NKMJ
Namık Kemal Tıp Dergisi
Namık Kemal Medical Journal

Research Article/Araştırma Makalesi

COMPARISON OF THE NONSURGICAL MANAGEMENT MODELS IN PATIENTS WITH PROLONGED AIR LEAKS FOLLOWING LOBECTOMY

Lobektomi Sonrası Akciğerin Uzamış Hava Kaçağında Uygulanan Cerrahi Dışı Tedavi Yöntemlerinin Karşılaştırılması

Murat SARIÇAM, Serkan KAYA

Tekirdağ Namık Kemal Üniversitesi, Göğüs Cerrahisi Anabilimdalı, Tekirdağ, TÜRKİYE.

Abstract

Aim: Aim of this study was to compare successful nonsurgical treatment models performed in the patients with prolonged air leakage (PAL) following lobectomy.

Materials and Methods: Treatment modalities applied to 108 patients who developed PAL after lobectomy between February 2000 and October 2018 were divided into three groups as negative suction, autologous blood pleuridesis and one way chest valves. Each treatment group was compared in terms of hospital stay and cost.

Results: The highest treatment cost was in the group treated with negative suction and the lowest hospital cost was due to autologous blood pleuridesis. In addition, the duration of treatment was the longest in the negative aspiration treatment group and the shortest hospital stay was in patients treated with one way valve.

Conclusion: Autologous blood pleurodesis should be preferred due to rapid effect and low cost in nonsurgical treatment of the patients with PAL after lobectomy.

Keywords: Lobectomy, air leak, treatment.

Öz

Amaç: Çalışmada lobektomi sonrası uzamış hava kaçağı (UHK) gelişen hastalarda uygulanmış ve başarıya ulaşmış cerrahi dışı tedavi yöntemlerinin karşılaştırılması amaçlanmıştır.

Materyal ve Metot: Şubat 2000 ve Ekim 2018 arasında lobektomi sonrasında UHK gelişen 108 hastalara uygulanmış tedavi yöntemleri negatif aspirasyon, otolog kan plöridezis ve tek yönlü göğüs valfi olmak üzere üç gruba ayrıldı. Her tedavi grubu hastanede kalış süresi ve maliyet açısından karşılaştırıldı.

Bulgular: Karşılaştırılan tedavi yöntemleri arasında en yüksek tedavi maliyetinin negatif aspirasyonla tedavi edilen grupta olduğu, en düşük hastane masrafının ise otolog kan plöridezis uygulamasından kaynaklandığı saptandı. Ayrıca tedavi süresi negatif aspirasyon uygulanan grupta en uzun iken en kısa hastanede yatış süresinin tek yönlü valf ile tedavi edilen hastalarda olduğu belirlendi.

Sonuç: UHK'nın cerrahi olmayan tedavisinde kısa sürede başarıya ulaşması ve düşük maliyeti nedeniyle otolog kan plöridezisin tercih edilmesi uygun olacaktır.

Anahtar Kelimeler: Lobektomi, hava kaçağı, tedavi.

INTRODUCTION

Prolonged air leak (PAL) is the air leak that lasts longer than 5 days, which is considered to be the average length of stay in the hospital after lung resections. Although there is no consensus about the length of duration which is termed as prolonged air leak after surgery in the literature, prolonged air leak with the ratio changing from 4% to 16% is the most frequently encountered complication after pulmonary resections[1].

Decreased pulmonary capacity, presence of pleural adhesions, large size of pulmonary resection, and insufficient nutritional status of the patient are risk factors for the development of PAL[2]. This complication resulted from pulmonary resections leads to conditions such as empyema and cardiac complications, which may require intensive care and thus increase cost of the treatment and extends length of hospital stay.

We aimed to investigate and compare the efficacy and cost effectivity of the nonsurgical treatment models for prolonged air leak after lobectomy in this study.

Corresponding Author / Sorumlu Yazar:

Murat SARIÇAM
Adres: Tekirdağ Namık Kemal Üniversitesi, Göğüs Cerrahisi Anabilimdalı, Tekirdağ, TURKEY.
E-posta: msaricam@nku.edu.tr

Article History / Makale Geçmişi:

Date Received / Geliş Tarihi: 23.05.2019
Date Accepted / Kabul Tarihi: 19.07.2019

MATERIAL and METHOD

Medical records of 1483 patients who had undergone lobectomy for primary lung cancer, bronchiectasis and lung metastases between February 2000 and October 2018 were retrospectively reviewed after granting the approval of Medical Faculty's Ethics Commitee on Noninvasive Clinical Trials numbered as 2019.20.02.04. Our study included 108 patients successfully treated with non surgical methods among 174 patients with continuing air leak on postoperative 5th day after lobectomy.

Selection and description of patients

Conditions mentioned below have been considered for patient selection:

a. Pneumoperitoneum, pleural tent and sealant had not been performed in the operation.
b. b.There was no more than 50% residual space in chest X-ray taken on the first postoperative day.
c. The fact was endoscopically proven that the air leak was not bronchially induced.
d. Only one of the treatment options was applied to the same patient.

Patients were divided into three groups according to treatment models such as negative pressure suction, autologous blood pleurodesis (blood patch) and application of one way chest (Heimlich) valves.

Technical information

Allowed negative pressure was adjusted as between -10 cm and -40 cm H_20 in negative pressure device. For the blood patch, 100 mL of blood obtained from the patient was given to the chest cavity from the existing chest drain, and the chest bottle was kept 80 cm above the bed level, allowing the patient to change position for next one hour. One way valve patients were discharged on the same day. On the 10th day of discharge, patients' drains were connected to the standard chest bottles and provocative clamping was applied. After 12 hours, the drain was removed when the lung was found to be non-collapsed in chest X-rays. In all methods, the day on which the chest tube removed was accepted as the success date.

Whole group of treatment models were evaluated in terms of age, gender, operative indication, type of lobectomies, the method of surgery and the duration and cost of PAL treatment. When calculating the cost, the daily hospital cost of 30 USD ($) was multiplied by the length of hospital stay. The price of a new negative suction device was divided equally to 26 people who received treatment for 1530 $ accepting that the device was not previously included in the clinic, The price of one way valve is calculated as $ 50.

Statistical evaluation

In calculating the sample width of our study, Power (the power of test) was determined by taking at least 0.80 and Type 1 Error 0.05. Descriptive statistics for continuous variables in the study were expressed as mean, standard deviation, minimum and maximum; categorical variables are expressed as number (n) and percentage (%). One-way analysis of variance (ANOVA) was used to compare the means of categorical data and Duncan test was used to determine different groups. Pearson's correlation coefficients were calculated to determine the relationship between treatment duration and cost, and Pearson's Chi-square test was used to determine the relationship between categorical variables. The statistical significance level was taken as 5% in the calculations and SPSS (IBM SPSS for Windows, ver.24) statistical package program was used for the calculations.

RESULTS

74 (68.5%) male and 34 (31.5%) female patients were included in the study. The mean age of the patient group was 59.1 ± 12.77 (range = 16-75) years. Among the indications for surgery, primary lung cancer was the first in 93 patients whereas12 patients had lung metastases and 3 patients had bronchiectasis. Thoracotomy was performed for 86 of the operations (79.6%) and thoracoscopy (VATS) for the remaining 22 (20.4%). The most common lung resection was left upper lobectomy with a rate of 42.6%. Prolonged air leakage after lobectomies was successfully treated with negative suction in 26 patients (24.1%), blood patch in 49 patients (45.4%) and one way valve in 33 patients (30.5%).

When all treatment modalities were evaluated together, the mean length of hospital stay was 2.49 ± 0.88 (range = 1-5) days, and the cost of treatments was 103.7 ± 39.59 (range = 30-210) $. The general group data of the patients are summarized in Table 1.

Table 1. Descriptive data of the patient group

CATEGORICAL DATA			
Parameters		**n**	**%**
Gender	Male	74	68.5
	Female	34	31.5
Indication for resection	Primary Lung Cancer	93	86.1
	Pulmonary Metastasis	12	11.1
	Bronchiectasis	3	2.8
Lobectomy	Left Upper Lobectomy	46	42.6
	Left Lower Lobectomy	16	14.8
	Right Upper Lobectomy	33	30.6
	Right Lower Lobectomy	13	12
Surgery	Thoracotomy	86	79.6
	VATS	22	20.4
Treatment	Negative Aspiration	26	24.1
	Blood Patch	49	45.4
	One-Way Chest Valve	33	30.5

CONTINUOUS DATA					
Parameters	**n**	**Mean**	**Std. Deviation**	**Min.**	**Max.**
Age (years)	108	59.1	12.77	16	75
Hospital stay (days)	108	2.49	0.88	1	5
Expenditure ($)	108	103.7	39.59	30	120

When the relationship between treatment groups and categorical variables were examined, no relation was found between sex, disease or surgery type and treatment groups (p> 0.05). In other words, different treatment groups are not affected by other categorical variables (Table 2).

Table 2. Relation between treatment modality and categorical variables

		NEGATIVE ASPIRATION		**BLOOD PATCH**		**ONE-WAY CHEST VALVE**		
PARAMETERS		**n**	**%**	**n**	**%**	**n**	**%**	***p**
Gender	Male	15	57.7	36	73.5	23	69.7	0.370
	Female	11	42.3	13	26.5	10	30.3	
Indication for resection	Primary Lung Cancer	22	84.6	42	85.7	29	87.9	0.981
	Pulmonary Metastasis	3	11.6	6	12.3	3	9.1	
	Bronchiectasis	1	3.8	1	2.0	1	3.0	
**Lobectomy	LUL	8	30.8	22	44.9	16	48.5	0.260
	LLL	2	7.7	8	16.3	6	18.2	
	RUL	11	42.3	12	24.5	10	30.3	
	RLL	5	19.2	7	14.3	1	3.0	
Surgery	Thoracotomy	24	92.3	37	75.5	25	75.8	0.183
	VATS	2	7.7	12	24.5	8	24.2	
Total		26	100	49	100	33	100	

*Pearson Chi-Square Test
**LUL: Left upper lobectomy, LLL:Left lower lobectomy, RUL: Right upper lobectomy, RLL: Right lower lobectomy

Comparison of continuous measurements according to treatment groups revealed no statistically significant difference in terms of patient age (p> 0.05). In contrast, a significant

difference was found between treatment groups in terms of treatment duration and cost ($p < 0.05$).

Duration of treatment was the longest in the negative suction group and the shortest hospital stay was in patients treated with one way valve. On the other hand, it was observed that the highest treatment cost was in the group treated with negative suction and the lowest hospital cost was noted in blood patch application. Comparisons of applied treatment models in terms of duration and costs of treatment models are detailed in Table 3.

Table 3. Comparison of treatments in terms of hospital stay and cost

Parameters		n	Median	Std. Deviation	Min.	Max.	*p
Hospital Stay (days)	Negative Suction	26	3.35[a]	0.892	2	5	<0.001
	Blood Patch	49	2.37[b]	0.859	1	4	
	One Way Valve	33	2.00[c]	0.000	2	2	
	Total	108	2.49	0.881	1	5	
Cost ($)	Negative Suction	26	153.46[a]	29.386	110	210	<0.001
	Blood Patch	49	73.06[c]	26.787	30	120	
	One Way Valve	33	110.00[b]	0.000	110	110	
	Total	108	103.70	35.591	30	210	

*ANOVA test **a, b, c:** Duncan Post Hoc test

Comparing the treatment methods, it is seen that one way valve application required the least hospital stay and the lowest cost is recorded with blood patch application. Comparisons of the length of hospital stays and costs were illustrated in (Figure 1).

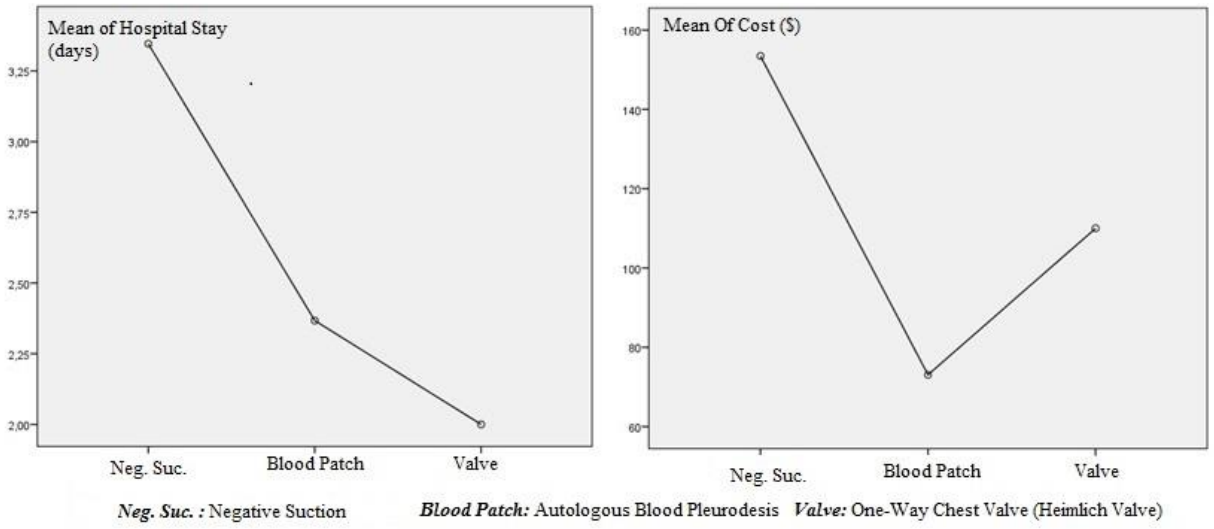

Figure 1. Length of hospital stay and cost of treatment methods

DISCUSSION

In this study, PAL developing after lobectomy was successfully treated with three different nonsurgical methods. Compared with the other two methods, autologous blood pleurodesis was the most cost-effective and one-way chest valve application was found to be successful with minimum hospitalization time.

PAL is a complication that seen up to 16% after lung resections, leading to increased cost of morbidity and prolonged hospitalization[3,4]. As a result of our study, the incidence of UHK in patients who underwent lobectomy in our clinic was found to be consistent with the prevalence rate of 11.7% reported in the literature.

The risk factors associated with the development of PAL include advanced age, long-term steroid utilization, malnutrition, impaired lung parenchymal structure, incomplete fissure and severe pleural

adhesions. In addition, the incidence of PAL increases after lobectomy, bilobectomy, decortication, aggressive lymph node dissection, and volume reduction lung surgery[1-3]. Our data show that patients who underwent thoracotomy had approximately 4 times more PAL development risk than VATS.

The division of the inferior pulmonary ligament during operation and formation of apical pleural tent in upper lobectomies and formation of pneumoperitoneum in lower lobectomies may be helpful in reducing residual space in order to prevent air leak. In addition, careful dissection of the fissure, application of low pressure during the re-inflating of the lung, slow closure of the stapler in the thick tissue, supporting the stapler line and the use of sealant are the surgical techniques that can be applied to prevent air leakage[4-6]. We observed that application of one or more of these procedures mentioned above considerably decreases the frequency of the development of PAL following lobectomies.

After lung resection, 95% of their PAL's are recovered within a few weeks by using closed underwater drainage rarely. Therefore, patients who have small amount of air leakage in the chest bottle and that do not cause symptom can be discharged and followed up with one way chest valves[5-7]. In our follow-up, no problems were encountered in the patients who were sent to their home with a valve. These results showed us drainage application with oneway valve is a safe treatment method.

It is reported that the closed underwater system can be used in the early period of air leakage, but when the air leakage is prolonged, the amount of pneumothorax is increased radiologically or the subcutaneous emphysema develops, the suction pressure of less than -20 cmH_2O should be applied by underwater drainage[6-10]. According to results of our study, when compared with the other two treatment models, negative pressure suction application has the longest length of hospital stay and the highest cost.

One of the treatment options for PAL is pleurodesis. Agents used for chemical pleurodesis include sterile talc powder, doxycycline, tetracycline, minocycline, and bleomycin. Chemical pleurodesis leads to complications such as chest pain, empyema, acute lung injury and impedes re-expansion of lung. Thus it is recommended in conditions that residual pneumothorax is very low or not present at all[6-8]. Autologous blood pleuridesis in air leakage treatment can be as successful as 92%, but complications such as tension pneumothorax, pleuritis and empyema due to obstruction of the chest drain in the range of 0-9% can be observed[10,11]. Close monitorization during the application and in early period after application is important to prevent sudden and serious complications likely to be.

CONCLUSION

PAL due to lung resection causes morbidity, extended length of hospital stay and increase in costs. Therefore, it is important to apply one or more of the techniques and methods to prevent air leakage during lobectomy. Despite the precautions taken air leakage due to lobectomy may occur. In these conditions, autolog blood pleurodesis should be preferred as a nonsurgical treatment option due to success in very short time and cost effectivity.

References

1. Dugan KC, Laxmanan B, Murgu S, Hogarth DK. Management of persistant air leaks. Chest. 2017;152(2):417-23.
2. Bakhos C, Doelken P, Pupovac S, Ata A, Fabian T. Management of prolonged pulmonary air leaks with endobronchial valve placement. JSLS. 2016;20(3):1-6.

3. Burt BM, Shrager JB. Prevention and management of postoperative air leaks. Ann Cardiothorac Surg. 2014;3(2):216-8.
4. Hunt BM, Aye RW. Prolonged air leak after lung resection. Cur Resp Med Rev. 2012;8(4):280-4.
5. Sakata KK, Reisenauera JS, Kerna RM, Mullona JJ. Persistent air leak – review. Resp Med 2018;137:213–8.
6. Brunelli A, Varela G, Refai M, Jimenez MF, Pompili C, Sabbatini A et al. A scoring system to predict the risk of prolonged air leak after lobectomy. Ann Thorac Surg 2010;90(1):204-9.
7. Elsayed H, McShane J, Shackcloth M. Air leaks following pulmonary resection for lung cancer: is it a patient or surgeon related problem? Ann R Coll Surg Engl. 2012;94:422–7.
8. Hance JM, Martin JT, Mullett TW. Endobronchial valves in the treatment of persistent air leaks. Ann Thorac Surg. 2015;100(5):1780–6.
9. Jabłonski S, Kordiak J , Wcisło S, Terlecki A, Misiak P, Santorek-Strumiłło E et al. Outcome of pleurodesis using different agents in management prolonged air leakage following lung resection. Clin Respir J. 2018;12(1):183–92.
10. Thapa B, Sapkota R, Sayami P. Autologous blood patching in the management of broncho-pleural fistula in spontaneous pneumothorax. JSSN. 2015;18(2):23-8.
11. Pathak V, Quinn C, Zhou C, Wadie G. Use of autologous blood patch for prolonged air leak in spontaneous pneumothoraces in the adolescent population. Lung India. 2018;35(4):328-31.