

Bipolar sealing devices in video-assisted thoracic surgery

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Abstract: Intraoperative bleeding is one of the main severe complications in complete video-assisted thoracic surgery (c-VATS) and post-operative air-leaks prevention still represents an important challenge. Usually, hemostasis is often difficult and unsafe when the VATS approach is performed and the potential role of bipolar sealing devices is still undefined, as proven by limited experiences reported in the literature. By introducing endostaplers in VATS surgery, it was possible to perform safe thoracoscopic resections of lung. On the other hand, several diathermy techniques have been proposed to reduce intraoperative blood loss in surgery. In particular, standard bipolar technology has proven to effect coagulation in small vessels. The aim of this study is to compare bipolar electro thermal devices to endostapler in VATS lung resections concerning intraoperative bleeding and post-operative air leaks.

Keywords: Video-assisted thoracic surgery (VATS); endostapler; bipolar electro thermal devices; lung surgery

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Introduction

Lung cancer surgery has evolved to a integrate several interpretations of a minimally invasive approach currently encompassed under the term of video-assisted thoracic surgery (VATS) which is recognized as an acceptable treatment for resectable non-small cell lung cancer (NSCLC) (1).

As the volume and complexity of cases has increased technical difficulties had arisen. Hilar and segmental lymph nodes dissection can represent a challenge for VATS surgeons in order to complete a safe dissection of vascular and bronchial structures without complications or conversion (2).

It is not unusual that patients with smoking history or benign infections in the past present with enlarged calcified nodes that are fused to the hilum, fissure and specially the bronchus which can lead to an accident during

the procedure if the surgeon has no experience handling this issue.

As the number of surgeons carrying out VATS lobectomies grows, it is very important for them how to handle bleeding complications so the completion of the procedure can be achieved safely. Endostaplers made it possible to perform safe thoracoscopic resections of lung parenchyma (3,4). However, the introduction of endostaplers increased the costs of hospitalization despite shorter operative times and length of stay.

Intraoperative bleeding represents is a fearsome complication in complete video-assisted thoracic surgery (c-VATS) and various diathermy techniques have been proposed to address in a cost-effective and safe way the issue of ligation of pulmonary vessels during VATS lobectomy. In 2015 Decaluwe *et al.* (5) published the results of a multicenter prospective evaluation of the incidence and

kind of major intraoperative complications during VATS anatomical lung resection. Conversion to open thoracotomy was necessary in 5.5% of patients; 48.8% of patients had intraoperative complications with bleeding accounted for 41.2% of all conversions; vascular injuries were observed in 2.9% of patients.

Sometimes hemostasis can be unsafe and difficult when the VATS approach is performed. Surgeons often require the use of sealing systems to achieve a better hemostasis with minimal damage to the surrounding tissue. However, the reported experience in the literature is limited and the potential role of this technique is undefined. The electro-thermal bipolar tissue sealing system (BS) has been extensively used in general surgery and other disciplines especially to divide short gastric vessels, splenic artery, liver tissue and colonic vessels (6,7).

The aim of this study is to compare the efficacy of bipolar electrothermal devices to endostapler in terms of intraoperative bleeding and post-operative air leaks reduction in VATS lung cancer resection. Secondary end-point of this study is to perform a cost-analysis of different procedures using different devices.

Operative technique

Endo Cutter Stapler places two- or triple-staggered rows of titanium staples and simultaneously divides the tissue between the two- or triple-staggered rows. The size of the staples is determined by the selection of different cartridge (2.5, 3.5 or 4.8 mm). The endo linear cutter staplers accommodate any of the straight single use loading unit sizes that are available in the 30, 45 and 60 mm lines. The device can be reloaded and used up to 20 times during the same procedure as recommended by manufacturers.

Endostaplers provide excellent tissue sealing and hemostasis while entailing disadvantages such as leaving foreign bodies in the suture lines and the high costs. Moreover, despite the possibility to articulate the device, because of their length and head size, endostaplers can be difficult to handle in certain situations.

Standard bipolar technology is used to coagulate vessels ranging from 1 to 3 mm in diameter. Its disadvantages include sticking, charring, and significant thermal spread. Bipolar coagulation generally involves a surgical procedure in which an instrument with two electrical poles that cauterizes and removes tissue is used. The instrumentation used in bipolar coagulation procedures typically includes a frequency generator. Modern units usually have more than

one power setting, allowing physicians' greater flexibility in deciding the amount of current to use during a particular procedure. Soft tissues generally require lower frequency impulses for effective removal than thicker, fibrous tissue. Bipolar coagulation systems generally produce lower levels of current than the original monopolar systems, which generated up to 2,500 volts. Bipolar systems usually only generate around 140 volts. A disposable forceps or two probes containing two small electrodes are attached to the power unit. It is the forceps that receives the high frequency waves or diathermy. Some models may also contain an opening for irrigation fluid. Forceps made from titanium eliminate tissue adherence problems, and they may also be covered with a protective polymer, which also prevents tissue sticking and tearing. The forceps cut through the tissue at the desired region and the current does not extend beyond the point of contact. The benefits of using bipolar coagulation over conventional surgical methods include a decreased risk of thrombosis formation, minimal tissue damage without suturing, and hemorrhage prevention.

In the last decade efforts were made to reach safe lung parenchyma cutting. Reportedly, ultrasonic dissection devices (8-10), saline enhanced thermal sealing (11,12), argon beam coagulator and Nd:YAG laser (13) have all been utilized as an alternative to staplers to perform pulmonary wedge.

The LigaSure vessel sealing system associates heat generated through bipolar radiofrequency (RF) energy, and precise jaw pressure to denature the collagen and elastin in a tissue or in a blood vessel. These proteins re-anneal to form an insoluble gel that ligates the tissue or vessel. The LigaSure Vessel sealing system (Covidien, Mansfield, MA, USA) comprises seven open configuration instruments and three instruments configured for laparoscopic application. These instruments are compatible with both the LigaSure generator and the recently released Force Triad generator. The Force Triad generator has monopolar, bipolar and LigaSure 'u' vessel sealing output, which has a seal algorithm that optimizes tissue effect. The generators detect the impedance of the tissue and establish the correct necessary quantity of energy to achieve an optimal seal. The FDA has approved the LigaSure 'u' system for sealing isolated arteries, veins and lymphatics up to 7 mm in diameter.

The Aquamantys[®] system (Medtronic, Minneapolis, MN, USA) is a single-use portable handheld device with a saline-irrigated tip and an adjustable RF energy generator system with integrated pump. It was launched commercially in its

current form in March 2006 (14). The combination of RF energy and saline provides haemostatic sealing of tissues, without charring or carbonisation. It has been widely adopted in a number of other surgical specialties, including orthopedic, hepatobiliary and neurosurgery. Reports in the literature of the use of the Aquamantys® system in a thoracic surgical setting are limited and are based on older, lower-energy models of the device that proved inefficient at sealing lung tissue (15,16).

Discussion

Many Authors reported that the LigaSure technology significantly reduces bleeding for an equivalent operating time compared with electrocautery. Moreover, many papers pointed out the feasibility and efficacy of LigaSure in lung fissures completion.

Nevertheless, vessel sealing devices (VSD) are not widely used in pulmonary vascular treatment during VATS lobectomy, mainly because of the vulnerability of pulmonary arteries wall and of concerns regarding major hemorrhagic morbidity and mortality, with the possibility to face a fatal complication such as bleeding.

When heat is released gradually, and provided the temperature remains <100 °C, proteins denature into an amalgam, which is mandatory for vessel coagulation. Moreover, the ultrasound energy induces a cavitation effect in water-containing tissues, and this promotes tissue separation. A drawback is just the release of a dust cloud caused by non-viable tissue particles sprayed by the electronic branches that can be uncomfortable mainly during close-up work. Moreover, thermic energy frequently causes adhesion of the sealed tissue to the branches of the instrument and this requires irrigation and careful handling.

Toishi and colleagues (17) recently reported the results of a protocol in which they detected burst pressure from different vessels when multiple pulmonary artery branches treated by VSD (both EnSeal, LigaSure or Harmonic devices) or ligation were apparent during an operation. They observed that VSD application reduced intraoperative bleeding, surgeon stress, both postoperative drainage output and drainage persistence if compared with VSD non-use. Moreover the incidence of adverse events was equivalent to that of VSD non-use. As well as other Authors, they experienced an advantage by VSD use in lymph-node dissection: VATS VSD use allows simple and reliable vascular and lymphatic closure reducing post-operative effusions and lymphatic fistulae.

As regard VSD use in fissure completion, in 2004 Shigemura *et al.* (18) reported encouraging results during non-anatomical lung resections using thermal sealing. They focused on twelve pulmonary resections in which resection of lung parenchyma was obtained with an ultrasound-driven scalpel and the cut end was sealed using LigaSure. Authors performed a measurement of the cut surface after resection and assessment of LigaSure sealing strength. They concluded that lung resection using LigaSure seemed technically feasible and easy compared to staplers, with encouraging preliminary results.

In 2013 Bertolaccini *et al.* (19) published a randomized control trial comparing outcomes of a group of patients treated by the use of LigaSure alone *vs.* a group of patients treated by staplers. No significant differences were observed between the two groups according to operating time, postoperative drain removal day and in-hospital stay. According to the Authors LigaSure allows a better tailoring of lung resection margins compared to staplers, thus saving more functional lung tissue that can fill the residual thoracic cavity. Finally no differences in costs because of the devices used (Stapler or LigaSure) were reported.

Santini and colleagues (7) used LigaSure for non-anatomical lung resections, bullectomies and fissure dissection in both open and VATS procedures. Analyzing their experience of 36 patients they observed good results in terms of hemostasis using LigaSure. LigaSure provided a better tailoring of non-anatomical lung resection margins compared to staplers, thus saving functional lung tissue and avoiding the use of multiple reloadable cartridges; this reduced costs.

Kovács *et al.* (20) reported good results in terms of usability of the LigaSure-Atlas for pulmonary wedge resection indicating it as an alternative to endostaplers and Ultracision. Moreover the author reported no difference in costs using LigaSure compared to endostapler.

In 2015 Martucci *et al.* (21) published the results of a pilot prospective randomized, controlled trial comparing LigaSure™ tissue fusion technology with the ForceTriad™ energy platform to the electrosurgical pencil on rates of atrial fibrillation after pulmonary lobectomy and mediastinal lymphadenectomy. They reported no significant difference in atrial fibrillation onset rates between the two groups of patients: there were no differences in percentages of post-operative complications between the two groups. According to the authors LigaSure use was associated to a significant reduction of mediastinal nodal dissection duration and the cumulative chest tube drainage.

Conclusions

Since its introduction to date VATS approach is going to be considered as a standard technique for resectable stage I NSCLC. Every day more surgeons in different hospitals challenge this kind of surgery, even bringing to the limit its indications. Probably that's why literature grows up in numbers of papers focusing on new strategies and new technologies that can help surgeons in performing lung resections easily.

We initially experienced VATS approach on stage I NSCLC diagnosed through low-dose CT scan screening programs (22,23). Nodules threated were small and we generally found no lymph-node dissemination at surgery. Nowadays, we tend to choose VATS approach even in STAGE II diseases and of course we face harder and often insidious lung and nodal dissection.

In conclusion, we support the view of many authors who believe that new technologies may be of some help to the surgeon, especially in performing challenging lung and nodal dissection, reducing operating time and intra-operative bleeding.

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None.

Footnote

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

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