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Primary Lung Tumors Invading the Chest Wall

Göğüs Duvarını İnvaze Eden Primer Akciğer Tümörleri

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Abstract

Aim: Lung cancer remains the leading cause of cancer deaths worldwide. The surgical approach to locally advanced non-small cell lung cancer (NSCLC) goes beyond the classical approach and requires a multidisciplinary approach both preoperatively and postoperatively. In addition to the tumor size, the location of T3 and T4 tumors affects the extent of the surgery.

Material and Method: Patients who underwent lung resection for cancer between March 2019 and October 2022 were retrospectively reviewed. Patients who underwent chest wall resection were evaluated in terms of age, gender, pathology, type of operation, survival, recurrence, complications, receipt of preoperative chemotherapy, tumor node metastasis (TNM) stage, whether or not mediastinoscopy was performed, STAS (The spread through air spaces) positivity, visceral pleural invasion, parietal pleural invasion, lymphovascular invasion, perineural invasion, and alveolar/bronchial wall invasion.

Results: Thoracic wall resection was performed in nine patients with locally advanced NSCLC. The use of prolene mesh was required in eight patients. All patients complained of pain in the thoracic wall in the preoperative period. Postoperative pathology results showed STAS positivity in four patients; alveolar/bronchial wall invasion in four; and visceral, parietal, pleural, and lymphovascular invasion in seven. The mean survival of the patients was 24.20 months (0.63–39). No patient developed recurrence during the follow-up period.

Conclusion: Chest wall resection and reconstruction for lung cancer is a surgical treatment method that should be performed without violating respiratory physiology and by using a small amount/number of synthetic materials.

Keywords: Cancer, lung, thoracic surgery,thoracic wall

Öz

Amaç: Akciğer Kanseri dünya çapında kanser ölümlerinin önde gelen nedeni olmaya devam etmektedir. Lokal ileri küçük hücreli dışı akciğer kanserinde (KHDAK) cerrahi yaklaşım klasik yaklaşımın ötesine geçerek hem preoperatif hem de postoperatif multidisipliner yaklaşım ihtiyacını doğurur. Tümörün boyutunun büyüklüğüne ek olarak, T3 ve T4 tümörlerin yerleşim yeri uygulanacak cerrahinin büyüklüğünü etkiler.

Gereç ve Yöntem: Mart 2019 ile Ekim 2022 yılları arasında akciğer kanseri nedeniyle rezeksiyon yapılan hastalar retrospektif olarak incelendi. Göğüs duvarı rezeksiyonu uygulanan hastalar yaş, cinsiyet, patoloji, operasyon şekli, sağkalım, nüks, komplikasyonlar, preoperatif kemoterapi alıp-almadığı, TNM evresi, mediastinoskopi yapılıp-yapılmadığı, STAS (The spread through air spaces) pozitifliği, visseral plevra invazyonu, paryetal plevra invazyonu, lenfovasküler invazyon, perinöral invazyon ve alveol/bronş duvarı invazyonu açısından değerlendirildi.

Bulgular: Lokal ileri küçük hücreli dışı akciğer kanseri nedeniyle 9 hastaya toraks duvarı rezeksiyonu uygulanmıştır. Hastaların 8'inde prolen mesh kullanma ihtiyacı doğmuştur. Tüm hastalarda preoperatif dönemde toraks duvarında ağrı şikayeti mevcuttu. Postoperatif patoloji sonuçlarında hastaların 4'ünde STAS pozitifliği, 4'ünde alveol/bronş duvarı invazyonu, 7'sinde visseral, paryetal plevra ve lenfovasküler invazyon tespit edilmiştir. Hastaların ortalama sağ kalım süresi 24,20 ay (0,63-39) olarak tespit edilmiştir. Takip süresi içerisinde nüks gelişen hasta olmamıştır.

Sonuç: Akciğer kanseri nedeniyle gerçekleştirilen göğüs duvarı rezeksiyonu ve rekonstrüksiyonu solunum fizyolojisine aykırı davralınmadan ve az miktarda/sayıda sentetik materyal tercih edilerek gerçekleştirilmesi gereken bir cerrahi tedavi yöntemidir.

Anahtar Kelimeler: Akciğer, göğüs cerrahisi, kanser, toraks duvarı

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INTRODUCTION

Lung cancer is the leading cause of cancer-related deaths worldwide. According to the 2020 data of the World Health Organization, the incidence rate of lung cancer is 22.4/100000 and it is the deadliest cancer, with a rate of 18/100000. The 5-year survival rate of lung cancer is 10%–20%.[1] Surgical resection is the best treatment option for non-small cell lung cancer.

The chest wall is involved in approximately 5% of all primary lung neoplasms, and this clinical condition is more common than primary chest wall tumors that invade the lung.[2] According to the 8th tumor node metastasis (TNM) classification, lung tumors invading the chest wall are classified as T3, and they account for approximately 45% of all T3 lung cancers.[3] Surgical resection consisting of excision of the primary lung cancer with associated chest wall resection and lymph node dissection is the treatment of choice for locally advanced tumors. The success of treatment depends on achieving R0 resection and the involvement of lymph nodes by the tumor. This study aimed to take a critical look at lung cancers invading the chest wall, focusing on the preoperative evaluation of patients, surgical techniques, postoperative complications, and overall outcomes.

MATERIAL AND METHOD

The Ethics committee approval was obtained for this study from the hospital's ethics committee. (Received from the Ankara City Hospital Ethics Committee with the number E1-20-817 on 25.06.2022)

All persons included in the study signed the informed consent form. Patients who underwent lung resection for malignancy between March 2021 and October 2022 were retrospectively reviewed. Patients who underwent chest wall resection were evaluated in terms of age, gender, pathology, type of operation, survival, recurrence, complications, receipt of preoperative chemotherapy, TNM stage, whether or not mediastinoscopy was performed, STAS (The spread through air spaces) positivity, visceral pleural invasion, parietal pleural invasion, lymphovascular invasion, perineural invasion, and alveolar/bronchial wall invasion. TNM stages were determined according to the American Joint Committee on Cancer/Union for International Cancer Control8th TNM staging classifications. Prior to surgical resection, the patients were preoperatively examined. For a routine preoperative examination, the patients were asked to undergo a positron emission tomography-computed tomography (PET-CT) scan and a pulmonary function test, along with hemograms and biochemical blood tests. High fluorodeoxyglucose uptake in the mediastinal lymph nodes during PET-CT indicated mediastinal lymph node metastasis.

Statistical analyses were performed using IBM Corp. (Released in 2021. IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: software). STAS, age groups, gender, type of operation, visceral pleural invasion, parietal pleural invasion, lymphovascular invasion, perineural invasion, alveolar/bronchial invasion, and TNM stages are presented using contingency tables. The chi-square test or Fisher's exact test (when the values observed in the cells did not meet the assumptions of the chi-square test) were used as appropriate to determine whether there was a difference between the groups in terms of these frequencies. The Mann–Whitney U test was used to compare age and survival between the groups. While investigating the associations between age and survival the Spearman test was used. A p-value of less than 0.05 was considered to show a statistically significant result.

RESULTS

Of the nine patients with lung cancer who underwent surgical treatment for thoracic wall invasion, one was a female and eight were males. The mean age of the patients was 62.6 years (45–74). All patients in the preoperative period had a pathological diagnosis. Pathological examination revealed squamous cell carcinoma in six patients, adenocarcinoma in two patients, and neuroendocrine carcinoma in one patient. All patients reported thoracic wall pain. All patients were active smokers. None of the patients who underwent PET-CT evaluation underwent mediastinoscopy before resection. Three patients with suspected mediastinal lymph node involvement on PET-CT evaluation underwent endobronchial ultrasound (EBUS). No patient received preoperative chemoradiotherapy.

The surgical procedures performed on the patients are shown in **Table 1**. One patient with limited respiratory reserve underwent wedge resection.

Patients were staged by the TNM system according to postoperative pathology reports. The prolene mesh used in thoracic wall reconstruction is shown in **Figure 2**.

T4 tumors invading the thoracic wall have also been discussed in our study (**Figure 1**). Of the patients with T4 disease, two had vertebral body invasion with thoracic wall invasion and one had a tumor greater than 7 cm.

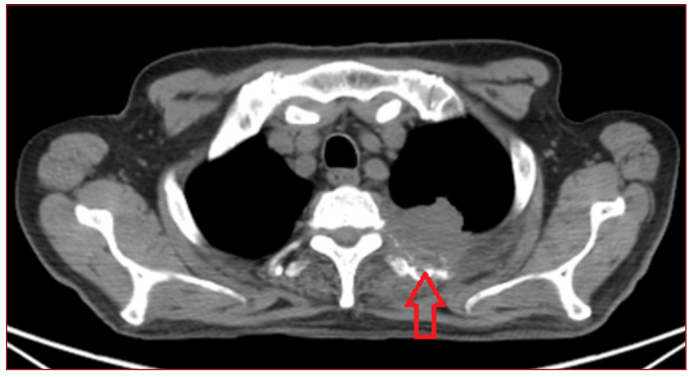

Figure 1: Lung cancer invading the paravertebral portion of the rib and the vertebral body (arrow).

Table 1: Surgical approaches and distribution of patients by pathology

Patient	Operation	Pathology	Parietal pleura status	TNM	Stage
1	Right lower lobectomy + anterolateral thoracic wall resection, including ribs 4, 5, and 6, and reconstruction using prolene mesh	Sqcc	+	T3N0M0	2B
2	Right lower lobectomy + anterolateral thoracic wall resection, including ribs 4, 5, and 6, and reconstruction using prolene mesh	Adenoca	+	T3N0M0	2B
3	Right upper lobe wedge resection + Posterior thoracic wall resection, including the ribs 2, 3.	Sqcc	-	T3N0M0	2B
4	Right upper lobectomy + Anterolateral thoracic wall resection, including the ribs 3, 4, 5, and reconstruction using prolene mesh	Sqcc	+	T4N1M0	3A
5	Right upper lobectomy + Anterolateral thoracic wall resection, including the ribs 3, 4, 5, and reconstruction using prolene mesh	Sqcc	+	T4N0M0	3A
6	Left lower lobectomy + anterolateral thoracic wall resection, including the 4th, 5th, 6th ribs, and reconstruction	Adenoca	+	T3N0M0	2B
7	Left upper lobectomy + Anterolateral thoracic wall resection, including the ribs 3, 4, 5, and reconstruction using prolene mesh	Sqcc	+	T4N2M0	3B
8	Right upper lobectomy + Resection of the posterolateral thoracic wall, including the ribs 2,3,4,5, and reconstruction using prolene mesh	Sqcc	+	T3N0M0	2B
9	Right upper lobectomy + Resection of the posterolateral thoracic wall, including the ribs 3, 4, 5, and reconstruction using prolene mesh	Neuro ca	-	T3N0M0	2B

Sqcc Squamous cell carcinoma, Adenoca Adenocarcinoma, Neuro ca Neuroendocrine carcinoma

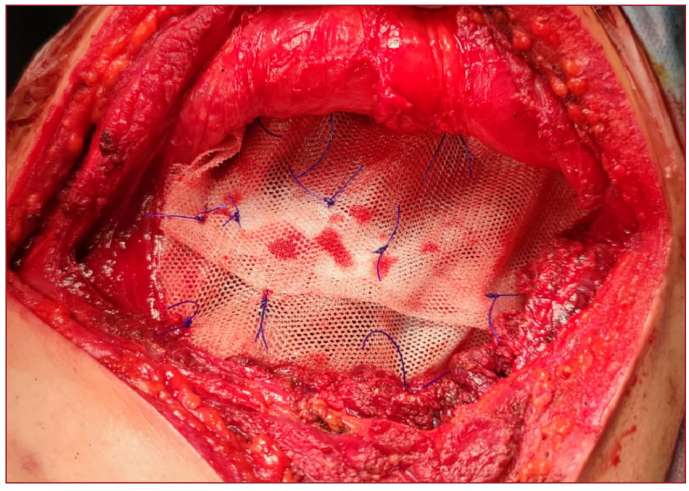

Figure 2: Appearance of the prolene patch used on the reconstruction of the thoracic wall

STAS positivity was detected in four patients; alveolar/bronchial wall invasion was detected in four; and visceral, parietal pleural invasion was detected in seven, and lymphovascular invasion was detected in six patients. There was no statistically significant difference between disease stages in terms of the rate of STAS positivity; parietal and visceral pleural invasion; and lymphovascular, perineural, and alveolar/bronchial invasion (p=0.232, p=0.526, p=0.526, p=0.325, p=0.455, p=0.455). There was no statistically significant difference in the rate of STAS positivity between histological groups (p=0.455). The recurrence rate and survival were not different between STAS-positive and STAS-negative groups (p=0.343, p=0.858),

One patient died on postoperative day 25 due to coronavirus disease 2019, and one patient died on postoperative day 19 due to cardiac complications. The mean survival of the patients was 24.20 months (0.63–39). One patient developed recurrence during the follow-up period. There was no statistically significant relationship between age and survival (p=0.897). The survival was not significantly different between patients with and without lymphovascular invasion, parietal pleural invasion, perineural invasion, alveolar/bronchial wall invasion, and visceral pleural invasion (p=0.571, p=0.391, p=0.858, p=0.858, p=0.858).

DISCUSSION

Coleman described the first surgical management of a primary lung cancer invading the chest wall in 1947.[4] The chest wall is involved in approximately 5% of all primary lung tumors.[2]

Chest wall infiltration is usually caused by peripherally located tumors and develops slowly. The tumor invades the parietal pleura, followed by the soft tissues and intercostal muscles, and finally the ribs. Extrapleural resection is sufficient only if the parietal pleura is infiltrated, whereas deeper invasion requires a complete chest wall resection. Tumor size and depth of invasion are not always directly correlated. In general, lung cancers invading the chest wall originate from the apico-posterior part of the upper or lower lobes.[5,6] The majority of our patients had tumors originating from the upper lobes. Considering the location, the best surgical approach is posterolateral thoracotomy. In our study, a traditional posterolateral thoracotomy was performed. In our patients with vertebral invasion, a high posterolateral thoracotomy was required and hemivertebrectomy was performed by a neurosurgeon.

In addition to symptoms secondary to lung malignancy, the most common clinical symptom at presentation is chest pain (>60%), which is highly specific for chest wall infiltration (>90%).[3] All of our patients complained of chest pain. The diagnosis is usually made radiologically. Tomography has an accuracy of 50%–91% in the diagnosis of T3 tumors.[7,8] Dynamic magnetic resonance imaging (MRI) may be useful to rule out a possible invasion of the parietal pleura.[9]

PET-CT scanning is recommended for the detection of preoperative hilar/mediastinal lymph node involvement.[3] In our study, patients underwent chest radiography, thoracic tomography, MRI for suspected vertebral body invasion and brain metastasis, and PET-CT for staging. Further invasive examinations, such as mediastinoscopy or EBUS, are indicated to exclude suspected nodal metastases. No patient underwent mediastinoscopy in our study. Three patients underwent EBUS for staging, and lymph node involvement was ruled out. The incidence of lymph node involvement is not related to the depth of chest wall infiltration or tumor size.[3] Similar results were obtained in our study.

Patients with locally advanced lung cancer are at high risk for postoperative complications and therefore require careful preoperative evaluation of comorbid conditions. All of our patients were evaluated preoperatively for comorbid diseases, and some patients required a multidisciplinary approach.

Preoperative pulmonary and cardiac evaluations should be performed. Pulmonary function tests, ventilation–perfusion scintigraphy, and echocardiography should be performed.

A differential diagnosis of lung cancer should be made, and diagnostic procedures such as transthoracic fine needle aspiration biopsy and bronchoscopy should be performed to make a preoperative tumor diagnosis. Preoperative histopathological diagnosis was made by transthoracic fine needle aspiration biopsy and bronchoscopy in eight patients and by intraoperative frozen section examination in one patient.

The goal of surgery must be to achieve R0 resection. Lung resection, systemic lymph node dissection, and chest wall resection are the surgical methods. All patients underwent R0 resection.

Chest wall reconstruction can be performed depending on the size and location of the chest wall defect. In general, small posterior defects closed by the scapula do not require reconstruction. Large defects and defects located in the anterior chest wall usually require reconstruction. If the defect is below the tip of the scapula, reconstruction is recommended to avoid potential compression of the scapula within the defect. The basic principles of reconstruction are preservation of chest wall stability and protection of vital organs and respiratory mechanics.[3] The need for reconstruction in chest wall resections ranges from 40% to 60%.[10,11]

For reconstruction, autologous live tissue extraction and moldable titanium rods or synthetic patches may be preferred. Firm materials are not recommended because they have a high risk of damaging the surrounding tissues and tend to break due to respiratory movements.[2] All synthetic materials used for reconstruction carry the risk of causing a foreign body reaction in the body. Infection at the operation site and allergic reactions due to the material used may be observed. We used prolene mesh in all of our patients and avoided the excessive use of synthetic material as much as possible. Complications such as foreign body reaction, loss of function, infection, and bleeding were not seen in any of our patients.

CONCLUSION

We believe that the anatomical and physiologic structures of the thorax should be preserved as much as possible in chest wall resection and reconstruction for lung cancer. Excessive and unnecessary use of synthetic materials may cause loss of respiratory function, infections, allergic reactions, and anatomical distortion. In reconstruction, the surgical procedure should be performed by resecting the tissues as much as possible while adhering to the principles of malignancy surgery.

ETHICAL DECLARATIONS

Ethics Committee Approval: The Ethics committee approval was obtained for this study from the hospital's ethics committee. (Received from the Ankara City Hospital Ethics Committee with the number E1-20-817 on 25.06.2022)

Informed Consent: All participants signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

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

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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