracotomy approach (n=57) in respect of postoperative pain-related morbidity. This study showed significantly (p<0.05) increased morbidity when patients underwent a limited lateral thoracotomy approach, probably due to greater impairment in early pulmonary function. As Landreneau et al. studied a very large patient collective (n=138), their findings confirm the tendency of increased morbidity (Table 2) that we found in the 47 patients we studied.

As costs play a certain role in modern medicine, we also recorded the expenses for both techniques. We found that intraoperative costs are higher in the VATS group, because of expensive stapling devices. In contrast to that finding is the significantly shorter hospital stay of patients operated on with VATS. Total costs of operation and hospital stay are less when the VATS technique is chosen. Thoracoscopic surgery for diseases of the lung was evaluated recently in respect to costs with controversial outcome. Molin et al. showed that VATS increases costs in patients undergoing lung biopsy for interstitial lung disease, comparing VATS with limited thoracotomy. In contrast, other authors reported reduced costs, when the VATS technique was chosen, due to shorter hospital stay. The reason for these different findings is probably the different study design, comparing VATS with limited thoracotomy removing small biopsy specimens on one hand, and with axillary or posterolateral thoracotomy for wedge resection or lobectomy on the other hand.

Thus, we conclude that in patients in whom the technique is feasible, the use of VATS leads to less postoperative pain and stress, as well as an improvement in oxygenation.

REFERENCES


Downloaded From: http://journal.publications.chestnet.org/pdfsaccess.aspx?url=data/journals/bronch/21733/ on 06/26/2017
Invasive Minimally Invasive Techniques