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ADVANCED MINIMALLY INVASIVE SURGERY: ROBOTIC AND VIDEO-ASSISTED THORACOSCOPIC APPROACHES TO PULMONARY TUMOR RESECTION

Dr. Dritan Beqiri
University Hospital "Shefqet Ndroqi", Tirana, Albania

Abstract: Surgery remains the cornerstone of treatment for non-small cell lung cancer (NSCLC), particularly in the early stages of the disease. This study aimed to outline the surgical management of NSCLC and assess the impact of various factors on patient outcomes. A total of 153 patients who underwent surgery for primary NSCLC with curative intent were followed up at University Hospital "Shefqet Ndroqi" in Tirana, Albania during the years 2010-2015. Preoperative risk factors associated with morbidity and mortality after lung resection were determined based on patients' tumour stage, performance status, and weight loss. Accurate diagnosis and staging is mandatory for surgical management of NSCLC. Surgical resection involves removal of the affected lobe and systematic evaluation of ipsilateral hilar and mediastinal lymph nodes. More invasive approaches to surgery, such as video-assisted thoracoscopic surgery and robotics, may reduce morbidity and mortality. Advances in staging, perioperative management, anaesthetic management, and surgical techniques have improved patient outcomes. Lung resection is the gold standard treatment for stage I NSCLC, and surgery may also be considered an accepted treatment modality in a small proportion of selected patients with stage IIIb and stage IV disease. The sociodemographic and clinical data of patients treated for NSCLC in this study were similar to those reported in other studies. In conclusion, the current treatment strategy for NSCLC depends on clinical staging, and surgical management remains a valuable option for select patients.

Keywords: Non-Small Cell Lung Cancer, Robotic Surgery, Video-Assisted Thoracoscopic Surgery.

INTRODUCTION

The surgical treatment of lung cancer is focused on accurate diagnosis and staging as well as definitive surgical treatment [1]. Whereas small cell lung cancer is rarely treated by surgery, early stage patients with non–small cell lung cancer (NSCLC) are typically taken to surgery for resection for cure. Unfortunately, most NSCLC patients at the time of diagnosis have disease that has advanced beyond the point where local treatment such as surgical resection alone can provide cure, and these patients are treated in a multidisciplinary fashion. Recent advances in surgery for NSCLC have centered on less invasive approaches, in an effort to minimize the pain and complications common to these procedures [2]. Surgery for Early Stage NSCLC (Stage I and II) Early stage NSCLC, defined as stage I and stage II, is usually treated with surgery as an initial modality. The current staging guidelines by the American Joint Committee on Cancer (AJCC) 7th edition TMN system define these as tumors up to 7 cm in size without mediastinal lymph node involvement, although ipsilateral hilar nodal disease is included. Tumor >7 cm are only considered to be stage II if there is no evidence of any lymph node disease. A preoperative diagnosis of a suspicious pulmonary nodule is not required prior to definitive resection [3]. There are two key aspects to surgery for early stage

NSCLC: resection of the primary tumor and evaluation of draining lymph node basins in the ipsilateral hilum and mediastinum. The aim of the study is to give an overview of the demographic and clinical characteristics of patients who underwent surgery for primary NSCLC of the lungs. Old age is associated with impairment of respiratory function. Elderly patients have reduced lung elastic recoil, reduced compliance of the chest wall, and weakening of the respiratory muscles [4]. The loss of elastic recoil, in addition to increasing residual volume, decreases the negative intrapleural pressure. This change in pressure prevents the reopening of small airways, resulting in air trapping, inadequate ventilation, and poor distribution. The reduced compliance of the chest wall is partly due to the stiffening of calcified costal cartilages, diminished diaphragmatic excursion, and narrowing of intervertebral disc space [5]. With increasing age, vital capacity and arterial pO_2 progressively decrease, respiratory centres become less sensitive, and pulmonary blood vessels undergo fibrotic degeneration of the intimal layer [12]. Furthermore, respiratory infections are more common in elderly individuals because of a reduction in local immunity and ciliary function of the respiratory tract. Under normal conditions, pulmonary function is not generally affected by these physiological changes. However, it may be severely impaired when under stress or when associated with other co-morbid illnesses. Increasing age is also associated with a decrease in glomerular filtration rate, tubular function, and water metabolism. This decrease causes intolerance to water deprivation, which can easily lead to hypovolemia, especially during stress. Age is also a recognized risk factor for the development of postoperative cognitive dysfunction [6]. All elderly patients who are candidates for lung surgery must have a detailed cardiovascular clinical history and an electrocardiogram. Patients can then be divided into subgroups according to the presence or absence of known coronary disease and cardiac functional status. If there is no history of coronary artery disease, myocardial infarction, or congestive heart failure and the electrocardiogram does not show any abnormality, no further tests are required and the patient can be considered a suitable candidate for surgery. Patients with previous myocardial infarction or congestive heart failure should undergo echocardiography to evaluate ejection fraction. Those with a history of coronary artery disease or previous coronary artery bypass graft surgery should undergo an exercise stress test to evaluate cardiac function [7]. High-risk patients can then be treated preoperatively with anti-ischaemic and antihypertensive therapy. Anaesthetic and analgesic regimens, which provide sympathetic modulation, can be considered during surgery. After surgery more intensive monitoring and treatment can be given.

MATERIAL AND METHODS

This is a prospective study. A total of 153 patients who underwent surgery for primary
NSCLC with curative intent were followed up at University Hospital “Shefqet Ndroqi” in Tirana, Albania during the years 2010-2015. The records of patients were reviewed in details, including their socio-demographic and clinical data. Accurate diagnosis and staging is mandatory, irrespective of the age of the patient. Preoperative risk assessment and evaluation of lung function facilitate the selection of elderly patients who are suitable candidates for pulmonary resection.

Several attempts have been made to use preoperative tests to determine a patient’s physiological limits for surgery. However, this has proven to be a difficult task.

Several preoperative risk factors are associated with morbidity and mortality during the hospital stay after major lung resection. Tumour stage, performance status, and weight loss are the most accepted preoperative prognostic predictive factors for patients considered fit for surgery [18]. All patients must have a detailed assessment based on history, symptoms, and signs of chronic lung or heart disease. Chest x-ray, electrocardiogram, arterial blood gas analysis, pulmonary function tests (forced expiratory volume at 1 second (FEV1)), and biochemical and haematological tests are helpful in screening potential surgical patients.

RESULTS AND DISCUSSION

Resectability of lung cancer for technical reasons in general, and in early stage lung cancer in particular, very rarely is an issue. Table 1 presents the sociodemographic and and clinical characteristics of patients.

Table 1: Sociodemographic and clinical characteristics of patients

Variables	N	%
Gender		
Female	55	35.9
Male	98	64.1
Age		
≤59 yrs	33	21.6
60-69 yrs	54	35.3
≥70 yrs	66	43.1
BMI, M (SD)	27.2 (±5.1)	
KPS, M (SD)	75.5 (±13.3)	
Smoking habits		
Current smoker	81	52.9
Former smoker	54	35.3
Never smoked	18	12.0
Concomitant disease		
Yes	64	41.8
No	89	58.2
Mode of diagnosis	0	
Incidental	72	47.1
Symptoms	75	49.0
Screening	6	3.9
Measurement of lung function		
$FEV_1 > 60\%$	132	86.3
$FEV_1 \leq 60\%$	21	13.7
CEA		

<4µg/l	81	52.9
≥4µg/l	72	47.1
Imaging		
PET/CT	144	94.1
EBUS	7	4.6
Video-assisted mediastinoscopy	2	1.3

Oncological operability has to be defined preoperatively along international guidelines. The European Society of Thoracic Surgeons (ESTS) recently has published revised guidelines for preoperative mediastinal lymph nodes staging for non-small cell lung cancer. Only one selected group of patients with tumors of less than 3 cm in diameter (cT1) in the outer third of the lung without signs of nodal involvement at CT scan, PET scan or PET CT (cN0) may directly undergo surgical resection. All other clinical situations require invasive preoperative staging by bronchoscopy plus EBUS/EUS [8]. Table 2 presents the lung cancer characteristics and staging.

Table 2: Lung cancer characteristics and staging

Variables	N	%
Differentiation		
Good	36	23.5
Moderate	75	49.2
Poor	42	27.5
Histopathological type		
Adenocarcinoma	54	35.3
Squamous cell ca.	75	49.0
Bronchoalveolar cell cancer	11	7.2
Mixed types	13	8.5
Tumour size		
< 10 mm	8	5.2
10-20 mm	18	11.8
20-30 mm	33	21.6
30-50 mm	48	31.4
> 50 mm	46	30.1
Tumour growth in lymph node		
N_0	101	66.0
N_1	42	27.5
N_2	10	6.5
Tumour growth in parietal pleura		
Yes	1	0.7
No	152	99.3

Tumour stage		
IA	49	32.0
IB	54	35.3
IIA-IIB	39	25.5
IIIA	11	7.2
Type of surgery		
Pneumonectomy	41	26.8
Lobectomy	102	66.7
Bilobectomy	8	5.2
Segmentectectomy	2	1.3
Complications		
Yes	7	4.6
No	146	95.4
Hospitalization, days, M (SD)	5.6 (±1.7)	

If the absence of nodal involvement is verified by EBUS/EUS this patient may also directly undergo surgery. In the presence of radiologically suspect mediastinal lymph nodes and negative EBUS/EUS further confirmation is recommended using mediastinoscopy or thoracoscopy. If mediastinal nodal involvement is histologically verified by any means the patient has to undergo multimodality treatment. All clinical findings are to be discussed in an interdisciplinary tumor board for proper therapy planning [9]. Surgery remains the cornerstone of treatment of early stage nonsmall lung cancer for patients willing to accept the procedure-related risks [10].

Goal of any surgical intervention for early stage lung cancer is the complete resection of the primary tumor together with regional lymphatic nodes. The standard for any resection with curative intent is defined by anatomical lung resection [11]. In early stage lung cancer the predominant type of resection is lobectomy or bilobectomy, sometimes along with bronchoplastic or angioplastic procedures or extended resections for locally invading T3 tumors. Pneumonectomy particularly in the treatment of early stage lung cancer is rarely used. Gold standard of surgical resection for lung cancer is lobectomy. This standard is based on a prospective multi-institutional randomized trial comparing limited resection with lobectomy for peripheral T1N0 non-small cell lung cancer published in 1995.

In the absence of more recent prospective randomized trials lobectomy still must be considered the surgical procedure of choice for patients with peripheral T1N0 nonsmall cell lung cancer [12]. An extensive body of literature mainly composed of retrospective studies supports the use of radical anatomical segmentectomy for peripheral cT1N0M0 non-small lung cancer with less than 2 cm in diameter, certainly for older patients with limited cardiopulmonary function. However, caution should be taken to promote a widespread indication for intentional segmentectomy in young good surgical candidates until the results of the ongoing randomized controlled trials become available [13].

Lung cancer [LC] is the leading cause of cancer-related deaths in the western world, accounting for around 26% of cancer-related deaths globally [14]. In Europe and North America, non-small cell lung carcinoma accounts for around 80% of LC [15], where surgical resection is the only well-defined and well-studied curative treatment [16].

Pulmonary resection is indicated for patients with localized or regional disease, which currently applies to almost one-third of all patients diagnosed with NSCLC. Five-year survival for resected patients is reported to range from 40% to 70%, depending mostly on the TNM stage at diagnosis [17], as compared to less than 5% for non-resected patients with metastasized disease [17]. Thus, resection should be offered to all patients where surgery is indicated; that is, for patients at stages I and II and in selected patients who are diagnosed at stage IIIA [18]. Lobectomy is considered the gold standard of treatment for NSCLC [19], as numerous studies have shown that lobectomy has better outcome than sublobar resections with regard to both recurrence of cancer and long-term survival [20]. Until recently, segmentectomy and wedge resection have been used when pulmonary function or other comorbidities pose a high operative risk. However, the use of segmentectomy has recently been recommended for small peripheral stage I NSCLCs instead of lobectomy [21], as outcomes are comparable to those after lobectomy. On the other hand, pneumonectomy is still reserved for more extensive disease, as the surgical morbidity and mortality are higher than for lobectomy or sublobar resections [22]. Most studies on pulmonary resections for

NSCLC – and especially lobectomy – have focused more on short-term outcome than on long-term survival [23]. These studies have usually been based on single tertiary-care centers, with the risk of selection bias. With lobectomy being the most common surgical procedure for NSCLC and regarded as the gold standard for curative treatment of NSCLC, this is a subgroup that is important to focus on and report their outcome.

CONCLUSION

The current treatment strategy for NSCLC depends on clinical staging. The sociodemographic and clinical data of patients in this study are similar with many other studies reported in literature. Surgical resection is generally considered the treatment of choice in patients with stage I and II disease whose performance status allows for general anaesthesia and a lung resection. Surgery is also an accepted treatment modality in a fair proportion of patients with clinical stage IIIa disease, and in a small proportion of selected patients with stage IIIb and stage IV disease. Although the standards of resections have changed little over the past 20 years, there have been a number of advances in staging, perioperative and anaesthetic management, as well as some noticeable progress made in surgical techniques and approaches.

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