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VATS VERSUS OPEN THORACOTOMY IN THE MANAGEMENT OF PRIMARY SPONTANEOUS PNEUMOTHORAX: A COMPARATIVE STUDY

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Abstract

Objective: To evaluate and compare the efficacy and results of VATS technique and that of open thoracotomy in management of primary spontaneous pneumothorax.

Patients and Methods: A total of 54 patients of primary spontaneous pneumothorax, 21 of them managed between July 1998 till December 1999 (18 months) by thoracotomy named group (I) and the other 33 patients group (II) undergoing thoracoscopy to manage primary spontaneous pneumothorax from January 2000 to June 2001 (18 months).

Results: The mean age of the patients in group (I) was 24.9 ± 5 years, and it was 25.3 ± 8 years for the group II. There were no females in group I, while there were 3 females (9%) in group II. Persistent air leak for more than 6 days in the first episode of patients and recurrent episodes of spontaneous pneumothorax were the major indications for surgical interference whether thoracotomy or VATS. Ligation of base of the blebs or bulla with an absorbable polydioxanone sutures, mechanical abrasion of the parietal pleura with a piece of gauze or Marlex mesh, with or without partial apical pleurectomy were the techniques used in both approaches. Operating time in group I (58 ± 8 min) was slightly longer than that in group II (38 ± 6.5 min). The mean ICT drainage amount in the first 24 hours postoperatively was more in group I (193 ± 36 ml) than that in group II (182 ± 33 ml). The mean dose of pethidine which was given in the 1st postoperative 24 hours in group I was more than that in group II (280 vs. 201) and it was statistically significant. Prolonged air leak more than 4
days occurred in 3 patients (14%) in group I and 2 patients (6%) in group II, while empyema occurred in 2 patients (10%) in group I and in 1 patient (5%) in group II. The period of I/C/T for group I was 4.3 ± 1 day, while it was 3.3 – 0.5 days for group II and the postoperative hospital stay was 10.3 – 1.1 days for group I and it was 4.5 – 0.6 days for group II. Follow-up for 12-18 months revealed recurrence in 3 patients (14%) in group I, two of them managed by rest and the other one managed by I/C/T insertion which was removed after 4 days, and recurrence occurred in two patients (5%) in group II, both of them were managed conservatively by rest and observation. All the recurrent cases were managed primarily by mechanical pleurodesis only without pleurectomy.

Conclusion: We concluded that video-assisted thoracoscopic surgery is a viable alternative to thoracotomy in the management of primary spontaneous pneumothorax. It is a safe procedure with less analgesic usage, shorter hospital stay and fewer complications. Apical pleurectomy with ligation of the blebs or bullae is superior to pleural abrasion in prevention of recurrence.

Introduction

Spontaneous pneumothorax is a condition that impacts significantly on healthcare experience (Yim, 2001). Spontaneous pneumothorax can be divided into primary spontaneous pneumothorax resulting from rupture of subpleural blebs or bullae, and secondary spontaneous pneumothorax, which is related to the presence of an underlying lung disease (e.g., emphysema) (Ayed and Al-Din, 2000). Primary spontaneous pneumothorax is a potentially dangerous condition which often affects young and otherwise healthy people. It is relatively uncommon problem with a reported incidence of 5-10 per 100,000, a male to female ratio of 6:1 and peak prevalence in the 2nd and 3rd decades of age (Al-Qudah, 1999). The approach to the initial management of spontaneous pneumothorax differs markedly from centre to centre, and it is difficult in practice to establish a standard protocol (Chann, 2000). The indications for surgical treatment include persistent air leak, recurrent spontaneous pneumoth-
orax, contralateral spontaneous pneumothorax, and spontaneous pneumothorax in a high risk occupation, such as pilot or diver (Parry et al., 1992). The aims of surgical treatment are to close the site of the air leak, to allow full re-expansion of the lung and to prevent future recurrence (Ayed and Al-Din, 2000). The standard surgical treatment of spontaneous pneumothorax is through a thoracotomy approach, with a very low recurrence rate (Murray et al., 1993). Video-assisted thoracic surgical approaches appear to be viable alternatives to thoracotomy when surgical management of spontaneous pneumothorax is required (Hazelrigg et al., 1993). Apical bullae of the lung can be resected, and pleural abrasion can be accomplished with minimal postoperative morbidity and usually a shorter postoperative hospital stay (Cannon et al., 1993).

The aims of this study were to review our experience in the management of primary spontaneous pneumothorax and evaluate the efficacy of VATS technique and open thoracotomy and to compare the results of both approaches in the management of primary spontaneous pneumothorax.

**Patients and Methods**

A total of 54 patients with recurrent or persistent (more than 6 days) spontaneous pneumothorax were included in this controlled clinical study, treated from July 1998 till June 2001, 21 of them (group I) underwent open posterolateral thoracotomy from July 1998 till December 1999, while from January 2000 till June 2001, 33 patients (group II) were scheduled for video-assisted thoracoscopy (VATS). In both approaches, resection of the apical blebs or bulae by ligation with parietal pleural abrasion with or without partial apical pleurectomy was done. Preoperative investigations included chest radiograph, CT of the chest and other routine preoperative laboratory investigations.

**Surgical Indications:**

Surgery was performed in 25 patients with 1st episode of spontaneous pneumothorax due to persistent air leak for more than 6 days (13 of them were in group I and the other 12 were in group II) and in the remaining 29 patients.
surgery was performed due to recurrent episodes of spontaneous pneumothorax (8 of them were in group I and 21 in group II).

Surgical Technique of Thoracotomy:
All patients received general anesthesia by inhalation. The patient was ventilated through a single lumen endotracheal tube. The patient was placed in the lateral decubitus position. The entire chest wall was prepared and draped in the standard manner. A limited posterolateral thoracotomy was made through the 5th intercostal space. The ribs were spread enough to introduce the operator’s hand and allowing the usage of different instruments. Careful inspection of the lung was done to identify any apical bullae or blebs even in the apex of the lower lobes. When any apical blebs or bullae were identified, ligation of their bases with absorbable polydioxanone sutures was done after grasping the blebs or bullae with an empty sponge stick. The procedure usually accompanied with parietal pleural abrasion with a piece of gauze or Marlex mesh extending from the apex down to the level of the diaphragm in all directions and in some cases the abrasion was accompanied by partial apical parietal pleurectomy extending from the apex down to the level of the thoracotomy incision to help adhesion of the lung to the chest wall. Any bleeding was controlled with electrocautery. Through separate incisions, two chest tubes were left in place for drainage of the pleural space. The incision was closed in layers with absorbable materials. The chest tubes were remained till full expansion of the lung and cessation of air leaks. All patients were discharged 3 days after removal of the last chest tube.

Operative Technique of VATS:
With the patient under general anesthesia using a double-lumen endotracheal tube, the patient received single lung ventilation throughout the VATS procedure. The patient was placed in a posterolateral thoracotomy position. A 10-mm trocar was introduced through 1.5 cm skin incision in the eighth intercostal space at the midaxillary line for insertion of a “0” degree videothoracoscope. Two additional ports were then insert-
ed under direct vision: a 12-mm trocar through the fifth intercostal space on the anterior axillary line, and another one through the fifth intercostal space posteriorly near the tip of the scapula. Careful examination of the apex of the lung searching for the site of bullae or blebs, and once any bulla or bleb was identified, it was grasped with an empty sponge stick, the base of the bulla or bleb was ligated with an endoloop of absorbable polydioxanone suture. If the site of the bleb or bulla was not identified, the anesthesiologist was asked to inflate the lung slowly with small tidal volume. Warm saline solution was introduced into the chest cavity until the actively leaking area become visible, and then ligation was done with the endoloop. Mechanical pleurodesis was then performed subsequently using Marlex mesh through one of the wounds to abrade the pleura as much as accessible in all directions to achieve good pleural adhesions. Partial apical parietal pleurectomy was performed in some patients to help adhesions. Then, a chest tube (32F) was introduced through the inferior wound and placed posteriorly and basely, and another one (28F) was introduced through the anterior wound at the 5th intercostal space and placed apically and anteriorly. All the incisions were closed with 2/0 silk. Then, low pressure (~20 cm H2O) suction system applied to the chest bottles during the first 24 hours postoperatively to achieve continuous and complete re-expansion of the lung. If no postoperative air leak detected, the suction system was disconnected and the apical chest tube was removed, after another 24 hours the basal chest tube was removed also, provided that the drainage was less than 100 ml. otherwise, the tube was removed after another 24 hours. All the patients were discharged the day after removal of the last chest tube.

Postoperative analgesics:
All the patients were transferred to the ward after complete anesthetic recovery and the analgesia (Pethidine) was given in a dose of 50 mg every 4-6 hours according to the need of the patients.

Post-procedure assessment:
Duration of the procedure in
minutes, total volume of the intercostal tube drainage in the first 24 hours, total amount of given analgesics in the first 24 hours, the period of preoperative ICT in days, the period of postoperative air leak in days, the period of postoperative hospital stay, complications, recurrence and periodical follow up of the patients were evaluated. All the results were collected and statistically analyzed.

**Statistical Analysis:**

Data were analyzed using t-test. Statistical analysis was conducted using SPSS (Version 7) for Windows statistical package. P-value < 0.05 was considered statistically significant.

**Results**

This study included 54 patients with primary spontaneous pneumothorax whether with 1st episode (25 patients) or recurrent episodes (29 patients), 51 were males (94.5%) and 3 females (5.5%), age ranged between 16-45 years old (mean age 24.8 ± 7 years). Twenty one patients (group I) of them underwent thoracotomy for management of the spontaneous pneumothorax and the other 33 patients (group II) were managed by VATS. Table I & II summarize all the results and data of the patients:

There was no significant difference (P-value > 0.05) between the mean ages of both groups. The period of preoperative ICT period was 4.8 ± 2 days for the thoracotomy group (I) and it was 4 ± 1.9 days for the group of VATS (II), but it was statistically non significant. In group I, the number of patients treated due to 1st episode was 13 patients (62%), while, it was 12 patients (36%) in group II. There were no statistical significant differences in the operative time and the mean ICT drainage in the 1st 24 hours postoperative ly between the group of thoracotomy (I) and group of VATS (II). There was no operative, early or late mortality in both groups.

There were significant differ-
ences (P-value ≤ 0.05) between group I and II in the mean amount of pethidine which was given in the postoperative 1st 24 hours as it was higher in group I than that was given in group II (280 mg vs. 201 mg). There were also statistical significance differences between the 2 groups in the mean period of postoperative air leak (2.2 vs. 2 days), mean period of post-operative ICT (4.3 vs. 3.3 days) and mean period of postoperative stay (10.3 vs. 4.5 days). There was persistent air leak for more than 5 days in 3 cases (14%) in group I and 2 cases (6%) in group II, the ICT was removed after full re-expansion of the lung and absence of air leak. Empyema occurred in two cases (10%) in group I and in only one case (3%) in group II. The 3 cases were managed by the appropriate antibiotics, and the ICT was removed after the drainage becomes less in amount, sterile and clear.

All the patients were followed-up for a mean of 14 months (12-18 months) revealing the recurrence of 3 cases (14%) in group I and 2 cases (6%) in group II. One patient (from group I) was managed by insertion of ICT which removed after 4 days after complete re-expansion of the lung, the other 4 patients were managed conservatively by rest and observation. The lung was completely re-inflated in all cases. All the recurrent cases were those in whom abrasion only was done without pleurectomy.

Table I: Summary of all cases of spontaneous pneumothorax with non-significant P-Value.

<table>
<thead>
<tr>
<th>Item</th>
<th>Thoracotomy (group I)</th>
<th>VATS (group II)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Number of patients</td>
<td>21</td>
<td>33</td>
<td>-</td>
</tr>
<tr>
<td>-Age (years)</td>
<td>24.9 ± 4.9</td>
<td>25.3 ± 8</td>
<td>0.23</td>
</tr>
<tr>
<td>-1st episode</td>
<td>62% (13/21)</td>
<td>36% (12/33)</td>
<td>0.066</td>
</tr>
<tr>
<td>-Recurrent episode</td>
<td>38% (8/21)</td>
<td>64% (21/33)</td>
<td>0.066</td>
</tr>
<tr>
<td>-Pre-operative ICT period</td>
<td>4.8 ± 2</td>
<td>4 ± 1.9</td>
<td>0.08</td>
</tr>
<tr>
<td>-Operating time (minutes)</td>
<td>58 ± 5</td>
<td>58 ± 6.5</td>
<td>0.45</td>
</tr>
<tr>
<td>-ICT drainage (1st 12 hour)</td>
<td>193 ± 36</td>
<td>182 ± 33</td>
<td>0.13</td>
</tr>
<tr>
<td>-Persistent air leak</td>
<td>14% (3/21)</td>
<td>6% (2/33)</td>
<td>0.3</td>
</tr>
<tr>
<td>-Empyema</td>
<td>10% (2/21)</td>
<td>3% (1/33)</td>
<td>0.31</td>
</tr>
<tr>
<td>-Follow-up period (months)</td>
<td>14.8 ± 2</td>
<td>14.7 ± 2</td>
<td>0.3</td>
</tr>
<tr>
<td>-Recurrence</td>
<td>14% (5/35)</td>
<td>6% (2/33)</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Table II: Summary of all cases of spontaneous pneumothorax with significant P-Value.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Thoracotomy (group I)</th>
<th>VATS (group II)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>21</td>
<td>33</td>
<td>0.00006</td>
</tr>
<tr>
<td>Pethidine (1st 24 hours)</td>
<td>280 ± 45</td>
<td>201 ± 40</td>
<td>0.002</td>
</tr>
<tr>
<td>Postoperative air leak</td>
<td>2.2 ± 0.9</td>
<td>2 ± 0.9</td>
<td>0.00002</td>
</tr>
<tr>
<td>Postoperative ICT period</td>
<td>4.3 ± 0.9</td>
<td>3.3 ± 0.5</td>
<td>0.00002</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>10.3 ± 1.1</td>
<td>4.5 ± 0.6</td>
<td>0.00002</td>
</tr>
</tbody>
</table>

**Discussions**

The 1st episode of spontaneous pneumothorax is traditionally managed by closed tube thoracotomy which considered as the main therapeutic approach in the majority of patients, but the procedure is usually ineffective in preventing recurrence (20%) and successful re-expansion occurred only in 80% of cases (Al-Qudah, 1999). The non-operative therapies of recurrent spontaneous pneumothorax have varied from rest and observation, needle aspiration and chemical pleurodesis with tetracycline or talc poudrage with a recurrence rate ranging from 22%-40%, while it is about 1% in operative techniques (Ribet, 1994). The rationale for operative approaches is to eliminate the cause of the recurrent pneumothoraces and to prevent future lung collapse by thorough pleurodesis (Yim, 2001). Surgical treatment of spontaneous pneumothorax can be through a thoracotomy or a video-assisted thoracoscopy approach (Miller et al, 2000). The advent of video-endoscopy revolutionizes the practice of surgery, within a short span of time, VATS has become an acceptable approach for the treatment of spontaneous pneumothorax (Boutin et al, 1995), (Vodicka et al, 2000) and (Yim et al, 2001). Thoracoscopic surgery can be carried out safely and effectively in the treatment of recurrent or persistent spontaneous pneumothorax (Al-Qudah, 1999), (Boutin et al, 1995) and (Takerno, 2000). Blebs or bullae, which are the cause of spontaneous pneumothorax, are easily managed by VATS with excellent results. The apical
bullae can be resected by one or combination of many methods as wedge resection using an endoscopic stapler, endoscopic loop technique, electrocoagulation or laser coagulation of blebs (Al-Qudah, 1999). (Inderbitzi et al, 1994) and (Liu et al,1995). The same could be done by open thoracotomy approach with comparable results to VATS. Few authors have tried to compare VATS technique with the open thoracotomy for the treatment of primary spontaneous pneumothorax (Al-Qudah, 1999). The principal advantage of VATS procedure over the open thoracotomy is the size of the incision (15-20 cm); where in VATS 3 incisions of less than 2 cm each are sufficient for exploring the thoracic cavity and dealing with the pathology. Small incisions generally reduce trauma access, postoperative pain, postoperative pulmonary dysfunction, catabolic response to trauma and wound related complications (Gehrhard et al, 1996).

Our series carried out on 54 patients of primary spontaneous pneumothorax indicated for surgical interference of different ap-

proaches due to persistent air leak for more than 6 days or due to recurrent episodes of pneumothorax to compare the results of VATS to the results of open thoracotomy as well as complications and recurrence in both techniques. Thoracotomy was carried in 21 patients (group I) and VATS was done in 33 patients (group II). In all cases, resection of the blebs or bullae was done by ligation of the base of the blebs or bullae with absorbable polythoxanone suture, the procedure accompanied by mechanical pleurodesis (abration) with or without apical partial pleurectomy to achieve good adherence of the lung to the chest wall. Mechanical pleurodesis by a piece of gauze or Marlex mesh was done by many other authors (Cannon et al, 1993), (Chan et al, 2001), (Ohno et al, 2000) and (Sassoon, 1995).

In other series, chemical pleurodesis with talc powder insufflations was done (Liu et al,1995). Partial apical parietal pleurectomy is another method of pleurodesis (Aayed and Al-Din, 2000), (Liu et al, 1995) and (McCarthy et al, 1997).

In our study, partial apical parietal pleurectomy was done in some patients especially those with
thickened pleura and no obvious blebs or bullae. In our series, there was no operative mortality and there was no early or late death. There was statistically non-significant difference in operative times between the 2 groups (58 ± 8 min vs. 58 ± 6.5 min). The same results were stated by many series as the mean operative period for thoracotomy ranged from 35-86 minutes and that of VATS ranged between 39-91 minutes but was not statistically significant (Al-Qudah, 1999). (Miller et al, 2000) and (Kim et al, 1996). The mean ICT drainage in the first 24 hours postoperatively in the 2 groups was (193 ml vs. 182 ml) and was not statistically significant, this was comparable to other series in which the drainage was (210 ml vs. 150 ml) and was statistically insignificant too (Al-Qudah, 1999).

The amount of analgesia which was given in thoracotomy group was more than that was given to the group of VATS (280 ml vs. 201 ml) and it was statistically highly significant (P-value was 0.000006). In other series it was ranged from (175 ml-300 ml) in group of thoracotomy and ranged from (125 ml - 225 ml) in group of VATS (Al-Qudah, 1999) and (Kim et al, 1996). The period of ICT in group I was 4.3 ± 0.9 days and it was 3.3 ± 0.5 days for the group of VATS, it was statistically highly significant (P-value was 0.00002). In other studies, the ICT period for the group of thoracotomy ranged from 3-4.3 days and that for the VATS group ranged from 2.7-5 days (Ayed and Al-Din, 2000), (Al-Qudah, 1999) (Hazelrigg et al, 1993), (Miller et al, 2000), (McCarthey et al, 1997), (Kim et al, 1996), (Naunheim et al, 1995) and (Tocescini et al, 2001). The postoperative hospital stay of our patients was 10.3 ± 1.1 days in group of thoracotomy and it was 4.5 ± 0.6 days in the group of VATS, it was statistically highly significant (P-value was 0.000002). In other series, the postoperative hospital stay was less in the group of VATS than that in the group of thoracotomy and ranged from 4.8-5.7 days in the group of thoracotomy, while it ranged from 2.9-5 days in the group of VATS (Al-Qudah, 1999), (Hazelrigg et al, 1993) and (Miller et al, 2000).
Post operative complications in the form of persistent air leak for more than 5 days occurred in 3 patients (14%) and empyema occurred in 2 patients (10%) in group of thoracotomy, while persistent air leak occurred in 2 patients (6%) and another case of empyema (3%) occurred in the group of VATS. In other studies, persistent air leak or empyema occurred in 0%-7% of their patients of both groups but complications still less in the group of VATS (Ayed and Al-Din, 2000), (Al-Qudah, 1999), (Cannon et al, 1993), (Miller et al, 2000), (Inderbitzi et al, 1994), (Ohno et al, 2000) and (Hatz et al, 2000).

Our patients were followed for 12-18 months (14.7 ± 2 months), recurrence occurred in 3 cases (14%) in group I, one of these 3 patients was managed by insertion of ICT which was removed after 4 days; the other 2 patients were managed conservatively by rest and observation, and recurrence occurred in 2 cases (6%) in group II, both were managed by rest and observation. All of the recurrent patients were cases of previous pleural abrasions without pleurectomy. Other authors followed-up their patients for a period ranging from 8-53 months, recurrence occurred in 0%-11%, all of them were cases of abrasion only without ligation or pleurectomy (Ayed and Al-Din, 2000), (Hazelrigg et al, 1993), (Inderbitzi et al, 1994), (Ohno et al, 2000), (McCarthy et al, 1997), (Hatz et al, 2000) and (Sjegen and Sortie, 2000).

**Conclusion**

VATS is a viable alternative to thoracotomy for the treatment of spontaneous pneumothorax whether 1st or recurrent episodes. It results in a shorter post operative ICT period, shorter hospital stay, less analgesia usage, low morbidity, no mortality, high patient acceptance and a low rate of recurrence. To reduce recurrence to a minimum rate, the procedure should be: ligation of the base of the blebs or bullae accompanied with mechanical pleurodesis of a wide area of the thoracic cavity to achieve good adhesion to the chest wall. If there is no obvious bleb or bullae, it is recommended to do a partial apical parietal pleurectomy to help more adhesion.
and decrease the rate of recurrence.

**References**


