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Robotic anatomic pulmonary resection in octogenarian patients with primary lung cancer: report of seven cases

Primer akciğer kanserli oktojenaryan hastalarda robotik anatomik akciğer rezeksiyonu: Yedi olgunun sunumu

Özkan Demirhan, Kemal Ayalp, Erkan Kaba, Elena Uyumaz, Mehmet Oğuzhan Özyurtkan, Alper Toker

Department of Thoracic Surgery, İstanbul Bilim University, Group Florence Nightingale Hospitals, İstanbul, Turkey

ABSTRACT

Background: This article aims to report our experience with robotic anatomic pulmonary resections in primary lung cancer patients aged 80 years and older and to compare the results with a younger patient population.

Methods: Data of 75 patients who were performed robotic anatomic pulmonary resection in our clinic between October 2011 and January 2015 for primary lung cancer were retrospectively evaluated. Patients were divided into two groups as patients aged 80 years and older (octogenarians, n=7) (6 males, 1 female; mean age 82.0±1.8 years; range 80 to 84 years) and patients aged below 80 years (non-octogenarians, n=68) (51 males, 17 females; mean age 61±11 years; range 31 to 79 years) and the obtained results were compared.

Results: Four lobectomies and three segmentectomies were performed in the seven octogenarian patients. Mean docking, console, and total operation durations were 21±12, 75±10 minutes, and 101±20, respectively. Mean duration of hospital stay was 6±4 days. There was no mortality, but minor complications occurred in two patients (29%). Although octogenarians had lower pulmonary function test results and longer durations of chest tube and hospital stay, their resection types, operation durations, resected lymph node numbers, size of lesions, mortality and morbidity rates were similar compared to those of non-octogenarians.

Conclusion: This preliminary study demonstrates that postoperative outcomes of octogenarians who underwent robotic anatomic pulmonary resection were similar to those of younger patients. Anatomical pulmonary resections with robotic approach may be performed in carefully selected octogenarian patients with primary lung tumor who may tolerate the operation and complete resection.

Keywords: Lung cancer; octogenarian; outcomes; robotic lung resection.

ÖZ

Amaç: Bu yazıda 80 yaş ve üstü primer akciğer kanseri hastalarında robotik anatomik akciğer rezeksiyonları ile deneyimlerimiz sunuldu ve sonuçlar daha genç bir hasta nüfusu ile karşılaştırıldı.

Çalışma planı: Ekim 2011 - Ocak 2015 tarihleri arasında primer akciğer kanseri nedeni ile kliniğimizde robotik anatomik pulmoner rezeksiyon uygulanan 75 hastanın verileri geriye yönelik değerlendirildi. Hastalar 80 yaş ve üstü (oktojenaryan, n=7) (6 erkek, 1 kadın; ort. yaş 82.0±1.8 yıl; dağılım 80-84 yıl) ve 80 yaş altı (oktojenaryan olmayan, n=68) (51 erkek, 17 kadın; ort. yaş 61±11 yıl; dağılım 31-79 yıl) olmak üzere iki gruba ayrıldı ve elde edilen sonuçlar karşılaştırıldı.

Bulgular: Yedi oktojenaryan hastaya dört lobektomi ve üç segmentektomi uygulandı. Ortalama robot kurulum, konsol ve toplam ameliyat süreleri sırasıyla 21±12, 75±10 ve 101±20 dakika idi. Ortalama hastanede kalış süresi 6±4 gün idi. Mortalite yoktu, fakat iki hastada (%29) minör komplikasyon gelişti. Oktojenaryan hastaların akciğer fonksiyon test sonuçları daha düşük, dren ve hastanede kalış süreleri daha uzun olsa da rezeksiyon tipleri, ameliyat süreleri, rezeke edilen lenf nodu sayıları, lezyonların boyutu, mortalite ve morbidite oranları, oktojenaryan olmayanlarla karşılaştırıldığında benzerdi.

Sonuç: Bu öncü çalışma robotik anatomik akciğer rezeksiyonu yapılan oktojenaryan hastaların ameliyat sonrası sonuçlarının daha genç hastalarla benzer olduğunu göstermektedir. Robotik yaklaşımla anatomik akciğer rezeksiyonları, ameliyatı ve tam rezeksiyonu kaldırabilecek uygun seçilmiş oktojenaryan primer akciğer tümörlü hastalarda uygulanabilir.

Anahtar sözcükler: Akciğer kanseri; oktojenaryan; sonuçlar; robotik akciğer rezeksiyonu.

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Correspondence: Mehmet Oğuzhan Özyurtkan, MD. İstanbul Bilim Üniversitesi Tıp Fakültesi, Grup Florence Nightingale Hastanesi, Göğüs Cerrahisi Anabilim Dalı, 34394 Şişli, İstanbul, Turkey.
Tel: +90 532 - 770 96 75 e-mail: moozyurtkan@hotmail.com

Lung cancer occurs at any age; however, it exhibits a 9.8-fold higher incidence in patients older than 65 years compared with a younger population.[1] Currently, the number of elderly patients with potentially resectable non-small cell lung cancer (NSCLC) is increasing with the aging of the world population, consistent with the age-related incidence of lung cancer.[2] Although complete resection is considered as the treatment of choice in potentially resectable NSCLC, surgeons are often faced with the critical decision of whether or not to perform surgery in elderly patients, since their surgical risks are higher compared to those of younger patients.[3]

Several retrospective studies have been conducted on the surgical treatment of NSCLC in octogenarians.[4-9] As there have been remarkable technological advances in the era of minimally invasive approaches, several authors have emphasized the efficacy of video-assisted thoracic surgery in this group of patients.[3,10,11] In addition, several reports on robotic anatomic pulmonary resections in malignant diseases have been published whose patient population consisted of some octogenarians.[12-14]

We adopted the da Vinci Robotic System (Intuitive Surgical, Inc, Mountain View, California, USA) in October 2011 and performed various thoracic surgical procedures in more than 150 cases, a majority of which consisted of anatomical lung resections in malignant lung diseases. Thus, in this article, we aimed to report our experience with robotic anatomic pulmonary resections in primary lung cancer patients aged 80 years and older and to compare the results with a younger patient population.

PATIENTS AND METHODS

Records of 75 patients who underwent anatomic pulmonary resection for primary lung cancer at İstanbul Bilim University, Group Florence Nightingale Hospitals between October 2011 and January 2015 were retrospectively reviewed. Then, patients were divided into two groups as patients aged 80 years and older (octogenarians, n=7) (6 males, 1 female; mean age 82.0±1.8 years; range 80 to 84 years) and patients aged below 80 years (non-octogenarians, n=68) (51 males, 17 females; mean age 61±11 years; range 31 to 79 years). The preoperative assessment included a history, physical examination, routine blood analysis, electrocardiography, and pulmonary function tests. All patients underwent preoperative cardiological evaluation. Radiological staging included a computed tomography (CT) of the chest, cranial magnetic resonance imaging, and positron emission tomography. One patient was histologically diagnosed to have lung cancer by transthoracic needle biopsy. The remaining patients were strongly suspected to have lung cancer by the CT of the chest, and positron emission tomography, and the final diagnosis was obtained during the operation. Only one patient who had mediastinal lymph node greater than 10 mm in the short axis underwent mediastinoscopy. The study protocol was approved by the İstanbul Bilim University Ethics Committee. A written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Each resection was performed by a single thoracic surgeon. Following single-lung ventilation, the patient was positioned on lateral decubitus position. Three ports were used. The camera was placed in the middle port. The robot was docked from the posterior of the patient with 30 to 45 degrees between the vertebral column of the patient, and transverse axis of the cart. With the robotic camera in the up-position, the ports and instruments were placed. The service port was opened at the 10^{th}-11^{th} intercostal space at the posterior part of the thoracic wall to be used for suctioning, retracting, and taking the specimens out. For resections concerning lower lobes, the service port was opened at the arm number two, as described elsewhere.[15] We had three incisions with this technique. The rest of the operation was performed with the camera in 30 degrees down position. Maryland or curved bipolar forceps for the right arm and prograsper for the left arm were used, and the positions were changed as needed.

For the diagnosis of an indeterminate nodule, a wedge resection was performed with the video-assisted thoracoscopic technique using the camera port of the robot, and the specimen was sent for frozen examination. The da Vinci Surgical System was used to perform individual dissection and isolation of the arterial, venous, and bronchial structures. The ligation and division of these structures were performed using endoscopic staplers (Ethicon Endo-Surgery, Inc., Cincinati, Ohio, and Covidien, Inc., CO, USA) and Hem-o-Lok (Teleflex Medical, Research Triangle Park, NC). After the completion of anatomical lung resection, systematic mediastinal lymph node dissection was performed. All resected materials were extracted through the service port covered with ALEXIS® soft tissue skin retractor (Applied Medical, Rancho Santa Margarita, CA, USA), and the main tissue containing the tumor was extracted using a plastic endobag. Then, the chest was closed by placing a single 28 F chest tube from the camera port. Except

Table 1. Preoperative characteristics of octogenarian patients

No	Age/Gender	Comorbidities	Symptom	Location of the lesion	FEV_1 value in mL	in %	C-stage
1	80/M	COPD, CABG	Sputum, cough	Right lower lobe	1850	60	IB
2	84/M	COPD, HT, CRF, Resected colon carcinoma	None	Right upper lobe	1600	60	IA
3	80/F	None	None	Right upper lobe	1800	80	IA
4	84/M	None	None	Right lower lobe	1600	55	IA
5	82/M	COPD	Cough	Left upper lobe	3350	78	IB
6	80/M	COPD, CABG, HT	None	Left upper lobe	2200	95	IA
7	81/M	HT, DM, Resected prostate carcinoma	Cough	Right upper lobe	3310	106	IIB

FEV_1: Forced expiratory volume in 1 second; C-stage: Clinical stage; COPD: Chronic obstructive pulmonary disease; CABG: Coronary artery bypass grafting; HT: Hypertension; CRF: Chronic renal failure; DM: Diabetes mellitus.

for one patient discharged with Heimlich valve, all chest tubes were removed during the hospital stay as soon as the drainage was less than 300 mL/day and no air leaks were present.

Demographic data included age, gender, symptomatology, associated comorbidities, pulmonary functional assessment, and the radiological stage. Perioperative data consisted of the type of resections, the operation durations, including the docking and console times, and the number of resected N1- and N_2-level lymph nodes. The docking time was defined as time from the first skin incision to the start of driving the robotic arm while seated at the console. The console time was defined as the time when principal surgeon drove the robotic arm while seated at the console, and performed the intrathoracic procedures (dissection, isolation of structures, ligation, divison, and taking the specimen out). The closure time included the period between the undocking of the robotic arms and the closure of the last skin incision. The operation time was defined as the sum of the docking, console, and closure times. Postoperative data included the hospital stay, chest tube duration, pathological analysis, and mortality and morbidity rates.

Statistical analysis

Descriptive statistics were used to report the means and standard deviations of the continuous variables, and number and percent of categorical variables. The results were statistically compared using Fisher's exact test and t-tests, as appropriate. A p value of less than or equal to 0.05 was considered a statistically significant difference.

RESULTS

Preoperative data of the octogenarian group are given in Table 1. Five patients (71%) had at least one comorbidity. Four patients (68%) were asymptomatic. Lung cancer predominated in the right lung (71%). The mean forced expired volume in one second values in mL and percentage were 2036±74 and 73±15, respectively. Perioperative data are demonstrated in Table 2.

The surgical procedures in the octogenarian group included four lobectomies (two left upper, one right upper, one right lower) and three segmentectomies (two right apical, one right common basal). None of the patients required conversion to either video-assisted or

Table 2. Perioperative data of octogenarian patients

No	Resection	Docking time (min)	Console time (min)	Operating time (min)	No of resected N_1 level lymph node	No of resected N_2 level lymph node	Conversion
1	Lobectomy	35	90	130	2	9	None
2	Segmentectomy	30	65	100	3	6	None
3	Segmentectomy	35	80	120	0	8	None
4	Segmentectomy	15	80	100	8	11	None
5	Lobectomy	5	65	75	7	11	None
6	Lobectomy	10	65	80	8	6	None
7	Lobectomy	15	80	100	7	7	None

Table 3. Postoperative outcomes of octogenarian patients

No	Size of the lesion (mm)	Diagnosis	C	Chest tube duration (days)	Hospital stay (days)	T status	N status	Pathological stage
1	35	Squamous	None	4	6	T_{2a}	N_0	IB
2	15	Squamous	None	3	4	T_{1a}	N_0	IA
3	15	Adeno	None	3	4	T_3	N_2	IIIA
4	25	Squamous	None	7	10	T_{1b}	N_1	IIA
5	35	Large cell	PAL	15	6	T_{2a}	N_0	IB
6	25	Adeno	None	3	5	T_{1b}	N_2	IIIA
7	75	Squamous	ITH	7	9	T_3	N_1	IIB

C: Complication; PAL: Prolonged air leak; ITH: Intrathoracic hematoma.

open approaches. The mean docking, console, and total operating times were 21±12 minutes, 75±10 minutes, and 101±20 minutes, respectively. The mean numbers of resected N_1- and N_2-level lymph nodes were 8±2 and 5±3, respectively.

Postoperative outcomes are presented in Table 3. Patients undergoing lobectomy had larger lesions (p=0.05). The mean durations of chest tube and hospital stay were 6±2 and 6±4 days, respectively. There was no mortality; however, minor complications occurred in two patients (29%). The first patient had prolonged air leak, which required suction applied to chest tube. An intrathoracic hematoma developed in the second patient, which resolved few days later without any further interruption.

Pathologically, three patients had early-stage (stage I) lung cancer and two patients had N2 diseases. Each patient had complete resection. The mean follow-up duration was 18±12 months. The first patient with N_2 diseases was found to have

Table 4. Comparison of variables between octogenarian and non-octogenarian patients

Variables	Octogenarians (n=7)	Non-octogenarians (n=68)	*p*
Age* (years)	81	61	<0.0001
Gender			0.7
Male	6	51	
Female	1	17	
Asymptomatic			0.4
Yes	4	31	
No	3	37	
Comorbidities			0.6
Yes	4	38	
No	3	30	
Forced expiratory volume in 1 second in (mL)*	2230	2395	0.3
Forced expiratory volume in 1 second in (%)*	76	81	0.3
Early stage (radiologically)	6/1	59/9	0.6
Lobectomy/segmentectomy	4/3	46/22	0.7
Size of the lesion (mm)*	30	31	0.5
Chest tube duration (days)*	5.7	4.7	0.3
Hospital stay (days)*	6	5.8	0.8
Docking time (min)*	20	16	0.2
Console time (min)*	80	84	0.3
Operating time (min)*	100	106	0.2
Number of resected N_1-level lymph nodes*	5.1	6.0	0.3
Number of resected N_2-level lymph nodes*	8.3	9.0	0.4
Complication			0.6
Yes	2	20	
No	5	48	

* Values are given in mean.

intrapulmonary micrometastasis in the same lobe and underwent segmentectomy. She then received chemotherapy, and was alive with metastatic disease at the 25th month. The second patient received radiotherapy, was alive and disease-free at the 10th month. The remaining five patients did not receive further treatment due to *(i)* early-stage disease, *(ii)* patient' will, and *(iii)* older age. One of them died due to metastasis on the 10th postoperative month, while the other four were alive and disease-free at the end of the study period.

Table 4 reveals the results of comparisons between octogenarians and non-octogenarians. Although octogenarians had lower pulmonary function test results and their chest tube and hospital stay durations were longer, there were no statistically significant differences in any parameters analyzed between the two groups.

DISCUSSION

Elderly patients with NSCLC usually have comorbidities, mostly cardiopulmonary disorders, and these make them high-risk candidates for surgery. In the past, age above 80 years was considered as a relative contraindication to pulmonary resection.[16] However, age itself is not considered as an exclusion criterion for surgical treatment of NSCLC.[17] More than 10 retrospective studies exist in the literature on surgery in octogenarians. Most of these reports are from Japan, since life expectancy of 80-year-olds is 8.5 years for males and 11 years for females in Japan, demonstrating that the Japanese population is aging.[10] There is also a recent study concerning pulmonary resection for NSCLC in nonagenarians.[18] Compared to Japanese, Turkish people have a mean life expectancy of 76 years. According to national data, life expectancy of 80 year-olds is 6.5 years for males and 8 years for females in our country.[19] Therefore, there is no specific report from Turkey about pulmonary resections in octogenarians.

Surgery for lung resection in elderly patients is a point to debate. There are controversies on whether to perform surgery or not. It was reported that surgery was the convenient treatment for elderly NSCLC patients, and postoperative complications were not associated with age.[20] Contrary to this, Wang et al[21] reported that older age was a significant risk factor for postoperative major complications. In our study, we compared seven octogenarians with 68 non-octogenarians and found no significant difference in postoperative outcomes between the two groups.

Another concern is that thoracotomy is accepted as an invasive procedure for elderly patients.[10] It was reported that video-assisted approach was superior compared to thoracotomy in terms of the small amount of blood loss, short period of chest tube drainage, low incidence of postoperative complications.[22] Several studies indicated octogenarians undergoing robotic anatomic pulmonary resections.[12-14] In addition, some patients who were older than 90 years of age underwent robotic pulmonary resections in the study of Dylewski et al.[12]

In our clinic, we mostly perform minimally invasive resections, and we have an experience with more than 350 anatomical lung resections, 380 thymectomies, and 70 thymomectomies using video-assisted thoracic surgery. We began the robotic program after adopting the da Vinci Robotic System in October 2011. We mostly selected patients with clinical T_{1a-b} lesions; however, as we gained experience, we also included patients with T_{2-3} lesions, and with neoadjuvant treatment. Due to the advantageous point of minimally invasive surgery in octogenarians mentioned above, we offer these approaches (either video-assisted or robotic) to elderly patients. Still, the only clear indications in patient selection for robotic surgery are patient's will and the coverage of the expenditures by the private insurance system.

We performed robotic anatomic lung resection in seven octogenarians with primary lung cancer. Of these, 71% had comorbidities and 29% developed minor morbidities which could be treated with conservative techniques. There was no death in the study. Postoperative morbidity and mortality rates for octogenarians with NSCLC have been reported as 8.4% to 65.9% and 0 to 8.8%, respectively.[3,5-11,16,22,23] Our results were within the range reported in the literature.

Another argued point is whether to perform lobar or sublobar resection in octogenarians. There are some reports suggesting that limited surgery is less invasive and is associated with the same prognosis as radical surgery for octogenarians with NSCLC. Okada et al.[23] performed lobectomy in 14 and sublobar resection in 30 octogenarians. They demonstrated similar morbidity, recurrence, and disease-specific survival rates in both groups. Ikeda et al.[17] proposed to perform segmentectomy in octogenarians in case of smaller lesion diameter and poorer pulmonary function tests. Contrary to this, Ito et al.[7] reported that lobectomy in octogenarians was associated with significantly higher rates of overall survival and disease-specific survival. There was no significant

difference in pulmonary function test results in our patients. We performed segmentectomy in case of smaller tumor, and when the possibility to reach a tumor-free surgical margin seemed possible.

A limitation of our study is its small sample size (n=7), since the sample size may have influenced the statistical power and limited the ability to generalize the present findings. However, to the best of our knowledge, there is no previous report on robotic anatomic pulmonary resection in octogenarians with NSCLC. Thus, our study is valuable as a preliminary study.

In conclusion, due to the aging population and increased incidence of lung cancer in elderly patients, the number of surgical resections in the elderly has been increasing. Our preliminary study on robotic anatomical pulmonary resection in NSCLC demonstrated that postoperative outcomes for octogenarians were the same as those for younger patients. Anatomical pulmonary resections with robotic approach may be performed in carefully selected octogenarians with NSCLC who may tolerate the operation and complete resection.

Declaration of conflicting interests

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