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Transcervical extended mediastinal lymphadenectomy (TEMLA) for staging of non-small-cell lung cancer (NSCLC)

Abstract

Introduction: The aim of the study is to analyze diagnostic yield of the new surgical technique — the Transcervical Extended Mediastinal Lymphadenectomy (TEMLA) in preoperative staging of Non-Small-Cell Lung Cancer (NSCLC).
Material and methods: Operative technique included 5–8 cm collar incision in the neck, elevation of the sternal manubrium with a special retractor, bilateral visualization of the laryngeal recurrent and vagus nerves and dissection of all mediastinal nodal stations except of the pulmonary ligament nodes (station 9).
Results: 698 patients (577 men, 121 women), of mean age 62.8 (41–79) were operated on from 1.1.2004 to 31.1.2010, including 501 squamous-cell carcinomas, 144 adenocarcinomas, 25 large cell carcinomas and 28 others. Mean operative time was 128 min. (45 to 330 min.) and 106.5 min. in the last 100 patients. 30-day mortality was 0.7% (unrelated causes) and morbidity 6.6%. The mean number of dissected nodes during TEMLA was 37.9 (15 to 85). Metastatic N2 and N3 nodes were found in 152/698 (21.8%) and 26/698 patients (3.7%), respectively. Subsequent thoracotomy was performed in 445/513 patients (86.7%) after negative result of TEMLA. During thoracotomy, omitted N2 was found in 7/445 (1.6%) patients. Sensitivity of TEMLA in discovery of N2–3 nodes was 96.2%, specificity was 100%, accuracy was 99,0%, Negative Predictive Value (NPV) was 98.7% and Positive Predictive Value (PPV) was 100%.
Conclusions: TEMLA is a new minimally invasive surgical procedure providing unique possibility to perform very extensive, bilateral mediastinal lymphadenectomy with very high diagnostic yield in staging of NSCLC

Key words: lung cancer, mediastinum, lymph nodes

Pneumonol. Alergol. Pol. 2011; 79, 3: 196–206

Introduction

The results of treatment of lung cancer are still highly unsatisfactory. The most successful modality in the treatment of Non-Small-Cell Lung Cancer (NSCLC) is surgery, which effectiveness is strongly correlated with stage of the disease. The patients with stage I NSCLC can expect 50–80% 5-year survival rate and the patients with stage II disease can expect 30–50% 5 year survival rate [1, 2]. In stage II and IIIA disease, confirmed pathologically, adjuvant chemotherapy is currently used, with expected 5–15% improvement in 5-year survival rates [2, 3]. In patients with stage IIIA discovered preoperatively neoadjuvant chemotherapy or chemoradiotherapy is usually proposed. According to the current American College of Chest Physicians (ACCP) recommendations published in 2007, both neoadjuvant and adjuvant therapy for stage IIIA are not standard modalities but should undergo evaluation in further clinical trials [3]. In stage IIIB the main treatment modality is chemoradiotherapy and in stage IV — chemotherapy, proposed in both cases to the patients in good general state, in the rest of the patients only supportive care is given [4, 5].

The role of diagnostics is to discover NSCLC and its earliest clinical stage, which is a base for optimal choice for therapy for the individual pa-

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Received: 15 November 2010 r.

ISSN 0867–7077

tient. Mediastinal staging plays a central role in the optimal choice of the most suitable treatment modality for patients with NSCLC [6, 7]. Classic technique of Computer Tomography of the Chest (Chest CT) is currently regarded insufficiently accurate and was supplemented with Positron Emission Tomography with Computer Tomography (PET/CT) and endoscopic techniques, including Endobronchial Ultrasonography with Transbronchial Fine Needle Biopsy (EBUS/TBNA) and Endoesophageal Ultrasonography and Fine Needle Aspiration (EUS/FNA) have been developed [7–10].

EBUS and EUS, especially when used in combination (combined EBUS/EUS — CUS) can reach a diagnostic sensitivity and specificity of 90% and enable a real time, ultrasonography guided biopsing of the mediastinal nodes [11–13]. EUS enables also visualization of infiltration of the esophagus, the trachea and bronchi, the aorta, the left atrium and the Superior Vena Cava [12–14].

However, invasive techniques remain a "gold standard". During the last two decades the well established techniques of cervical mediastinoscopy and anterior mediastinotomy were supplemented with new introduced techniques of videomediastinoscopy, Videothoracoscopy (VTS), anterior mediastinotomy, Video-Assisted Mediastinoscopic Lymphadenectomy (VAMLA) introduced by Martin Hurtgen (Koblenz, Germany) and Transcervical Extended Mediastinal Lymphadenectomy (TEMLA) introduced by the first author of this article (MZ) [7, 15–17].

In this article, the technique and results of TEMLA will be presented for the first time in the Polish literature. The aim of the study is to analyze diagnostic yield of the new surgical technique — the Transcervical Extended Mediastinal Lymphadenectomy (TEMLA) in preoperative staging of Non-Small-Cell Lung Cancer (NSCLC).

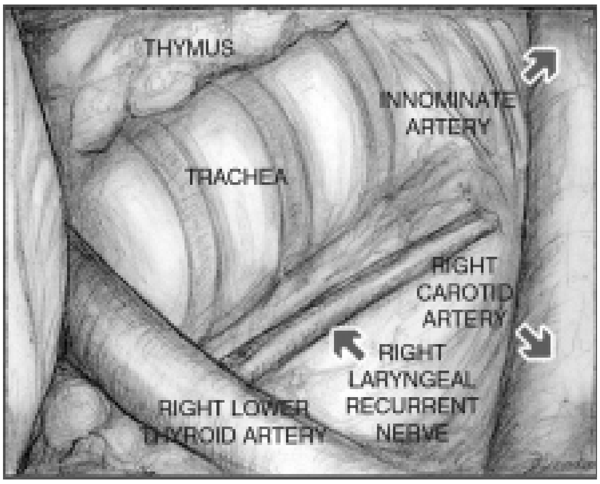

Figure 1. Dissection of the right laryngeal recurrent nerve (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/ /mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

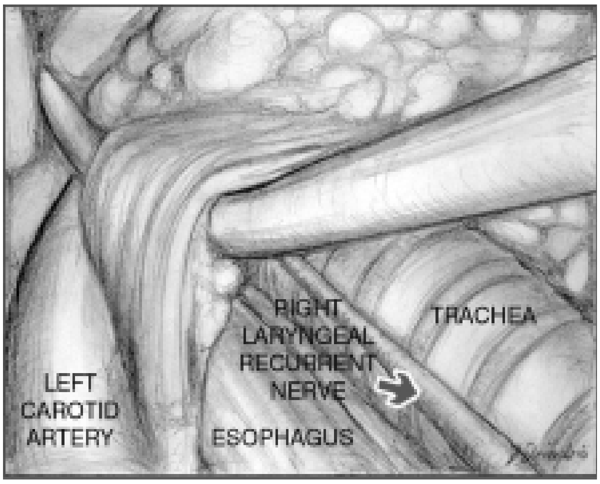

Figure 2. Dissection of the left laryngeal recurrent nerve. To expose the nerve, the vascularized fascial layers covering the nerve must be divided (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

Surgical technique of TEMLA

The operation starts from the 5 to 8 cm collar incision in the neck.

Subplatysmal flaps are widely dissected for better exposure of the mediastinum during the procedure. Visualization of both laryngeal recurrent nerves is obligatory in every case (Fig. 1, 2). The left recurrent nerve is especially endangered during the procedure, so it must be dissected very delicately and carefully protected from injury. Circumferential dissection of the nerve is not advisable, in our opinion it increases the risk of injury of the nerve. Preservation of the last layer of fascia covering the nerve is preferable. The detailed technique of visualization of the laryngeal recurrent nerves was described elsewhere [18].

Both vagus nerves must also be found. The vagus nerve lies between the carotid arteries and internal jugular veins (Fig. 3). The vagus nerves are the important landmarks for further dissection in the mediastinum.

Elevation of the sternal manubrium with a hook connected to the frame mounted on the ope-

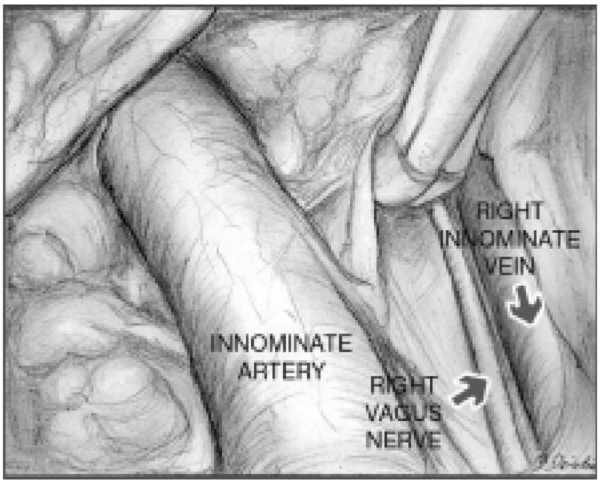

Figure 3. Dissection of the right vagus nerve (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi: 10.1510/ /mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

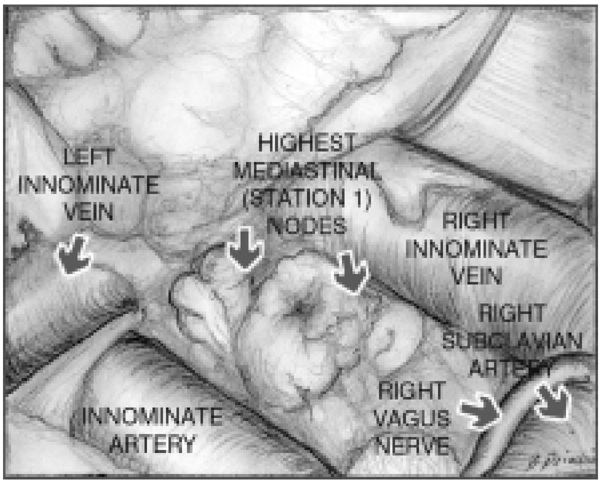

Figure 4. Dissection of the highest mediastinal nodes (station 1) (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

rative table is a critically important part of the procedure (Rochard frame, modified Munster system, Aesculap-Chifa, Poland). Elevation of the sternum widens access to the mediastinum from the neck and enables reaching the deeply located mediastinal structures.

During TEMLA all mediastinal nodal stations except for the pulmonary ligament nodes (station 9 according to the Mountain-Dresler Classification) are removed [19, 20]. Generally, most part of TEMLA is an open procedure, with exception of dissection of the subcarinal (station 7), periesophageal (station 8) and the left lower paratracheal (station 4L) nodes which are dissected in the mediastinoscopy-assisted fashion with aid of Linder-Dahan two-blade mediastinoscope (Richard Wolf, Knittlingen, Germany). The paraaortic, station 6 and aorta-pulmonary window, station 5 nodes are sometimes dissected with aid of videothoracoscope introduced to the mediastinum through the operative wound. An attempt should be made to remove en-bloc the nodes with the surrounding fatty tissue. Only the left paratracheal (station 4L) nodes are removed individually, due to close proximity of the left recurrent nerve.

Bilateral supraclavicular lymphadenectomy and even deep cervical lymph node dissection is possible during TEMLA through the same incision.

The mediastinal dissection begins from removal of the highest mediastinal, station 1 lymph nodes lying above the left innominate vein. Resection of the upper poles of the thymus at the level of the left innominate vein improves access to the mediastinum (Fig. 4).

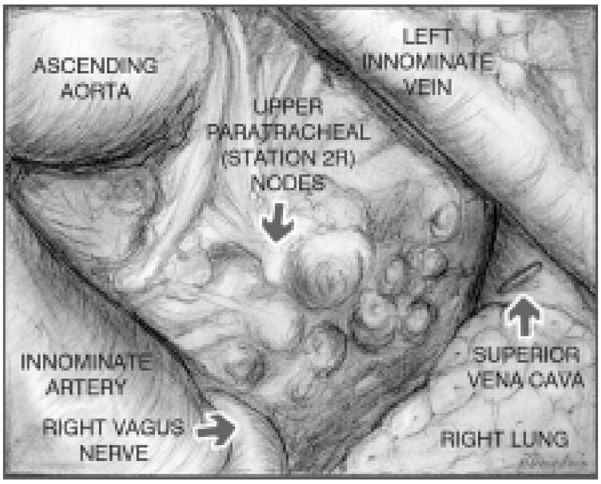

Figure 5. Dissection of the the upper paratracheal nodes (station 2R) from the ascending aorta, the azygos vein, the trachea and the right main bronchus (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, oi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

The next step is a dissection of the right paratracheal space, which proceeds along the posterior wall of the Superior Vena Cava until the azygos vein becomes visible. Right upper paratracheal, station 2R nodes located above the apex of the aortic arch and below the left innominate vein are dissected and removed (Fig. 5).

The right lower paratracheal, station 4R nodes are dissected from the trachea, right main bronchus, Superior Vena Cava, the azygos vein, the ascending aorta and the right mediastinal pleura (Fig. 6).

Very occasionally, retrotracheal, station 3P nodes are found and removed (Fig. 7). We never found any metastatic lymph node in this station.

In the right sided tumors the next step is a dissection of the prevascular, station 3A nodes, located in front of the Superior Vena Cava, right to the ascending aorta (Fig. 8). This station is never involved in the left sided tumors.

In our opinion, dissection of the left paratracheal nodes is the most difficult and risky part of TEMLA, because these nodes lie in the close proximity to the left recurrent nerve (Fig. 9). Generally, the left upper paratracheal, station 2L nodes lie in front of the nerve and the left lower, station 4L nodes lie behind the nerve (Fig. 10). The subcarinal and periesophageal nodes (stations 7

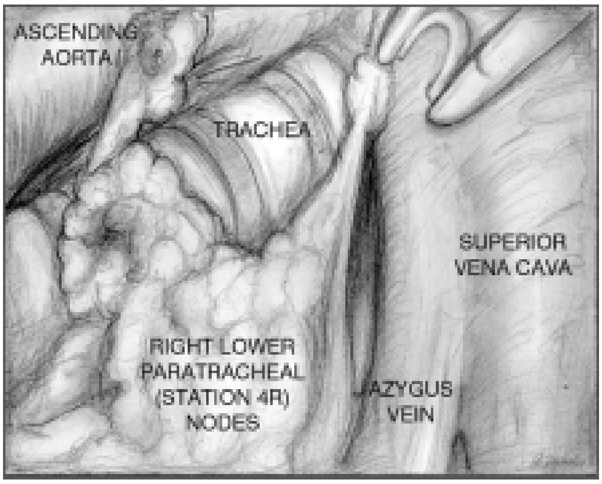

Figure 6. Dissection of the the lower paratracheal nodes (station 4R) from the ascending aorta, the azygos vein, the trachea and the right main bronchus (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

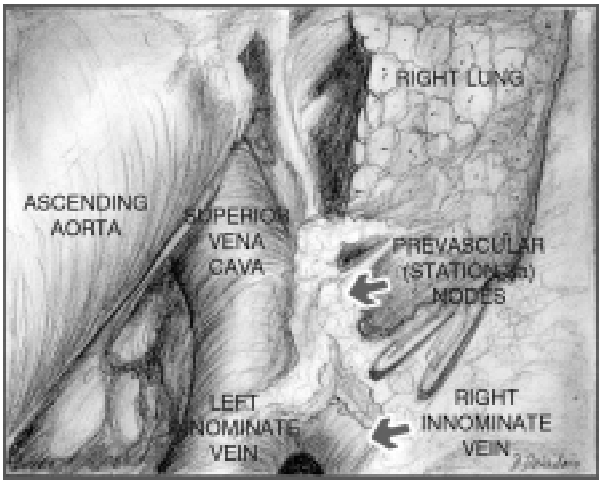

Figure 8. Dissection and removal of the prevascular nodes (station 3A) (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

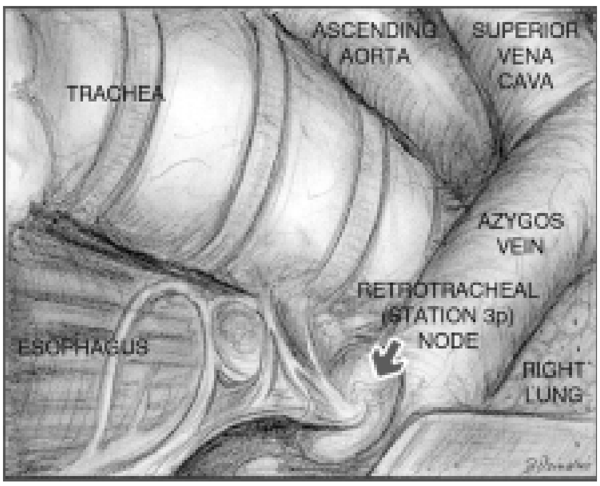

Figure 7. Dissection and removal of the retrotracheal nodes (station 3P) (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

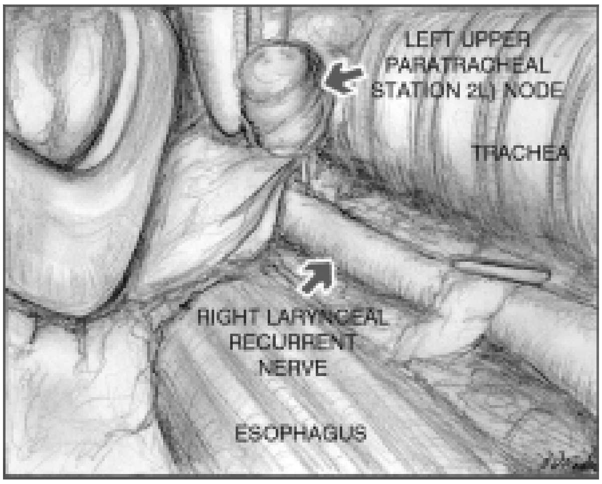

Figure 9. Dissection and removal of the left upper paratracheal nodes (station 2L) (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

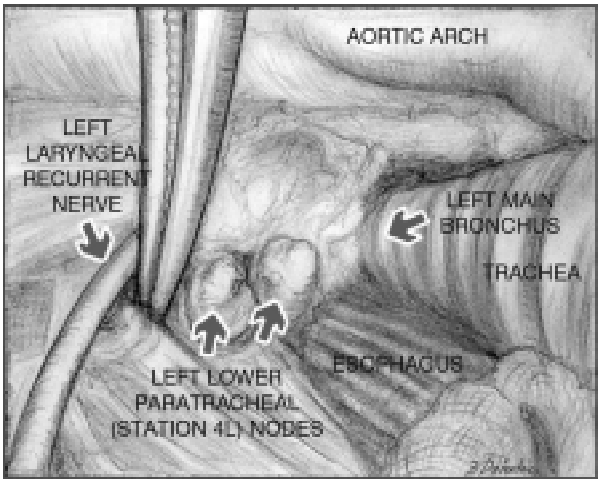

Figure 10. Dissection and removal of the left lower paratracheal nodes (station 4L) (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

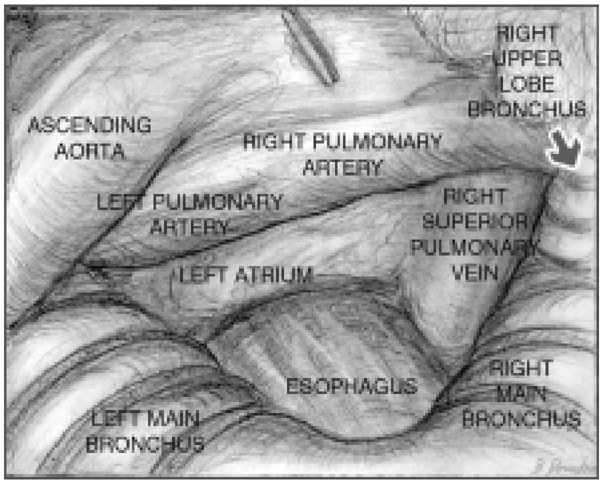

Figure 11. View of the subcarinal region after removal of the subcarinal (station 7) and the periesophageal (station 8 nodes) (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/ /mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

and 8) are dissected with aid of Linder-Dahan mediastinoscope.

During dissection of the subcarinal, station 7 nodes the fascial layer covering the nodes must but divided. Usually, one or several prominent bronchial arteries crossing the operating field must be coagulated with harmonic knife or bipolar coagulation or clipped and divided because they hamper further dissection.

The subcarinal nodes must be dissected from the trachea, main bronchi (laterally), the esophagus (posteriorly) and the main pulmonary arteries (anteriorly). After completion of this part of the operation the tracheal bifurcation, both main bronchi, both pulmonary arteries, pericardium covering the left atrium, the right superior pulmonary vein and the right upper lobe bronchus become clearly visible (Fig. 11).

In majority of patients, but not in all patients, the periesophageal, station 8 nodes are found and removed. The limited length of the Linder-Dahan mediastinoscope precludes possibility of removal of the pulmonary ligament (station 9) nodes.

Dissection of the station 4L nodes is performed in the mediastinoscopy-assisted fashion after completion of the dissection of stations 7 and 8, with the mediastinoscope withdrawed from the subcarinal area and introduced along the left main bronchus.

The entrance to the aorta-pulmonary window containing stations 6 and 5 lie between the left innominate vein and the left carotid artery. The left vagus nerve is a landmark of dissection. Division of the fascial layer between the left carotid artery and the left innominate vein facilitates the entrance to the aorta-pulmonary window (Fig. 12).

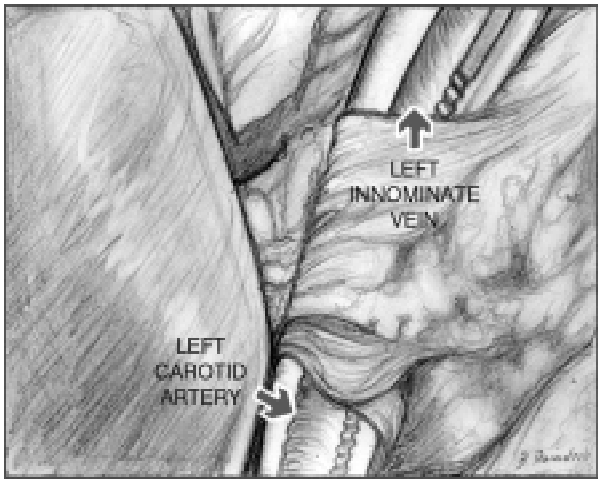

Figure 12. Division of the lascial layer between the left carotid artery and the left innominate vein creates entrance to the pulmonary artery window space (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

At first, the adipose tissue is dissected from the wall of the ascending aorta down to the level of the left pulmonary artery with a peanut sponge (Fig. 13). Medial retraction of the ascending aorta is a safe maneuver facilitating access to the aorta-pulmonary window.

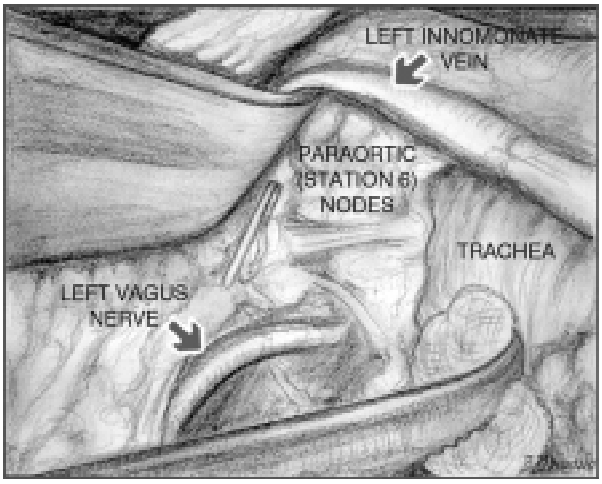

Figure 13. Entrance to the left paraaortic space containing the paraaortic (station 6) and the aorta-pulmonary window (station 5) nodes (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi: 10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

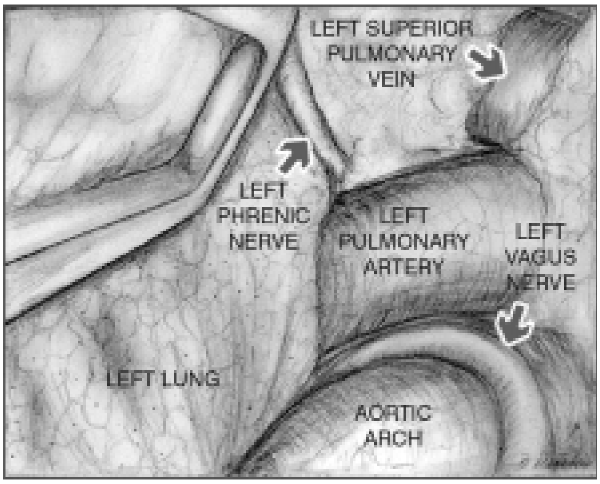

Figure 14. View of the aorta-pulmonary window area after dissection of the station 5 and station 6 nodes (reproduced from Zieliński M., Kuzdzal J., Nabialek T., Hauer L., Pankowski J., Dziadzio B. Transcervical extended mediastinal Lymphadenectomy. Multimedia Manual of Cardiothoracic Surgery, doi:10.1510/mmcts.2005.001693, with permission from the European Association of Cardio-thoracic Surgery. Copyright 2005)

The whole fatty tissue from the aorta-pulmonary window space is removed. Any blood vessel crossing the space is clipped and divided.

Dissection proceeds along the left vagus nerve. The fatty tissue is then dissected from the left mediastinal pleura until the clear pleura and the underlying left lung become well visible and removed en-bloc with the surrounding fatty tissue (Fig. 14). Left pulmonary artery, the left phrenic nerve and the left superior pulmonary vein are well visible after completion of dissection. Coagulation and division of the hemiazygos accessory vein crossing the operative field is sometimes necessary. In case of opening of the mediastinal pleura there is no need for drainage of the mediastinum. Insertion of the piece of fibrin sponge and hyperinflation of the lungs during closure of the wound with high End-Expiratory Pressures that is all what is necessary in such patients, without the need of drainage of the pleural cavity.

Currently, the indications for TEMLA in NSCLC in our department include preoperative staging of potentially operable patients after negative results of prior EBUS/TBNA and EUS/FNA, regardless of the mediastinal nodal status on Computer Tomography (CT) and Positron Emission Tomography/Computer Tomography (PET/CT).

Results

TEMLA was performed on 698 patients, 577 men and 121 women in age 41–79 (mean age 62.8) from 1.1.2004 to 31.1.2010. There were 501 squamous-cell carcinomas, 144 adenocarcinomas, 25 large cell carcinomas and 28 others. Time of operation was 50 to 330 min. (mean 128 min.). In the last 100 patients mean time of operation was 106.5 min. There was small injury of the right main bronchus managed with fibrin sponge packing and no other intraoperative injuries of the vitally important structures, including major vessels, tracheobronchial tree or the esophagus.

Complications of TEMLA occurred in 46/698 of patients (6.6%) (Table 1), with temporary laryngeal nerve palsy in 17/698 patients (2.4%) and permanent nerve palsy in 2/698 patients (0.3%). Pneumothorax necessitating pleural drainage occurred in 1/698 patients (0.1%), pleural effusion in 15/698 patients (2.1%). Asymptomatic widening of the mediastinum was noted in about 40% of patients. It necessitated no treatment, subsided after several days and was not regarded a postoperative complication. There were 5 postoperative deaths unrelated to the procedure (mortality 0.7%) (Table 2).

The number of dissected nodes during TEMLA was 15 to 85 (mean 37.9). Metastatic N2 nodes were found in 152/698 patients (21.8%) and N3 nodes were found in 26/698 patients (3.7%). Metastatic nodes were most prevalent in station 7, station 4R, station 2R, station 5 and station 4L. Subsequent thoracotomy was performed in 445/513 patients (86.7%) after negative result of TEMLA.

There were 110 pneumonectomies, 37 sleeve-lobectomies, 280 lobectomies/bilobectomies, 3 sublobar resections and 15 explorations (3.4%) (Table 3).

Table 1. Complications of 698 transcervical extended mediastinal lymphadenectomy (TEMLA) procedures

Complication	n (%)
Pleural effusion (conservative treatment)	12 (1.7)
Laryngeal recurrent nerve palsy — overall	16 (2.3)
Temporary bilateral laryngeal recurrent nerve palsy	2 (0.3)
Permanent laryngeal recurrent nerve palsy	3 (0.4)
Pneumothorax (necessitating chest drainage)	2 (0.3)
Pneumothorax (conservative treatment without chest drainage)	3 (0.4)
Respiratory insufficiency (ventilator)	5 (0.7)
Postoperative psychosis	2 (0.3)
Perforation of the duodenal ulcer	1 (0.1)
Cerebral haemorrhage	1 (0.1)
Subarachnoid hemorrhage	1 (0.1)
Cardiovascular insufficiency	1 (0.1)
Overall morbidity	46 (6.6)
Deaths	5 (0.7)

Table 2. Causes of death after transcervical extended mediastinal lymphadenectomy (TEMLA)

Cause of deaths	Day of postoperative death	Number of patients
Pulmonary heamorrhage due to angio-bronchial fistula	15.22	2
Cardiac infarct	2	1
Brain haemorrhage	4	1
Cause unknown	2	1

Table 3. Types of pulmonary resections in 445 patients operated on after negative result of transcervical extended mediastinal lymphadenectomy (TEMLA)

Type of pulmonary resection	Number of patients (%)
Pneumonectomy	110 (24.7)
Sleeve-lobectomy	37 (8.3)
Lobectomy/bilobectomy	280 (62.9)
Sublobar resection	3 (0.7)
Exploratory thoracotomy	15 (3.4)
Overall	445

During thoracotomy, omitted N2 was found in 7/445 (1.6%) patients and omitted normal mediastinal nodes were found in 53/445 patients (11.9%). Omitted metastatic N2 nodes were found in the station 5 (2 patients), station 7 (1 patient), station 4R (1 patient), station 8 (1 patient) and station 9 (2 patients).

Table 4. Diagnostic yield of transcervical extended mediastinal lymphadenectomy (TEMLA) for non-small-cell lung carcinoma

Diagnostic parameter	Value (%)
Sensitivity	96.2
Specificity	100
Negative predictive value (NPV)	98.7
Positive predictive value (PPV)	100
Accuracy	99.0

Sensitivity of TEMLA in discovery of N2–3 nodes was 96.2%, specificity was 100%, accuracy was 99,0%, Negative Predictive Value (NPV) was 98.7% and Positive Predictive Value (PPV) was 100% (Table 4). The postoperative mortality was 1.7% in the years 2004–2009, 4.3% in 2004 and 1.2% in the years 2005–2009. In the period 2002–2003, before introduction of TEMLA the postoperative mortality in our department was 3.5%. The number of pulmonary resection for NSCLC in the years 2004–2005 decreased of more than 25% in comparison to the period 2002–2003.

Comment

The main advantage of TEMLA for staging of NSCLC is the possibility to remove almost all mediastinal lymph nodes with the surrounding fatty tissue. Mean number of 37.9 nodes/procedure were removed (from 15 to 85 nodes/procedure). Such complete removal of the mediastinal nodes increases the reliability of staging. No other invasive staging technique enables such complete assessment of the mediastinal nodes. For comparison, mean number of 8.7–20.7 nodes was removed during VAMLA [15, 21]. During mediastinoscopy, normally, 1–2 lymph nodes from each of five stations accessible in this procedure (stations 2R,4R, 2L, 4L and 7) and mean number of 1–2 nodes were biopsied during EBUS and EEUS procedures [7, 9, 11–14, 22]. In 7 patients who underwent TEMLA omitted N2 nodes were found during subsequent thoracotomy (false negative results). The reasons for omitting of these nodes were dependent to the learning curve. In the last three hundred TEMLA procedures there were no false negative results.

The morbidity of TEMLA in current study was relatively low. Most of the complications were minor and subsided during follow-up period and there were no life-threatening intraoperative complications. Two from five postoperative deaths can be attributed to the progression of cancer (fatal hemorrhage secondary to the fistula between the pulmonary artery and the bronchial tree) and two other were independent events (myocardial infarct and intracerebral hemorrhage). In one patient the cause of death was unknown, the postmortem examination was not performed because objections of the patient's family. In no case, the death was a consequence of surgical complications. These data showed that invasiveness of TEMLA was limited and the concerns about the safety of this procedure were not confirmed in our experience. Despite moderate invasiveness, TEMLA is a relatively time consuming procedure, however it was well tolerated by the patients. Current mean operative time has been substantially reduced, however, from 160 to 128 minutes, and to 106 minutes for the last one hundred patients, due to the growing experience of the surgeons of our team. It must be underlined, that all surgeons of our team perform TEMLA.

Due to very liberal inclusion criteria to TEMLA there was considerable number of patients who did not undergo subsequent thoracotomy after negative result of TEMLA (operability 86.7%). Several patients in marginal cardio-respiratory state deteriorated after TEMLA which precluded subsequent thoracotomy. TEMLA was a kind of "biological test" and provided information about the mediastinal nodes that were useful in planning of futher oncological treatment, especially radiotherapy. The previous study comparing standard mediastinoscopy and TEMLA showed no significant difference in deterioration of the pulmonary function [17], which confirmed that TEMLA was a minimally invasive procedure, like standard mediastinoscopy and VAMLA. Minimally invasive intrathoracic procedures are those performed without thoracotomy with retraction of the ribs or sternonotomy. The example of the minimally invasive thoracic operation is the extended transcervical thymectomy. Results of 445 patients who underwent thoracotomy indicate that previous TEMLA was not an obstacle to perform safely all kinds of pulmonary resections, including sleeve-lobectomies and pneumonectomies. Thoracotomy was usually performed in 2–3 weeks after TEMLA, after obtaining a report of histopathological studies of all resected mediastinal nodes. The adhesions in the mediastinum have never been any serious obstacle in performance of the operation. The rate of exploratory thoracotomy was low — 3.4% (15/445), however it showed the difficulties in preoperative staging of T factor, usually responsible for resectability of the tumor. TEMLA, which was a metod of staging of the mediastinal nodes, and not a tumor, didn't enable to eliminate totally a possibility of exploratory thoracotomy.

The postoperative mortality was 1.7% in the years 2004–2009, 4.3% in 2004 and 1.2% in the years 2005–2009. In the period 2002–2003, before introduction of TEMLA, the postoperative mortality in our department was 3.5%. These data indicate, that introduction of TEMLA is not associated with increased risk of postoperative mortality but, conversely, it leads to decrease the mortality, probably due to better selection of patients for pulmonary resection. Due to more accurate preoperative staging there was a decrease for more than 25% of the number of pulmonary resections for NSCLC after introduction of TEMLA. The high incidence of squamous cell carcinoma in our patients was caused by predominance of this type of NSCLC in the south regions of Poland which was showed by ongoing international MAGRIT study.

In our recent study we showed that TEMLA had a significantly higher diagnostic yield than all other mediastinal staging modalities (PET/CT, EBUS, EUS, and remediastinoscopy) [23]. The results of future studies will show if TEMLA should be considered the gold standard of mediastinal nodal restaging after neoadjuvant therapy in patients with NSCLC as was suggested by P. van Schill in the editorial commentary in the European Journal of Cardiothoracic Surgery [24].

Conclusions

TEMLA is a new minimally invasive surgical technique enabling unique possibility to perform very extensive bilateral lymphadenectomy of the mediastinum with very high diagnostic yield.

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