Prospective study on video-assisted thoracoscopic surgery in the resection of pulmonary nodules: 209 cases from the Spanish Video-Assisted Thoracic Surgery Study Group

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Abstract

Objective: The diagnosis of pulmonary nodules has become one of the main indications of video-assisted thoracoscopic surgery (VATS), especially for small nodules not accessible by bronchoscopy or by percutaneous transthoracic needle aspiration. In this study we evaluate the indications, diagnostic safety, complications, and technical difficulty of VATS in the diagnosis of pulmonary nodules in Spain. Materials and methods: We conducted a prospective study of 209 patients with one or more pulmonary nodules from a group of Spanish thoracic surgery divisions (The Spanish Video-assisted Thoracic Surgery Study Group). Data was collected and evaluated on variables contained on a questionnaire including demographic information, characteristics of the nodules, identification methods, surgical technique, morbidity and mortality rates, and diagnostic yield. Results: The mean size of the nodules was 1.9 cm (range 0.3–5 cm). A total of 93.3% were peripheral. A diagnosis was established in 100% of the cases. In this study, 51.1% of lesions were benign and 48.8% were malignant. In 16.3% of cases, a conversion to thoracotomy was needed. The morbidity was 9.6% and the mortality 0.5%. We found a relationship between the size of a nodule and a diagnosis of malignancy \( P < 0.019 \) and between a central location and a need to convert to thoracotomy \( (P = 0.002) \). Patients with nodules \( \geq 2 \) cm had a greater risk of complications \( (P = 0.0001) \). Conclusions: In the diagnosis of pulmonary nodules, VATS has a specificity of 100% and a low mortality rate. The probability of developing complications is higher when the nodule is \( \geq 2 \) cm. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Pulmonary coin lesion; Video-assisted thoracic surgery; Lung neoplasm; Diagnosis; Lung disease

1. Introduction

The aim when evaluating patients with a solitary pulmonary nodule is to reduce as much as possible any delay in the diagnosis and treatment of malignant nodules, while avoiding operating on patients with benign lesions. The 5-year survival rate in patients treated for T1N0M0 bronchogenic carcinoma [1] is > 65%. These encouraging results should stimulate a more aggressive attitude in the diagnosis of pulmonary nodules. An incidental finding of a pulmonary nodule during preoperative work-up is not unusual. The diagnosis of these pulmonary nodules has become one of the main indications for video-assisted thoracoscopic surgery (VATS), especially in small nodules [2] where bronchoscopy or percutaneous transthoracic needle aspiration (PTNA) is not indicated. The advantages of VATS over other procedures are its lower degree of trauma compared with conventional surgery and the complete resection that can be performed on a nodule, which leads to greater diagnostic security than with needle aspiration.

In this study we report the experience of a group of Spanish centres (the Spanish Video-assisted Thoracic Surgery Study Group; see Appendix A) in diagnosing pulmonary nodules by using VATS.

2. Materials and methods

Data on the results of using VATS was prospectively collected from 17 member hospitals of The Spanish Video-assisted Thoracic Surgery Study Group. Between 7 January 1996 and 7 January 1998, 1573 patients were operated on. The questionnaires sent back by each hospital included data on demographics, localization and size, and previous clinical suspicion, in addition to technical aspects such as the method used to identify the nodule, number of trocar sites, resection technique, number of endostaple cartridges used, number of cases requiring conversion to...
thoracotomy, final pathological diagnosis, morbidity and mortality.

We studied 209 consecutive patients (136 males and 73 females) operated on by VATS (as our first choice) who had one or more pulmonary nodules. Nodule is defined as a lesion under 6 cm, round or oval in the lung parenchyma on a chest radiograph, in the absence of atelectasis or pneumonia; the radiological aspect of the nodules was indeterminate, with no evidence of benign pattern calcification (target, central diffuse or laminated). The size was measured using the large diameter in solitary nodules or the biggest one if multiple.

We compared the results in the group of hospitals with more than 20 cases with hospitals with 20 or less cases.

Other analyzed variables were age of the patients and size of the nodules (categorized in two groups each according to the values of the median). Nodules were also classified into two groups, considering as peripheral all nodules situated in the one-third external from the hilum and those situated in the two-thirds close to hilum as central [3]. We correlate between the number of nodules by computed tomography (CT) scan and that found at operation.

Statistical analysis was done using SPSS 8.0 for Windows 98. Using contingency tables, correlation among the discrete variables being studied was calculated. Chi-square ($\chi^2$) was calculated using Fisher’s exact test. Also, an estimation of the risk was calculated using an odds ratio and its 95% confidence interval (CI). Independent variables that showed a relationship to morbidity were entered into a logistic regression analysis to identify the influence of each on the development of complications. For continuous variables a ROC curve was constructed to evaluate its strength as a diagnostic predictor and to establish an appropriate cut-off point.

### 3. Results

Two hundred and nine patients (136 males and 73 females) were included in this study. The mean age was 57 years (SD 14.11, median 60, range 15–87 years). The majority of cases (121 patients, 57.8% of total) were collected by four hospitals.

Characteristics of the nodules: 166 patients (79.4%) had only one nodule; 19 patients (9.1%) had two; nine patients (4.4%) had three or more and in three patients (1.4%) no nodule was found at the time of surgery (in all three cases the preoperative CT scan showed a solitary nodule). In all cases the correlation between preoperative imaging and surgery was absolute, but in 12 patients we could not correlate the number of lesions because only biopsy forceps or resection of one nodule (patients with multiple nodules) was done. The size of the nodules ranged between 0.3 and 5 cm with a mean of 1.9 cm (SD 0.9, median 2 cm).

Localization was peripheral in 93.8% and central in 6.2%. The method of localization most frequently used was visual in 103 cases (49%), followed by digital or instrumental palpation in 82 cases (39.2%). Some form of preoperative localization procedure was used in ten cases (4.8%). In ten patients (4.8%) cyto-histologic preoperative diagnosis was obtained; the preoperative method for histological diagnosis was transbronchial biopsy in eight patients (3.8%) and PTNA in 15 patients (7.2%). Another 13 cases (6.2%) were operated on after a cytological sample suggestive of malignancy, and in all of them, preoperative diagnosis was confirmed. The pathological diagnosis was most frequently benign (51.1%), while 48.9% of the cases were malignant. There was a slightly higher prevalence of bronchogenic carcinoma over metastatic lesions (Table 1).

Conversion to thoracotomy was performed in 34 cases (16.3% of the total). The causes are listed in Table 2.

Complications appeared in 9.6% (17 patients) and are listed in Table 3. One patient died postoperatively (0.5%) due to intestinal obstruction caused by a neoplasm of the colon.

No case of tumour seeding at the trocar site was detected, and only one case of metastatic relapse was reported during

### Table 1

<table>
<thead>
<tr>
<th>Histology</th>
<th>Number</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>Malignant</td>
<td>102</td>
<td>48.9</td>
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<tr>
<td>Bronchogenic cancer</td>
<td>51</td>
<td>24.7</td>
</tr>
<tr>
<td>Metastatic</td>
<td>47</td>
<td>22.7</td>
</tr>
<tr>
<td>Other tumour</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Benign</td>
<td>107</td>
<td>51.1</td>
</tr>
<tr>
<td>Granuloma</td>
<td>51</td>
<td>24.7</td>
</tr>
<tr>
<td>Hamartoma</td>
<td>28</td>
<td>13.5</td>
</tr>
<tr>
<td>Benign tumour</td>
<td>11</td>
<td>5.5</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>7.2</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Conversion to thoracotomy</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oncologic criteria</td>
<td>21</td>
<td>11.4</td>
</tr>
<tr>
<td>Technical troubles/Intubation</td>
<td>12</td>
<td>6.4</td>
</tr>
<tr>
<td>Pleural adhesions</td>
<td>10</td>
<td>5.4</td>
</tr>
<tr>
<td>Inability to localize</td>
<td>10</td>
<td>5.4</td>
</tr>
</tbody>
</table>

### Table 3

<table>
<thead>
<tr>
<th>Morbidity</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air leaks &gt;5 days</td>
<td>9</td>
<td>5.1</td>
</tr>
<tr>
<td>Infections</td>
<td>2</td>
<td>1.1</td>
</tr>
<tr>
<td>Residual pleural spaces</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Persistent postoperative pain</td>
<td>1</td>
<td>0.5</td>
</tr>
</tbody>
</table>
the follow-up period of this study. In two cases, there were distant metastases of the primary lung tumour.

The mean postoperative stay in this study was 6.24 days (range 0–27; SD 4.76, mode 4 days). There is no statistical relationship between the number of lesions and a diagnosis of benignity or malignancy. Nor is the number of lesions associated with the probability of metastases.

A diameter > 2 cm was associated with malignancy ($P = 0.019$; odds ratio $2.19$, 95% CI $1.13–4.21$). The number of nodules greater than 3 cm was 18 (8.6%) and those with a diagnosis of malignancy 14 (6.6%).

There also exists an association between central location of a nodule and the need to convert to thoracotomy ($P = 0.002$; odds ratio $6.150$, 95% CI $1.8–20.2$).

Hospital case-load influenced only the rate of conversion to thoracotomy. In the more experienced hospital, the rate of conversion was significantly higher than in the other group ($P = 0.015$). If we compare the causes of conversion, we find a higher rate of conversion due to oncological criteria in the experienced group (15 cases) versus the inexperienced one (five cases).

The length of postoperative stay was obviously associated with the occurrence of complications ($P < 0.0001$). On univariate analysis, patients older than the median (60 years) showed a higher risk of complications ($P < 0.0001$), and those with nodules greater than the median value showed a higher risk of postoperative complications ($P < 0.0001$). On multivariate study by stepwise Cox regression analysis, size of nodule was the main prognostic predicting factor ($P = 0.001$). A ROC curve was constructed using the rates of complication for each of the quarters of nodule size (Fig. 1). The area below the curve is 0.77 (SE 0.06). The odds ratio for the cut-off point at 2.05 cm is 5.83 (95% CI 2.05–16.56).

4. Discussion

The importance of diagnosing a solitary pulmonary nodule derives from the high risk of malignancy [4]. Video-thoracoscopy is being increasingly used in the diagnosis of pulmonary nodules. The accuracy and the low morbidity of the technique are the reason for its increasing use [5]. Malignancy risk is related to the age of the patient, history of smoking, previous neoplasms, size of the lesion, growth, location [6], etc. There is abundant clinical evidence demonstrating that screening in high-risk patients (heavy smokers and former smokers) significantly improves the early detection rate, stage, resectability, and long-term survival of patients with lung cancer. Therefore, as Smith commented [7], the existing public health policy discouraging the screening for lung cancer must be reconsidered. On X-ray studies the only characteristic suggesting a benign etiology is absence of growth in the past 2 years. Furthermore, growth of the lesion or a size greater than 3 cm increases the likelihood of malignancy [6].

Bronchoscopy and CT scan-guided PTNA are generally not useful in nodules of less than 2 cm. In our series, two-thirds of the nodules were less than 2 cm, and nodules greater than 2 cm rarely have a diagnosis that is specific for a benign etiology [6], therefore having a clinically unacceptable percentage of false negatives. However, in cases of malignancy the patient is going to undergo surgery anyway, so it seems recommendable to perform video-thoracoscopy on all patients with a pulmonary nodule.

According to our data the presence of a lesion in the two-thirds closest to the hilum, defined as a central nodule, is six times more likely to lead to conversion to thoracotomy than a peripheral one. Considering these results we should look at central nodules almost as a contraindication for VATS. Additionally, in our series, the percentage of conversions to thoracotomy due to the inability to locate the nodule was only 5.4% (ten cases), which could justify the scarce usage of preoperative localization methods in the hospitals participating in our study (4.8%) [8–11]. It is interesting to point out that in almost 40% of cases, the localization of the nodule was done digitally or by instrumental palpation. Some authors recommend deliberately placing the entry points into the thorax so that one of them is near the lesion. This would allow a finger to be introduced in order to inspect the nodule.

It is interesting to emphasize that in three cases (1.4%) no nodule was found after conversion to open surgery, and follow-up did not demonstrate any recurrence or missed at initial exploration. In our Medline search we did not encounter any studies relating failure to find lung nodules; this may be because the authors have a tendency to communicate only successful procedures [12].

In our series we have not found any association between a diagnosis of malignancy and the need to convert to thoracotomy. This is attributable to the fact that technical difficulties as well as pleural adhesions often override
oncological criteria. We also found no association between previous clinical suspicion and a need to convert to thoracotomy.

Some authors have reported an association between the size or number of nodules and the probability of malignancy [13]. However, in our series, only a size > 2 cm (one-third of nodules) was associated with malignancy, and not the number of nodules, as might be expected. This may be because, as in the Ginsberg et al. [14] series, the prevalence of malignant diagnoses was higher.

The presence of a nodule > 2 cm increases the risk of complications fivefold, mainly due to postoperative air leaks. On the logistic regression analysis, size is the variable that has the greatest influence, probably because age and size are both related.

Although mean postoperative hospital stay is influenced by the presence of complications, with the exception of morbidity our results show figures higher than the mean published in the literature [13]. We have found no relation between these figures and any other variable, thus leading us to think that there may be structural factors in the different hospitals influencing length of stay. Nor is there a relation between experienced hospitals and others with small case-loads and postoperative hospital stay.

In summary, VATS is a technique that provides a 100% rate of diagnosis of pulmonary nodules with low morbidity/mortality. Conversion to thoracotomy is related to central location. Finally, the probability of developing postoperative complications is greater when the nodule is larger than 2 cm.

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References


Appendix A. The Spanish Video-Assisted Thoracic Surgery Study Group

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Dr Gaspar Gómez H. San Pablo, Barcelona
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Dr Miguel Mateu H. Mutua de Terrasa, Barcelona
Dr Laureano Molins H. Sagrado Corazón, Barcelona
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Dra Mercedes de la Torre H. Juan Canalejo, A Coruña
Dr Antonio Torres H. San Carlos, Madrid