

The Geometric and Ergonomic Appeal of Uniportal Video-Assisted Thoracic Surgery

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KEYWORDS

- Lung cancer • Geometry • Ergonomics • Minimally invasive thoracic surgery
- Video-assisted thoracic surgery • Uniportal VATS

KEY POINTS

- The configuration of 3-port video-assisted thoracic surgery (VATS) is similar to a trapezoid, an unfavorable geometric shape for visualization with the standard 2-dimensional monitors.
- The uniportal VATS approach creates sagittal planes from a caudocranial perspective.
- The uniportal VATS approach preserves the depth and 3 dimensions of the intraoperative visualization.
- Uniportal VATS enables the operative surgeon to bring the operative fulcrum inside the chest.
- The uniportal VATS approach generates ergonomic advantages during the surgery.

INTRODUCTION

The idea of uniportal video-assisted thoracic surgery (VATS) was first proposed in 1924 by Singer, who devised an instrument to perform the surgical procedures through the same incision.¹ In early years of this century, Gaetano Rocco described the technique for the uniportal VATS wedge pulmonary resection.² From this report, the progressive refinements of this technique were associated with a broader range of surgical indications, including the major anatomic pulmonary resections for lung cancers.³ Nevertheless, because of its relatively recent description and implementation, this approach had the potential and the relative urgency to expand the scientific

evidence about its benefits and to explore new areas of practice. Some articles have already demonstrated the advantage of the uniportal VATS in comparison to the traditional multiportal techniques in terms of the reduction of postoperative pain and hospital stay as well as a prompt return to daily life activities.⁴ At the same time, there is a lack of great comparative or randomized studies aimed at verifying a consistent positive effect of the uniportal approach on the outcomes mentioned above, particularly in patients undergoing major lung resection for cancer. To this date, the geometric characteristics of uniportal VATS are known: one small incision without further dissection of the intercostal space with the

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simultaneous introduction of instruments in the thoracoscope through an ideal circular truncated cone, wide as a surgeon's fingerbreadth. The thoracoscope is handled to show the position of the instruments during the procedure with simple zooming in/out of the operative field. An enhanced hand-eye coordination to visualize and operate the thoracoscope-instruments ensemble is also required in uniportal VATS.⁵ In this article, the geometric and ergonomic appeal of uniportal VATS is discussed to better understand the foundations of this approach.

A BRIEF HISTORICAL NOTE OF THE GEOMETRIC EVALUATIONS IN UNIPORTAL VIDEO-ASSISTED THORACIC SURGERY

In a comment to the first description of uniportal VATS lobectomy in 2011 written by Diego Gonzalez-Rivas,⁶ it was suggested that the uniportal approach translates the thoracoscope 90° along a sagittal plane, bringing the operative tools to address the target lesion from a vertical and craniocaudal perspective. The uniportal approach was different from the classic 3-port settings, in which the lozenge configuration allows maximal convergence of the operative instruments from each side of the target lesion. The field of vision obtained with the uniportal VATS can be restricted by the short incision thoracotomy and the interference of instruments, but with the use of largely curved instruments and the 30° video thoracoscope does not present blind spots.⁷ Nevertheless, the occasion for writing the first articles about geometry and uniportal VATS originated from the first world meeting on uniportal VATS held in Naples on 26 October 2012. At that time, some of the world VATS and uniportal VATS experts convened to assess the status quo and the future perspectives of uniportal VATS as a potential adjunct to the techniques in the thoracic surgical armamentarium (Fig. 1).⁸

GEOMETRIC APPROACH OF THE UNIPORTAL VIDEO-ASSISTED THORACIC SURGERY LOBECTOMY

Although uniportal VATS lobectomy is performed based on translational approach along sagittal projective planes, in the 3-port VATS procedure, the bidimensional geometric configuration of a lozenge produces interference with the optical source. The interference, in turn, creates in 2 dimensions a new optical plane with the genesis of a dihedral or torsion angle. Because, according to Euclid's elements, a plane is any flat, 2-

dimensional surface, the uniportal approach works along the camera motion to the target (view axis) and 2 planes (the VATS instruments).⁷ Therefore, the geometric configuration of the uniportal VATS approach is entirely different from the standard 3-port VATS settings.⁹

Three-Port Video-Assisted Thoracic Surgery Lobectomy Approach

In the typical 3-port VATS lobectomy approach, small ports are used without rib spreading. The strategy for ports placement follows the famous baseball diamond configuration and corresponds to a trapezoid in plane geometry (Fig. 2).¹⁰ The surgeon's eyes (ie, the 30° thoracoscope) are in point *A*; the target lesion lies in front at point *B*. The other 2 ports are placed at points *C* and *D* to allow for the placement of the left- and right-hand instruments and the triangulation toward the target in point *B* along 2 vectorial planes (\overline{CB}) and (\overline{DB}). The viewing axis is a vector (\overline{AB}); this is perpendicular to the operative port axis \overline{CD} and follows the natural longitudinal axis of the patient (feet toward the head). Nevertheless, this setting fails to reproduce the real-life setting, where the surgeons and assistants position themselves around the operating table. In real contexts, many surgeons stand anterior to the patient in lateral decubitus; therefore, the real axis of the operation is translated posteriorly (Fig. 3). The posterior port (*D*) is translated along the viewing axis, and the surgeon is too far from the instrumentation. Also, if the assistant stands on the opposite side of the operating table, the visual axis would be completely different.

Anterior Three-Port Video-Assisted Thoracic Surgery Lobectomy Approach

The 3-port VATS port placement strategy has been modified, as described by Henrik Hansen and colleagues,¹¹ to cope with these technical and ergonomic issues, thus generating the posterior translation of the trapezoid (Fig. 4). The camera port (*A*) was brought more anterior up to the anterior axillary line (*A'*). The posterior port (*D*) was placed further caudally (*D'*). The utility port position (*C*) remains unchanged. Although the trapezoid was preserved, the axis *A'B* was more comfortable for the operating surgeon.

Biportal Video-Assisted Thoracic Surgery Lobectomy Approach

After gaining experience with the 3-port VATS approach, Gaudet and D'Amico¹² realized that the posterior port (*D'*) was not always essential,

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