Editorial

Pulmonary metastasectomy and laser-assisted resection

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Provenance: This is an invited Editorial commissioned by the Section Editor Laura Chiara Guglielmetti (Cantonal Hospital Winterthur, Kantonsspital Winterthur, Switzerland).

Comment on: Franzke K, Natanov R, Zinne N, *et al.* Pulmonary metastasectomy - a retrospective comparison of surgical outcomes after laser-assisted and conventional resection. Eur J Surg Oncol 2017;43:1357-64.

Submitted Mar 13, 2018. Accepted for publication Apr 09, 2018.

doi: 10.21037/jtd.2018.05.08

View this article at: http://dx.doi.org/10.21037/jtd.2018.05.08

Lung is the next most common site of metastases after liver, affecting almost one third of patients with malignancies worldwide (1). Surgical removal of metastases is the second most frequent surgical intervention in thoracic surgery, representing 15–50% of the workload in European thoracic surgical centres. The most common tumors metastasizing to the lung are breast, colorectal, renal cell and head and neck carcinoma.

In 1947, Alexander and Haight (2) presented the first results for lung metastasectomies. They established the criteria for suitability, which were revised in 1965 by Thomford (3) and, with minor changes are still valid today. They are: (I) primary tumor is controlled; (II) there should be no evidence for extrapulmonary metastatic disease; (III) the metastases seem technically resectable; and (IV) the patient must be able to tolerate the resection. In addition, as newer effective therapies have emerged, there should be no better alternative therapy.

Up to date various publications have demonstrated safety and effectiveness with a 5-year survival of 20–60% with lung metastasectomy comparing to 5–10% for patients with untreated metastatic disease. Regardless the primary tumour the most important prognostic indicator remains the complete resectability of lung metastases. The role of intraoperative lymph node sampling or dissection remains controversial and not well defined. There is no doubt that lymph node dissection provides information for accurate staging, but there is no evidence of any other clinical impact.

From the International Registry of Lung Metastases a study of 5,206 cancer patients with lung metastases from USA, Canada and Europe showed survival benefit when undergoing surgical resection (4). Numerous subsequent case series studies have supported these findings but up to date no prospective randomized trials are available to confirm the effectiveness of pulmonary metastatic surgery. Some authors believe that the survival difference may be related to a more benign tumor biology or patient selection with favourable prognostic characteristics (slower progression and fewer metastases) than those treated with chemotherapy alone (5,6). The Pulmonary Metastasectomy in Colorectal Cancer (PulMiCC) trial is ongoing and hopefully will provide answers (7). All patients should be treated as part of a multidisciplinary team including surgeons, oncologists, radiologists.

In daily practice, different approaches are accepted and can be applied—including minimally invasive techniques (VATS) and thoracotomy—to resect the lung metastases. Thoughtful surgeons differ in the approach to such resections, with some preferring operating techniques that minimize the trauma and pain to the patient, and others favouring open techniques with the goal of maximizing the likelihood of resection of all detectable nodules. Open surgical approaches, as thoracotomy or sternotomy and even clamshell incision for bilateral lesions, have been reported to lead to the detection and as a result resection of more metastases than VATS techniques. Retrospective studies suggest that this improved detection and resection with open techniques does not lead to improved survival after surgery.

Another advantage of VATS is the ability to perform repeat operations as it results in fewer pleural adhesions than thoracotomy, and does not complicate a potential repeat operation by thoracotomy (8).

It is still not clarified whether a lesion overlooked by CT but detected by palpation results in a demonstrated benefit in terms of life expectancy (9,10). Furthermore, advances in imaging technology and various techniques for localization of the lesions increase the success of VATS technique.

Over the past years, several studies have reported almost equivalent survival rates of minimal invasive approach as compared with thoracotomy. In a study of Gossot *et al.* with sarcoma patients with lung metastases thoracoscopic resections yield survival rates comparable to open resections (11). Mutsaerts *et al.* (12) reported similar survival in patients with solitary peripherally located metastasis comparing thoracoscopic and thoracoscopic followed by confirmatory thoracotomy approach. Similar results were demonstrated by other studies (13). Dong *et al.* in a meta-analysis, including 6 retrospective studies showed that VATS resection has 1, 3, and 5-year survival rates and the 1-year disease-free survival rate which are almost equivalent to those of thoracotomy. However, there was significant statistical difference between the 3-year disease free survival rate, which favored thoracotomy. They concluded that open approach was still valid (14).

The resection of lung parenchyma can be performed with stapling devices, electrocautery and laser assisted surgery (LAS). Regarding the extent of resection, parenchyma-sparing approaches aiming to preserve pulmonary function are critically important.

Lung metastases are usually resected non-anatomically, which can be performed easily with the use of stapler, which is the standard technique, but occasionally inappropriate surgical margins and more lung tissue is sacrificed, especially in central lesions. Alternatively, laser and electrocautery can be used for pulmonary metastasectomy. With the use of electrocautery the resection surface is coagulated in an uneven and irregular manner. The risk of bleeding and later haemorrhage after monopolar-cutter resection is much higher comparing to laser and is associated with increased risk of fistula and air leak due to severe thermal injury (15).

In an experimental study, Fiorelli *et al.* compared three techniques (monopolar electrocautery; neodymium-doped yttrium aluminium garnet laser and harmonic technology) of non-anatomical lung resections in a pig model. They reported that depth of thermal damage is less in the harmonic group when compared with the laser and electrocautery group (16).

In 1967, Minton and colleagues (17) reported their experience on rabbit lung metastasectomies with pulsed laser energy of 1,064-nm Nd:YAG laser . Since then, the use of laser in pulmonary metastasectomy has widely increased and different wavelengths of lasers were investigated. Rolle *et al.* (18) compared the effect of 1,064 and 1,318 nm wavelengths and demonstrated that Nd:YAG laser emitting the 1,318 nm wavelength is superior for lung resection.

Only few studies have reported results for LAS. The potential advantages of Nd:Yag laser resection include significantly higher number of lung nodules in comparison to conventional techniques and complete resection of multiple bilateral and centrally located lesions as it is a parenchyma-saving technique with low risk of true local recurrences.

Baier *et al.* reported that laser resection allows complete resection of larger number of metastases compared with conventional stapler resection in other reports, while achieving equivalent long-term survival rates and allowing repeated resections in case of recurrence (19).

In another retrospective study, Osei-Agyemang *et al.* demonstrated that although a higher number of metastases was resected in the laser group, there was no significant benefit in the long-term survival (20).

Rolle *et al.* used 1,318-nm Nd:YAG laser for pulmonary metastasectomies. After their initial experience with the first 100 patients, published the results on 328 patients and concluded that laser facilitates the resection of more metastases, even in cases of multiple bilateral or centrally located metastases, has a significant influence on conservation of pulmonary parenchyma and appears to minimize complications (21).

Some investigators have employed 1,318-nm neodymium-doped yttrium-aluminum garnet laser for resection of lung metastases. They demonstrated that with the use of this technique achieved good results, in terms of radical resection and survival, as conventional surgical metastasectomy (22).

Meyer *et al.* presented their experience of laser resection of lung metastases under video-assisted thoracoscopic control via a minithoracotomy in 15 patients. They concluded that it is a safe and easy to perform procedure enabling the palpation the whole lung systematically (23).

Franzke *et al.* in retrospective analysis, they compared resection with use of laser and conventional resection using other devices in 178 patients. There was no statistically significant survival difference between the two methods

despite a significantly higher number of resected metastases in the laser group (24).

In summary, metastasectomy is considered a safe and effective approach for a patient with lung metastases whose primary cancer is well controlled. Although no prospective, randomized studies are available, numerous retrospective studies have demonstrated that resection of metastases limited to the lungs may be associated with prolonged survival. The European Society of Thoracic Surgeons created a Lung Metastasectomy Working Group of an international group of surgeons in 2006 with initial intention to evaluate the evidence and to generate guidance for the future in pulmonary metastasectomy. Completeness of resection is the key to long-term survival and open thoracotomy and VATS are two different surgical approaches for lung metastasectomy with equal survival outcomes.

Pulmonary metastasectomy with laser is a safe technique that appears to minimize complications and facilitates the complete resection of a significantly higher number of metastases compared to stapling resections, while achieving equivalent long-term survival rates. This tissue-saving technique allows repeated resections in case of recurrence.

Acknowledgements

None.

Footnote

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

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Cite this article as: Panagiotopoulos N, Patrini D, Lawrence D, Scarci M, Mitsos S. Pulmonary metastasectomy and laser-assisted resection. J Thorac Dis 2018;10(Suppl 17):S1930-S1933. doi: 10.21037/jtd.2018.05.08

