Microlobectomy—where do we stand?

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Abstract: Video-assisted thoracoscopic surgery (VATS) have been shown to be superior to open procedures, particularly with regards to pain and post-operative recovery, though high-levels of pain may still be reported due to large intercostal port sizes. Microlobectomy is a novel endoscopic lobectomy technique building on VATS lobectomies, with the principle that there are no intercostal ports larger than 5 mm. CO_2 insufflation is used to improve access to the chest and a 12 mm subxiphoid port is created to function as a utility port and can be extended further to facilitate specimen removal. All instruments utilized are 5 mm in size, including a 5 mm camera. However, a standard 12 mm stapler can be used through the subxiphoid incision, which provides excellent access to all the hilar structures bilaterally. Additionally, newer instruments are being developed to facilitate easier improved dissection of vascular structures and lymph nodes, such as the FlexDex needle holder, which is an articulated endoscopic needle holder facilitating movements in all directions, similar to a robotic instrument. The main advantage of a microlobectomy is reduced post-operative pain and shorter time to mobilisation, enabling a faster recovery. In our experience of microlobectomies, we have had patients successfully discharged on the first post-operative day. The development of a greater variety of 5 mm instruments that are similar to conventional VATS instruments may enable more surgeons globally to adopt the microlobectomy approach.

Keywords: Minimally invasive thoracic surgery (MITS); lung cancer; lobectomy; video-assisted thoracoscopic surgery (VATS)

Received: 13 April 2018; Accepted: 22 June 2018; Published: 17 September 2018.
doi: 10.21037/shc.2018.08.04
View this article at: http://dx.doi.org/10.21037/shc.2018.08.04

Introduction

The last 30 years have seen huge advances in thoracic surgery, arising from a need due to a lung cancer epidemic accompanying the rise of smoking and industrial pollution. A key innovation was the development of video-assisted thoracoscopic surgery (VATS) lobectomy in 1991, which allowed major pulmonary resection without a thoracotomy and reduced rib spreading, scarring, post-operative pain, therefore leading to shorter length of stay (1). However, with concerns about the safety of VATS and contained adoption, open procedures remained predominant until recently. In the last decade, a combination of technological innovations and rising demand for minimally invasive surgery paved the way for a resurgence of the VATS surgeon. Furthermore, an increased awareness and understanding of the consequences of postoperative pain and quality of life led to a profession-wide shift towards a more holistic approach, looking at the patient's functionality, instead of solely survival (2,3). This, in combination with surgeon experience favoured the expansion of VATS. Improved pain control is one of the biggest benefits of VATS surgery, which then enhances postoperative quality of life and functional recovery.

Thoracoscopic procedures have been shown to be associated with lower morbidity when compared to open procedures. They are associated with lower rates of post-operative atrial fibrillation, pneumonia, respiratory failure as well as reduced air leaks, chest drain duration and length of stay (4). Particularly in patients with reduced basal pulmonary function (FEV_1 ≤60% predicted), a thoracotomy resulted in higher rates of respiratory complications including respiratory failure and pneumonia when

Figure 1 This is a video demonstrating a right middle lobectomy using the microlobectomy technique. The principles of this technique are no intercostal incisions greater than 5 mm, with the addition of a 12 mm subxiphoid utility port, which may reduce postoperative pain (16).
Available online: http://www.asvide.com/article/view/27121

compared to VATS procedures (5).

However despite huge advances in VATS, some patients still report severe pain following VATS lobectomies (3,6). Traditional VATS procedures still require an intercostal utility port and its extension for specimen removal. Therefore, rib spreading and nerve damage can still be caused by relatively large mini-thoracotomy utility incision, and the use of large (12 mm) ports in the intercostal space and intercostal specimen removal. The average size of an intercostal space (measured at the 5^{th} intercostal space) is approximately 8.9 mm (7) whilst most standard VATS ports are 10 mm. Consequently, a certain degree of trauma to the intercostal neurovascular bundle is likely of significant levels.

High levels of pain post-operatively results in poor compliance with physiotherapy, reduced coughing effort and a slow return to pre-operative levels of mobility, reducing pulmonary re-expansion and predisposing the patient to atelectasis and pneumonias. Severe pain also results in tachyarrythmias or atrial fibrillation (8,9).

With further development of VATS further strategies to reduce intercostal incisions arose, whilst still maintaining safety and achieving similar or improved oncological results (10). One such approach—the uniportal VATS lobectomy—utilises a single intercostal utility port and was first described by Gonzalez *et al.* (11). Leading on from this was the development of uniportal subxiphoid VATS lobectomies, which entirely avoid intercostal incisions and has been performed extensively at the Shanghai Pulmonary Hospital (12). More recently, robotic approaches to thoracic surgeries, including lobectomies and thymectomies, have been described. However, robotic technology is expensive and often limited in availability, requiring extensive training of both the surgeon, the assistant and theatre staff. It is also associated with a steep learning curve (13,14). We have previously described the 'microlobectomy' (15). The aim of a microlobectomy is to further minimise the size of intercostal incisions and reduce rib spreading. Here we describe the use of the novel FlexDex needle holder in a microlobectomy.

Operative technique

Microlobectomy

The underlying principles of a microlobectomy are that there is no intercostal incisions larger than 5 mm, use of a subxiphoid 12 mm utility port for specimen retrieval and chest drainage, CO_2 to enhance the field and only 5 mm instruments are adopted in the intercostal space. The operative techniques are summarized below, but discussed by Dunning *et al.* in greater detail (*Figure 1*).

The patient is selectively intubated, the midline is marked and is then placed in the lateral decubitus position. The surgeon and the assistant usually stand in front of the patient.

In the anterior approach, intercostal ports are first placed in the fourth intercostal space and then the sixth and seventh intercostal spaces. However, the ports may be positioned according to the surgeon's usual VATS preferences. The first 5 mm port is inserted with CO_2 insufflation attached to the trocar, which enables rapid creation of a pneumothorax and collapse of the lung on insertion of the port into the pleural cavity. A 5 mm camera is used to insert the transparent port into the chest under direct vision. CO_2 insufflation is set at 6 to 10 mmHg throughout the procedure. Subsequently, the subxiphoid port is created under camera vision and following this, two further 5 mm intercostal ports are created.

Following creation of the ports, dissection of the vasculature and bronchi are performed as per usual techniques but utilizing 5 mm instruments, including a 5 mm camera. Lymphadenectomy should also be safely carried out, as per IASLC requirements, in this approach. Stapling is carried out through the subxiphoid port for vasculature, bronchi and lung parenchyma. The position of the subxiphoid port, at the end of the oblique fissure, gives a

Figure 2 The novel FlexDex endoscopic articulated needle holder: a 'wristlet', worn by the user, which attaches on to the instrument, enables transmission of a full 360 degrees rotation from the wrist to the needle holder through a wire. The additional degrees of movement from the wrist is typically seen as one of the big advantages of the robot. The user can control the articulation of the instrument using the blue handle seen in the picture. A close up of the needle holder can be seen (B).

suitable angle to access all the hilar structures and therefore can be used to staple bronchi and vasculature of all lobes.

Subxiphoid port

The subxiphoid port is created under camera vision, with the camera directed at the inferior sternal border. A vertical 2 cm incision is made in the midline to allow for the use of 12 mm utility port and the electrocautery is used to dissect the soft tissue down to the xiphisternum. When creating this port, it is important to keep the incision in the linea alba without dividing any fibres of the rectus abdominis, as this can increase postoperative pain. Following soft tissue dissection, a finger is inserted into the incision towards the sternum under camera guidance to sweep the pleura away from the sternum and aid blunt dissection. A 12-mm port can then be inserted with CO_2, which aids flattening of the diaphragm into the abdominal cavity. At the end of the operation, this port is then extended further, to about four to five cm in length, as needed, to facilitate specimen removal. Again, when extending the port, it is important to ensure the incision is in the midline through the linea alba to minimise postoperative pain.

FlexDex needle holder

The FlexDex needle holder has been trialed at our institution for microlobectomy. The FlexDex is a novel articulated endoscopic needle holder (*Figure 2*). Unlike normal thoracoscopic instruments, the FlexDex needle holder articulates in all directions of movement, similar to motions made possible by the DaVinci robot. The instrument comes in two parts—the needle holder itself and a bracelet that is worn on the operating surgeon's wrist and attaches onto the needle holder. Consequently, this technology allows for replication of the full rotatory movements of the wrist. Though designed as a needle holder, the flexibility that the FlexDex instruments provide are particularly helpful to the dissection in a microlobectomy. In particular, it is useful to manoeuvre around hilar structures, especially getting under pulmonary artery branches. As such it provides a novel and cheaper alternative to robotic surgery.

In our approach, the FlexDex was inserted directly through the skin and chest wall without the use of a port in order to minimise the size of the intercostal incisions, as it would otherwise require an 8 mm port (*Figure 3*).

Advantages

Because microlobectomy is likely to be associated with lower levels of pain, it promotes intensive physiotherapy, early mobilization, and enables a fast-tracked discharge. Given that hospital length of stay directly correlates to the development of hospital acquired infections, this also has the knock-on effect of minimizing the incidence of infections, especially pneumonias, which is particularly important in patients who may already have poor baseline lung function.

In our experience we have had patients undergoing microlobectomy discharged on the first post-operative day. Chest drains were briefly observed post-operatively and subsequently removed in the high dependence unit (HDU), if air leak was negligible and the chest X-ray was normal.

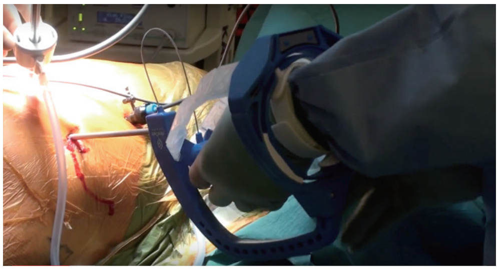

Figure 3 The FlexDex needle holder in the chest wall.

They were subsequently monitored in the HDU for a few hours and if stable with minimal or no oxygen requirements, transferred to the ward the same evening. They also received a comprehensive visit from the physiotherapist and returned for further sessions of physiotherapy to the hospital as an outpatient. The patients were also closely followed up by the thoracic surgery specialist nurses in the days and weeks following surgery.

Future of microlobectomy

Further fine-tuning of the intra-operative and immediate post-operative period along with a multidisciplinary outpatient approach including intensive physiotherapy may allow for a fast track or same-day discharge pathway to be expanded to a wider cohort of patients. Additionally, development of a wider range of 5 mm instruments including a 5 mm stapler may enable more surgeons to adopt the microlobectomy approach, with minimal alterations to their traditional VATS approach.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editors (Roberto Crisci and Luca Bertolaccini) for the series "Surgical Approaches to VATS Lobectomy: Meet the Experts" published in *Shanghai Chest*. The article did not undergo external peer review.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/shc.2018.08.04). The series "Surgical Approaches to VATS Lobectomy: Meet the Experts" was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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doi: 10.21037/shc.2018.08.04
Cite this article as: Jayakumar S, Nardini M, Migliore M, Paul I, Dunning J. Microlobectomy—where do we stand? Shanghai Chest 2018;2:69.