Perspective on Thoracic Surgery

Location techniques of pulmonary lesions during video-assisted thoracic surgery: a perspective

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We read with interest the article by Bertolaccini *et al.* describing the use of radioactive injections to identify small solitary pulmonary nodules or impalpable ground glass opacities (GGO) during video-assisted thoracic surgery (VATS) surgery (1). The advocates of localization methods for these lesions have described over the years different techniques in thoracic surgery, most of them derived from their uses in other organs and specialties.

Available methods

The use of CT-guided hooks applying a valid concept used in the diagnosis of small breast lesions diagnosis was probably the initial one. Ciriaco *et al.* (2) described its use in a series of 53 VATS procedures in 2004, and successful identification rates over 95% can be achieved with this method by several authors in series over 50 cases (3-5). The potential pitfalls of this technique were the potential side effects of pneumothorax and bleeding, but also migration of the wire, when the lung collapses during surgery. It does require collaboration with the Radiology Unit and the patient to be transferred into the operating theatre straight from the Scanner suite. These two areas vary from unit to unit hence the process might not be universally reproducible.

To minimize the potential for migration of the wire clinicians developed the insertion of metal coils. The metal coils are no longer attached to the chest wall reducing the potential for migration at lung collapse but also requiring less care to avoid touching or manipulating the wire during transfer from CT scan into the operating position. Mayo *et al.* published a large series of 73 of 75 cases identified by coils in 2009 with a fluoroscopy time of under 2 minutes (6). Once again the arrangements with the Radiology Unit and the transfer into the operating room are required, but in addition the operating room must be suitable for on the table radiology in order to identify the metal coil.

Non-metal markers have been described for identification of lesions during VATS surgery. In 1994 Lenglinger *et al.* reported the use of methylene blue helping identification in 14 out of 15 patients (7), results mimicked by Vandoni *et al.* in 2002 in series of 54 patients with a success of 93% (8). The benefit proposed was the safety of avoiding deployment of wires, and not requiring any special radiological equipment in the operating room. However, during VATS the methylene blue mainly directs to the surface point of access and dispersion of the dye might make difficult exact localizations of the lesions.

Injection of radiological contrasts did prove 100% successful in 15 and 10 patients respectively by the groups of Choi in 1998 (9) and Lee in 2012 (10). It does however require the availability of radiological equipment in the operating room in order to locate the lesion marked by contrast.

A potential advance was adopted from liver surgery, with the ability to identify nodules via ultrasound probe was initially described by Greenfield *et al.* in 1997 (11) and nicely presented by Piolanti in 2003 in multiport VATS identifying 37 of 40 nodules (12). Sortini and colleagues in 2005 improved the outcomes in a series of 25 cases over palpation alone

with a median time of 8 minutes to locate the nodules (13). In cases of pure GGO, Kondo identified 53 lesions using ultrasound probe of which only 19 were palpated (14). In this series patients with chronic obstructive pulmonary disease (COPD) were excluded, clearly defining some of the limitations of this technique. Later on, Rocco *et al.* described the use in single-port VATS surgery in 2011 (15).

Radioguided identification

The use of radionuclides as described by the authors was described successful in 44 of 46 nodules with a median size of 0.9 cm by Stiles *et al.* in 2006 (16), and later on 30 of 32 nodules less than 1 cm diameter by Bellomi in 2010 (17). This technology requires, as well described in the paper by Bertolaccini, the availability of a probe and equipment to identify the radiation within the area marked. Chella published the first pilot study of its use during VATS surgery in 2000 (18).

Bellomi in particular reported their experience over 3 years, but their inclusion criteria was quite open: one of any of nodule size less than 1 cm, subsolid morphology, or distance from the pleura more than 1 cm. This very inclusive selection criteria led to a proportion of cases most probably not requiring any aid for intraoperative location, and did not save a thoracotomy in all cases. Similarly, the cohort reported from Stiles comprised nodules up to 2.2 cm in size with a median distance from the pleura of 5 mm. Again, some patients required thoracotomy for identification by palpation.

Summary

All these technologies can aid the identification of deep nodules and non-palpable lesions during VATS surgery. The invasive ones can carry complications, such as pneumothorax, bleeding, migration and even air embolism (19). The ultrasonic method is potentially safer, but as with the other methods require training and equipment expenses. Overall, surgeons should use whatever facilities and expertise is available to them in order to improve outcomes.

However, it is clear from all of these reports that a large proportion of the lesions subject to localization methods would be also located without them. Lesions over 1 cm or in peripheral locations within 2 cm of the pleural surface can be identified during VATS. A careful evaluation of the current CT scans with excellent definitions, assessment by means of 3-D scans or reconstructions are of high value to locate the area of the lesions. Division of adhesions and mobilization of the inferior pulmonary ligament can improve palpation of lesions during VATS. Current work on virtual bronchoscopic guidance can also increase the yield for preoperative biopsies. Overall it is highly unlikely that any of these localization techniques become widely used and make an impact in a large number of patients.

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Footnote

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

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