Postoperative pain detracts from early health status improvement seen after video-assisted thoracoscopic lung volume reduction surgery

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Received 13 March 2003; received in revised form 19 June 2003; accepted 24 June 2003

Abstract

Objectives: To assess the impact of lung volume reduction surgery (LVRS) on postoperative pain. Methods: Fifty-two patients, 34 male/18 female, median age 59 (46–70) years, underwent unilateral video-assisted thoracoscopic (VAT) LVRS. FEV1, TLC, RV and RV/TLC ratio were assessed preoperatively and at 3, 6, 12 and 24 months post surgery. At the same time interval health status was assessed by Euroqol and SF 36 questionnaires. Results: Significant improvements in health status, as assessed by SF 36, persisted from 3 months to 1 year. However, in the pain domain there was a worsening of the mean score from 74 preoperatively to 64 at 3 months, 68 at 6 months, 73 at 12 months and 65 at 24 months. The improvements in Euroqol score were not statistically significant. However, they became significant for at least 2 years postoperatively, when those patients who had a worsening pain score postoperatively were excluded. While the percentage of patients with a worsening of pain scores measured with SF 36 remained between 40 and 45% even 2 years after LVRS, when using Euroqol this percentage did decrease from 30% at 3 months to 14% at 2 years. There was no significant correlation between the change of scores and length of operation, hospital stay or air leak. It was also not statistically significant whether these patients had an extra procedure (redo thoracotomy or insertion of extra drain postoperatively). There were some significant correlations between changes in hyperinflation and changes in pain scores but this was not consistent for Euroqol and SF 36. Conclusion: Postoperative pain detracts from global improvement in health status after LVRS even after unilateral VATS. There may be an influence of alterations in chest mechanics after surgery on the development of pain.

1. Introduction

Lung volume reduction surgery (LVRS) as was first described in 1958 by Otto Brantigan [1] was performed via lateral thoracotomy in which the peripheral areas of the lung were excised. Cooper re-introduced the concept of LVRS via median sternotomy incorporating simultaneous bilateral surgery [2]. With the introduction of video-assisted thoracoscopic surgery (VATS), LVRS has also been performed by VATS.

The benefits of LVRS have been reported both in terms of respiratory physiology as well as health status.

Disease-specific health status questionnaires have the advantage of being more sensitive to changes but generic instruments measure the impact of LVRS on various different aspects of health status. One of these aspects that affect health status and which is especially relevant after a surgical procedure is pain. Both the Short Form (SF 36) and Euroqol generic health status questionnaires contain questions regarding the degree of pain experienced by the patients [3,4]. Those with worse pain score will have a worse health status score.

Non-randomised studies comparing the degree of acute pain up to 3 weeks after VATS and open thoracotomies, found significant less pain after VATS [5–7]. Studies of the effects of VATS on chronic pain are sporadic but do suggest this occurs less frequent after VATS than after open thoracotomies [8]. None of these studies involve LVRS. As the primary objective of LVRS is to improve health
status in patients with severe emphysema we wanted to
assess the long-term effect of pain on health status after
unilateral VAT LVRS.

2. Patients and methods

Over a 5-year period we have assessed 230 patients for
LVRS by a multi-disciplinary selection panel comprising: a
respiratory physician, a physiotherapist, two radiologists
and two surgeons. All patients underwent physical exam-
ination, basic spirometry, plethysmography, arterial blood
gas analysis, chest radiography, computed tomography and
radionuclide ventilation/perfusion scintigraphy.

2.1. Selection criteria

Patients had to have significant symptomatic dysfunction
judged by the modified MRC dyspnoea scale as grade 3–5.
Spirometric inclusion criteria consisted of an FEV$_1$ of 15–
40% of predicted; residual volume (RV) in excess of 200%
of predicted; total lung capacity (TLC) greater than 120% of
predicted and a RV/TLC ratio over 60%. Anatomical
criteria included the presence of heterogeneous emphysema
with target areas of severe emphysema on CT scan.
Physiological heterogeneity was assessed on radionuclide
scintigraphy. This was quantitated by calculating the so-
called Q score as determined by the ratio of perfusion in the
target zone to the total lung perfusion [9]. Patients with
target areas in either upper or lower lobes were included.

Exclusion criteria included single large bullae, hyper-
capnia ($pCO_2$ greater than 7 kPa or 53 mmHg), greatly
reduced diffusion capacity ($K_{CO}$ less than 25% of predicted).

All patients underwent preoperative pulmonary rehabi-
litation. Exercise tolerance was assessed using the shuttle
walk test. Patients who could not complete a distance of 150
m in a shuttle walk test did not proceed to operation.
Rehabilitation was carried out as a 7-week out-patient or 2-
week in-patient programme.

Before surgery but after rehabilitation patients completed
Form with SF 36 (SF 36, Fig. 1) and Euroquol health status
questionnaires (Fig. 1) [3,4]. The Form with SF 36-item
questionnaire (SF 36) is a generic health status question-
naire in which 36 questions cover eight health domains;
physical functioning, social functioning, role limitations due
to physical problems, role limitations due to emotional
problems, mental health, energy/vitality, pain and general
health status. For each domain scores are transformed to
range from 0 (worst possible health status) to 100 (best
possible health status). The Euroquol is also a generic
questionnaire consisting of five dimensions; mobility, self-
care, usual activities, pain and discomfort, anxiety and
depression. Each dimension is scored from 1 to 3 (no
problem to extreme problem). These scores can be
transformed into a single index of health status.

\begin{tabular}{|l|}
\hline
\textbf{Euroquol} \tabularnewline
Pain/discomfort \tabularnewline
I have no pain or discomfort \tabularnewline
I have moderate pain or discomfort \tabularnewline
I have extreme pain or discomfort \tabularnewline\hline
\textbf{SF 36} \tabularnewline
\textit{How much bodily pain have you had during the past 4 weeks?} \tabularnewline
None \tabularnewline
Very mild \tabularnewline
Mild \tabularnewline
Moderate \tabularnewline
Severe \tabularnewline
Very Severe \tabularnewline\hline
\textit{During the past 4 weeks, how much did pain interfere with your normal work?} \tabularnewline
Not at all \tabularnewline
A little bit \tabularnewline
Moderately \tabularnewline
Quite a bit \tabularnewline
Extremely \tabularnewline\hline
\textbf{Epidural score} \tabularnewline
Pain at rest \tabularnewline
No pain \tabularnewline
Mild pain \tabularnewline
Moderate pain \tabularnewline
Severe pain \tabularnewline\hline
Pain at movement \tabularnewline
No pain \tabularnewline
Mild pain \tabularnewline
Moderate pain \tabularnewline
Severe pain \tabularnewline\hline
\end{tabular}

Fig. 1. The three different types of questionnaires used to assess pain after
VAT LVRS.

2.2. Surgical approach

At the start of our LVRS programme all operations were
performed bilaterally via median sternotomy or VATS. To
obtain a homogenous group of patients these patients were
excluded from this study. Subsequently one of the surgeons
adopted a policy of staged unilateral VATS LVRS,
operating on the least perfused lung first, with the timing
of the second operation determined by the patient on the
basis of symptomatic deterioration.

Surgical approach was though three 2-cm incisions.
Flexible ports were used to minimize intra operative
trauma (Flexipath, Ethicon Endo Surgery Inc., Cincinnati,
OH). All operations entailed stapled resection of function-
less areas of lung using pericardial buttresses. After
completion of the operation one or two drains 28F were
positioned through the VATS incisions and attached to a
5 kPa suction.
All patients had thoracic epidurals inserted in the anaesthetic room prior to their surgical procedures. Redo-operations were also performed with an epidural catheter in situ. The epidural infusion contained fentanyl 5 mcg/ml with bupivacaine 0.1% in 250 ml 0.9% saline. Whilst the patients had an epidural catheter hourly to four-hourly, scoring of the pain was performed using the epidural score (Fig. 1). In three patients epidurals were converted to intravenous morphine after 2–3 days due to redness around the entrance site of the epidural catheter. In the remaining patients epidurals were weaned gradually depending on the patients’ requirements. Most patients were discharged on a combination of oral analgesia consisting of paracetamol, dihydrocodeine and a non-steroidal anti-inflammatory drug.

2.3. Postoperative follow-up

Patients were reviewed in out-patient clinics at 3, 6, 12 months and then annually after surgery. At each visit, patients underwent detailed spirometry and plethysmography. They also completed SF 36 and Euroquol health status questionnaires.

2.4. Statistical analysis

Data were analysed using SPSS Version 9.0 statistical software. The relationships between preoperative and postoperative variables were assessed using the paired or unpaired Student’s \( t \)-test and the Wilcoxon test. All \( P \) values were reported without corrections for multiple comparisons, a \( P < 0.05 \) was considered to indicate a statistically significant difference.

3. Results

3.1. Preoperative characteristics

From 1997 to 2002, 52 patients underwent unilateral VATS LVRS. Median age was 59 (46–70) years. There were 34 male and 18 female patients. Two of the 52 patients subsequently proceeded to a staged bilateral procedure within 2 years of the first operation, in these patients the changes in respiratory physiology and health status after their second operation were omitted in the analysis of this study.

Nine patients have died since their operation but before their 2-year follow-up. None of the living patients were lost to follow-up but in some patients we were not able to obtain pulmonary function tests or health status questionnaires (admitted to ITU or lived geographically too far away to attend all yearly appointments) (Table 1).

3.2. In-hospital stay

Seven patients had a left-sided procedure, 45 patients a right-sided procedure. Average amount of lung tissue resected was 85 (32) g. The median duration of the general anaesthesia was 83 (40–240) min. In one patient the VAT was converted to an open procedure due to multiple adhesions. Four additional patients subsequently had an open thoracotomy for bleeding (one patient) or persistent air leak. Another five patients had an additional drain inserted postoperatively.

Median postoperative stay was 14 (6–197) days. Median duration of drain stay was 13 (40) days. Median duration of epidural was 6 (2–40) days. Thirty-day mortality was 2%. This patient died of sudden bleeding after removal of a chest drain.

3.3. Postoperative changes in respiratory physiology

Table 2 shows the postoperative changes in pulmonary physiology. The reduction in hyperinflation remains significant at least 2 years after LVRS.

3.4. Postoperative changes in health status

3.4.1. SF 36

At 6 months and 1 year the scores in seven out of eight domains were higher than preoperative values. Significant changes were seen in four domains from three months up to 1 year. At 2 years the scores tended to have deteriorated to scores below preoperative values. The scores in the pain
domain never reached preoperative values with significant worsening of the scores at 3 months (Table 3).

### 3.4.2. Euroquol

Although scores remained elevated from preoperative values these changes never reached statistical significance. However, when those patients were excluded who had a worsening pain score, a statistically significant increase was seen lasting at least 2 years post LVRS (Fig. 2; Table 3).

### 3.5. Correlations of pain score

The postoperative changes in pain scores as measured with the Euroquol questionnaire and with SF 36 correlated with each other although at each time interval there were more patients who had a worsening pain score, a statistically significant increase was seen lasting at least 2 years post LVRS (Fig. 2; Table 3).

#### 4. Discussion

In our patients health status and respiratory physiology improves after LVRS. However, even after 2 years patients experience pain, which detracts from the global improvement in health status.

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**Table 3**

<table>
<thead>
<tr>
<th></th>
<th>Preop</th>
<th>3 months</th>
<th>6 months</th>
<th>1 year</th>
<th>2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical functioning</td>
<td>25 (13)</td>
<td>41 (26)**</td>
<td>39 (24)**</td>
<td>38 (21)**</td>
<td>29 (17)</td>
</tr>
<tr>
<td>Social functioning</td>
<td>49 (27)</td>
<td>61 (32)**</td>
<td>59 (30)*</td>
<td>65 (29)**</td>
<td>47 (27)</td>
</tr>
<tr>
<td>Role limit physical</td>
<td>18 (27)</td>
<td>16 (31)</td>
<td>28 (32)</td>
<td>34 (37)</td>
<td>17 (27)</td>
</tr>
<tr>
<td>Role limit emotional</td>
<td>65 (40)</td>
<td>53 (45)</td>
<td>70 (39)</td>
<td>68 (42)</td>
<td>57 (37)</td>
</tr>
<tr>
<td>Mental health</td>
<td>68 (19)</td>
<td>69 (21)</td>
<td>71 (19)</td>
<td>74 (15)*</td>
<td>66 (18)</td>
</tr>
<tr>
<td>Energy</td>
<td>39 (18)</td>
<td>44 (22)*</td>
<td>44 (20)*</td>
<td>44 (22)</td>
<td>37 (21)</td>
</tr>
<tr>
<td>Pain</td>
<td>74 (28)</td>
<td>64 (30)*</td>
<td>68 (30)</td>
<td>73 (25)</td>
<td>65 (30)</td>
</tr>
<tr>
<td>GHP</td>
<td>30 (19)</td>
<td>40 (19)**</td>
<td>37 (20)*</td>
<td>35 (19)*</td>
<td>26 (16)</td>
</tr>
<tr>
<td>EQ</td>
<td>54 (26)</td>
<td>56 (26)</td>
<td>58 (27)</td>
<td>58 (22)</td>
<td>55 (22)</td>
</tr>
<tr>
<td>Euroquol pain score</td>
<td>1.6 (0.6)</td>
<td>1.9 (0.6)**</td>
<td>1.8 (0.6)*</td>
<td>1.8 (0.5)*</td>
<td>1.7 (0.6)</td>
</tr>
</tbody>
</table>

Wilcoxon test comparing postoperative values with preoperative values; * P < 0.05, ** P < 0.01.
There are few studies evaluating the effects of VATS on long-term pain. It is difficult to compare these studies. They often consist of different patient groups, use different methods of assessing pain and at different time intervals.

Stammberger’s study of 173 patients, evaluating the early and long-term pain complaints after VATS, did find that in many patients the pain was of a shorter duration than in our study (Table 3) [10]. However, this was a retrospective study, using only one self-reported questionnaire on a heterogeneous group of patients undergoing a variety of surgical procedures. Passlick looked at a group of 60 patients who had a VATS procedure for spontaneous pneumothorax and found that after a median follow-up of 59 months 32% still experienced chronic pain [11]. Hutter also found chronic sequelae (pain in 20.1%, as well as numbness and dysesthesia) in 31.4% at least 2 months after thoracoscopy for benign disease [12]. Also, after lobectomies for malignant tumours VATS was found to cause less acute and chronic pain compared to thoracotomies [8].

In our study we found different results depending on which questionnaire we used. The reason more patients have a worsening pain score as measured with SF 36 may be due to its higher sensitivity to measure smaller changes. The Euroqol questionnaire has only one question related to pain with three possible answers, while the SF 36 has two questions with each five or six possible answers. Nevertheless, a standardised health status questionnaire may be a better way of assessing the duration of pain rather than a self-reported duration of pain.

Long-term pain after thoracotomy is common, occurring up to 50% after 2 years. It seems from our study as well as others that this is also a problem after VATS. The next step would be to find out what predicts postoperative pain and how to reduce it. Katz found early postoperative pain the only factor that predicted long-term pain [13]. We found no correlation between the epidural score or duration of epidural used in the acute postoperative period and the long-term changes in pain scores. It may be that the routine use of epidurals avoids too severe pain in the early period, thereby eliminating this risk factor for subsequent pain.

Hutter found a significant correlation whether one or two drains were used [12]. We found no such correlation. Again, this may be related to our routine use of postoperative epidural for pain relief; the usual difference in pain experienced with one or two drains in situ may have been eliminated.

Our population differs from the other studies in that all our patients have severe emphysema. In a group of hospitalised patients with advanced COPD 21% was reported to have severe pain [14]. Pain in patients with emphysema has been found to correlate with FEV1/FVC [15]. However, we found no such correlation. The fact that patients with emphysema can suffer from severe pain may also be a contributing factor that we have failed in our study to show that adequate control in the acute period is related to the avoidance of long-term pain.

We found no correlation with the preoperative BMI and the subsequent change in pain scores. There were some correlations between the subsequent improvements in BMI and the improvements in pain scores. It may be that patients who have less pain are able to eat better and so increase their BMI. It has been found that LVRS increases BMI, however, probably not related to increased intake of food [16]. It may be that those with improved BMI have a different chest wall configuration causing less strain on musculo-skeletal structures. This may also be the mechanism behind the observation that there seems to be some correlation between changes in RV and changes in pain score.

As regards to the correlation between preoperative pain scores and subsequent pain score; obviously those patients with a 100% score are not able to improve their score even further. Those who already have a low pain score, the added

### Table 4
Percentage of patients with worsening pain score

<table>
<thead>
<tr>
<th></th>
<th>3 months</th>
<th>6 months</th>
<th>1 year</th>
<th>2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF 36 (all pat)</td>
<td>15/37 = 41%</td>
<td>14/38 = 37%</td>
<td>13/35 = 37%</td>
<td>10/22 = 45%</td>
</tr>
<tr>
<td>SF 36 (only pat with addit procedure)</td>
<td>2/6 = 33% (NS)</td>
<td>3/6 = 50% (NS)</td>
<td>1/5 = 20% (NS)</td>
<td>2/4 = 50% (NS)</td>
</tr>
<tr>
<td>EQ (all pat)</td>
<td>11/37 = 30%</td>
<td>10/38 = 26%</td>
<td>7/35 = 20%</td>
<td>3/22 = 14%</td>
</tr>
<tr>
<td>EQ (only pat with addit procedure)</td>
<td>2/6 = 33% (NS)</td>
<td>2/6 = 33% (NS)</td>
<td>1/5 = 20% (NS)</td>
<td>0/4 = 0% (NS)</td>
</tr>
<tr>
<td>Stammberger [7]</td>
<td>25%</td>
<td>14%</td>
<td>4%</td>
<td></td>
</tr>
</tbody>
</table>
pain of the operation may not influence the score much. It becomes less clear why these patients often improve their scores post-LVRS.

Various anaesthetic and surgical techniques have been described to reduce acute postoperative pain after VATS. It is doubtful whether alternative analgesic methods, such as intraoperative blocks and transcutaneous electrical nerve stimulation [17,18] would add any benefit, as all our patients already have epidural analgesia. Senturk’s randomised study comparing three different analgesia techniques (thoracic epidural analgesia with or without preoperative initiation and intra-venous patient-controlled analgesia) found that preoperatively initiated thoracic epidural analgesia was most effective in controlling pain in the acute and long-term period [19].

We use flexible surgical ports to minimize intraoperative trauma. Other techniques described include the localized partial rib resection and the placements of all instruments along one intercostal space. However, the reported study was only on nine patients and it may be technically less useful in a more complicated procedure as LVRS [20]. Still in an experimental stage but potentially a solution to prevent post-VATS pain is bronchoscopic LVRS. Several techniques have been described. Ingenito’s group reports on the favourable results of an animal study in which hyperinflated lung is transformed into contracted scar tissue after installation of various solutions into the bronchi [21]. Lausberg’s ex vivo study in human lungs involves the placement of stents between pulmonary parenchyma and large airways to improve expiratory flow [22].

Perhaps the best solution of managing post-VATS pain at present is the more frequent and earlier referral of patients to a specialized pain clinic. For post-thoracotomy pain posterior multidermatomal intercostal nerve blocks, epidural blocks and paravertebral blocks have all been used with success [23].

Some of the health status benefit of LVRS is offset by postoperative pain and it is important to inform patients about this possibility. It would be interesting to compare this group of LVRS patients with our other patients who undergo VATS, who we do not routinely use flexible port on, and who do not have routinely epidural pain relief. Their drain stay as well as their total hospital stay tends to be shorter.

References