Uniportal and single-incision video-assisted thoracic surgery: the state of the art


ª Department of Surgery, The Chinese University of Hong Kong, Hong Kong, China
ª National Cancer Institute, Naples, Italy
× Department of Imaging and Interventional Radiology, The Chinese University of Hong Kong, Hong Kong, China
ª Minimally Invasive Thoracic Surgery Centre, Central, Hong Kong, China

* Corresponding author. Division of Cardiothoracic Surgery, The Chinese University of Hong Kong Prince of Wales Hospital, 30-32 Ngan Shing Street, Shatin, NT, Hong Kong SAR, China. Tel: +852-2632-2629; fax: +852-2637-7974; e-mail: calvinng@surgery.cuhk.edu.hk (C.S.H. Ng).

Received 5 April 2014; received in revised form 14 May 2014; accepted 21 May 2014

Abstract
‘Intelligence is the ability to adapt to change.’

Stephen Hawking (1942–present)
Genel Bilgiler - 1

• Açıklan VATS’a geçiş: 1990’lar
• Uniportal VATS’ın uygulanışı: 2000
• 5 mm ve 3 mm kamera, sempatikotomi
• Uniportal VATS wedge: 2004
• Uniportal Lobektomi: 2011 (Gonzales-Rivas)
• e-NOTES (Natural orifice transluminal endoscopic surgery)
• Zhu ve ark (2013): e-NOTES sempatikotomi
• Fleksibl endoskopik platform (Olympus ve Storz)
The transumbilical approach used a 5-mm ultrathin flexible gastroscope to incise through the diaphragm to reach the operating site. Hot biopsy forceps were deployed to complete the thoracic sympathectomy. The 35 patients who received this procedure suffered no complications, and experienced less pain and higher satisfaction with the aesthetic results when compared with conventional needlescopic sympathectomy, without any delayed complications in any patient. Such an approach might be adequate for performing simple thoracic procedures; however, a more sophisticated endoscopic platform will be needed for more complex thoracic surgery. Lately, flexible endoscopic platforms, such as EndoSamurai (Olympus, Tokyo, Japan) and Anubiscope (Karl Storz, Tuttlingen, Germany), have been developed for NOTES. These endoscopic platforms are usually deployed through a steerable endoscopic overtube, and utilize three channels (two articulating, one nonarticulating) with specialized instruments. In the context of NOTES, a needle cautery is used to create a pathway through the natural oriﬁce organ, and endoscopic graspers, cautery and clips can be allowed to perform the necessary surgery. The manoeuvrable instrument arms allow an impressive 5 DoF of movement for instruments, resulting in superb manual dexterity and ergonomics. Compared with the standard endoscope, these advanced platforms provide the operator with much greater control, and the ability to have traction and countertraction through a single endoscopic port. However, traversing the trachea or oesophagus to enter the thoracic cavity for NOTES of the chest might remain the territory of the most adventurous thoracic surgeon for a very long time.

The current DaVinci robotic system has been around for over a decade. Despite offering excellent visual feedback and robotic arm dexterity and precision, it is undeniable that multiple ports are required. Although performing robotic surgery through specialized single-incision laparoscopic surgery (SILS) ports is possible with computer-compensated movements to overcome the difﬁculties associated with instrument crossover, robotic SILS is probably the limit for the current system design in terms of minimizing surgical access trauma. The main reason for this limitation is simple; essentially the robot is 'outside' of the patient. To move forwards into a higher realm, the whole robotic approach needs to be revised. To perform complex robotic thoracic surgery through a single small incision, the robot's 'shoulders', 'arms' and 'head and eyes' must move inside the thoracic cavity. There are currently two promising systems, the Insertable Robotic Effector Platform (IREP) developed by Columbia University, USA, and the KidsArm System developed by MacDonald Dettwiler Space and Advanced Robotics, Ltd, in partnership with Centre for Image-Guided Innovation and Therapeutic Intervention (CIGITI) at Hospital for Sick Children in Toronto.
the IREP, certain minor technical considerations still need to be ironed out, such as the limited 60° rotation of the wrist, which might hinder suturing efficiency. Nevertheless, these systems will be the next generation of surgical robots that will totally transform and redefine minimally invasive single-incision thoracic surgery.

ADJUNCTS

The minimally invasive approach of single-port VATS might result in less surgical access trauma, and opens up opportunities to further reduce hospital stay and fast-track patients postoperatively. In 2010, Rocco et al. described the feasibility of performing single-port VATS.
the IREP, certain minor technical considerations still need to be ironed out, such as the limited 60° rotation of the wrist, which might hinder suturing efficiency. Nevertheless, these systems will be the next generation of surgical robots that will totally transform and redefine minimally invasive single-incision thoracic surgery.

**ADJUNCTS**

The minimally invasive approach of single-port VATS might result in less surgical access trauma, and opens up opportunities to further reduce hospital stay and fast-track patients postoperatively. In 2010, Rocco et al. described the feasibility of performing single-port VATS.
Görüntü-rehberli Cerrahi

- i-VATS: Image-guided VATS (Rapheal Bueno/Harvard)
- Image-guided for uniportal VATS (isPVATS)
- Kancalı-tel yerleştirmeye ve ameliyat aynı salonda.
middle lobe wedge resection for a pulmonary nodule in an 'awake', nonintubated and non-mechanically ventilated patient. The operation was performed under mild sedation, single-shot epidural regional anaesthesia, and bronchoscopically guided Fogarty balloon placement into the middle lobe bronchus to facilitate collapse at the target lobe [33]. The same group in the subsequent year used a similar 'awake' technique to perform single-port VATS for spontaneous pneumothorax [34]. The concept of ambulatory thoracic surgery, particularly facilitated by the single-port technique, might further evolve and provide favourable cost and length of hospitalization implications.

One of the criticisms of uniportal VATS lung resection is the difficulty in palpating and assessing tumours through a single small incision usually positioned at the mid-thoracic region. For small tumours and those with low solid component, lesion identification might prove to be even more challenging. Rocco et al. [35] recently described the successful use of intraoperative articulating ultrasound probe to identify small nodules during uniportal VATS lung resection. The use of other adjuncts, such as preoperative computed tomography-guided hookwire localization of the lung mass, can help the surgeon to identify the culprit lesion. In selected cases, hookwire localization might also allow the uniportal VATS incision to be minimized [36]. Nevertheless, the time between hookwire localization performed at the radiology department and subsequent surgery should be limited because of the possibility of pneumothorax, and to decrease the risk of hookwire dislodgement. The recent development of advanced multimodality image-guided operating room (AMIGO) use in different surgical specialties has opened up new possibilities. Although AMIGO has been widely utilized in many medical specialties, particularly cardiology and vascular surgery, its use in minimally invasive thoracic surgery, also known as image-guided VATS (iVATS), was only first reported in 2013 by Prof. Raphael Bueno's group at Harvard University, Brigham and Women Hospital, Boston. In the subsequent year, the group at The Chinese University of Hong Kong, Hong Kong became the first to pioneer AMIGO image guidance for uniportal (single-port) VATS (iSPVATS) (Fig. 4). Essentially, the application of AMIGO in VATS is twofold. Firstly, the hookwire insertion and uniportal VATS surgery can now be performed in one room, reducing the risks associated with patient transfer and delays, such as pneumothorax, hookwire displacement and discomfort. There could also be cost benefits with less transfers and porter use, and time savings. In addition, if the hookwire migrates or dislodges, a DynaCT scan can rapidly and conveniently be done to reinsert the hookwire or relocalize the lesion. Secondly, for those lesions for which it might not be feasible to insert a hookwire because the lesion is either too close to major thoracic vessels or not accessible by a percutaneous approach, a real-time on-table scan can be performed to localize the lung lesion for resection and potentially provide additional information on resection margins. In the future, with the development of radiolucent instruments, it might be possible to perform thoracic imaging and iSPVATS simultaneously in the AMIGO, further improving resection accuracy and safety.

**CONCLUSION**

Uniportal VATS brings with it unique challenges to overcome that will require an evolution in surgical approach, technological interventions, technical adjuncts and perhaps advances in robotics. The difficulties in deciding which approach or technology to apply to a particular patient might require even more discretion. As the great Italian Renaissance artist Michelangelo (1475–1564) once said, 'The greatest danger for most of us is not that our aim is too high and we miss it, but that it is too low and we reach it.' The recent rapid developments in uniportal VATS have led us to redefine the status quo and to push the boundaries of minimally invasive thoracic surgery.
Son Söz

• ‘Tehlikeli olan, ulaşması çok zor olan bir amacımız olup buna ulaşamamak değil, çok kolay bir amacımız olup, buna ulaşamamızdır’

(Mikelanj (1475-1564))