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REVIEW ARTICLE

Transcervical Extended Mediastinal Lymphadenectomy – Indications and Technique

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Abstract Accurate mediastinal staging is the hallmark of a good thoracic oncology program. Despite advancements in imaging, surgical staging remains the gold standard of mediastinal staging for lung cancer. This review article summarizes the technique of transcervical mediastinal lymph node dissection and its role in the staging of non-small cell lung cancer (NSCLC).

Keywords Lymphadenectomy · Lung cancer

Introduction

Accurate mediastinal lymph node staging is important for prognostication and to guide the administration of neoadjuvant and adjuvant therapy in non-small cell lung carcinoma. Cervical mediastinoscopy allows visual inspection of the right and left paratracheal spaces and the subcarinal space, enabling biopsy of nodal stations 2R, 4R, 2L, 4L and 7, but does not enable complete dissection of these stations. The most important surgical advancement in mediastinal lymph node staging in the past few years has been the introduction of extended transcervical staging, as initially introduced by Zielinski in 2004. Transcervical extended mediastinal lymphadenectomy (TEMLA) was developed to enhance lymph node sampling obtained by conventional mediastinoscopy and provides thorough evaluation of the mediastinum by allowing for complete removal of mediastinal lymph node stations 1, 2R, 4R, 3A (prevascular), 3P (retrotracheal), 2L, 4L, 5, 6, 7, and 8. This paper provides a guide to establishing a standard operative technique of TEMLA that can be adopted by general thoracic surgeons.

Even though mediastinoscopy is accurate, false positive and false negative results still occur. In an initial large series, the performance of TEMLA was better than routine mediastinoscopy [1]. No definite contraindications exist to TEMLA except permanent end tracheostomy. This procedure can be performed in any patient regardless of habitus; however, thin patients with no neck extension limitations and wide thoracic inlets have more favorable anatomies. Relative contraindications include: previous mediastinoscopy or extensive head and neck surgery involving mediastinal dissection, extensive innominate artery calcification (embolic risk), previous median sternotomy, and extensive superior mediastinal fibrosis such as from radiation therapy.

Operative Steps

The patient is positioned supine with a roll under the shoulder and the neck extended. This can be facilitated by dropping the head-piece of the operating table. The patient may be intubated with either a single or a double-lumen tube; the latter usually does not interfere with the procedure as long it is secured well and taped out of the way, however, in the ocasional patient it may limit tracheal mobility. If using a single lumen endotracheal tube, a NIM monitor can be used to assist in confirmation of the recurrent laryngeal nerve. A right radial arterial line is placed to monitor innominate artery compression. The arms are then tucked to make room for the Rultract™ (Rultract Inc, Cleveland, OH) retractor. The neck and anterior chest are prepped and draped in a routine manner for mediastinoscopy from the chin to below the xiphoid process.

A transverse collar incision is made about 1 cm superior to the sternal notch to a length of 6–8 cm. Bilateral anterior

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jugular veins are divided and subplatysmal flaps are developed superiorly and inferiorly with the upper flap reaching the level of the thyroid cartilage and the lower flap extending below the margin of the sternal notch (Fig. 1). The strap muscles are dissected from the thyroid, and separated in the midline away from the inner surface of the sternum. At this point, retrosternal dissection is performed to make space for the hook of the Rultract™ retractor. Of note, adequate time should be spent creating flaps and dissecting structures before the application of the retractor as any shortcuts tend to decrease exposure significantly. Elements for this retractor system frequently exist in hospitals that perform coronary artery bypass grafting because it is used to expose the mammary artery, but with a single post. A bridge is connected to posts on both sides of the patient to allow maximal lift.

The right thyrothymic ligament is then initially divided. The fascial layer covering the right carotid artery is divided, with the carotid arteries on both sides dissected and the recurrent laryngeal nerves identified and protected. It is imperative to maintain the line of dissection over the anterior surface of the artery, to protect the recurrent laryngeal nerve from injury. The Rultract™ retractor is set up and a hook is used to elevate the sternum. The anesthesiologist supports the head and neck during this maneuver and adjusts the head support once the elevation is complete. Once the sternum is elevated to allow for improved exposure of the mediastinum, a plane of dissection is established anterior to the right carotid and is followed to the innominate artery. This plane is used to separate the innominate artery from the brachiocephalic veins. During this dissection, level 1 lymph nodes can be dissected out (Fig. 2).

Right Paratracheal Dissection

The right paratracheal space dissection is performed next. The plane anterior to the innominate artery is developed and

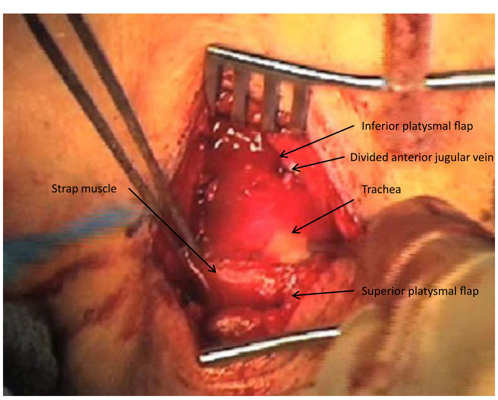

Fig. 1 Operative photograph showing the transverse cervical incision to accomplish TEMLA. Subplatysmal flaps have been raised and the strap muscles are being separated

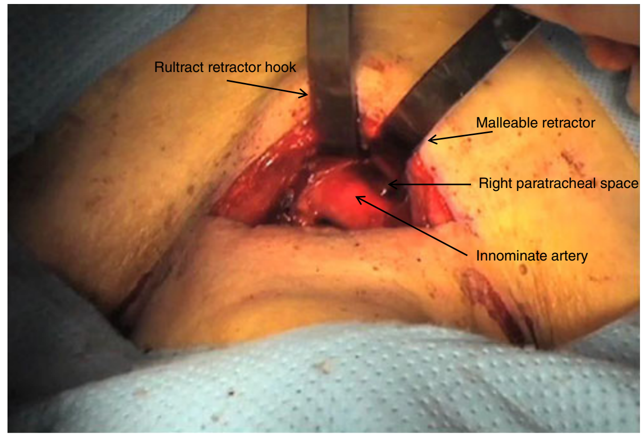

Fig. 2 In this operative photograph, the Rultract retractor hook has been placed retrosternally and the sternum has been elevated. The innominate has been dissected and the right paratracheal space accessed

extended inferiorly to the artery into the "TEMLA path" that is bounded by the pleura laterally and the right lateral trachea medially. The space is visualized well by lateral retraction with a narrow malleable retractor on the pleura and a peanut sponge pushing the lateral trachea medially. It is important to note that full mobilization of the right carotid and brachiocephalic artery is what enables this exposure, which is much better than what is possible with a mediastinoscope, particularly for the 2R station. The lymph node packet is mobilized by blunt dissection and can be retrieved using ring forceps. Any vascular attachments are divided using a 5 mm Ligasure™ or similar energy device (Covidien Inc, Mansfield, MA). Mobilization of the superior packet leads to much better visualization of the deeper lymph nodes. Use of loupes and a headlight are used to enhance the visual field. Occasionally, a 5 mm thoracoscope can also be used to improve visualization particularly in the obese patient with a short neck. A combination of blunt dissection and Ligasure™ are used to evacuate the right paratracheal space to the point where the right pleura, the superior vena cava, the azygous vein, and the right mainstem bronchus are clearly visualized (Fig. 3). This extensive dissection also facilitates thoracoscopic lobectomy/pneumonectomy as well as saves time by avoiding the need to dissect these stations by VATS.

Subcarinal Dissection

The subcarinal space dissection is performed next. The pretracheal fascia is divided and the pretracheal plane of dissection is developed to the carina. Further dissection separates the right main pulmonary artery from the carina. Once adequate separation is accomplished, the Wolf mediastinoscope (Richard Wold Gmbh, Knittlingen, Germany) is

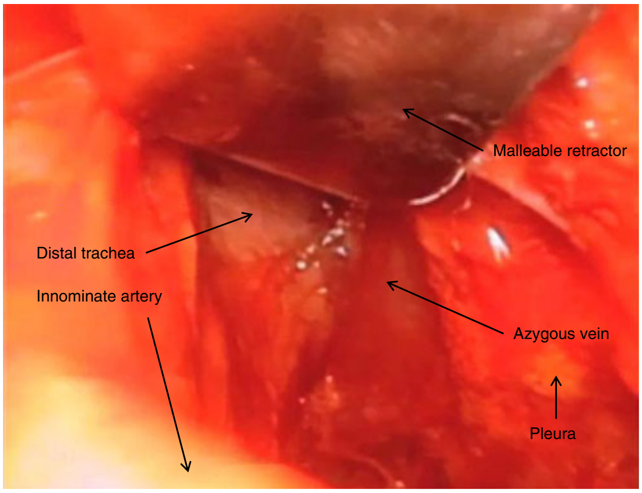

Fig. 3 Dissection of the deep right paratracheal space. After the lymph node packet is removed, the distal trachea and azygous vein can be clearly visualized

inserted in the space between the pulmonary artery and the carina so that the upper lip of the mediastinoscope is beneath the pulmonary artery. It is only after this is accomplished that the blades of the mediastinoscope are spread both in a vertical direction and at an angle. This separation enables enough visualization and space to work with two thoracoscopic instruments under direct vision. The edge of the lymph node packet is grasped with the thoracoscopic tissue graspers and blunt dissection is used to separate it from the esophagus. The bronchial artery is divided using a 5 mm Ligasure™. Further blunt and Ligasure™ dissection is used to dissect off the packet from bilateral mainstem bronchi and the packet is delivered en-bloc. The operating mediastinoscope allows passage of multiple instruments so that the first assistant can provide sufficient suction and counter traction to avoid vascular injury (Fig. 4). Occasionally, patients have thoracic inlets mobile and open enough to permit direct viewing of the distal tracheobronchial dissection.

Left Paratracheal Dissection

While anatomic factors may encourage a different order, the left paratracheal space is dissected next. Dissection is started in the left neck with the identification of the recurrent laryngeal nerve. The nerve is followed into the mediastinum. Along the way, the left paratracheal lymph nodes are bluntly dissected out. No cautery or any other form of energy is used for hemostasis on the left side to avoid injury to the nerve. Annoying bleeding is controlled with topical anticoagulation agents. Compared to the right paratracheal and subcarinal lymph node regions, there are usually fewer lymph nodes in the high left paratracheal region. This dissection can be carried out using the Wolf mediastinoscope; however, it is often performed under direct vision just after the right paratracheal dissection and before the subcarinal packet is approached. Usually, the scope is necessary for the distal 4 L nodes.

Aorto-pulmonary window and para-aortic lymph nodes (Levels 5/6) can be addressed next. While dissection of these lymph nodes via TEMLA is feasible and well described, we prefer the exposure afforded by left VATS. Therefore, we reserve dissection of these lymph nodes via VATS for all left sided lesions at the time of definitive resection – also malignant involvement of isolated lymph nodes in this station does not deter us from resection at the same time as long as the lymph nodes are technically completely resectable. For right sided lesions, involvement of lymph nodes in this station in the absence of subcarinal or left paratracheal lymph node involvement is extremely unlikely, therefore the dissection of these lymph nodes does not add much to staging information.

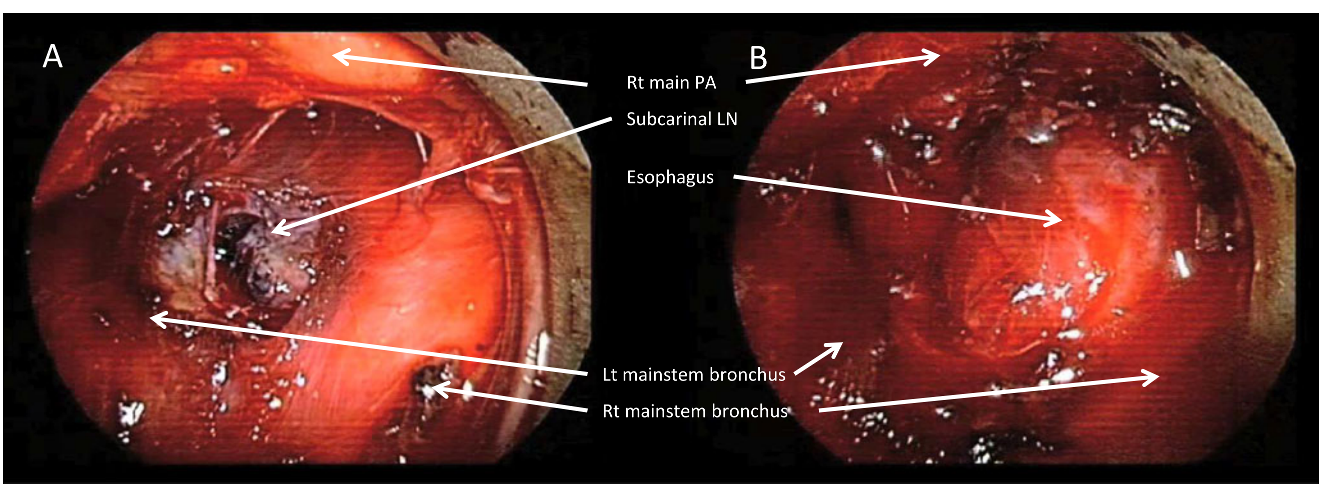

Fig. 4 Operative views of the subcarinal space as seen via the Wolf mediastinoscope before (**a**) and after (**b**) lymph node dissection

Initial Results

The safety of TEMLA is reported as being good, although all published reports are from a single European center. The following complication rates were reported in a large series that looked at TEMLA in previously untreated patients – temporary laryngeal nerve palsy (2.3 %), permanent laryngeal nerve palsy (0.8 %), pneumothorax (0.4 %), pleural effusion (4.3 %), and asymptomatic mediastinal widening (60 %) [2]. The largest series comparing endoscopic and surgical primary staging and restaging of non-small cell lung cancer was reported at the 14th World Lung Cancer Conference in 2011. In this report, TEMLA showed a higher diagnostic yield (http://iaslc.technetrics.com/assets/WCLC-2593-4-July-1430.pdf). The sensitivity of TEMLA in discovering cancer in primary staging was 98.6 %, compared with 88.9 % for EBUS/EUS. TEMLA's specificity was 100 %, compared with 98.7 % with EBUS/EUS. TEMLA's negative predictive value (NPV) was 99.7 % and its positive predictive value (PPV) was 100 %, compared with NPV of 84.1 % and PPV of 99.1 % for EBUS/EUS. In terms of staging accuracy, the results are stellar both in patients without neo-adjuvant therapy and in patients after neo-adjuvant therapy, although published results are from a single center [1–6].

It is important to keep in mind that no benefit has been demonstrated with routine lymphadenectomy in early stage NSCLC (ACOSOG Z0030) [7]. Thus, we perform TEMLA in situations with a high likelihood of occult N2 disease and for restaging the mediastinum after neoadjuvant therapy; in the latter situation, other modalities of restaging such as PET/CT and EBUS are not very accurate. Tumors with a high likelihood of occult N2 disease include large tumors (> 7 cm), imaging findings that suggest aggressive disease (central necrosis, satellite nodules, and high PET avidity), bulky N1 disease as suggested by imaging, and two synchronous primary lesions.

In summary, TEMLA is a promising technique that deserves multi-institutional evaluations for enhanced staging and in approaching the mediastinum for other pathology. Future studies are needed to determine whether TEMLA improves patient selection or survival with regards to lung cancer resection.

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