Effects of Postoperative Three-Balls Respiratory Exercise on Respiratory Function Tests in Smoking Patients Who Underwent Extremity Surgery Under Generel Anesthesia

Sigara Içen Hastalarda Ameliyat Sonrası Üç Top Solunum Egzersiz Uygulamasının Solunum Fonksiyon Testleri Üzerine Etkisi

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Abstract

Introduction	Incentive spirometry is used to reduce pulmonary complications after surgical interventions under general anesthesia. In this study, we aimed to investigate the effect of postoperative incentive spirometry on pulmonary function tests in patients who smoke and undergo extremity surgery under general anesthesia.
Materials and Methods	Eighty patients with ASA I-II physiological score, aged 18-61 years, who underwent extremity operation in a 3rd level hospital were included in the study. After the patients were divided into two groups as 40 patients in each group, smokers of 10-20 cigarettes per day for at least 5 years and non-smokers and the groups were once more randomized according to whether they would use incentive spirometry (three balls of breathing exercise) or not. Group K (n=20):Non-smoker and not using incentivespirometry, Group T (n=20): Non-smoker and using incentivespirometry, Group S (n=20): Smoker of 10-20 cigarettes per day for at least 5 years andnot using incentive spirometry, Group ST (n=20): Smokers of 10-20 cigarettes per day for at least 5 years and using incentive spirometry.
Results	The demographic data similar between the groups. When the groups were compared in terms of preoperative and postoperative FVC and FEV1 values, the postoperative FVC values in Group K and Group S were found to be significantly lower than the preoperative values (p=0.001, p=0.002, respectively). Postoperative PEF values were significantly lower than preoperative values (p=0.024, p=0.024, p=0.001, respectively). When compared within groups, postoperative VC values in Group K and Group S were found to be significantly lower than preoperative values (p=0.037, p=0.012, respectively). When the groups were compared statistically in terms of preoperative and postoperative FEV1/FVC values, no significant difference was found (p>0.05).
Conclusion	It was found that postoperative worsening of respiratory function test values in smokers who received general anesthesia has improved with the use of incentive spirometry. For this reason, it is assumed that the use of incentivespirometry in the postoperative period in extremity operations performed under general anesthesia will be helpful in preventing postoperative respiratory complications.
Keywords	General anesthesia, cigarette, incentivespirometry, respiratory function test, Genel anestezi, sigara, solunum fonksiyon testleri, insentifspirometri., insentifspirometri

Özet

Amaç	Anestezi altında cerrahi girişimler sonrasında ortaya çıkan pulmoner komplikasyonları azaltmak için insentif spirometri kullanılmaktadır. Bu çalışmada, sigara içen ve genel anestezi altında ekstremite cerrahisi uygulanan hastalarda post operatif insentif spirometri uygulamasının solunum fonksiyon testleri üzerine etkisini araştırmayı amaçladık.
Gereç ve Yöntemle	3. Basamak bir hastanede extremite operasyonu uygulanan, 18-61 yaş arası, ASA I-II fizyolojik skoru olan80 hasta çalışmaya dahil edildi. Hastalar her grupta 40 hasta olarak en az 5 yıl/günde 10-20 adet sigara içen ve sigara içmeyen olarak 2 gruba ayrıldıktan sonra her grup insentifspirometri (üç top solunum eksersizi) kullanıp kullanmayacağına göre randomize edildi. Grup K (n=20): Sigara içmeyen ve insentifspirometri kullanmayan, Grup T (n=20): Sigara içmeyen ve insentifspirometri kullanan, Grup S (n=20): En az 5 yıl/günde 10-20 adet sigara içen ve insentif spirometri kullanmayan, Grup ST (n=20): En az 5 yıl/günde 10-20 adet sigara içen ve insentifspirometri kullanan.
Bulgular	Çalışmaya katılan hastaların demografik verileri gruplar arasında benzerdi. Preoperatif ve postoperatif FVC ve FEV1 değerleri bakımından gruplar karşılaştırıldıklarında Grup K ve Grup S'deki postoperatif FVC değerleri preoperatif değerlere göre anlamlı derecede düşük bulundu (sırasıyla p=0,001, p=0,002).Gruplar içi karşılaştırmalarda Grup K, Grup S ve Grup ST'dekipostoperatif PEF değerleri preoperatif değerlere göre anlamlı derecede düşük bulundu (sırasıyla p=0,024, p=0,024, p=0,001). Gruplar içi karşılaştırıldıklarında Grup K ve Grup S'deki postoperatif VC değerleri preoperatif değerlerine göre anlamlı derecede düşük bulundu (sırasıyla p=0,037, p=0,012). Gruplar kendi içlerinde preoperatif ve postoperatif FEV1/FVC değerleri bakımından istatistiksel olarak karşılaştırıldıklarında anlamlı bir fark bulunmadı (p>0,05).
Sonuç	Genelanestezi alan sigara içen hastalarda postoperatifkötüleşen solunum fonsiyon testi değerlerininsentifspirometre kullanımı ile düzeldiği saptandı. Bu nedenle genel anestezi altında uygulananekstremite operasyonlarında postoperatif dönemde insentifspirometri kullanımının, postoperatif solunum komplikasyonlarını önlemede faydalı olacağı düşünülmektedir.
Anahtar Kelimeler	Genel anestezi, sigara, solunum fonksiyon testleri, insentifspirometri

INTRODUCTION

Negative effects of anesthetic agents on the lungs may be described as decrease in functional residual capacity, upward displacement of the diaphragm, change in ventilation/perfusion balance due to inhibition of hypoxic pulmonary vasoconstriction response, and deterioration in mucociliary clearance (1). The effect of anesthesia on lung volumes is related to the change in tonic and phasic activity of respiratory muscles during spontaneous breathing. (2). After anesthesia, mucociliary activity decreases for 4-6 days postoperatively, which increases the risk of postoperative pulmonary complications (3).

The smoking negatively affects the periods of anesthesia. Thus,pre-operative smoking cessation is mandatory to reduce the risk of postoperative complications (4).

The time required for respiratory functions to return to normal after smoking cessation varies between 12 hours and 8 weeks (5).Patients also should be actively supported in order to increase postoperative functional residual capacity and lung tidal volume and to remove tracheobronchial secretions(6). Incentive spirometry is a mechanical device used to prevent or reduce post-operative pulmonary complications. Incentive spirometry provides collateral ventilation in the alveoli and strengthens the inspiratory muscles (7). In this study, we aimed to investigate the effect of postoperative incentive spirometry on pulmonary function tests in smokers who underwent extremity surgery under general anesthesia.

MATERIAL and METHODS

Eighty cases with voluntary informed consent aged between 18-61, with the American Society of Anesthesiology (ASA) I-II physiological score who are planned to undergo lower and upper extremity operations under general anesthesia were included in the study. Cases with a history of pneumonia and tuberculosis and who were inable to communicate for pulmonary function test (PFT) were excluded from the study. The patients were taught to use a spirometer (Spiro Analyzer ST-90, FukudoSangyo). Preoperative forcedvital capacity (FVC), forced expiratory volume (FEV1), peak flow rate (PEF), vital capacity (VC), FEV1 /FVC % basal values were measured with a spirometer and recorded.

A total of 80, 40 smokers and 40 non-smokers, were included in the study. Afterwards, each group were randomized into two sub-groups by drawing lots as those who will use incentive spirometry (three ball respiratory exercises) and those who will not. Thus, a total of 4 groups were formed;

Group K (n=20): Non-smoker and not using incentive spirometry

Group T (n=20): Non-smoker and using incentive spirometry

Group S (n=20): Smoker of 10-20 cigarettes per day for at least 5 years and not using incentive spirometry

Group ST (n=20): Smokers of 10-20 cigarettes per day for at least 5 years and using incentive spirometry

In order to ensure a uniform practice while using incentive spirometry throghout the study period.

In the postoperative period, the incentive spirometry technique was used at the 6th hour after the operation and between 08:00 and 19:00 the next day, with 5 minutes of inspiration and expiration every hour. No respiratory exercise was performed in other cases. The pulmonary function test was repeated in all patients 48 hours after the operation. FVC, FEV1, peak inspiratory flow rate (PE(I)FR), VC, FEV1 /FVC % values were recorded again.

Informed Consent and Ethics Committee Decision

All patients included in the study were informed and a written consent form was obtained. Ethics committee approval was obtained from Trakya University Faculty of Medicine Dean's ScientificResearch Evaluation Commission (TÜBADK) 2011/93 with the decision number 09/06 dated 20/04/2011.The studywas conducted in accordance with the Declaration of Helsinki.

Statistical analysis

Statistical evaluation was done with SPSS 19.0 (Licence No: 10240642) statistical package program at Trakya University Faculty of Medicine, Department of Biostatistics. After checking the conformity of the measurable data with

Tab1e 1. *Demographic characteristics of the groups.*

	Group K	Group T	Group S	Group ST	p
Sex(n)	13/7	16/4	9/11	11/9	0,131*
(M/F) (%)	65/35	80/20	45/55	55/45	
Age (mean±SD)	42,65±8,29	35,4±9,52	45,45±12,32	36,3±7,91	0,698**
Weight (mean±SD)	73,70±12,14	73,45±13,23	78,25±11,15	73,00±13,56	0,519**
Height(mean±SD)	170,25±7,30	172,55±7,86	166,75±10,20	171,30±6,74	0,141**

** post-hoc Tukey test; ** KolmogorovSmirnov*

Table 2. *Forced vital capacity values of the groups.*

FVC (lt)	Group K	Group T	Group S	Group ST	p*
Preoperative(mean±SD)	3,62±0,90	3,72±0,96	3,95±2,35	3,54±0,76	0,672
Postoperative(mean±SD)	3,12±0,75	3,76±0,77	2,65±0,87	3,5±0,84	0,001
p**	0,001	0,313	0,002	0,940	

FVC:Forced vital capasity.
** Mann Whitney U test, ** Kruskal Wallis*

normal distribution with a single sample Kolmogorov Smirnov test, analysis of variance and post-hoc Tukey test were used for comparisons between groups for those with normal distribution, and Kruskal-Wallis analysis of variance and Mann Whitney U test for those with non-normal distribution. Wilcoxon two-sample paried test was used for intragroup comparisons, and Pearson $\chi 2$ test was used for qualitative data. Median (Min-Max) values and arithmetic mean±standard deviation were given as descriptive statistics. The limit of significance was chosen as $p<0.05$ for all statistics. After Kruskal Wallis analysis of variance, Bonferroni correction was made for pairwise comparisons and the limit of significance was chosen as $p<0.008$.

RESULTS

I80 cases were included in the study and afterwards, each group were randomized into two sub-groups by drawing lots as those who will use incentive spirometry and those who will not. Thus, a total of 4 groups were formed (Figure 1).

Comparison of patients in terms of gender, age, weight and height distribution revealed no significant difference between the groups (Table1)

While there was no statistically significant difference between the groups in terms of preoperative FVC level (p=0.672), there was a significant difference between Group S and Group ST and Group S and Group T in terms of postoperative FVC level (p=0.003; p=0.001, respectively). When the groups were compared in terms of preoperative and postoperative FVC values, the postoperative FVC values in Group K and Group S were found to be significantly lower than the preoperative values (p=0.001, p=0.002, respectively) (Table 2).

Figure 1.*Grouping of patients included into the study according the status of intensive spirometry use.*

While there was no statistically significant difference between the groups in terms of preoperative FEV1 values

Table 3. *Forced expiratory volume1 values of the groups.*

FEV1(lt)	Group K	Group T	Group S	Group ST	p*
Preoperative(mean±SD)	3,14±0,67	3,47±0,74	2,87±0,83	3,23±0,67	0,062
Postoperative(mean±SD)	2,76±0,69	3,57±0,59	2,38±0,88	3,17±0,64	0,001
p**	0,001	0,096	0,001	0,332	

**FEV1: Forced expiratory volume 1*
** Mann Whitney U test, ** Kruskal-Wallis*

Table 4. *Peak flow velocity values of the groups.*

PEF (lt/sec)	Group K	Group T	Group S	Group ST	p*
Preoperative(mean±SD)	7,07±1,92	6,34±1,89	6,12±2,35	7,94±1,61	0,014
Postoperative(mean±SD)	6,2±1,65	6,34±1,90	5,25±2,27	6,79±1,00	0,005
p**	0,024	0,794	0,024	0,001	

PEF:Peak expiratuar flow.
** p<0,05; Mann Whitney U test, **p<0,05; Kruskal-Wallis*

Table 5. *Vital capacity values of the groups.*

VC (lt)	Group K	Group T	Group S	Group ST	p*
Preoperative(mean±SD)	3,75±0,95	4,08±0,96	3,07±1,07	3,92±0,68	0,010
Postoperative(mean±SD)	3,39±0,66	4,03±0,96	2,75±0,77	3,81±0,58	0,001
p**	0,037	0,324	0,012	0,070	

VC:Vital capacity.
* Mann Whitney U test, ** Kruskal-Wallis

(p=0.062), there was a significant difference between the groups in terms of postoperative FEV1 values (p=0.001). Between Group ST and Group T, between Group S and Group T and between Group S and Group ST the difference was significant (p=0.001, p=0.001, p=0.001, respectively). Intragroup comparison of preoperative and postoperative FEV1 values reevaled that postoperative FEV1 values in Group K and Groups S were found to be significantly lower than the preoperative values (p=0.001, p=0.001, respectively) (Table 3).

There was a significant difference between groups in terms of preoperative PEF values (p=0,014), this difference was between Group S and Group ST(p=0,004). There was a significant difference between groups in terms of post-operative PEF values (p=0,005), this difference was between Group S and Group ST(p=0,001). Intragroup comparison of preoperative and postoperative PEF values has revealed that post-operative PEF values of Group K, Group S and Group ST were significantly lower relative top re-operative values, (respectively, p=0,024, p=0,024, p=0,001) (Table4).

There was a significant difference between groups in terms of preoperative VC values (p=0,010), this difference was between Group S and Group ST and Group S and Group T (respectively, p=0,002; p=0,002).

There was a significant difference between groups in terms of post-operative VC values(p=0,001), this difference was between Group S and Group ST and Group S and Group

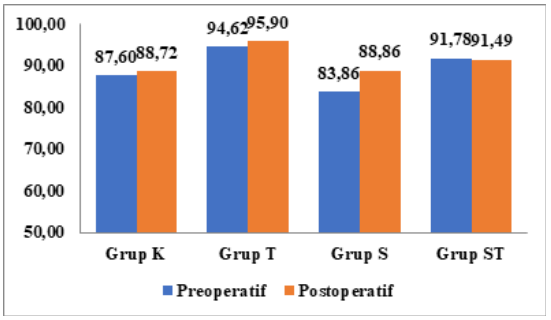

Figure 2. *The figure shows the distribution of the tiffeneau ratio (FEV1/FVC) values between groups.*

T (respectively, p=0,001; p=0,001). Intragroup comparison of preoperative and postoperative VC values has revealed that postoperative VC values in Group K and S were significantly lower relative to preoperative values (respectively, p=0,037, p=0,012)(Table5).

There was no statistically significant difference between the groups and in intra-group comparisons in terms of preoperative and postoperative FEV1/FVC levels. (p>0,05; Figure2).

DISCUSSION

Since the physiological impact of abdominal, cardiac, or thoracic surgery on respiratory function varies widely, most of the complications occur after thoracic and upper abdominal surgery(8). Therefore, we conducted our study in extremity operations in order to eliminate the effects of surgical site and technique on spirometry.As the daily number of cigarettes smoked and the duration of smoking increase, the percentage of decrease in flow velocity tests are higher than the percentage of decrease in volume tests (9).In a study by Rizzo et al.,pulmonary complications developed in 36.4% of patients who underwent thoracic surgery. They reported that 60% of the cases that developed complications were in the smoking group. (10).There are many studies reporting that smoking impairs lung functions in the elderly (11). In fact, the negative effects of smoking on PFT occur even at younger ages. Moreover, the decrease in PFT with age begins earlier in smokers than in nonsmokers and also develops more rapidly (12).

Amara et al., in a study conducted on men aged 55-86, found the mean FEV1 values of non-smokers to be higher than those of smokers (13).It has been reported that spirometric tests used to obtain information about the respiratory tract are significantly affected by age, height, weight differences and smoking (14).In the study of Aparici et al.,they enrolled smokers in a smoking cessation program and showed that their pulmonary function tests were improved after one year (15). Sheril et al. have followed up smokers and non-smokers for 14 years and have reported that FEV1 and VC values decreased in line with respiratory symtoms in bıth groups but FEV1/FVC ratio have deteriorated more in smokers compared ton on-smokers (16). In our study, VC values were found to be lower in smokers in PFTs performed in the preoperative period. When preoperative values were compared with postoperative values, FVC, FEV1, PEF and VC values were found to be lower in the postoperative period.There are studies showing that pulmonary physiotherapy is effective in preventing postoperative pulmonary complications (17) Several studies have shown that incentive spirometry is beneficial in preventing pulmonary complications after abdominal surgery (18). In the study conducted by Fagevik et al. (19), 368 patients who underwent upper abdominal surgery were evaluated.The postoperativepulmonary complication rate was 6% in the respiratory- exersize group and 27% in the control group. Zileli et al. (20) investigated the effects of respiratory and incentivespirometry exercises on respiratory functions in 45 patients diagnosed with DMDand have reported that there was a significant improvement in the VC, FVC and FEV1/FVC % parameters in the patients who had training compared to the control group.

In most of the studies comparing different treatment modalities (incentivespirometry, intermittent positive pressure ventilation, continuous positive pressure airway, etc.) used for postoperative pulmonary physiotherapy, superiority of one modality to could not be proven (21,22).

In our study, it was found that the negative effect of general anesthesia on PFT was decreased in patients using incentivespirometry in the postoperative period, and similar results were obtained with on FVC, FEV1 and VC values in the preoperative period. Postoperative PEF values were found to be lower than preoperative values in patients who smoked and used incentivespirometry. This may indicate the negative effect of smoking on major airways.

Although different from our study, in a meta-analysis that may contribute to the same goal with our study, the effect of the exercise training modality used in pulmonary rehabilitation to improve skeletal muscle mass, function and exercise capacity in COPD was reviewed. Moderate evidence supports that exercise training has significant and

beneficial effects on peripheral skeletal muscle strength and exercise capacity in stable COPD patients (23).

Our study has some limitations. For instance, the patient population was limited since a certain disease group (in the surgery group?) was included into the study. One of the strengths of the study is that it is a prospective study.

CONCLUSION

In conclusion; in smoking patients who will be operated under general anesthesia postoperative PFT values deteriorates severely and who smoke, and use of Incentive spirometry in the postoperative period improves this negative condition. For this reason, the use of incentivespirometry in the postoperative period in extremity operations under general anesthesia will be helpful in preventing postoperative respiratory complications.

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