Editorial

Is the video-assisted pulmonary segmentectomy the preferred approach to the early stage non-small cell lung cancer?

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Over the last ten years, the widespread adoption of the lung cancer screening programs together with improvements in imaging modalities, have led to diagnosing a more considerable number of small solid lung tumour (<1 cm) and ground-glass opacity (GGO). Video-assisted thoracic surgery (VATS) lobectomy is considered the preferred treatment for non-small cell lung cancer (NSCLC) even if though many types of research have recently demonstrated the promising oncological efficacy of the VATS anatomical segmentectomies for stage IA lung cancer (1,2).

Furthermore, numerous papers in medical Literature have shown similar clinical and oncological outcomes between VATS segmentectomy and VATS lobectomy for the treatment of small lung tumour (<1 cm). Shapiro *et al.*, comparing 113 VATS lobectomy to 31 VATS segmentectomy for early-stage lung cancer over a median follow-up time of 22 months, reported no differences in the hospital length of stay, in the duration of the chest tube and insignificant or minor complications. Notably, the rates of locoregional recurrences and cumulative survival resulted similar in the two groups (3). Recently Fan *et al.* in a meta-analysis of 24 studies (overall 11,360 patients) comparing sub-lobectomy and lobectomy in lung cancer ≤2 cm found no differences in the five-year overall survival (4).

Nevertheless, the role of sub-lobar resection for the treatment of early-stage NSCLC is still under debate, and most of the published articles are retrospective analysis. Currently, there are two ongoing randomised trials that, hopefully, should provide new potential evidence on this topic (Japan Clinical Oncology Group 0802/West Japan Oncology Group 4607L, and Cancer and Leukaemia Group B 140503). What we have learned from the Literature is that the segmentectomy is a valid option for marginally fit patients affected with small peripheric NSCLC T1aN0, or synchronous lung primary lesions or potential metachronous primary tumour (small contralateral lesions) (5,6). Compared to the wedge resection, the segmentectomy offers better oncological outcomes and provides wide and deep surgical margins and an active nodal clearance and evaluation. In the patients who could benefit from parenchyma-sparing procedures (e.g., elderly), anatomical segmentectomy, if feasible, is a safe and effective alternative to major lung resection.

Moreover, VATS segmentectomy should be considered as a valid option for the treatment of GGO patients. GGO is often multi-focal (usually with a low rate of local recurrences), and a multi-step or redo surgery is often required. When concerning about hilar and mediastinal lymph node assessment, VATS segmentectomy seems to offer an adequate lymph node evaluation. Authors comparing VATS segmentectomy versus VAST lobectomy found no differences in the stations and the number of lymph nodes dissected between the two technique (7,8).

When compared to open segmentectomy, the VATS approach is associated with a considerable reduction of length of stay, costs, overall complications and an equivalent number of mediastinal lymph node harvested (9). Thoracoscopic approach to lung segmentectomy is contraindicated when is impossible to obtain a complete resection. If parenchymal margins are <2 cm, or if the diameter of a tumour is >2 cm a lobectomy should be performed.

The advent of newer technological development, such as dedicated instrumentation and energy devices and the growing interest in new VATS approaches (uniportal and subxiphoid VATS) has dramatically changed the role of the surgery. VATS segmentectomy is a safe and effective surgical technique. On the other hands, compared to VATS lobectomies, VATS segmentectomies are more complicated, and the surgeon's experience is mandatory. The anatomical structure of the lung segments is relatively complex, and the anatomical variations are several, increasing the risk and the difficulty of segmentectomy. Therefore, detailed preoperative evaluation of the anatomy of bronchial and vascular segmental division is compulsory.

The 3-dimensional computed tomography bronchography and angiography (3D-CTBA) allows greater accuracy in the localisation of lung nodules and the relationship with the surrounding bronchi and blood vessels. It may also facilitate the detection of possible anatomical variations. A precise preoperative plan and more accurate knowledge of anatomy reduce the probability of accidental ligation of the intersegmental vein and, therefore, the postoperative haemoptysis or segment infarction. 3D CT simulation may facilitate the identification and resection of a non-palpable nodule or GGO. Thoracoscopic segmentectomy using 3D CT simulation should represent a valid alternative to wedge resection for a tumour requiring the preoperative localisation of the lesion (10).

Typical sublobar resections include trisegmentectomy (lingula sparing), lingulectomy, superior or posterior segmentectomy of the right upper lobe, and basilar segmentectomy (one or more segments). Similar to the open approach, VATS segmentectomy is performed proceeding with dissection and individual isolation/division of segmental vessels and bronchi. For most segmentectomy, the procedure begins isolating the vein, followed by artery or bronchus, depending on the different segment dissected. The parenchymal division is usually performed at the end of the procedure, after the division of vessels and bronchi at the hilum. If a tumour is placed close to the intersegmental fissure should be appropriately performing a more extensive resection, such as bi or tri-segmentectomy.

Recently Zhu *et al.*, from the Sichuan University of Chengdu (CN), presented a surgical strategy to perform VATS left S3 segmentectomy. Authors reported a step by step single-direction VATS segmentectomy. The single-direction procedure is performed with a three ports approach (camera port for 30° camera lens, two others operative ports). Segmentectomy is progressively proceeded to isolate and divide the elements from superficial to the deeper plane. The vein is dissected first, then the artery, and the bronchus. The procedure ends with the dissection of the intersegmental plane. According to the Authors, the single-direction strategy avoids continuous manipulation of the lobe (turning the lobe over the hilum) and may facilitate the identification and the dissection of the intersegmental plane, in particular when not visible (11).

Demarcation of the intersegmental plane can be challenging during VATS segmentectomy. Furthermore, in lung cancer surgery, the achievement of appropriate surgical margin is critical. In literature, several techniques have been reported to identify intersegmental plane successfully. Okada *et al.* described the use of a jet-ventilation selectively applied to the resected bronchus. Thus, the intersegmental plane is quickly and easily ventilated, and the margins are identified. As the ventilation is applied only to a single segment, this procedure can be performed with a VATS approach with an appropriate surgical view (12). Kamiyoshihara *et al.* proposed another interesting method to distinguish segment margins. A butterfly needle is used to insufflate, selectively the resected segment. However, this method can cause, occasionally, air embolism in the vessels close to the bronchus (13). Alternatively, the intersegmental plane can be demarcated with a transbronchial infusion of indocyanine green (ICG) into the pulmonary segment or intravenous injection of ICG after vessels division. Although infusion of ICG via transbronchial or vein injection seems to be an efficient method, the cost of the procedure is relevant, the demarcation line vanishes very quickly, and when infused through the bronchus the spread is not uniform, resulting in a not clear identification of the intersegmental plane (14,15).

On the contrary, the single-direction anatomical segmentectomy, described by Zhu *et al.*, performed the parenchyma division using the slip-knot method, based on the creation of an inflation-deflection line (11). The slip-knot is a monofilament loop placed around the target bronchus. The lung is adequately ventilated, and the slip-knot is pulled to close the bronchus. The target segment remains inflated, and the surrounding segment collapse. Dissection is then conducted along the inflation-deflation line. Emphysematous lungs, airway obstruction (e.g., sputum) or pleura adhesion may represent possible drawbacks of this technique.

In conclusion, VATS anatomic segmentectomy is a safe and effective option to treat stage IA lung cancer reserved for skilled thoracoscopic surgeons. Recent studies (even if retrospective) showed that VATS segmentectomy offers

good oncological outcomes with morbidity, loco-regional recurrence, and overall survival similar to VATS lobectomy. Notably, most of the surgeons perform more frequently VATS segmentectomy in high-risk patients not eligible to standard lobectomy. In our opinion, VATS segmentectomy should be present in the surgical armamentarium for the management of early-stage NSCLC patients with a parenchymal margin of at least 2 cm. VATS segmentectomy should also be contraindicated if there is the incapability to obtain a radical resection.

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Footnote

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

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