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Uniportal video-assisted thoracic surgery for primary spontaneous pneumothorax: clinical and economic analysis in comparison to the traditional approach

Michele Salati[a,*], Alessandro Brunelli[a], Francesco Xiumè[a], Majed Refai[a], Valeria Sciarra[a], Andrea Soccetti[b], Armando Sabbatini[a]

[a]*Unit of Thoracic Surgery, Department of Respiratory Diseases, 'Umberto I°' Regional Hospital, Ancona, Italy*
[b]*Administration Department, 'Umberto I°' Regional Hospital, Ancona, Italy*

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Abstract

We aimed to verify the clinical and economic effects of uniportal video-assisted thoracic surgery (VATS) in patients with primary spontaneous pneumothorax (PSP) compared to traditional three-port VATS technique. We analyzed 51 consecutive patients (23 three-port VATS and 28 uni-port VATS), treated by bullectomy and pleural abrasion, to detect differences between the two groups with regard to intraoperative management, postoperative course, pain, paraesthesia and costs. Data about pain and paraesthesia were collected by telephonic interview within a minimum follow-up period of six months. Compared to three-port VATS, patients treated by the uni-port VATS were discharged more quickly (3.8 days vs. 4.9 days, $P=0.03$) and experienced paraesthesia less frequently (35% vs. 94%, $P<0.0001$). No difference in chronic pain was observed between the two groups (numeric pain score: 0.6 uni-port vs. 1.3 three-port, $P=0.2$). Compared to three-port VATS, we found a significant reduction in postoperative costs for the patients operated on by the uni-port technique (€1407 vs. €1793, $P=0.03$), without any increase in surgical costs. In conclusion, uniportal VATS appears to offer better clinical (postoperative stay and rate of paraesthesia) and economic (postoperative costs) results than the standard three-port VATS for treating primary spontaneous pneumothorax.

Keywords: VATS; Pneumothorax; Pain; Costs

1. Introduction

Video-assisted thoracic surgery (VATS) has been described as offering substantial clinical and economic advantages in comparison to open surgery for many clinical conditions [1–5]. In particular, regarding spontaneous pneumothorax, several studies have shown that this procedure is as effective as thoracotomy in terms of recurrence and complication rates [6, 7], but can reduce postoperative pain, use of analgesics, postoperative drainage duration, postoperative stay and cost compared with open surgery [7–10].

Recently, with the aim to further reduce invasiveness of VATS, Rocco and colleagues demonstrated the feasibility of performing wedge pulmonary resections through a uniportal VATS approach [11]. Subsequently, the same authors were able to show that treating primary spontaneous pneumothorax (PSP) by uniportal VATS resulted in less postoperative pain and paraesthesia compared to standard three-port VATS [12].

Based on these encouraging reports, starting from July 2005 we modified the traditional three-port VATS approach for spontaneous pneumothorax to the uniportal approach.

The objective of this study was to assess the clinical and economic results of uniportal VATS performed in patients with PSP in comparison with our previous experience with the conventional three-portal approach.

2. Materials and methods

2.1. Studied population, operative and postoperative management

We analyzed the difference between two groups of patients operated on for PSP at our institution between July 2002 and January 2007.

A total of 51 consecutive patients operated on for PSP were analyzed: 23 patients (16 males and 7 females) submitted to three-port VATS (July 2002–June 2005) and 28 patients (17 males and 11 females) submitted to uniport VATS (July 2005–January 2007).

Apart from the surgical access, all patients had the same surgical procedure, consisting of bullectomy and pleural abrasion.

The uniportal technique we used in our patients was similar to the one described by Rocco and colleagues [11]. Briefly, we performed a 2.5 cm incision at the level of the 5th intercostal space in the median axillary line, through

*Corresponding author. Via A. De Gasperi 17/c, 60020, Offagna, Ancona, Italy. Tel.: +390717107020; fax: +390715964433.
E-mail address: michelesalati@hotmail.com (M. Salati).

which a 5 mm 30° video thoracoscope and two 5 mm instruments or endo-stapler were inserted.

Three-port VATS was performed with triangled trocars position: the 10 mm video thoracoscope was inserted through the trocar in the 7th intercostal space and the instruments through the two other ports placed along the 5th intercostal space.

In both groups, bullectomy was performed by staplers and pleurectomy by a scratch pad mounted on an endograsper. At the end of the procedure all patients had a 24F chest drain placed at the apex of the pleural space: in the three-port VATS it was inserted through the thoracoscope port and in the uni-port VATS through the unique port used. The chest tube was then removed the day after air-leak stopped and after chest X-ray demonstrated a well expanded lung.

Postoperative pain management was standardized and did not change in the two groups of patients. It consisted of paracetamol per os (up to a maximum of 3 g per day) and tramadol i.v. as needed.

2.2. Dataset, cost calculation and data analysis

This is a retrospective analysis performed on a prospective database.

A minimum number of 16 patients per group was determined in order to detect a difference of three points in VAS score between the groups, with a significance level of 0.05 and a statistical power of 90%, according to the results reported by Jutley et al. [12].

Variables included in the prospective dataset were the followings: gender, age at operation, site of pathology, type of approach (uni- or three-port), duration of surgery (min), conversion to thoracotomy, number and types of staplers used, duration of air-leak (prolonged if more than five days), postoperative hospital stay (days), postoperative complications and recurrence.

Data about postoperative pain, paraesthesia and activity were gathered by a telephonic interview. The same surgeon performed all the interviews, explaining the pain scale and possible experienced neurologic symptoms. Patients were also asked to grade their present activity (same or less than before the operation) and whether they currently were using any analgesic therapy. Chronic postoperative pain as defined by Macrae [13] was assessed by using a progressive numeric pain score (from 0 (no pain) to 10 (maximum experienced pain)) and the Mc Gill's pain questionnaire [14]. Paraesthesia was defined according to the criteria and descriptors reported by Sihoe et al. [8].

Mean postoperative follow-up time was 24 months, with a minimum follow-up of six months (range: 6–56 months). Follow-up was complete in 45/51 (88.2%) patients, 4 of 23 (17.4%) three-port patients and 2/28 (7%) uni-port patients were lost to follow-up.

In order to evaluate the economic aspects of both approaches, we calculated for each patient the variable costs of the material used during the operation, and the fixed costs of the occupancy of the operating theatre (hourly cost multiplied by the hours of occupancy per patient) and of postoperative hospital stay (daily costs multiplied by the number of postoperative days per patient). Cost data were obtained from the Administration Department of Umberto I Hospital.

The normal distribution of numeric variables was assessed by the Shapiro–Wilk normality test. Comparisons between groups (three-port vs. uni-port VATS) were performed by the unpaired Student's *t*-test or the Mann–Whitney test for numeric variables with or without normal distribution. Categorical variables were compared by means of the χ^2-test or the Fisher's exact test as appropriate. All tests were two-tailed and a significance level of $P<0.05$ was selected. All the tests were performed by using Stata 8.2 statistical software (Stata Corp., College Station, TX).

3. Results

Median age at operation was similar in the two groups (25 years three-port vs. 23 years uni-port). Site of pathology was the apex of the affected lung for all patients with the exception of two patients in the three-port group with blebs in the superior segment of the lower lobe.

Table 1 shows the differences between the two groups in terms of operative and postoperative characteristics and recurrence rates. Patients in the uni-port group had a significantly shorter postoperative stay, compared to those in the three-port group (3.8 vs. 4.9 days, $P=0.03$).

In this series, no conversion to open surgery was necessary. Two procedures lasted longer than 2 h (one in each group) due to the presence of dense and diffuse pleural adhesions. No major cardiorespiratory or surgical complications were noted in the two groups with the exception of four cases of air leak longer than five days (3 for the three-port vs. 1 for uni-port).

Table 2 summarizes the results of the telephonic interviews to estimate pain, paraesthesia and grade of activity after a follow-up time of at least six months (mean for the uni-port group = 13 months, three-port = 39 months, $P<0.0001$). The rate of paraesthesia was significantly lower in the uniportal group compared to the three-port group (35% vs. 94%, $P<0.0001$), whereas no difference in chronic pain incidence was noted between the two groups.

Table 1
Comparison of intraoperative and postoperative variables between uni-port and three-port groups

	Uniportal VATS	Three-portal VATS	*P*-value
Age (years)	24 (6.3)	26.4 (6.4)	0.17*
Operation time (min)	72.3 (31.8)	68.7 (25.5)	0.67*
Postoperative stay (days)	3.8 (1.8)	4.9 (2.4)	0.03*
Prolonged air-leak (>5 days) (*n*, %)	1/28, 3.5%	4/23, 17%	0.09**
Recurrence rate (*n*, %)	3/28, 10%	3/23, 13%	0.62**

Results are expressed as means ± S.D. unless otherwise specified.
*Mann–Whitney test, **χ^2-test.

Table 2
Comparison of pain, paraesthesia and activity between uni-port and three-port groups

	Uni-port	Three-port	*P*-value
Numeric pain scale (0–10 scale)	0.6 (1)	1.3 (1.7)	0.24*
McGill at rest (0–5 scale)	0.15 (0.5)	0.56 (1.2)	0.28*
McGill cough (0–5 scale)	0.15 (0.46)	0.33 (0.59)	0.38*
McGill arm (0–5 scale)	0.31 (0.74)	0.78 (1.1)	0.19*
Paraesthesia (*n*, %)	9/26, 35%	18/19, 94%	<0.0001**
Normal activity	25/26, 96%	15/19, 79%	0.069**

Results are expressed as means ± S.D. unless otherwise specified.
*Mann–Whitney test; **χ^2-test.

Table 3
Comparison of intraoperative and postoperative costs between uni-port and three-port groups

	Uni-port	Three-port	*P*-value
Surgical material costs (€)	968 (215.6)	1016 (280.4)	0.69*
Operating room occupancy costs (€)	241 (106)	229 (84.8)	0.67*
Postoperative stay costs (€)	1407 (649.2)	1793 (893.5)	0.03*

Results are expressed as means ± S.D.
*Mann–Whitney test.

Table 3 shows the results of the economic analysis. Uniportal VATS did not increase the costs of surgical instrumentation or the costs of occupancy of the operating room. On the other hand, uniportal VATS determined a significant reduction in the postoperative costs by almost €400/patient ($P=0.03$).

4. Discussion

The uniportal VATS technique was first described by Rocco and colleagues [11] as an effective approach to safely perform wedge resections for pulmonary lesions or for treatment of primary spontaneous pneumothorax in association with pleural abrasion. The same authors demonstrated that, compared to the traditional three-portal technique, uniportal VATS was able to reduce postoperative stay, pain and paraesthesia in patients operated on for spontaneous pneumothorax [12].

Based on their results and on our previous experience with three-port VATS, from July 2005 we started to perform uniportal VATS in patients with primary spontaneous pneumothorax. This study was designed to evaluate the clinical and economic results obtained by this technique in comparison with a historical consecutive group of patients affected by the same pathology and treated by traditional three-portal VATS.

Similar to the study from Rocco and colleagues [11], even this study was not randomized. Nevertheless, we believe it can add to the existing literature on this subject because it assessed the clinical and economic impact of this technique in a sizeable group of patients evaluated with a long follow-up (min. six months).

We found that the uniportal VATS, despite of a different perspective to the target lesion, allowed to perform the same type of operation in the same time as the three-port VATS. A major concern raised in previous investigations on this approach was the increased surgical costs due to the use of roticulating disposable instruments [11]. However, we found that surgical costs were comparable between the two groups as they had a similar operating theatre occupancy time and similar surgical material costs obtained by using for all the procedures reusable material, with the exception of single-use linear endo-staplers for the three-port group and single use roticulating endo-staplers for the uniportal group.

We confirmed previous findings [12, 15] related to an early discharge of the patients operated on by uniportal VATS compared to the three-port procedure, presumably due to less postoperative pain and faster recovery. It must be noted that although our study is not a randomized trial, the postoperative pain management and chest tube removal protocol remained constant in all patients during the period of the study and irrespective of the surgical approach.

As a consequence of the shorter postoperative stay, compared to the traditional technique, we observed a decrease of 21.5% in the postoperative stay costs of patients operated on by the uni-port approach, which seems to warrant under an economic perspective a more widespread use of this technique for treating PSP.

The follow-up analysis was conducted in order to investigate the recurrence rate after changing our traditional approach to the disease and to verify if the pain reduction observed by other authors in the early postoperative period was confirmed also at a later time (at least six months follow-up). We found that the uniportal approach did not increase the risk of recurrence of pneumothorax (10% uni-port vs. 13% three-port) and allowed almost all patients to resume complete working and physical activities as before the operation. This latter observation was less frequent in the three-port group (96% uni-port vs. 79% three-port). Moreover, only one-third of patients operated on by uni-port VATS reported some form of paraesthesia vs. 94% of those treated by conventional approach. As demonstrated by previous studies [7, 9], paraesthesia seems to represent a consistent problem affecting the three-port technique, which does not seem the case with uniportal VATS. However, the finding about the recurrence rate should be interpreted with caution due to the shorter follow-up time in the uniportal group.

In conclusion, we showed that in patients with primary spontaneous pneumothorax the uniportal VATS offered better results in terms of postoperative stay, restoring of complete physical activity after the operation and postoperative paraesthesia rate in comparison with the traditional three-port VATS. Furthermore, the uniportal VATS had surgical costs similar to and postoperative stay costs lower than the three-port VATS.

Even though the analysis was performed on data prospectively collected and periodically audited, patients were not randomized between the two procedures. Thus, our encouraging results warrant a larger prospective randomized trial for confirmation.

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