

History and current status of mini-invasive thoracic surgery

Jianxing He, MD, PhD, FACS

Department of Cardiothoracic Surgery, the First Affiliated Hospital of Guangzhou Medical College, Guangzhou, Guangdong, China; Guangzhou Institute of Respiratory Disease, Guangzhou, Guangdong, China; China State Key Laboratory of Respiratory Disease, Guangzhou, China

ABSTRACT

Mini-invasive thoracic technique mainly refers to a technique involving the significant reduction of the chest wall access-related trauma. Notably, thoracoscope is the chief representative. The development of thoracoscope technique is characterized by: developing from direct peep to artificial lighting, then combination with image and video technique in equipments; technically developing from diagnostic to therapeutic approaches; developing from simpleness to complexity in application scope; and usually developing together with other techniques. At present, the widely used mini-invasive thoracic surgery refers to the mini-open thoracic surgery performed mainly by using some instruments to control target tissues and organs based on the vision associated with multi-limb coordination, which may be hand-assisted if necessary. The mini-invasive thoracic surgery consists of three approaches including video-assisted thoracic surgery (VATS), video-assisted Hybrid and hand-assisted VATS. So far the mini-invasive thoracic technique has achieved great advances due to the development in instruments of mini-invasive thoracic surgery which has the following features: instruments of mini-invasive thoracic surgery appear to be safe and practical, and have successive improvement and diversification in function; the specific instruments of open surgeries has been successively developed into dedicated instruments of endoscopic surgery; the application of endoscopic mechanical suture device generates faster fragmentation and reconstruction of organ tissues; the specific delicate instruments of endoscopic surgery have rapid development and application; and the simple instruments structurally similar to the conventional instruments are designed according to the mini-incision. In addition, the mini-invasive thoracic technique is widely used in five aspects including diseases of pleura membrane and chest wall, lung diseases, esophageal diseases, mediastinal diseases and heart diseases. However, there remain many problems in specifications and trainings, economic cost, conservation and innovation. Therefore, particular attention should be paid to these problems. Nevertheless, the promotion of thoracic surgery appears promising in the future.

KEY WORDS

nonagenarian; mutation; Mini-invasive Thoracic Surgery; video assisted thoracic surgery (VATS); robotic thoracic surgery

J Thorac Dis 2011;3:115-121. DOI: 10.3978/j.issn.2072-1439.2010.03.01

When God was creating human beings, he covered people's various secrets indeliberately. Curiosity is human's nature. And endoscope, one of the bridges between human visual feeling and those secrets, enables humans to explore their own secrets artistically and to remove the existential threats handily.

History of mini-invasive thoracic surgery

Notably, thoracoscope is the chief representative. How far the

development history of thoracoscope technique steps is closely associated with the status of social scientific development at that time. Table 1 lists the important events in development history of thoracoscope technique. From these historical series, we can find that the development of thoracoscope technique is characterized by: a) developing from direct peep to artificial lighting, then combination with image and video technique in equipments; b) technically developing from diagnostic to therapeutic approaches; c) developing from simpleness to complexity in application scope; d) usually developing together with other techniques.

Video-assisted thoracic technique wasn't started late somehow in our country as compared with that in other foreign countries. In April 1994, the earliest study class and seminar on video-assisted thoracic technique were successively held in General Hospital of the people's Liberation army (PLA) (301 hospital) and the First Affiliated Hospital of Guangzhou Medical College, which had exerted profound influence on the

No potential conflict of interest.

Corresponding to: Jianxing He, MD, PhD, FACS. No. 151 Yanjiang Rd, Yuexiu District, Guangzhou 510120, Guangdong, China. Tel: 86-20-8306-2777; Fax: 86-20-8335-0363. Email: drjianxing.he@gmail.com.

Submitted Jan 10, 2011. Accepted for publication Feb 20, 2011.

Available at www.jthoracdis.com

ISSN: 2072-1439 © 2011 Journal of Thoracic Disease. All rights reserved.

Table 1. The important events in development history of thoracoscope technique

| | |
|-------|--|
| 1806 | Bozzini used the endoscope to examine urinary bladder |
| 1821 | Carson used artificial pneumothorax (APT) in treatment of pulmonary tuberculosis |
| 1882 | Forlanini introduced the method of producing closed pneumothorax |
| 1883 | Newman equipped the endoscopes with electric lights |
| 1895 | Roentgen discovered X-ray |
| 1910 | Jacobaeus described the first thorascopic examination |
| 1913 | Jacobaeus used thoracoscope to release pleural adhesion |
| 1922 | Jacobaeus classified the pathological changes based on the thorascopic examination |
| 1928 | Cova published the color atlas |
| 1935 | Mistal published Endoscopy et Pleurolyse |
| 1937 | Alexander believed that thoracic surgery should be performed by surgeons |
| 1938 | Lelong used a thoracoscope to diagnose visceral inversion, which increased its usefulness |
| 1945 | Isoniazid developed thoracic technique for treatment of pulmonary tuberculosis |
| 1950s | Swierenga used thoracoscope to examine spontaneous pneumothorax and Sattler used it to diagnose pleural effusion |
| 1970s | Thoracic technique started flourishing gradually |
| 1980 | The first International Forum on thoracic technique was held in Marseilles |
| 1989 | LoCicero started using Nd: YAG laser |
| 1990s | Video-Assisted Thoracic Surgery (VATS) |
| 1990s | Hybrid VATS |

development of thorascopic surgery in China (1). With the support of Chinese Journal of Surgery, the 2nd national scientific seminar and training course on thorascopic surgery was held in Hangzhou in November 1995, complex thorascopic surgeries such as esophageal surgery, patent ductus arteriosus (PDA) and pulmonary lobectomy were involved. In November 1996, the 3rd national scientific seminar on thorascopic surgery was held in Guangzhou, with thymusectomy and lung volume reduction surgery involved, and so on. Along with introduction, learning and development, video-assisted thoracic lobectomy of lung, esophagectomy and thymusectomy were performed in China almost in pace with the world. In 1998, the thoracic surgery group, Chinese Medical Association (CMA) of Thoracic and Cardiovascular Surgeries was established.

Definition and concept of mini-invasive thoracic surgery

Development in modern surgery is mainly directed at organ transplantation, artificial material and mini-invasive technique. The introduction of thoracic technique has brought an important advance in mini-invasive thoracic surgery. Although thoracic technique is the chief representative of mini-invasive thoracic technique, this does not mean the whole of mini-invasive thoracic surgery. Till now, people have increasingly deepened their understandings of mini-invasive thoracic surgery.

Mini-invasive thoracic surgery refers to the mini-open thoracic surgery performed mainly by using some instruments to

control target tissues and organs based on the vision associated with multilimb coordination, which may be hand-assisted if necessary. This surgery is technically performed by using the reusable deep slender tools or disposable tools for excision or reconstruction of the target tissues, with combination of stereoscopic images from direct vision and two-dimensional video images from thoracoscope. Mini-invasive thoracic surgery consists of three approaches including video assisted thoracic surgery (VATS), video-assisted Hybrid and hand-assisted VATS. The pure video-based operation is one part of mini-invasive thoracic surgery but not the whole (2).

Mini-invasive thoracic surgery is a concept that minimizes the chest wall access-related trauma by modern techniques under circumstances where intrathoracic nidus treatment of mini-invasive thoracic surgery is as thorough as that of the conventional thoracotomy hence the mild trauma and injury to body systems of patients. Mini-invasive thoracic surgery refers to its surgical incision is relatively smaller than that of conventional thoracic surgery but not absolutely small in size. In addition, the injuries to functions of heart, lung, liver and kidney, nervous system and locomotor system caused by mini-invasive thoracic surgery are very few statistically.

The definition of mini-invasive thoracic surgery has a very wide-ranging scope, which contains two concept quintessences in terms of the current status of mini-invasive development in cardiothoracic surgery and abdomen surgery at home and abroad: a) Mini-invasive thoracic surgery refers to the surgery involving a minimal injury to patients' organ function; b)

The incisions of mini-invasive thoracic surgery is significantly contracted as compared with those of the conventional surgery. At present, any thoracic surgery that satisfy the two requirements above can be considered as mini-invasive thoracic surgery.

VATS usually refers to thoracic surgery that involves insertion of instruments through many small chest incisions under two-dimensional video images, and hand-assisted VATS mainly refers to thoracic surgery performed by inserting the surgeon's hand instead into the chest cavity through one of the chest incisions to control the target organs under a two-dimensional video images. And image-assisted minimal incision surgery refers to the mini-incision thoracic surgery that involves excision and reconstruction of the target tissues (main diseased regions such as pulmonary hilus, mediastinum and esophagus) using the reusable deep slender tools or disposable tools through a limited chest incision under direct vision, and surgical procedures in the non-main operating field with combination of the assisted two-dimensional video images, which may be hand-assisted if necessary. These differential techniques have their own scopes of application, in which that technique is the best technical alternative. Safety and efficacy are central to the selection criteria of techniques, followed by guarantee of radicality and thoroughness, and then mini-invasiveness.

Current status of development and application of mini-invasive thoracic technique

Mini-invasive thoracic technique has been developing rapidly, which is manifested by more and more conceptual acceptance from the public, quicker improvement and update in surgical instruments of endoscopic surgery, wider scope of application and more and more scholars to master and perform mini-invasive thoracic surgery.

The development in instruments of mini-invasive thoracic surgery, as the precondition of development and progress in mini-invasive thoracic surgery, is characterized by the features below:

- Instruments of mini-invasive thoracic surgery appear to be safe and practical, and have successive improvement and diversification in function.
- The specific instruments of open surgeries have been successively developed into dedicated instruments of endoscopic surgery.
- The application of endoscopic mechanical suture device generates faster fragmentation and reconstruction of organ tissues.
- The specific delicate instruments of endoscopic surgery have rapid development and application.
- The simple instruments structurally similar to the conventional instruments are designed according to the mini-incision.

In recent years, surgical robot is one of the advances in

instruments of mini-invasive thoracic surgery. Generally speaking, surgical robots refer to machines that are able to perform or assist in performing surgical operations. However, they are still needed to be controlled by a doctor to perform a surgery currently. At present, the major robotic system mainly consists of Aesop system, Zeus system, DaVinci system, and so on. If video-assisted thoracoscope is considered having realized the revolution in input end of surgical information, the presence of surgical robots then realizes the revolution in output end. The combination of surgical robotic technique and remote video transmission technique makes telesurgeries possible. In September 2001, laparoscopic cholecystectomy was successfully performed on a 68-year-old patient in a operation room (OR), Strasbourg Hospital, France using the Zeus robot by a surgeon controlling its movements through watching telescreen in New York, America, 7000 kilometers far away from France and across the Atlantic. The further mini-invasive thoracic surgery advances, the more significant interpenetration, interaction and integration across the techniques.

More and more thoracic surgeries were performed using mini-invasive thoracic technique based on the scope of application.

Diseases of pleura membrane and chest wall

Thoracoscope technique has been commonly employed in diseased pleura membrane biopsy, pleural decortication and pleurodesis, or clearance of effusion, empyema and hemothorax, ligation of fractured intercostal arteries or ruptured thoracic ducts. In 1988, Nuss, an American doctor, performed Nuss surgery to treat funnel chest by hanging up the sternum after placing arcuate buttress plate on the back of sternum, which was a major advance in treatment of funnel chest. These surgeries are uncomplex in technique and low-risk. Thoracic surgery can minimize trauma and greatly improve the accuracy of surgeries, which is thus fit for application.

Lung diseases

According to surgical skills, the surgical procedures can be allocated into lung biopsy, pulmonary resection, pulmonary lobectomy, pneumonectomy and bronchoplasty surgery. At present, all of surgeries above can be performed by using mini-invasive thoracic technique in terms of the surgical technology. Nevertheless, the role of mini-invasive thoracic technique in treatment may be differential based on different diseases, different disease degrees and surgeons with different levels of proficiency.

Lung biopsy and pneumoresection are surgeries that only need to remove a fraction of lung tissue from patients mainly for a definite diagnosis and sometimes for direct treatments. In the surgical diagnosis and treatments of lung diseases, these surgeries need the least excisional tissue, the lowest difficulty

level of mini-invasive thoracic technique hence the most common use and most obvious advantages of mini-invasive thoracic technique, among which the most commonly seen are pulmonary nodule biopsy, diffuse lung disease biopsy and treatment of pneumothorax pulmonary bullae. Traditionally, the procedures above are performed using 2 or 3 incisions (1 observation incision + 1 or 2 operational incisions). Along with advance of delicate instruments and surgical skills, surgeries can be performed with only one incision by using one-channel cannula, or much smaller needle-type thoracoscope which further improves the mini-invasiveness of surgery.

For those surgeries requiring removal of a relatively larger part of lung tissue, they are usually performed after confirming diagnosis. These surgeries are usually performed when pulmonary lobectomy can't be tolerated by tumor patients, including wedge resection, segmentectomy, and lung volume reduction surgery for severe emphysema and bullectomy. In addition, these surgeries are uncomplex and convenient mainly involving successive excision of lung tissue and suture by using the endoscopic suture cutting instrument, without individual treatment of pulmonary vessels and bronchia involved. Such mini-invasive surgeries also have significant advantages, and are commonly used.

Based on diseases requiring anatomic lobectomy of lung such as lung cancer, bronchiectasis and destroyed lung, anatomic treatments of blood vessel and bronchia are involved in these surgeries. Reliability and safety are highlighted in order to avoid massive hemorrhage during surgery and bronchopleural fistula after surgery. Notably, lung cancer needs to be guaranteed a reliable efficacy of lymph node dissection. Microtrauma of thoracoscopic surgery enables some patients whose pulmonary function can't tolerate conventional surgeries originally to undergo surgical treatments. In 1992, VATS pulmonary lobectomy was first reported by Lewis (3). So far the most commonly employed surgical approaches have two aspects: a) unopen incision. VATS is performed entirely under thoracoscope; b) open incision. Hybrid VATS is performed by combination of thoracoscope-assisted observation and macroscopic vision. There is technically no problem in pulmonary lobectomy performed using the first approach, with 1 observational incision + 1 longer surgical incision + 1 or 2 incisions for assistance of stretch. For the second approach, surgeries need to be performed entirely on two-dimensional plane under thoracoscope by using relatively longer endoscopic surgical instruments, which greatly requires an intense surgical perception from a surgeon. The surgical time needed of this approach is much longer than that of the first approach, whereas the pain may be favorably alleviated after surgery. 1 observational incision + 1 longer open incision are usually needed in the second approach. Such surgeries can be performed on the operational field in combination of two-dimension and three-dimension under partial direct vision. Moreover,

conventional instruments can be employed. The advantages of this approach are improved precision and speed, decreased time of manual suture and enlarged surgery space. This approach is more practical in surgeries involving reconstruction such as bronchoplasty. Nevertheless, there may be a more significant pain after surgery because of the opened incision and the accessory incision over 2cm. Therefore, each approach has its own advantages and disadvantages, which should be selected depending on the performing level of surgeons, balance across safety, efficiency and economic expenditure, with no absolute rules.

Along with the increase of surgical practice, people have found various advantages of VATS pneumonectomy and dismissed many worries. The multicenter study (Cancer and Leukemia Group B 39802) supported by Swanson showed a lower incidence rate of postoperative complications and shorter retention time of thoracic ducts of VATS pneumonectomy as compared with those of the conventional thoracic surgery (4). Furthermore, a summary report of 1100 cases by McKenna demonstrated a very low mortality rate (<1%) of perioperative period of VATS pneumonectomy and incidence rate of complications (5). In addition, more studies have shed light on other advantages of VATS pneumonectomy such as alleviated pain after surgery, minimal blood loss during surgery, more favorable pulmonary function after surgery (6).

There were still some conflicts over VATS technique for treatment of lung cancer before 2006. These problems mainly center on as to whether the longer surgical time and frequent stretch of pulmonary lobe will lead to iatrogenic metastasis, whether VATS technique contributes to a safe pulmonary lobectomy and an effective lymph node dissection under circumstance of nondirect vision. If it's possible, whether the surgical time and learning time of VATS technique will be increased, and whether this will decrease the harm of microtrauma in this surgery. Actually, thoracoscope is an instrument used for diagnosis by surgeons, but not a diagnostic purpose. However by the year 2006, along with the application of VATS technique for 14 years, statistics of large numbers of cases and reports of event free survival had been done. Thus VATS radical resection of pulmonary carcinoma was identified and believed to be included in the standard treatment approach of resection of pulmonary carcinoma by National Comprehensive Cancer Network (NCCN) guideline, which is also greatly suggested for old people and people with poorer constitution. VATS system can provide better lighting and clear magnified images of the deep part and the details, which is impossible for the conventional surgeries. As long as surgeons have a good foundation of general thoracic technique and proficient skills in mastering thoracoscope, and the VATS technique and the conventional thoracotomy is organically combined, sufficient scope of excision and standard lymph node dissection can be accomplished during tumor surgery. If conventional surgeries

can be performed with assistance of thoracoscope, this can also improve the surgeons' grasp of the overall surgical situation. In the contrary, adhering too strictly to the incision 1cm longer or shorter than the standard will lead to the ossification of surgeries because the patient's condition + equipment condition + the surgeon's skill = personalized mini-invasive thoracic technique. For an individual person in realistic society, a patient needs the most suitable surgical approach but not really the highest technical approach. However, the thoracoscope just resolves the surgical access without changing the essence of thoracic surgery. The efficacy is the premise, and the safety is the first. If VATS or VAMT is found not to satisfy the safe radical excision and not to achieve the efficacy of conventional surgeries, such surgery should be immediately transferred into micro-incision surgery, which also should be a major principle of mini-invasive thoracic surgery. In recent years, along with the development of mini-invasive thoracic technique and an update of conception, mini-invasive thoracic surgery can be performed not only on patients with stage I or stage II lung cancer, but patients with stage III lung cancer by quite a few scholars.

Of mini-invasive techniques, video mediastinoscopy also deserves to be mentioned. Video mediastinoscopy is performed by inserting the mediastinoscope through the small incisions beside the neck and the sternum to visually diagnose and remove the pathological tissues or swelled lymph nodes in peri-trachea, carinal trachea and bronchial region with combination of video technique. Although mediastinoscopic technology has been promoted in the clinical application for more than 40 years, video mediastinoscopy was first clinically used by Sortini et al in 1994 (7). In addition to mediastinal lymph node biopsy, the traditional mission, video mediastinoscope may allow for lymph node dissection, excision of mediastinal mass, or excision of esophageal carcinoma instead of thoracoscope and treatments of malignant pleural effusion (MPE) and palmar hyperhidrosis, etc.

Esophageal diseases

Video-assisted thoracoscope is currently combined with laparoscope, which almost involves every surgical treatment of esophageal diseases. For treatments of benign esophageal diseases, Heller myotomy on thoracoscope has been considered as a safe and effective approach in treatment of esophageal achalasia, and VATS resection of benign esophageal neoplasm or esophageal diverticulum is also convenient and simple, which is thus commonly performed. Nevertheless, there are still debates over mini-invasive technique in treatment of malignant esophageal diseases. In 1991, thorascopic lobectomy of esophageal cancer was first performed by Collard and Gossot. At present, along with the development of more than ten years, NCCN believes that mini-invasive esophagectomy can favorably decrease the occurrences of complications and the recovery time after surgery as compared with the conventional

surgery, and mini-invasive surgery is suitable for the old patients with esophageal cancer. But so far no clinical randomized trial can be found to verify a better improved long term survival rate of minimally invasive lobectomy of esophageal cancer as compared with that of the conventional surgery, in many cases, the conventional open lobectomy of esophageal cancer is still considered as the standard method. At present, video-assisted thoracoscope or the assisted incision is more frequently used in gastroesophagostomy by mobilizing from the esophagus to the median abdominal incision, or laparoscope by mobilizing stomach, chest or internal collar incision. In the past few years, the combination of thoracoscope and laparoscope has been more and more commonly used in both esophageal cancer treatment and reconstruction.

Mediastinal diseases

Most of mediastinal tumors and surgical diseases can be treated with mini-invasive surgery such as mediastinal ectopic thyroid gland, thymic cyst, myasthenia gravis and stage I thymoma, which thus is popular with more and more patients and doctors. Mini-invasive mediastinoscopy combined with thoracoscope has a significant improvement in the surgical visual field. Compared with the conventional surgery, mini-invasive mediastinoscopy has a greatest advantage of slight blood loss, followed by decreased hospitalized time, good cosmetic effect, rapid recovery and less pain. Nevertheless, the mini-invasive mediastinoscopy has raised some doubts for using mini-invasive thymectomy in treatment of myasthenia gravis (MG) and stage I thymoma as to whether the nidus tissues can be entirely removed by mini-invasive surgery, especially thorascopic surgery. But as the days goes by, mini-invasive mediastinoscopy is increasingly performed on patients hence less and less doubts over this point. For operation on thymus, total thymectomy can be performed by using one of the mini-invasive surgical approaches including an unilateral or bilateral thoracoscope, a neck incision, and the combination of these two approaches, if the patients are seriously selected and the surgery is carefully performed, which is no less effective than the conventional open thoracotomy. However, operation on thymus should be immediately converted to midsternal incision surgery or antero-lateral incision surgery, when thymoma is found to have malignant syndromes such as invasion of adjacent tissues, or the thymus can't be removed entirely using the thoracoscope during surgery.

Heart diseases

At present, most of surgeries in the field of cardiac surgery can be performed using video-assisted thoracic technique. The application of thoracoscope technique in cardiac surgery has several major aspects below:

- Thoracoscope-assisted cardiac surgery: Thoracoscope-assis-

ted cardiac surgery refers to a technique that involves insertion of a thoracoscope used as the light source or an image collector of the specific regions through a small incision of chest wall under direct vision. In 1995 and 1996, the success of thoracoscope-assisted mini-invasive direct coronary artery bypass was reported by Benetti and Stevens, respectively. In 1996, Chang was the first to perform 8 repairs of auricular septal defect by making a 4- to 7-cm incision under video-assisted thoracoscope, which achieved a satisfactory result. In addition, repair of mitral valve was successfully performed using thoracoscope by Carpentier the same year. In 1997, replacement of mitral valve was performed using a thoracoscope by Chitwood. In 1998, replacement of tricuspid valve was successfully performed using thoracoscope by Robin. At present, thoracoscope-assisted cardiac surgery, with a most mature development, has a significant decrease in surgical trauma as compared with the conventional surgery, whereas there remains a relatively large incision.

- Robotic thoracic surgery: In 2002, Torracca et al reported that 7 repairs of auricular septal defect was successfully performed with the da Vinci Surgical System by using peripheral extracorporeal circulation, blocking of aorta and cardiac cold penetration techniques under the thoracoscope, and all the patients recovered well after surgery. Nevertheless, there exist two great defects on robotic thoracic surgery. The first is the lack of visual and tactile feedbacks from surgeons, followed by the great defects in surgical equipments including inharmony operation, relatively higher technical difficulty and longer surgical time. Moreover, these equipments are very expensive and thus remain in the stage of exploration.
- Video-assisted thoracic surgery: Compared with thoracoscope-assisted cardiac surgery, video-assisted thoracic surgery is performed by insertion of the specific instrument through a tiny incision in chest wall under observation of video-assisted thoracoscopic image capture screen. Video-assisted thoracic surgery is in best conformity with the principle, whereas it requires a relatively higher technique, which thus prohibits the widespread use of video-assisted thoracic surgery. In 1994, ligation of patent arterial duct was first performed using VATS in mainland China, which achieved a favorable efficacy. From 2000 to 2001, atrial septal defects (ASD), ventricular septal defect, replacement of mitral valve, Ebstein orthopedic surgery and coronary artery bypass surgery were successively performed under video-assisted thoracoscope. For skilled operators, the operation time of video-assisted thoracic surgery can be as low as 1/3~1/4 of that of robotic thoracic surgery, which can save a majority of financial and material resources and thus tallies with the realistic situation of China.

Thoracic surgery under thoracoscope can be classified into 2 levels depending on the degree of trauma: 1) Thoracoscope-assisted surgery: The surgical approach involves technical applications of thoracoscope technology, peripheral extracorporeal circulation and myocardial preservation in congenital cardiac surgery. The incisions located beside the sternum and in the lower right breast, can be further reduced to 4- to 8-cm, which then further decreases the degree of trauma. However, the surgical procedures inside the chest cavity still needs to be performed under direct vision using this approach which hasn't reached the level of pure thoracoscope. 2) Pure thoracic surgery. This surgery aims at being performed by inserting a thoracoscope through a hole instead of a tiny incision without involving direct vision. In the present historical conditions, the operators can fully exert the effects of surgical techniques including the modern thoracic technique, peripheral extracorporeal circulation and myocardial preservation according to practical situation, and minimize the surgical trauma.

Future directions

Specifications and trainings

After more than a decade of surgical practice, video-assisted thoracic technique has achieved remarkable advances and reached a certain scale in China. Based on the present national conditions, the domestic scholars have done various beneficial exploration on know-how about developing thoracic technique, which makes the thoracic technique much easier to be mastered and performed. However, it should be noted that the level and scale of thoracic technique are uneven in different areas, and the trainings accepted previously are widely divergent as well. Thus, some hidden problems undoubtedly exist in the performance of thoracic technique. In addition, the formed techniques should successively be summarized and promoted, and the exploration of the techniques being explored still needs to be performed in an orderly manner. "Laissez-faire to management" is an inevitable trend of development control in this technique. At present, Qualification of mini-invasive thoracic surgery or technique hasn't been carried out in China. Nevertheless, the pressure on developing qualification will be gradually increased in order to avoid the public's worries and to control the occurrence of complications due to insufficient trainings, and this is also a protective measure. In 2006, Ministry of Health (MOH) started the qualification program of professional technique training base and established a set of specifications that make concrete provisions on the qualities of both equipments and trainees in the thoracic training base, which requires the thoracic surgeons to accept sufficient trainings following these specifications and to perform thoracic surgeries only after they meet the requirements and achieve the certifications. Hereafter thoracic technique will gradually become a part of conventional thoracic vocational

trainings and one of the standard techniques requisite to a cardiac surgeon. Furthermore, the trainings of thoracic technique should be listed as one of the indispensable training contents of thoracic technique.

Economic cost

Thoracic surgery can alleviate the trauma, which contributes to improving the quality of life after surgery, this no doubt is a long-term advantage. However, thoracic technique undoubtedly needs more equipments, instruments and disposable medical supplies. On the whole, thoracic surgery has a greater increase in hospitalization cost as compared with the conventional surgery. Since China is a developing country, particular attention should be paid to three aspects as to how should doctors develop the technique and reduce the economic cost without affecting the mini-invasiveness, safety and convenience of this technique, how should the domestic instrument manufacturers develop the reliable instruments and compete by reducing cost, and how should Chinese government improve the system of medical insurance and provide the extensive and in-depth medical insurance. Only these three aspects are favorably developed can the individual economic cost of thoracoscopic surgery actually decrease hence a widespread use of thoracic surgery (8).

Conservation and innovation

Surgery is a rapidly developing technique with oppositions between novel and old techniques and between advanced and backward techniques, and the thoracic surgery is no exception. Although thoracic surgery aroused controversy and suspicion at the beginning of development, it is rapidly developing at present. Therefore, we should hold an objective and integrated attitude towards the development and the application of thoracic surgery

but not despise the new technique for its novelty and the lack of performance, or easily give up because of the small number of suitable population then and there. Moreover, we should clearly note that the promotion of thoracic surgery is an inevitable trend.

References

1. He JX. Several problems of minimally invasive thoracic surgery. *Zhonghua Wai Ke Za Zhi* 2007;45:1515-7.
2. He J, Shao W, Cao C, Yan TD, Wang D, Xiong X, et al. Long-term outcome of hybrid surgical approach of video-assisted minithoracotomy sleeve lobectomy for non-small-cell lung cancer. *Surg Endosc* 2011. [Epub ahead of print]
3. Lewis RJ, Caccavale RJ, Sisler GE, Mackenzie JW. One hundred consecutive patients undergoing video-assisted thoracic operations. *Ann Thorac Surg* 1992;54:421-6.
4. Swanson SJ, Herndon JE 2nd, D'Amico TA, Demmy TL, McKenna RJ Jr, Green MR, et al. Video-assisted thoracic surgery lobectomy: report of CALGB 39802--a prospective, multi-institution feasibility study. *J Clin Oncol* 2007;25:4993-7.
5. McKenna RJ Jr, Houck W, Fuller CB. Video-assisted thoracic surgery lobectomy: experience with 1,100 cases. *Ann Thorac Surg* 2006;81:421-5.
6. Yan TD, Black D, Bannon PG, McCaughan BC. Systematic review and meta-analysis of randomized and nonrandomized trials on safety and efficacy of video-assisted thoracic surgery lobectomy for early-stage non-small-cell lung cancer. *J Clin Oncol* 2009;27:2553-62.
7. Sortini A, Navarra G, Santini M, Occhionorelli S, Sartori A, Bresadola V, et al. Video-assisted mediastinoscopy. A new application of television technology in surgery. *Minerva Chir* 1994;49:803-5.
8. He J, Shao W, Cao C, Yan T, Wang D, Xiong XG, et al. Long-term outcome and cost-effectiveness of complete versus assisted video-assisted thoracic surgery for non-small cell lung cancer. *J Surg Oncol* 2011. [Epub ahead of print]