

The era of uniportal video-assisted thoracoscopic surgery

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The first anatomic lung resection was performed through video-assisted thoracoscopic surgery (VATS) in 1992. Since then, VATS technique has been evolving in terms of clinical indications and surgical technique for early stage (I or II) non-small cell lung cancer (NSCLC) treatment.

Accordingly, thoracotomy has been replaced by multiportal-VATS (M-VATS) (4-3-2 surgical ports) moving towards uniportal-VATS (U-VATS) (single surgical port). Reduced number and size of surgical incisions led to a decreased inflammatory response less, postoperative pain and better cosmetic results for patients (1).

The transition from the thoracotomy to VATS determined a reduction in postoperative complication, chest tube permanence, postoperative length of stay and postoperative pain resulting in lower costs for VATS procedures (2,3).

Early on U-VATS was used for wedge resection, treatment of primary spontaneous pneumothoraxes, sympathectomy, pericardial window, removal of small mediastinal masses and evacuation of hemothorax (4).

In the last ten years, Gonzalez-Rivas *et al.* developed this technique for even more complex resections like lobectomy and sleeve segmentectomy, lobectomy, pneumonectomy, chest wall resection and pulmonary artery and bronchial reconstruction (sleeve lobectomy) (5).

In literature, there are a number of studies comparing U-VATS versus M-VATS, but they are all retrospective studies.

The introduction of new technologies such as HD

and 3D lens camera, flexible thoracoscopy, extremely fine needlescopic, thinner and ergonomic surgical instruments, smaller and angled mechanical stapler has been promoting the development of U-VATS. Thus, the use of the new generation flexible 5 mm 0° videoscope with an 85-degree rotating tip may allow a better view of posterior hilum thus facilitating the dissection and lymphadenectomy (6).

Moreover, in UVATS the introduction of instruments is parallel to videoscope obtaining a similar point of view to that of open surgery unlike in M-VATS approach where a triangular geometric configuration consents a maximal convergence of surgical instruments but often with an interference with optical source (7,8). For these reasons U-VATS is not considered as a natural evolution of M-VATS by many authors, but rather a thoracotomy development.

For the U-VATS lobectomy the surgical incision (3–4 cm) is performed at the fourth intercostal space along the anterior axillary line for upper lobe resection and at the fifth intercostal space for middle and inferior lobe resection. In the latter case, the dissection order is generally the vein first, then the artery and the bronchus, while for the upper lobe is better to start with the dissection of the artery (9). Furthermore, in UVATS trocars or rib retractors are not used reducing the insult to the intercostal nerves.

The use of soft tissue retractors (like Alexis®) to facilitate the introduction of instruments may be suggested. Anterior approach is generally preferred.

The surgeon is located in front of the patient and the assistant can be located either in front or alongside of the

surgeon (6,10). At the end of surgery, the chest tube is inserted at the posterior extremity of the incision.

The lymphadenectomy is essential in lung cancer surgery for staging and tumor local control. The effectiveness of lymphadenectomy whether in VATS or thoracotomy still is controversial. Many authors showed that, mostly using proper tools, same lymphadenectomy results can be obtained in VATS and thoracotomy approach, and better results have been showed in U-VATS than in M-VATS (11).

Liu *et al.* showed that both in U-VATS and in M-VATS the quantity and quality of dissected lymph nodes are the same. Nevertheless, the exposure of the left-side subcarinal area in U-VATS is sometime could be quite challenging, comparing to M-VATS (12).

Mu *et al.*, in a study published in 2015 showed a less number of dissected lymph nodes (7.02 ± 8.60 vs. 13.34 ± 9.26 , $P < 0.001$) and a less number of lymph node stations examined (4 ± 1 vs. 6 ± 1 , $P < 0.001$) in U-VATS than those obtained in M-VATS lobectomy (13).

Moreover it is still strongly debated the issue of surgical time. Tamura *et al.* (14) highlighted in their experience the longer operative time for bullectomy, partial lung resection and thymectomy in U-VATS, same as Lin *et al.* for U-VATS lobectomy (U-VATS 132.3 ± 13.2 vs. M-VATS 105.4 ± 12.5 , $P < 0.05$) (15).

Instead, Shen *et al.* in their study showed that the duration of lobectomy in U-VATS was shorter than in M-VATS (65.7 ± 14.8 vs. M-VATS 81.3 ± 13.6 , $P < 0.001$), although the duration of lymphadenectomy was longer in U-VATS than in M-VATS (9).

In 2011 Gonzalez *et al.* described the initial experience in VATS lobectomy, comparing three different periods of time (first period from 2007 to 2008, second period from 2008 to 2009 and third period from 2009 to 2010) and showing that the learning curve is crucial for the improvement of the operative time in VATS lobectomy; consequently, the third period is characterized by lower operative times than the previous ones (16).

The transition from thoracotomy to the U-VATS may require several steps. The surgeon could have less difficulty to switch from the traditional VATS to U-VATS, having already gained more dexterity with instruments and methods (17).

Many authors have directed their work toward the difference in postoperative outcomes between U-VATS, M-VATS and thoracotomy. Numerous studies showed that VATS is associated to a lower morbidity (29.1% vs. 31.7%) and mortality (1% vs. 1.9%) comparing to thoracotomy.

VATS is associated with lower major cardiopulmonary complications, atrial fibrillation, atelectasis and wound infection. Moreover, VATS is characterized by a shorter length of stay. For these reasons, VATS is considered the best approach especially for elderly patient (over 70 years old) and for patients with FEV1 $< 40\%$ (18).

However, the most important goal has been achieved by the decrease of postoperative pain due to a single incision without rib spreading. This issue led to a reduction of hospitalization and to a rapid return to work (19) resulting in lower cost and reduced time to start adjuvant chemotherapies. Nevertheless, the oncological benefits and 5-year survival appear equivalent in VATS compared with open surgery for stage I non-small-cell lung cancer (Regional lymphadenectomy, nodal upstaging, overall and disease-free survival were similar between the two techniques) (20).

Moreover, although the benefits of VATS compared to thoracotomy are now well known, there are conflicting opinions regarding the difference in postoperative outcomes between U-VATS and M-VATS.

Harris *et al.* (21) in their review including eight large retrospective studies showed that U-VATS, compared with M-VATS, was associated to a shorter duration of chest tube permanence and lower morbidity, without significant differences in number of lymph nodes dissected, conversion rate to open thoracotomy or operative time. Furthermore, Dai and colleagues in their propensity-matched comparative analysis showed a reduction of intraoperative blood loss and postoperative pain with a higher patient satisfaction score in U-VATS (22). French *et al.* did not find significant differences in conversion rate, perioperative bleeding, mortality and median operative time between the two techniques (23). Chung *et al.* in their retrospective experience did not find differences in operative time, chest tube permanence, postoperative 30-day mortality, number of removed lymph nodes, reoperation rate and length of postoperative hospital stay between the two groups (M-VATS lobectomy vs. U-VATS lobectomy) (24).

Moreover, a large number of intraoperative complications, such as intraoperative bleeding, can be controlled both in conventional VATS than in U-VATS with a lower conversion rate to thoracotomy (25), reaching operative time similar to open surgery. This is due to the increasing experience of the surgeons and the development of surgical techniques and surgical instruments shaped especially for the U-VATS procedure, with the recent

advent of high definition camera.

In the present study, Shen *et al.* compared patients with NSCLC underwent thoracoscopic lobectomy through M-VATS or U-VATS by using the propensity-matched analysis, presenting detailed tables and well describing the surgical technique.

This paper is interesting because the authors enrolled a large number of patients (411 patients between 2013 and 2014). The two samples are extremely homogeneous. The study is the first report present in literature where the propensity-matched analysis is used to compare the uniportal technique with the multiportal one (there are studies where this statistical test is used to compare the open technique versus VATS). More interestingly, the study showed the comparison between data analyzed with propensity score-matched test and data analyzed not with this test, confirming how the propensity provided stronger homogeneous results.

Finally, the first 15 cases of U-VATS lobectomy were eliminated from the study to limit the effect given by the learning curve. Thus, the study is statistically valid.

Another strong point of this paper is that all surgical procedures, despite the high number of patients enrolled, were performed by the same surgeon. More in detail, statistically significant results were obtained for the operative time ($P > 0.001$). In the U-VATS group, the operative time was shorter than the M-VATS group (65.7 ± 14.8 vs. 81.3 ± 13.6), while the operative time for the lymphadenectomy was longer (29.6 ± 16.7 vs. 17.4 ± 13.3).

By contrast, this is a retrospective study. Moreover, the sample size is small for the propensity-matched method. Given that, the propensity score method is generally used on large samples, often recruited from international databases.

In conclusion, U-VATS is proved to be a viable alternative to open surgery, although advantages over traditional VATS especially from the point of view of outcomes are not clear yet. Indeed, there are not strong differences between the two techniques. However, it has been proved that the U-VATS is a technique with a favorable learning curve.

Many retrospective studies have already confirmed the advantage of single port technique compared with multi-port in term of better postoperative pain control, easier surgical approach and better cosmetic results in thoracic surgery.

Future prospective studies and longer follow-up may reveal new benefits and novel indications for U-VATS procedure.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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