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Original Article / Özgün Makale

Role of body mass index, airflow obstruction, dyspnea level, exercise capacity index and maximal oxygen uptake on predicting the postoperative complications of lung resections for patients with lung cancer and chronic obstructive pulmonary disease

Akciğer kanseri ve kronik obstrüktif akciğer hastalığı olan hastalarda akciğer rezeksiyonlarının ameliyat sonrası komplikasyonlarını öngörmede vücut kütle indeksi, hava yolu obstrüksiyonu, dispne düzeyi, egzersiz kapasitesi indeksi ile maksimal oksijen alımının rolü

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ABSTRACT

Background: This study aims to investigate the effect of body mass index, airflow obstruction, dyspnea level, and exercise capacity (BODE) index on predicting the postoperative complications of lung resections and compare this effect with spirometry and maximal oxygen uptake in patients with lung cancer accompanied by chronic obstructive pulmonary disease with the indication of lung resection.

Methods: A total of 33 patients (30 males, 3 females; mean age 60.4±9.5 years; range 32 to 76 years) who were performed lung resection at our clinic between April 2012 and April 2013 were included in the study. Spirometry and stair climbing test were performed in all patients and their BODE index and maximal oxygen uptake values were calculated preoperatively. The patients were divided into four groups by their BODE index: Group 0 (BODE index= 0, n=8), group 1 (BODE index= 1, n=14), group 2 (BODE index= 2, n=7) and group 3 (BODE index= 3 or 4, n=4).

Results: There was no significant difference between the groups in terms of demographics, clinical characteristics, exercise capacity, and operation types (p>0.05). BODE index was significantly correlated with all spirometric values (r= –0.36/–0.58), many complications (r=0.49/0.50), time to intubation, and durations of intensive care unit and hospital stays (r=0.34/0.40, p<0.05). Maximal oxygen uptake was not correlated with any of these parameters (p>0.05).

Conclusion: Our study indicates that the BODE index is superior in the prediction of postoperative complications of lung resections in patients with obstructive airway symptoms when compared with spirometric test and maximal oxygen uptake results and advises that the BODE index should be routinely used in clinical practice.

Keywords: Airflow obstruction, body mass index, dyspnea level, and exercise capacity index; lung cancer surgery; maximal oxygen uptake; postoperative care; spirometry.

ÖZ

Amaç: Bu çalışmada akciğer rezeksiyonu endikasyonu bulunan, kronik obstrüktif akciğer hastalığının eşlik ettiği akciğer kanseri hastalarında vücut kütle indeksi, hava yolu obstrüksiyonu, dispne düzeyi ve egzersiz kapasite (BODE) indeksinin akciğer rezeksiyonlarının ameliyat sonrası komplikasyonlarını öngörmedeki etkisi belirlendi ve bu etki spirometri ve maksimal oksijen alımı ile karşılaştırıldı.

Çalışma planı: Nisan 2012 - Nisan 2013 tarihleri arasında kliniğimizde akciğer rezeksiyonu uygulanan toplam 33 hasta (30 erkek, 3 kadın; ort. yaş 60.4±9.5 yıl; dağılım 32-76 yıl) çalışmaya dahil edildi. Ameliyat öncesinde tüm hastalara spirometri ve merdiven çıkma testi yapıldı, hastaların BODE indeksi ve maksimal oksijen alımı değerleri hesaplandı. Hastalar BODE indekslerine göre dört gruba ayrıldı: Grup 0 (BODE indeksi= 0, n=8), grup 1 (BODE indeksi= 1, n= 14), grup 2 (BODE indeksi= 2, n=7) ve grup 3 (BODE indeksi= 3 ya da 4, n=4).

Bulgular: Gruplar arasında demografik, klinik özellikler, egzersiz kapasitesi ve ameliyat tipleri açısından anlamlı farklılık yok idi (p>0.05). BODE indeksi spirometrik değerler ile (r= –0.36/–0.58), birçok komplikasyon ile (r=0.49/0.50), entübasyon zamanı ve yoğun bakımda ve hastanede kalış süreleri ile (r=0.34/0.40, p<0.05) anlamlı derecede ilişkili idi. Maksimal oksijen alımı bu parametrelerin hiçbiri ile ilişkili değil idi (p>0.05).

Sonuç: Çalışmamız, spirometrik test ve maksimal oksijen alımı sonuçları ile karşılaştırıldığında BODE indeksinin obstrüktif hava yolu semptomları olan hastaların akciğer rezeksiyonlarında ameliyat sonrası komplikasyonları öngörmede daha üstün olduğunu göstermekte ve klinik uygulamada rutin olarak kullanılması gerektiğini önermektedir.

Anahtar sözcükler: Hava yolu obstrüksiyonu, vücut kütle indeksi, dispne düzeyi ve egzersiz kapasite indeksi; akciğer kanseri cerrahisi; maksimal oksijen alımı; ameliyat sonrası bakım; spirometre.

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Although lung resection is the most effective therapeutical option in the treatment of many diseases such as lung cancer, it causes decreased lung functions, exercise capacity and quality of life in postoperative period.[1] Despite the availability of preoperative evaluation algorithms which are accepted to reveal the related risk factors, there is no gold standard to estimate postoperative morbidity and mortality. The most important parameters including spirometry, carbon monoxide diffusion test, stair climbing test, and maximal oxygen uptake (VO_{2max}) values are calculated based on the maximum exercise effort. Nevertheless, their role in determining postoperative complications is still contradictory in the literature.[2]

It was substantiated that chronic obstructive pulmonary disease (COPD) accompanies 73% of the males and 53% of females with lung cancer, which is the most common reason for lung resection.[3] Chronic obstructive pulmonary disease was defined as one of the most important factors that causes increased mortality and complications during postoperative period. In patients with COPD, risk of postoperative pulmonary complication is 2.7 to 4.7 times higher.[4] Therefore, testing the severity of COPD may be helpful in predicting postoperative complications.

Spirometry tests are important as well as the assessment of clinical symptoms in the diagnosis and treatment of patients with COPD. However, it is agreed that spirometry alone is not sufficient for the clinical monitoring of patients with COPD. Several prognostic factors affecting survival have been defined in COPD patients.[5-7] It has been shown that the combination of four variables was strongly correlated with the prognosis of the COPD,[8] including body mass index (B), airway obstruction severity (O), the perceived severity of the dyspnea level (D) and exercise capacity (E), which formed the scoring system named BODE index. This system has been demonstrated to be a superior prognostic factor compared to spirometry-based staging systems developed by American Thoracic Society and many other similar associations.[7,8]

BODE index was initiated to be used and interpreted in the routine follow-up of patients with COPD as well as in lung surgeries such as volume reduction surgery or lung transplantations.[9,10] Unfortunately, to our knowledge, BODE index has not been utilized for other diseases accompanied by COPD which necessitate lung resection.

Therefore, in this study, we aimed to investigate the value of BODE index on predicting the postoperative complications after lung resections and compare prediction with spirometry and VO_{2max} in patients with lung cancer accompanied by COPD who had undergone lung resection.

PATIENTS AND METHODS

This prospective study was approved by the Scientific Research Evaluation Board of Medical Faculty of Dokuz Eylül University with the decision dated 03 May 2012 and numbered 2012/16-14. Informed consents were obtained from all enrolled patients before the assessments. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Inclusion criteria were as follows:

- Subjects who were planned to undergo lung resection for lung cancer accompanied by COPD,
- Clinically stable patients (who do not receive supplemental oxygen therapy and do not have any medical conditions that worsen with physical effort),
- Forced expiratory volume in one second/forced vital capacity (FEV_1/FVC) ≤70%, FEV_1 <80%,
- The patients with body mass index (BMI) <40 kg/m^2,
- Absence of any psychological, neurological, musculoskeletal diseases or any condition that prevents mobilization.

Exclusion criteria included:

- Rejecting participation in the study,
- Heart rate that reaches maximum heart rate (220-age) during walking or stair climbing tests,
- Evaluation parameters that cannot be completed due to any reason.

Fifty-nine patients planned for lung resection at the Clinic of Thoracic Surgery of Medical Faculty of Dokuz Eylül University between April 2012 and April 2013 were evaluated during the data collection period. Four of these patients were excluded since independent ambulation was not available and two patients were excluded due to rejection to participation. Fifty-three patients were identified to be included in the study. Twenty of these patients were excluded because their results of FEV_1/FVC >70% at spirometry. Therefore, finally, a total of 33 patients (30 males, 3 females; mean age 60.4±9.5 years; range 32 to 76 years) were enrolled. All resections were

performed through thoracotomy. Lung resections included pneumonectomy, lobectomy, bilobectomy, segmentectomy, and wedge resections. The patients were divided into four groups by their BODE index as follows: BODE index 0 (group 0, n=8), BODE index 1 (group 1, n=14), BODE index 2 (group 2, n=7), and BODE index 3 or 4 (group 3, n=4).

Patients were evaluated using preoperative evaluation methods accepted by European Respiratory Society, including spirometry and stair climbing test.[1,11] Maximal oxygen uptake value obtained with stair climbing test was calculated using the following formula:[11]

- Number of stairs climbed in a minute=(number of floor x number of stairs in one floor)/time (minute)
- Work=height of one stair (0.16 m) x number of stairs climbed in one minute x body weight (kg) x 0.1635
- Total VO_{2max} (mL/min)=[5.8 x body weight (kg)] + 151 + (10.1 x work)
- VO_{2max} (mL/kg/min)=VO_{2max} (mL/min)/body weight (kg)

Patients' BODE indices was determined as defined by Celli.[8] According to this information, FEV_1 value was evaluated by spirometry and BMI was calculated. Modified Medical Research Council Scale was used for dyspnea assessment.[12] Exercise capacity was evaluated with six minutes walking test (6MWT).[13] All derived data were matched with the scores at Table 1 and total score was represented as the BODE index.[8]

After the operation, patients were monitored in the intensive care unit (ICU), then they were extubated. Time of intubation to extubation was recorded as the time from the completion of the operation to the extubation as hours. After one-day follow-up in ICU, patients with normal ranges of blood analysis and normal chest radiographs were begun to be followed-up in the ward. Time from the operation to the hospitalization in the ward was recorded as ICU stay as days.

We recorded the presence of prolonged air leak (PAL), lung re-expansion defect, secretion retention, respiratory failure, the need for additional oxygen supply, the need for additional tube thoracostomy, time to tube withdrawal, hospital stay, ICU stay, intubation time, and other non-pulmonary complications developed during the postoperative period.

Air leak that persisted beyond postoperative seventh day was considered as PAL. Similarly, patients without lung expansion in the control chest radiographies at postoperative seventh day were considered to have lung expansion defect. Patients who needed additional tube thoracostomy due to PAL or lung expansion defect were recorded.

During the postoperative period, it were considered that there is secretion retention in patients who could not remove their bronchial secretions; thereby, having occurred atelectasis or having needed bronchial aspiration by applying nasotracheal aspiration and/or fiberoptic bronchoscopy. Patients who could not be weaned from mechanical ventilator or who became hypoventilated when weaned during the postoperative period were considered to have respiratory failure. Patients who were hypoxic according to the arterial blood gas analysis (partial pressure of dissolved oxygen <60 mmHg) when withdrawn from the oxygen supply, despite being weaned from mechanical ventilator after the operation, were considered to require additional oxygen supply.

Based on chest radiographies that were obtained daily after the operation, chest tubes were removed and this period was defined as the time to tube withdrawal in patients who had lung re-expansion, did not have air leak from chest tube, and had daily pleural drainage equal to or less than 100 mL (400 mL for pneumonectomy). On the next day, patients who had lung re-expansion on chest radiograph were discharged. This postoperative period was recorded as the hospital stay. All other non-pulmonary complications such as cardiac arrhythmia and intestinal ileus were recorded as additional complications.

Table 1. Score scale used in calculation of BODE index

	0	1	2	3
Forced expiratory volume in one second (%)	≥65	50-64	36-49	≤35
Six minute walking distance (m)	≥350	250-349	150-249	≤149
MMRC dyspnea scale point	0-1	2	3	4
Body mass index (kg/m^2)	>21	≤21		

BODE: Body mass index, airflow obstruction, dyspnea level, and exercise capacity index; MMRC: Modified Medical Research Council.

Table 2. Comparison of demographics, clinical characteristics and operation types between BODE index groups (n=33)

	Group 0 (n=8)			Group 1 (n=14)			Group 2 (n=7)			Group 3 (n=4)			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Distribution of gender													
Female	0	0.0		1	7.1		1	14.3		1	25.0		0.52
Male	8	100.0		13	92.9		6	85.7		3	75.0		
Operation type													
Segmentectomy/wedge resection	2	22.2		5	35.7		3	50.0		2	50.0		0.87
Bilobectomy/lobectomy	4	44.4		5	35.7		2	33.3		2	50.0		
Pneumonectomy	3	33.3		4	28.6		1	16.7		0	0.0		
Chest wall resection													
Yes	0	0.0		2	14.3		0	0.0		0	0.0		0.42
No	9	100.0		12	85.7		6	100.0		4	100.0		
Height (m)			1.7±0.1			1.7±0.1			1.7±0.1			1.7±0.1	0.09
Body mass index (kg/m^2)			24.4±3.2			25.4±4.2			24.2±5.7			24.6±6.7	0.92
FEV_1 (L)			2.0±0.2			2.2±0.6			1.6±0.3			1.3±0.5	0.01
FVC (L)			2.9±0.4			3.2±0.9			2.7±0.5			2.1±1.0	0.21
FEV_1/FVC (%)			66.0±2.6			65.6±4.7			58.8±7.1			62.5±6.5	0.16
VO_2max (mL/kg/min)			22.5±3.1			24.5±6.3			26.9±8.4			18.6±5.6	0.30
Six minute walk distance (m)			495.0±62.2			500.8±83.6			446.7±57.5			382.5±104.4	0.03
Number of stairs (number)			124.2±17.3			126.3±9.4			112.7±21.2			117.0±26.0	0.30

BODE: Body mass index, airflow obstruction, dyspnea level, and exercise capacity index; SD: Standard deviation; FEV_1: Forced expiratory volume in one second; FVC: Forced vital capacity; VO_2max: Maximal oxygen uptake.

Statistical analysis

The obtained data were analyzed using SPSS version 15.0 package program (SPSS Inc., Chicago, IL, USA). The results were presented as mean ± standard deviations and percentages. For the three patient groups allocated by their BODE index, mean values were compared using non-parametric Student t test and numerical values were compared using chi-square test. Intercorrelation of the relevant parameters was interpreted using Pearson correlation coefficient analysis. For our study results, $p<0.05$ was considered to be statistically significant.

RESULTS

One patient (3%) died due to ileus. The demographic and clinical characteristics of groups according to BODE index score were similar and there was no difference between sexes ($p>0.05$). Only FEV_1 value was statistically significantly different across the groups ($p=0.01$). Based on BODE index scores, patients had similar VO_{2max} values and stair climbing test results ($p>0.05$) but walking distance was statistically different ($p=0.03$, Table 2).

The types of operation with similar operation-related prognostic factors were examined in three categories as patients who underwent wedge resection and segmentectomy, patients who underwent lobectomy or bilobectomy, and patients who underwent pneumonectomy. In terms of the BODE index, the distribution of these categories was similar ($p>0.05$). Also, the distribution of the two patients who underwent chest wall resection, which is another factor affecting postoperative complications, was not statistically different across the groups ($p>0.05$, Table 2).

During the postoperative follow-up, time of intubation, ICU stay, time of tube withdrawal, and hospital stay of the patients showed a homogeneous distribution among the groups ($p>0.05$, Table 3).

Table 3. Comparison of postoperative follow-up parameters between BODE index groups*

	Group 0	Group 1	Group 2	Group 3	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	*p*
Intensive care unit stay (days)	1.0±0.0	0.9±0.3	1.0±0.0	23.8±44.2	0.76
Time to intubation (hours)	3.7±1.3	3.6±1.6	4.2±1.6	73.8±112.8	0.36
Hospital stay (days)	7.3±2.9	7.5±5.8	6.5±3.0	38.3±55.2	0.01
Time to tube withdrawal (days)	6.3±3.6	5.9±6.1	5.4±3.3	6.3±3.3	0.76

BODE: Body mass index, airflow obstruction, dyspnea level, and exercise capacity index; SD: Standard deviation; * Time to tube withdrawal was analyzed by excluding patients who underwent pneumonectomy.

Despite the homogenous distribution of groups according to BODE index, the presence of complications, respiratory failure, the need for additional oxygen supply, and additional complications were found to be statistically significantly different between the BODE groups ($p<0.05$). The proportion of patients without complication decreased in line with increasing BODE index ($p=0.15$, Table 4).

We showed that the BODE index score was significantly correlated with all spirometric test results ($r= -0.36/-0.58$, $p<0.05$) and walking distance ($r= -0.42$, $p=0.02$). Maximal oxygen uptake value was negatively correlated only with the age ($r= -0.35$, $p=0.05$). BODE index score was significantly correlated with postoperative complications, including secretion retention, respiratory failure, and additional complications ($r=0.49/0.50$, $p<0.001$). However, VO_{2max} value was not correlated with any of the postoperative complications ($p>0.05$). BODE index score was correlated statistically significantly with time to intubation, ICU stay, hospital stay, and the need for additional oxygen supply ($p\leq0.05$). Maximal oxygen uptake value was not correlated with any of these parameters ($p>0.05$) except the need for additional oxygen supply ($p=0.04$, Table 5).

DISCUSSION

In our study, we have demonstrated that the BODE index detected postoperative complications more accurately compared to spirometric and VO_{2max} values in patients with airway obstruction who underwent lung resection.

During our study, 39.4% of the patients had at least one postoperative complication, including secretion retention, lung expansion defect, prolonged air leak, and additional complications in increasing order of incidence rate. In the literature, the incidence of postoperative complication was reported as 24% to 48% when all lung resections were considered.[14] In this sense, our data are consistent with the literature.

Another important point that should be considered in the assessment of complications is the type of resection performed. In various series, the rates of

Table 4. Comparison of distribution of postoperative complications between BODE index groups*

	Group 0		Group 1		Group 2		Group 3		
	n	%	n	%	n	%	n	%	*p*
No complication	7	87.5	9	64.3	3	42.9	1	25.0	0.15
Prolonged air leak									
Yes	2	33.3	2	20.0	1	20.0	1	25.0	0.94
No	4	66.7	8	80.0	4	80.0	3	75.0	
Lung re-expansion defect									
Yes	1	16.7	2	20.0	2	40.0	1	25.0	0.82
No	5	83.3	8	80.0	3	60.0	3	75.0	
Secretion retention									
Yes	0	0.0	3	21.4	2	33.3	3	75.0	0.36
No	9	100.0	11	78.6	4	66.7	1	25.0	
Respiratory failure									
Yes	0	0.0	0	0.0	0	0.0	3	50.0	0.00
No	9	100.0	14	100.0	6	100.0	2	50.0	
Additional complication									
Yes	0	0.0	2	14.3	1	16.7	3	75.0	0.02
No	9	100.0	12	85.7	5	83.3	1	25.0	
Postoperative death									
Yes	0	0.0	1	7.1	0	0.0	0	0.0	0.72
No	9	100.0	13	92.9	6	100.0	4	100.0	
Additional oxygen supply									
Yes	1	11.1	2	14.3	0	0.0	3	75.0	0.02
No	8	88.9	12	85.7	6	100.0	1	25.0	
Additional chest tube insertion									
Yes	1	16.7	1	10.0	1	20.0	0	0.0	0.81
No	5	83.3	9	90.0	4	80.0	4	100.0	

BODE: Body mass index, airflow obstruction, dyspnea level, and exercise capacity index; * Analysis was performed by excluding patients who underwent pneumonectomy to evaluate parameters including prolonged air leak, lung expansion defect, and need for additional thoracotomy.

Table 5. Correlation of BODE index scores and maximal oxygen uptake values with other parameters*

	BODE	VO_2max	Age	BMI	FEV_1 (%)	FVC (%)	FEV_1/FVC	6-min walk distance	Number of stairs
BODE index	-	-0.06	0.06	-0.01	-0.58***	-0.47**	-0.36*	-0.42*	-0.23
VO_2max	-0.06	-	-0.35*	-0.30	-0.02	0.07	-0.15	0.30	0.25
Prolonged air leak	0.01	-0.13	0.49***	-0.18	-0.06	-0.19	0.15	-0.13	-0.02
Lung re-expansion defect	0.17	0.17	0.40*	-0.25	-0.20	-0.21	0.04	-0.24	-0.02
Secretion retention	0.50***	-0.02	0.18	0.08	-0.26	-0.29	0.08	-0.35*	0.05
Respiratory failure	0.49***	-0.20	0.15	-0.04	-0.34	-0.39*	0.19	-0.50***	0.12
Additional complications	0.50***	-0.30	0.22	0.14	-0.33	-0.38*	0.14	-0.36*	-0.15
Need for additional oxygen	0.34*	-0.37*	0.26	0.02	-0.21	-0.20	0.02	-0.32	-0.15
Additional tube thoracostomy	-0.05	-0.02	0.34	-0.12	0.60	0.08	0.03	-0.17	-0.02
Time to tube removal	0.09	0.01	0.33	-0.02	0.05	-0.05	0.11	-0.19	0.14
Time to intubation	0.40*	-0.02	0.24	-0.05	-0.42*	-0.49***	0.13	-0.26	0.09
Intensive care unit stay	0.35*	0.04	0.24	-0.05	-0.41*	-0.49***	0.10	-0.17	0.09
Hospital stay	0.36*	-0.03	0.33	-0.07	-0.39*	-0.51***	0.18	-0.26	0.08

BODE: Body mass index, airflow obstruction, dyspnea level, and exercise capacity index; BMI: Body mass index; FEV_1: Forced expiratory volume in one second; FVC: Forced vital capacity; VO_2max: Maximal oxygen uptake; * $0.01< p\leq0.05$; ** $0.001< p\leq0.01$; *** $p\leq00.001$; Each number represents "r value" which is the indicator of correlation.

postoperative complication after pneumonectomy ranged between 33% to 81%.[15] In our study, we believe that the complication rate equal to 25% of the eight patients who underwent pneumonectomy was due to the small number of patients who underwent this procedure.

In various series, mortality rates in the early period after pneumonectomy and lobectomy were reported to be 6% to 8% and 2% to 4%, respectively.[16-19] Our mortality rate was 3% (n=1). The mortality rate for pneumonectomy was 12.5% although there was no mortality in the other cases of lung resection. Although the mortality rate seems to be higher for pneumonectomies in our study compared to the literature; however, it is difficult to interpret the results accurately based on only one subject. In addition, this subject did not die due to cardiopulmonary reasons but died because of intestinal obstruction.

While no correlation was shown between BODE index score and VO_2max value calculated from the stair climbing test result, BODE index had a significant correlation with walk distance obtained from 6MWT. The presence of a correlation between BODE index score and walk distance, which is a parameter used to calculate BODE index, is not surprising. As the correlation between BODE index and VO_2max was not reported to be strong in the literature, it was claimed that modified BODE index that also includes VO_2max should be calculated and utilized.[20] We believe that the difference between BODE index and VO_2max and stair climbing test results from the forefront position of the airway obstructive factors in our patients. Accordingly, BODE index was shown to be a gold standard to determine the prognosis in patients with COPD and superior to spirometry and exercise tests.[7,8]

Another interesting point was the correlation of demographical and clinical outcome parameters of the patients with BODE index and VO_2max values. While BODE index scores were correlated with all spirometric test results and other values of patients, VO_2max value was correlated only with the age. Although this result conflicts with the findings in the literature, it suggests that BODE index is more valuable than routinely used VO_2max value to demonstrate postoperative complications.[21]

We confirmed this prediction by examining the correlation of postoperative complications with BODE index and VO_2max values. Accordingly, BODE index score was correlated with secretion retention, respiratory failure, and additional complications; whereas VO_2maxvalue was not correlated with any complications. Thus, we showed that BODE index was more reliable compared to VO_2max value in the demonstration of the postoperative complications.

Furthermore, BODE index score was correlated with time to intubation, ICU stay, hospital stay, and the need for additional oxygen supply. On the other hand, VO_2max values were only correlated with the need for additional oxygen among these parameters, indicating the superiority of BODE index compared to VO_2max value in demonstrating the postoperative complications as well as the parameters related to patient comfort, hospitalization cycle, and medical care costs.

The similarity of all demographical and clinical characteristics of patients in the four groups generated by BODE index scores increases the reliability of our study for intergroup comparison. Patients also had similar BODE index scores in terms of exercise capacity and related parameters. Moreover, the

similarity of the distribution of operation types showed that the groups were quite homogeneous and that the differences detected were not affected by postoperative parameters.

Despite this homogeneous distribution, the incidences of respiratory failure, need for additional oxygen supply, and additional complications were significantly different across the groups. Secretion retention, respiratory failure, and additional complications had higher prevalence rates with increasing BODE index scores. Although not statistically significant due to the small sample sizes of the groups, this result indicates that BODE index may be efficient in predicting postoperative complications.

The limitations of our study include the small sample size and low ratio of female patients to all patients. Furthermore, the interpretation of the objective parameters such as carbon monoxide diffusion test, ventilation/perfusion scintigraphy or maximal cardiopulmonary exercise test, which we did not indicate in our study, might provide clearer results regarding the value of BODE index in this issue. Also, studies with larger sample size that investigate the effect of BODE index on medical care costs are required.

In conclusion, our study suggests that the body mass index, airflow obstruction, dyspnea level, and exercise capacity index is superior in the prediction of postoperative complications of patients with dominant obstructive airway symptoms when compared with spirometric test results and maximal oxygen uptake values. In light of all these data, we recommend the examination of the body mass index, airflow obstruction, dyspnea level, and exercise capacity index along with other parameters during the preoperative period for lung cancer patients accompanied by chronic obstructive pulmonary disease and with the indication of lung resection. In addition, we believe that the index composed of simple and inexpensive tests and measurements which do not increase the load on patients and which may be used practically in all clinics may be beneficial.

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