Editorial

Pulmonary nodules and mini-invasive lung resection: do we have the right "tool" for their intraoperative localization?

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Lung resection still remains the best cure for early stage non-small cell lung cancer (NSCLC). Therefore, identification of the cancer in the early stage becomes the main goal, whenever a suspicious nodule is detected at chest CT scan.

The use of mini-invasive techniques, such as video thoracoscopy and robotic lung resection, is nowadays increasing in the thoracic surgery practice compared to the standard thoracotomy approach, changing in the last decade from 1.3% of VATS among all lobectomies to 13% (1). The escalation of mini-invasive techniques is connected with a significant reduced postoperative pain, lower morbidity, better preservation of pulmonary function and decrease of hospitalization associated with a better cosmetic result (2).

Pulmonary nodules (PNs) represent the most common reason for VATS and/robotic resections. Most lesions can be easily detected by inspection and tactile evaluation with an instrumental probe. However, some lung nodules are difficult to identify thoracoscopically. The small size of the nodule and/or their distance from the pleural surface might be limiting factors for a successful thoracoscopic resection (3). Moreover, ground glass opacities (GGOs) are more often detected at CT scan and they are challenging to be identified in the lung parenchyma even during a standard thoracotomy. A limited resection of GGO is nowadays the suggested procedure for their treatment, so a detailed localization of the lesion becomes more and more important in the surgical practice of lung resection (4).

Techniques to localize PNs vary from preoperative injection of methylene blue (5) or colored collagen (6) at the site of the PN to intraoperative ultrasound detection and CT-guided positioning of a metal wire (7-9). A failure rate of around 13% for methylene blue injection has been reported due to either an excess of liquid injected or an error in nodule localization (5). Intraoperative ultrasound detection requires a special flexible probe and it can be limited by the presence of air in the lung when complete collapse is not feasible (9). Moreover, despite the lack of complications and the high sensitivity and specificity found with the use of ultrasound (10) only a few cases are reported in the literature and it is known to present limitations in localizing inflammatory nodules (11). Probe and/or digital palpation could also be useful methods for localizing PNs, although these techniques are effective only when the nodule is superficial or >20 mm in size. Microcoil and fiducial marker placement decreases the discomfort of patients during the waiting time to enter the operative room, compared to other invasive procedures, but requires fluoroscopic guidance during the surgical procedure, increasing radiation exposure for surgeons. The success rate is reported to be 93–98.4% with complications occurring in 3–10% of the patients including migration of the coil, air embolism and hemothorax (12). We have previously reported our experience with preoperative computed tomography-guided hook wire localization and

we have found that it represents a useful marker with minor complications and a high rate of success in expert hands (3).

Most of the above described techniques are performed preoperatively in the radiology unit leading to a possible increase of the possibility of dislocation of the marker and/or of the occurring of pneumothorax and hemothorax. The use of a hybrid operating room for the intraoperative assessment and localization of PNs is advocated by some authors (13,14) although specific institutional organization is required for such procedure.

Despite the several possibilities of PN's localization, chest CT scan still remains the main technique to rely on and some Authors state the possibility to avoid markers positioning for PN with the use of three dimensional (3D) computed tomography simulation (15,16). The development of multi-detector computed tomography has enabled 3D images of lung structures. The 3D reconstruction can be very helpful in anatomical lung resection, including segmentectomy which is a more complicated operative procedure than standard lobectomy for his anatomical complexity due to the variability of vascular and bronchial structures at different levels.

Kato and colleagues have reported an interesting series about thoracoscopic anatomical lung segmentectomy using 3D computed tomography simulation without tumour marking for PNs that were non-palpable and non-visualized (17). A detailed anatomical 3D pulmonary arteriovenous reconstruction was performed using a volume-rendering method and arteries and veins were distinguished interpreting the differences in contrast agent densities. A targeted segment on the CT image was identified containing the PN in the horizontal, coronal and sagittal planes, then the artery and the veins were recognized on the 3D image and finally measurements to obtain an adequate surgical margin were performed. 3D images were useful both before and during operation. The correct resection rate of the otherwise undetectable tumor was 100% (17).

Surely 3D CT simulation might represent a valid alternative to marker positioning for non-detectable PNs, especially for intraparenchymal lesions requiring segmentectomy. This technique is safe and does not add complications to the surgical procedure. Therefore, it is important to make some considerations correlated first of all with the necessity of well trained personnel and secondary with the possible difference in measurements between an inflated lung at the CT scan and a collapsed one during surgery, leading to the need to expand the resection in order to obtain adequate surgical margins. Moreover, superiority of anatomical resections over wedge resection for low-grade lung tumor is still controversial in literature (4,18).

In conclusion, the widespread performing of minimally invasive lung resections for early stage NSCLC has led to the need of a more accurate preoperative localization of PNs. Different techniques present advantages and complications that have to be evaluated according each Department experience. A close cooperation between thoracic surgeons and radiologists is often advocated for a successful procedure.

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Footnote

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

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