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ARAŞTIRMA / RESEARCH

A single center comparison of cost analyses of different volume reduction therapy methods in the treatment of emphysema

Amfizem tedavisinde farklı volüm küçültücü tedavi metodlarının maliyet analizlerinin tek merkezli karşılaştırması

Bayram Metin[1], Yavuz Selim İntepe[2], Mahmut Kılıç[3], Şener Yıldırım[4], Erdoğan Çetinkaya[5]

[1]Bozok University, Faculty of Medicine, Thoracic Surgery Department, [2]Chest Disseases Department, [3]Health School, Public Health Department, [4]Thoracic Surgery Department, Yozgat, Turkey;
[5]Yedikule Chest Diseases and Thoracic Surgery Education and Research Hospital, Dept. Chest Disease, İstanbul, Turkey

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Abstract

Purpose: The aim of this study was to evaluate and compare preoperative and postoperative one year-cost analyses of endobronchial valve and enbronchial coil practices and volume-reduction surgical methods applied for the purpose of reducing volume in the patients with emphysema.

Material and Methods: All the data regarding the one-year-preoperative and postoperative hospital costs of the patients in our hospital, 11 of whom received an endobronchial valve, 9 of whom received an endobronchial coil and 7 of whom underwent a volume reduction-surgery due to emphysema, were obtained along with the data of the respiratory function test and 6-minute walking test results by accessing into the database of our hospital.

Results: The entire research group consisted of 27 patients. Following valve and coil and the volume reduction-surgical intervention, there had been an increase in SFT FEV1% values of the patients with emphysema by 54.0%, 44.4% and 24.6%, respectively, whereas another increase was observed in their six-minute walking distances values by 85.7%, 78.7% and 34.1%, respectively. When the costs of the interventions on emphysema were analyzed, valve ($12943.6) and coil ($11328.9) practices were seen to be almost 5 times more costly than the Volume-reduction surgical treatment ($2444.3).

Conclusions: The most economical method in terms of transaction costs is the volume-reduction surgery.

Key words: Cost analysis, emphysema, volume-reduction.

Öz

Amaç: Amfizem hastalarında volüm küçültme amacıyla uygulanan endobronşial valf, endobronşial coil uygulaması ve volüm küçültücü cerrahi yöntemlerinin işlem öncesi ve işlem sonrası bir yıllık süreçteki maliyet analizleri yapılarak, birbirleri ile karşılaştırması amaçlandı.

Gereç ve Yönem: Hastanemizde amfizem nedeni ile endobronşial valf uygulanan 11, endobronşial Coil uygulanan 9 ve volüm küçültücü cerrahi uygulanan 7 hastanın prosedürden önceki bir yıl, prosedür ve prosedür sonrası 1 yıllık süreçte ki tüm hastane maliyetleri, solunum fonksiyon testi ve 6 dakika yürüme testi sonucu verileri hastanemiz veri tabanından girilerek elde edildi.

Bulgular: Araştırma grubunun tamamı 27 hasta olup, yaş aralığı 40-72, median yaş 57, yaş ortalaması 57.1 ± standart sapması 8.8 yıldır. valf, coil ve volüm küçültücü cerrahi müdahale sonrasında Amfizem hastalarının; SFT FEV1% değerlerinde sırasıyla %54.0, 44.4 ve 24.6 (total %41.1) artış, 6 MWT değerlerinde sırasıyla %85.7, 78.7 ve 34.1 (total %69.8) artış görülmüştür. Amfizem hastalarına yapılan müdahalelerin maliyeti incelendiğinde, Valf (12943.6 $) ve Coil (11328.9 $)'in Volüm Küçültücü cerrahi (2444.3 $) yönteme göre yaklaşık 5 kat daha pahalı olduğu görülmüştür.

Sonuç: İşlem maliyeti olarak en ekonomik metod volüm küçültücü cerrahidir.

Anahtar kelimeler: Maliyet analizi, amfizem, volüm küçültme.

Yazışma Adresi/Address for Correspondence: Dr. Bayram Metin, Bozok University, Faculty of Medicine, Department of Thoracic Surgery, E-mail: drbaymet@hotmail.com
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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive disorder that occurs in connection with the inflammatory response developing in the airways because of a long-term inhalation of harmful gases and particles, notably cigarettes[1]. In emphysema, however, there is an elastic/responsive recoil loss that develops as the result of the tissue damage due to chronic inflammation and an air trapping due to the early closure of the bronchioles. Consequently, the lungs cannot stretch in the thorax any longer and undergo a functional loss. Since the capacity of deep inhalation becomes rather difficult, the exercise tolerance decreases, the respiratory work load increases, and the respiratory muscles get exhausted due to hyperfunction. Thus, the life quality of patients is degenerated due to the chronic respiratory trouble and the decrease in the exercise capacity[2].

The effectiveness of conventional medical treatment methods comprising bronchodilator and anti-inflammatory agents is limited in the patients with emphysema[3]. In this case, it was shown that the volume-reduction surgery which provides an opportunity to be applied on the selected patients had brought a direct solution to hyperinflation, which is the actual problem in the patients with emphysema, thanks to the resection of the non-functioning pulmonary regions as well as providing a prominent recovery in pulmonary functions, exercise capacity and life quality[4,5]. In recent years, various endoscopic volume-reducing methods have been developed to substitute for the volume-reduction surgery without allowing for a surgical morbidity load[6].

Here, in this study, starting one year earlier than the whole process, we made the comparison of the primary hospitalization costs along with their functional values, including the beds and prices of polyclinic (ambulatory) examinations, treatments and medical equipments that are required when the patients on whom volume-reductions surgery, pulmonary volume-reduction coil and endobronchial valve practice are performed due to their complaints of COPD and emphysema visit our hospital during the one-year- pre- and post operative process.

MATERIAL AND METHODS

In this study, the medical files and the database invoice information of the patients on whom endobronchial valve or coil was applied and those on whom volume-reduction surgery was performed due to Stage IV COPD were retrospectively reviewed in Bozok University, Medical Faculty, The Clinics of Thoracic Surgery and Thoracic Diseases between the period January 2011 and September 2015. Prior to the commencement of the study, an approval was received from the Ethical Committee of Non-Invasive Clinical Researches in Bozok University (The Ethical Committee date and number: Nov., 8th, 2015/604-712).

During the preoperative and postoperative one year-period pertaining to a total of 27 patients, 11 of whom were treated by valve therapy, 9 of whom had received a coil therapy and 7 of whom had undergone a volume-reduction surgery; the number of annual hospital applications, the number of annual hospitalizations, the number of annual hospitalization days, the annual patient costs per person (in US $) , the respiratory function tests and (SFT) FEV1 (%) values of the patients along with the six-minute walking distances (6 MWT) were all examined through the use of hospital medical records. Separately, the total cost (in US $) of the performed intervention and the number of hospitalization days of the patients were reviewed, as well.

Preoperative examinations

HRCT (High-Resolution Computed Tomography) and the quantitative lung perfusion scintigraphies of all the patients were performed for the purpose of determining the preoperative localization and severity/intensity of emphysema. The preoperative arterial blood gas examinations, respiratory function tests, echocardiography evaluations, dyspnea scoring processes and the body plethysmography examinations of all the patients were performed, as well. In each of the three groups, the patients consisted of those with COPD at Stage III-IV, whose FEV1 values in their respiratory function tests proved to be at the range of 20-45%, whereas the their residual volumes were found to be above 175%, and the six-minute walking distance proved to be below 300 meters.

Volume reduction-surgical procedures

While 5 cases had applied to our clinic with the complaints of heterogenous emphysema and respiration due to giant apical bullae, 2 cases had applied with the complaint of pneumothorax. A surgical operation was performed on 2 patients on whom drainage tubes were placed due to pneumothorax on account of the fact that a common heterogenous emphysema and common apical bullae alomng with a prolonged air leak were detected in their High-Resolution Chest Computed Tomographies (HCRT). All the patients whose preoperative preparations were completed were taken into operation, and a double-lumen selective intubation was performed with the help of a pediatric fiberoptic bronchoscope under general anaesthesia. Later on, a 3-5 cm-thoracoscopy port incision over the 6th intercostal space was performed on all the patients, and a piece of alexis-protective retractor was placed in. The lungs were explored through a 30°thoracoscopy and a single-port thoracoscopy. In order to resect the giant bullae in the apical region of the lungs along with the tissue with peripheral emphysema, a wedge resection was performed by using 3-5 pieces of endoscopic staplers. The stapler line was supported by using polyglycolic acid patches/grafts (NEOVEIL)®, and the amount of the postoperative air leak was tried to be minimized. The amount of specimens resected through wedge resection were in widths covering an average of 20-30% of the upper lobes in all the cases. Separately, the other parenchymal regions, notably the lower lobe superior segment, in all the cases were also checked, and the existing bullous formations were excised by using an endoscopic stapler and supporting sheaths. Afterwards, an apical parietal pleurectomy was performed in all the cases for pleurodesis purposes. After hemorrhage and air leaks had been checked/controlled, the procedure was completed by placing in all the cases a piece of drainage tube from the insertion site of thoracoscopy. While a prolonged air leak that lasted more than 10 days was seen in 2 of our cases whose postoperative drainage follow-ups were performed, no additional complication was encountered in the other cases.

Endobronchial valve application procedure

While a procedure under general anaesthesia was performed in the operating room environment on 2 of the cases whose required preoperative preparations had been completed, 9 of them received a consciousness sedation through the use of a 2-5 cc Dormicum administered IV pathway, and the procedure was done in company with the local anaesthesia performed with oropharyngeal lidocaine in the Bronchology Unit. In order to achieve a high level of effectiveness through the endobronchial valve, there must be no occurrence of any collateral ventilation resulting from the other lobe or lobes neighbouring the blocked lobar fissure[7]. As the result of the tomographic evaluations of our cases whose fissure integrities were ensured, a Zephyr® (Pulmonx, Inc., Palo Alto, CA, USA) brand-endobronchial valve application ranging between 2-5, according to the number of lobar segments targeted through the loading catheter, was performed from inside the fiberoptic bronchoscopy lumen without performing the collateral measurement. On the other hand, in the cases whose fissure integrity we were unsure of by considering their tomographies, the valves were placed after it was determined by using Chartis™ system (Pulmonx Inc, Paolo Alto, CA (USA) that there was no collateral circulation among the lobes[7]. No procedure-related early complication was experienced in any of the cases we had applied valves to.

Endobronchial coil application procedure

A single-lumen intubation under general anaesthesia was performed in the operating room environment on all of our patients whose preoperative preparations had already been completed. Entering into the lobe targeted unilaterally (single-sided) by means of a fiberoptic bronchoscope from inside the intubation tube under the guidance of fluoroscopy, 10-14 pieces of PneumRx® coiled wires were placed in. Only in one of our cases did pneumothorax develop on his postoperative first day, and hence, thoracoscopy was performed on the patient by the thoracic surgery, and two pieces of coils falling into the pleural space were extracted.

Cost analysis

Since our hospital is the only university hospital of the city it is located in, all the follow-ups and medical interventions of all the patients were performed within the same center for 2 years. The number of polyclinics visited by all of our patients in our hospital for 2 years, the number of hospitalizations, the durations of hospitalizations, all

the medical equipments and consumables used, costs of operations, surgery and procedures, radiological examinations, laboratory examinations and the costs of medications used by the patients during their hospitalizaiton period as well as the ambulance costs, including the minimum amount of costs, were all extracted from the invoice review unit of our hospital and were then collected. All the invoice costs, such as one-year-preoperative volume-reduction costs, volume reduction costs in the process of the procedure, and one-year postoperative volume-reduction costs, were calculated separately. The hospital applications of the patients who had applied with the complaint of other problems rather than COPD were not included in the study data. All the charges for the matter involved were transversed (crossed) from the past rate of exchange records of The Central Bank of the Turkish Republic and were converted into the American dollar (U.S.$) of that day.

Statistical analysis

The data were evaluated on SPSS statistical program. Since the number of data proved to be few, Related Wilcoxon signed ranks test, Kruskal-Wallis test and Mann Whitney U test, which fall among the non-parametric tests, were used in the analysis of the data. Whether or not the examined variables showed any alteration before and after the intervention was analyzed through the Related Wilcoxon Signed Ranks Test. The pre-intervention and post-intervention differences between the examined variables were calculated, and on the other hand, whether or not these differences showed any change in accordance with the methods of intervention was analyzed through Kruskal-Wallis test. According to Kruskal-Wallis test, those among these methods that statistically differed a great deal from one another were compared in the form of pair-wise groups by using Mann Whitney U test to see which method the difference in question stemmed from.

Since the number of annual hospital applications of the patients pertaining to pre-intervention and post-intervention periods along with the number of annual hospitalizations and the number of annual hospitalization days consisted of whole numbers (integers), both the median and mean values of these variables were calculated. Since the patients' annual patient cost per person (U.S.$), their respiratory function tests and (SFT) FEV1 (%) values, their six-minute walking distances (6 mwt) and the transaction costs (U.S.$) are continuous variables, the mean values regarding these variables were calculated, as well.

RESULTS

The entire research group consists of 26 male patients whose age range is between 40-72, while the median age is 57, and the mean age is 57.1 ± standard deviation is 8.8 years. According to the applied valve, coil and volume-reduction surgical interventions, the median age (mean age) is 56 (57.9), 58 (60.1) and 50 (52.0) years, respectively. In the wake of valve, coil and volume-reduction surgical interventions, the hospitalization periods of COPD patients due to intervention is almost 3 times more than the median 10 days in volume-reduction surgery, median 3 days in Valve procedure and median 2 in Coil procedure (p=.004) (Table 1).

The hospitalization periods due to valve and coil procedures are similar (MW-U: Z=.53, p=.596). Following the valve, coil and volume-reduction surgical interventions, there was a decrease seen in the number of annual applications of COPD patients to the polyclinic (median:7 times) by 58.3%, 66.7% and 60.0%, respectively, and another decrease in the number of hospitalizations (median: 6 times) by 75.0%, 77.8% and 66.7%, respectively; on the other hand, there was, again, a decrease seen in the number of hospitalization days (median: 71 days) by 82.9%, 91.2% and 75.0%, respectively, and a decrease by 43.6%, 66.1% and 47.5%, respectively, in the annual patients costs (mean: 329.4 U.S. $). These positive changes in the wake of the intervention were found to be statistically significant in each of the three methods (Table 2).

When the postoperative differences of variance in the number of annual applications to the polyclinic as well as the number of annual hospitalizations and annual hospitalization days when compared with the preoperative period are calculated, these differences were seen to be statistically significant in accordance with the methods of intervention.

While the differences in the number of annual applications to the polyclinic and in the number of annual hospitalization days were insignificant between Valve (mean rank: 16.09) and Coil (mean rank: 19.11) methods (p>.05), the difference in Valve and Coil methods is lower than the Volume-reduction surgical method (mean rank: 4.14), and

the difference between them is statistically significant. The difference of decrease in the annual patient costs was found to be statistically insignificant according to the methods in question (Table 3).

Table 1. Operation costs and the number of hospitalization days

Intervention type (n)	Operation costs U.S. $	Hospitalization days median (mean)
Valve (11)	12943.6	3 (4.4)
Coil(9)	11328.9	2 (3.9)
VRS(7)	2444.3	10 (10.1)
Mean /median	9.683.3	5 (5.7)
KW X^2 (p)	17.2 (<.001)	11.2 (.004)

KW: Kruskal-Wallis test, U.S:American Dolars

Table 2. Effects of the interventions performed on COPD patients on patient costs and patient comfort

Variables	Intervention type	n	Pre intervention med.(mean)	Post intervention med.(mean)	Different median (%) [a]	Z (p) [b]
Number of hospital attends	Valve	11	12 (11.8)	4 (4.4)	7 (-58.3)	2.95 (.003)
	Coil	9	12 (12.2)	4 (4.0)	8 (-66.7)	2.72 (.007)
	VRS	7	5 (5.4)	2 (1.9)	3 (-60.0)	2.41 (.016)
	Total	27	11 (10.3)	4 (3.6)	7 (-36.4)	
Number of hospitalizations	Valve	11	8 (8.0)	2 (2.0)	6 (-75.0)	2.97 (.003)
	Coil	9	9 (8.8)	2 (1.7)	7 (-77.8)	2,69 (.007)
	VRS	7	3 (2.6)	1 (0.7)	2 (-66.7)	2,53 (.011)
	Total	27	8 (6.9)	2 (1.6)	6 (-75.0)	
Number of hospitalization days	Valve	11	88 (87.5)	16 (15.3)	73 (-82.9)	2,93 (.003)
	Coil	9	91 (96.1)	13 (11.4)	83 (-91.2)	2.67 (.008)
	VRS	7	24 (23.4)	6 (4.7)	18 (-75.0)	2.37 (.018)
	Total	27	85 (73.7)	11 (11.7)	71 (-83.5)	
The annual hospitalization costs ($) [c]	Valve	11	602.7	340.0	262.7 (-43.6)	2.43 (.015)
	Coil	9	813.3	276.1	537.2 (-66.1)	2.67 (.007)
	VRS	7	681.4	514.3	167.1 (-24.5)	1.98 (.048)
	Total	27	693.3	363.9	329.4 (-47.5)	
FEV1 (%)[c]	Valve	11	28.5	43.8	-15.4 (54.0)	2.94 (.003)
	Coil	9	28.4	41.0	-12.6 (44.4)	2.67 (.008)
	VRS	7	40.7	50.7	-10.0 (24.6)	2.37 (.018)
	Total	27	31.6	44.7	-13.0 (41.1)	
6 mwt (m) [c]	Valve	11	160.0	297.2	-137.2 (85.7)	2.94 (.003)
	Coil	9	163.9	292.9	-129.0 (78.7)	2.67 (.008)
	VRS	7	166.0	222.6	-56.6 (34.1)	2.37 (.018)
	Total	27	162.8	276.4	-113.6 (69.8)	

6 mwt: 6 minute walking test, FEV1: Forced expiratory volume in 1 second.

Table 3. Importance of postoperative differences of variance pertaining to the examined variables

Variables	Intervention type	n	Mean Rank	KW X^2 (p)	Groups	MW-U Z (p)
Number of hospital attends pre-post difference	Valve	11	16.09		VALVE-COIL	1.14 (.253)
	Coil	9	19.11	15.8 (<.001)	VALVE -Surgical	3.45 (.001)
	VRS	7	4.14		COIL- Surgical	3.42 (.001)
Number of hospitalizations pre-post difference	Valve	11	15.14		VALVE-COIL	2.04 (.042)
	Coil	9	20.39	17.8 (<.001)	VALVE -Surgical	3.60 (<.001)
	VRS	7	4.00		COIL- Surgical	3.45 (.001)
Number of hospitalization days pre-post difference	Valve	11	15.36		VALVE-COIL	1.79 (.074
	Coil	9	20.11		VALVE -Surgical	3.49 (<.001)
	VRS	7	4.00	16.8 (<.001)	COIL- Surgical	3.34 (.001)

The annual hospitalization costs pre-post difference ($)	Valve	11	11.86		VALVE-COIL	1.83 (.068)
	Coil	9	18.56	4.52 (.105)	VALVE -Surgical	.05 (.964)
	VRS	7	11.50		COIL- Surgical	1.85 (.065)
FEV1 (%) pre-post difference mean	Valve	11	10.86		VALVE-COIL	1.03 (.304)
	Coil	9	14.78	3.54 (.171)	VALVE -Surgical	1.91 (.056)
	VRS	7	17.93		COIL- Surgical	.69 (.490)
6 mwt (m) pre-post difference	Valve	11	9.36		VALVE-COIL	.95 (.341)
	Coil	9	11.89	15.5 (<.001)	VALVE -Surgical	3.50 (<.001)
	VRS	7	24.00		COIL- Surgical	3.34 (.001)

6 mwt: 6 minute walking test, FEV1: Forced expiratory volume in 1 second. VRS: Volume Reduction Surgery

In the wake of the Valve, Coil and Volume-reduction surgical interventions, it was seen that there was an increase by 54.0%, 44.4% and 24.6%, respectively, in SFT FEV1% values of COPD patients, and an increase by 85.7%, 78.7% and 34.1%, respectively, in their 6 MWT values. These positive changes in the wake of the intervention were found to be statistically significant in each of the three methods. The differences of variance in the patients' SFT FEV1% values were not statistically significant among Valve, Coil and Surgical methods (p=.171). The difference of variance in the patients' 6 MWT values (mean rank 9.36) was higher in Valve and Coil procedures (mean rank: 11.89) in comparison to the Volume-reduction surgery (mean rank: 24.0) (p<.01), the difference between Valve and Coil procedures was statistically insignificant.

When the costs of the interventions performed on the COPD patients are reviewed, it is seen that Valve ($12943.6) and Coil ($11328.9) procedures proved to be almost 5 times more costly than the Volume-reduction surgery ($2444.3) (p<.001). The transaction costs of Valve and Coil procedures are also different from each other (MW-U: Z=1.99, p=.047).

DISCUSSION

The origin of Pulmonary Volume-reduction surgery is based on the fact that Brantigen et al. (1956) had surgically resected the emphysematous region of the lungs to cure severe emphysema[8]. Snider et al., in their literature compilations staring from 1950s until 1966s, which contained 22 articles and case reports in which surgical resections performed due to a bullous emphysema comprising a total of 476 patients were mentioned, stated that there were unobtrusive recoveries seen in the postoperative pulmonary functional capacities of the patients who had giant bullae pervading more than one-third of a hemithorax[9].

Cooper et al., on the other hand, resected 20-30% of both lungs by means of median sternotomy. They supported the stapler line used during the resection process with peri-strips made of cattle pericardium and achieved a recovery process reaching up to 82% during their postoperative respiratory function tests. Nevertheless, they reported that there was a prominent recovery in the life quality, also adding that they had reduced the operative mortality rates from 18% down to 4.8% through the use of sternotomy technique[10]. By means of single-port thoracoscopic interventions, the application of which has increased in recent years in a number of thorax surgical procedures, several anatomic and non-anatomic surgical resections can be performed from a single cut/incision. Since the number and sizes of the incisions in the thorax had been minimized, a prominent decrease in the complication rate as well as a prominent shortening in the recovery period in these patients were reported[11]. We also operated on our 7 patients within our surgical group through the use of a single-port videothoracoscopic surgical method, and the stapler lines in all of our cases were supported by using polyglycolic acid patches/grafts (NEOVEIL). In none of our cases was any perioperative mortality or a serious morbidity experienced.

It is important to be selective for the volume-reduction surgical procedure in the terminal COPD patients because of the high risk of mortality and morbidity[9]. In recent years, endoscopic volume-reducing methods have been developed for these terminal COPD patients for whom the medical treatment becomes insufficient and the surgery becomes highly risky. These techniques vary

according to the morphology in CT and the sub-type of emphysema. There are reversible blocking techniques in a heterogenous disease, the effectivenesses of which are similar to one another, as well as the non-blocking irreversible options in a homogenous disease. To that end; the blocking reversible tools, such as Pulmonx® endobronchial valves and Spiration® intrabronchial valves; the non-blocking tools, such as PneumRx® pulmonary volume-reducing coils (wires); on the other hand, the non-blocking ireversible techniques, such as bronchoscopic thermal vapour ablation (BTVA) and Aeris polymeric pulmonary/lung volume-reducing system (PLVR), and the methods like airway bypass system used in homogenous diseases, are all at the stage of research, development and application[6]. According to the radiological evaluation result, a coil procedure was applied to our 9 cases who had homogeneous emphysema, whereas a valve procedure was applied to our 11 cases who had mainly heterogeneous and bullous emphysema.

Until today, there have been several studies conducted on the complications of endobronchial treatment methods, notably surgery, as well as the treatment activities performed in this respect, and these studies have been conducted both in the form of comparisons and alone[9-13]. Slebos et al. performed a total of 28 procedures, such as a unilateral coil application to 4 out of 16 patients and a bilateral coil application to 12 of them. They reported that in the postoperative 6th month, there had been a 14.9%±17.0% -increase at the value of FEV1 and a 84.4 m±73.4 m- increase at the value of 6MWT [12]. Venuta et al. performed a unilateral Zephyr valve application to 40 patients with heterogeneous emphysema at the age range of 35-75, whose FEV1 values were below 35% and residual volumes (RV) were above 180%. Consequently, they achieved a statistically significant improvement in the oxygen requirement and as the result of FEV1 , RV, 6MWT and life quality questionnaires. A high level of success was achieved in the patients with fissure integrity. It was reported that the opportunity to perform a lung transplantation was achieved in 3 postoperative patients[13]. As the result of our study, on the other hand, an increase by 54.0%, 44.4% and 24.6%, respectively (total: 41.1%), was seen in FEV1% values during the postoperative one-year period of COPD patients and an increase by 85.7%, 78.7% and 34.1%, respectively (total: 69.8%), was observed in 6 MWT values in the wake of Valve, Coil and Volume-reduction surgical interventions. These positive changes following the intervention were found to be statistically significant in each of the three methods. The differences of variance in the patients' FEV1% values were found to be statistically insignificant among the groups (p=.171), and the difference of variance in 6 MWT proved to be higher in Valve (mean rank: 9.36) and Coil (mean rank: 11.89) procedures when compared with that of Volume-reduction surgery (mean rank: 24.0) (p<.01); whereas the difference between Valve and Coil procedures were found to be statistically insignificant. We can identify the decline in 6MWT value within the surgical group with the negative effects of the surgical procedure on physical activity during the first one-year-period.

In the literature review, no comparison was found as to the price/cost analysis and functional evaluation including all the volume-reduction surgery, bronchoscopic coil and valve procedures. In the study of NETT, a study comparing the cost analyses of medical and surgical treatments performed on 1218 COPD patients was reported. Medications, transportation and hospital costs were obtained from the medical data. For 10 years involving the operational process; survival, life quality and costs were calculated. In the surgical group, the hospitalization period along with the requirement of a nursing-care follow-up at home during the first postoperative one year were found to be significantly higher than the medical therapy group. In the second year, on the other hand, these percentages dropped down at a considerable level when compared with the medical therapy group. It was reported that although the surgical treatment was considered as more costly than the medical treatment during the first 3-year-follow up, the surgical treatment could still be more effective in terms of costs/expenditures as long as the positive effects of surgery were sustained for a long time through protective measures[14]. When Pietzsch et al. compared the endobronchial valve treatment with the medical one in the cases with severe emphysema, they stated that it was an effective method of treatment in terms of costs in accordance with the German Health Care System[15]. In our study, the hospitalization period due to intervention in the Volume-reduction surgical method (median: 10 days) was found to be almost 3 times as much when compared with that of the Valve (median: 3 days) and Coil procedures (median: 2 days). The hospitalization periods due to Valve and Coil

procedures were found to be similar. Following the valve, coil and volume-reduction surgical interventions, there was a decrease seen in the number of annual applications of the patients with COPD to the polyclinic (median:7 times) by 58.3%, 66.7% and 60.0%, respectively, and another decrease in the number of hospitalizations (median: 6 times) by 75.0%, 77.8% and 66.7%, respectively; on the other hand, there was, again, a decrease seen in the number of hospitalization days (median: 71 days) by 82.9%, 91.2% and 75.0%, respectively.

When the postoperative differences of variance in the number of annual applications to the polyclinic as well as the number of annual hospitalizations and annual hospitalization days when compared with the preoperative period are calculated, these differences were seen to be statistically different in accordance with the methods of intervention. While the differences in the number of annual applications to the polyclinic and in the number of annual hospitalization days were insignificant between Valve (mean rank: 16.09) and Coil (mean rank: 19.11) methods ($p>.05$), Valve and Coil methods are more effective than the Volume-reduction surgical method (mean rank: 4.14), and the difference between them was found to be statistically significant. When the costs of all the interventions performed on our patients are reviewed, it is seen that Valve ($12943.6) and Coil ($11328.9) procedures are 5 times more costly than the Volume- reduction surgery ($2444.3). The transaction costs of Valve and Coil procedures were also found to be different from one another. As the result of our study, it follows that the total cost of the Volume-reduction surgery is a more economical practice in comparison to the reimbursements of the social security institutions of our country.

According to the results of our study, the most economical method in terms of transaction costs is the Volume-reduction surgery; yet, the valve and coil group yield more beneficial results for patients in terms of the duration of hospitalization and the postoperative morbidity. We are of the opinion that along with the future advancements in technology, the medical products used in endobronchial treatment will turn into a more economical practice when the costs of these products are minimized. İn addition Large and well-designed studies are needed to known which method is cheaply.

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