Original Article

Evaluation of two different respiratory physiotherapy methods after thoracoscopy with regard to arterial blood gas, respiratory function test, number of days until discharge, cost analysis, comfort and pain control

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Abstract

Introduction: Although the methods used in thoracic surgery have been developing rapidly over the last five decades, postoperative pulmonary complications are seen in this field more than in other surgical branches. We aimed at comparing the acute effects of incentive spirometry (IS) and breathing retraining exercises by a respiratory physiotherapist or experienced physiotherapist.

Methods: Patients were randomized into two groups as spirometry and physiotherapist. Combined respiratory exercises were implemented through IS inspirometry group and by a physiotherapist in physiotherapist group. Blood gas, respiratory function tests, survey results of the Burford pain thermometer, discharge days, and cost analyses of both groups were examined just before the beginning of physiotherapy and on the 3rd day of therapy.

Results: There were no statistical difference in first and last values of pH and PCO_2 and also there were no difference between groups ($P > 0.05$). Forced expiratory volume one second (FEV_1) values are statistically increased compared to basal levels in both groups and mean difference in FEV_1 values was statistically increased in physiotherapist group compared to spirometry group ($P < 0.001$). Forced vital capacity (FVC), PO_2 and SaO_2 values are statistically increased compared to basal levels in both groups but mean difference in FVC values was not statistically different between groups ($P > 0.05$). Cost analysis was not statistically different, mean hospitalization day and mean pain score were statistically decreased in physiotherapist group.

Conclusions: Based on the outcome of this study, respiratory physiotherapy methods carried out by a respiratory physiotherapist are more effective in acute cardiothoracic conditions after thoracotomy compared to IS by patients.

Key words: Incentive spirometry, postoperative complications, respiratory physiotherapy

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Introduction

Since being implemented in thoracic surgery, thoracotomy and video-assisted thoracoscopic surgery methods have progressed rapidly over the last five decades.[1-3] Diagnosis and treatment techniques change constantly, especially for pleural effusions, which is a subject dealt with frequently in chest disease and thoracic surgery, and diagnostic potential increases with each passing day.[4] Diagnosis percentages

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of pleural effusions through thoracentesis and/or closed pleural biopsy are 25% and 60%, respectively, and as is seen, these methods have a very low diagnosis potential.[4,5] Thoracoscopyis both a reliable and easy method to use for diagnosing and treating pleural effusions. The use of thoracoscopy by an experienced physician increases both the diagnosis percentage and the surgeon's reliability. Especially the incidence of postoperative pulmonary complications after thoracic surgery is greater compared to other surgeries.[6,7] Pulmonary complications continue to be the most frequent cause of postoperative death, and they are the most frightening and unwanted complications for surgeons.[8] Although there are many postoperative complications that are seen, the highest mortality is with pulmonary complications. These complications include atelectasis, consolidation, pleural effusion, permanent air leakage, and pneumonia.[6-8] Another frequently seen postoperative complication is a pain. Insufficient coughing, limitation of movement and insufficient breathing develop in cases of pain that cannot be brought under control, and mortality may increase through pulmonary and cardiac complications that are seen in such cases.[9]

It is emphasized that operation time and method, age, weight, smoking, skeletal deformities and the existence of pulmonary disease are associated with the prevalence of these complications in the studies carried out on this topic in particular.[8,9]

Methods developed for preventing these complications are preoperative walking, active intervention and incentive spirometry (IS) for strengthening breathing muscles, percussion, vibration, postural drainage, effective coughing and early mobilization. Implementation of these suggestions by a competent and physiotherapist increases their efficiency.[8-12]

There have been only a few research studies analyzing the physiotherapeutic methods used in patients undergoing thoracic surgery, and efficiency of pain control, shoulder mobilization exercise, and extensive postoperative physiotherapeutic intervention were reported from these studies.[1-3] In some studies, it was emphasized that the physiotherapy implemented after major surgery was unneeded and increased costs.[13-16]

Comparative studies that analyze the acute effects of different chest physiotherapy methods after thoracic surgery operations on arterial blood gas (ABG) and respiratory function are rarely seen in the literature. Therefore, we wanted to report on the effects of thoracoscopy and tube thoracostomy methods, which are the most frequently used methods in thoracic surgery, on ABG and respiratory function of patients by implementing breathing exercises through IS and physiotherapy (P), which are two methods of chest physiotherapy in the early postoperative period, together with a cost analysis comparison, pain and satisfaction comparisons and discharge time comparisons in relation to the literature.

Methods

The Institutional Ethical Committee approved this study, which was performed in accordance with the ethical principles for human investigations as outlined by the Second Declaration of Helsinki.

Fifty patients with pleural effusion, who were hospitalized between the dates of March 2013 and March 2014 and implemented thoracoscopy included in this study. Patients underwent thoracoscopy with pleural sampling and who did not have atelectasia and postoperative air leakage, with expanded chest radiography after postoperative 24 h, were included in the study. Patients with additional pathologies such as rib fracture, with air leakage and also implemented parenchymal sampling were excluded from the study. Fifty consecutive patients who met the inclusion criteria stated above were randomly chosen into two groups. Respiratory physiotherapy with only the IS was implemented to the spirometry (first) group patients after being taught by physiotherapist; and diaphragm respiration, costal respiration exercises, efficient coughing, posture exercises and combined respiration exercises were supervised or carried out by respiratory or experienced cardiopulmonary physiotherapist for thirty minutes and two times a day to the physiotherapist (second) group.

Respiration physiotherapies were initiated in both groups after seeing that the lungs were expanded by evaluation of chest radiographies 24 h postoperatively. Blood gases were taken from both patient groups just before the start of physiotherapy and on the 3rd day of physiotherapy, and their pulmonary function tests (PFT) were checked. Alterations in the pH, PO_2, PCO_2 and SPO_2 values in the ABG of the patients and in the forced expiratory volume one second (FEV_1) and forced vital capacity (FVC) values in the PFT were evaluated. In addition, information such as on which day patients were discharged, cost data and findings of the Burford pain thermometer[17] survey, which was implemented on the postoperative 1st and 3rd days for each patient, were evaluated. Use of the Burford pain thermometer is currently not common in our country. This scale involves clear-cut verbal expressions combined with numbers: 0–1 defines painlessness, 2–3 dull, 4–5 disturbing, 6–7 acute, 8–9 extreme severity, and 10 insufferable pain. Pain and satisfaction were evaluated with this survey between the two groups.

Statistical methods

Statistical Package for the Social Sciences (SPSS) 21 (IBM Corporation, Armonk, New York, United States) and PAST programs were used in data analysis. The conformity of univariate data to normal distribution was analyzed with the Kolmogorov–Smirnov test, Shapiro–Wilk test and variation coefficients, and the conformity of multivariate data to normal distribution was analyzed using Mardia, and Doornik Omnibus test. Parametric methods were used in the analysis of variables with normal distribution, and nonparametric methods were used in the analysis of variables without normal distribution. Independent-samples *t* and Mann–Whitney U (Exact) tests were used in the comparison of two independent groups. Paired-samples *t* and Wilcoxon Signed Ranks tests were used for twice repetitive measurement of dependent variables and general linear model-repeated ANOVA tests were used for analyzing the interaction of the repetitive measurements of variables according to groups. The comparison of categorical data was measured through Pearson Chi-square (exact) test. Quantitative data are expressed as mean ± standard deviation and median ± Interquartile Range values in the tables. Categorical data are expressed as number and percentages. Data were analyzed at 95% confidence level, and *P* value was regarded as significant if it was smaller than 0.05.

Table 1: Intergroup age, gender and smoking

	Groups			*P* value
	Intensive spirometry	Professional physiotherapy	Total	
Sex				
Male	18 (72%)	18 (72%)	36 (72%)	1
Female	7 (28%)	7 (28%)	14 (28%)	
Age				
Avarage±SD	49,20±12,22	51,20±12,22	50,20±12,13	0,565
Cigaratte				
Smoke	6 (24%)	6 (24%)	12 (24%)	1
Nosmoke	19 (76%)	19 (76%)	38 (76%)	

Pearson Chi Square Test (exact) - Independent *t*-test. SD=Standard deviation

Results

A total of 25 patients, 18 (72%) males and 7 (28%) females, with an age average of 49.20 ± 12.22 were in the group IS. Six (24%) of these patients were smokers, whereas 19%76%) were nonsmokers [Table 1]. A total of 25 patients, 18 (72%) males and 7 (28%) females, with an age average of 51.20 ± 12.22 were in the group P. Again, 6 (24%) of these patients were smokers, whereas 19%76%) were nonsmokers [Table 1]. It was determined that both groups were homogeneous, and there was not any significant difference between them statistically ($P > 0.05$). As shown in Table 1, there was no difference between the two groups with regard to smoking, which is one of the most frequent reasons for postoperative respiratory complications and increases this complication 6-fold ($P > 0.05$).[18]

Table 2: FEV1, FVC, pH, PO_2, PCO_2, SPO_2 changes of data

	Groups				^{+}P value
	Intensive spirometry		Professional physiotherapy		
	Avarage±SD	^{++}P value	Avarage±SD	^{++}P value	
FEV1					
First++	1.78±1.24	<0.001	1.88±1.2	<0.001	<0.001
End++	2.08±1.11		2.34±1.2		
Variation (First-End)++	−0.2±0.17		−0.35±0.2		
FVC					
First+	2.08±0.68	<0.001	2.13±0.76	<0.001	0.393
End+	2.21±0.68		2.28±0.73		
Variation (First-End)+	−0.13±0.13		−0.16±0.09		
Ph					
First+	7.40±0.05	0.144	7.44±0.04	0.268	0.323
End+	7.38±0.02		7.30±0.60		
Variation (First-End)+	0.02±0.05		0.14±0.60		
PO_2					
First+	71.36±12.09	<0.001	72.92±12.68	<0.001	0.508
End+	88.00±7.61		91.32±9.03		
Variation (First-End)+	−16.64±9.12		−18.40±9.72		
PCO_2					
First+	34.87±5.24	0.414	36.07±5.49	0.954	0.535
End+	34.08±1.64		36.13±1.73		
Variation (First-End)+	0.78±4.72		−0.06±4.81		
SPO_2					
First+	93.40±1.72	<0.001	94.52±1.77	<0.001	0.450
End+	95.77±1.92		97.24±1.67		
Variation (First-End)+	−2.37±1.56		−2.72±1.71		

General Linear Model Repeated Anova (Wilks' Lambda) Paired *t*-test – Mann Whitney U test +=Avarage SD (Standard Devition); ++: Medyan±IQR (Inter Quartile Range); ^{++}P value=For variation in groups; ^{+}P value=For variation between groups

Table 3: Cost, satisfaction and number of days until discharge for IS and PP groups

	Groups				*P* value
	Intensive spirometry		Professional physiotherapy		
Cost analysis					
Cost (money)	376 €-567 €		386 €-713 €		0.414
Avarage (money)	437.87 €±83.45€		464.43±86.43 €		
Period of treatment					
Amount (days)	4-12		3-9		<0.001
Avarage (days)	10.12±3.34		8.63±3.86		
	Postop. 1	Postop. 3	Postop. 1	Postop. 3	
The value of painfull					
Score	2-6	4-8	2-6	4-9	<0.001
Avarage	4.1±1.35	7.4±2.87	4.4±2.1	8.6±2.64	

Pearson Chi Square Test (exact) - Independent *t*-test. SD=Standard deviation

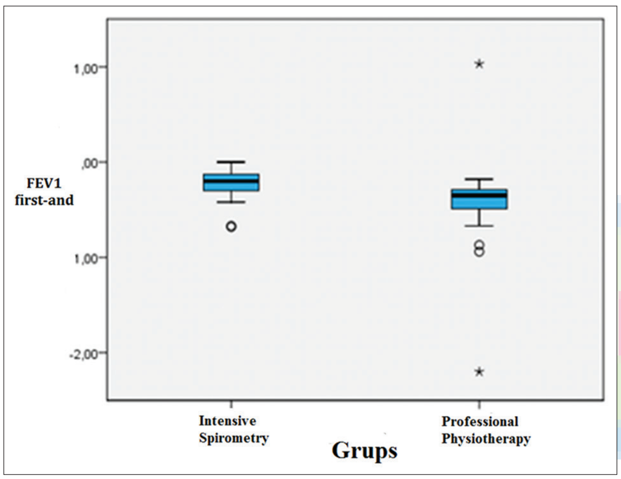

Figure 1: FEV1 changes between IS and PP

As shown in Table 2, after comparing FEV_1, FVC, pH, PO_2, PCO_2, and SPO_2 values were compared in themselves as the first and last values; both groups were compared between each other. A statistically significant increase was determined in the FEV_1 and FVC values in the IS intragroup PFT parameters ($P < 0.001$). A statistically significant increase was determined in the PO_2 and SPO_2 values in the IS intragroup ABG parameters ($P < 0.001$), when it was not determined a statistically significant change in the pH ($P = 0.144$) and PCO_2 ($P = 0.414$) values [Table 2]. There was a statistically significant increase in the FEV_1 and FVC values in the P intragroup PFT parameters ($P < 0.001$). A statistically significant increase was determined in the PO_2, SPO_2 values in the IS intragroup ABG parameters ($P < 0.001$), when it was not determined a statistically significant change in the pH ($P = 0.268$) and PCO_2 ($P = 0.954$) values [Table 2]. A statistically significant difference emerges between the two groups only with regards to the increase in the FEV_1 value in the comparison of IS and P groups ($P < 0.05$) [Figure 1], when it was not determined a statistical significance difference between the two groups in the alterations of FVC, pH, PO_2, PCO_2 and SPO_2 values ($P > 0.05$).

We see that only FEV_1 value changes were significant in the comparison of the IS and PP groups ($P < 0.05$) [Figure 1]. There was no difference between the two groups with regard to changes in FVC, pH, PO_2, PCO_2 and SPO_2 values ($P > 0.05$).

The cost analysis, the average discharge day and Burford pain thermometer values of two groups were compared in Table 3. When the average cost analysis of the group IS was 437.87 € ±83.45 €, the average cost analysis of the group P was determined as 464.43 € ±86.43 €. A statistically significant difference was not determined between two groups in terms of the cost analysis ($P > 0.005$). When the patients in the group IS were discharged in 10.12 ± 3.34 days on the average, the patients in the group P was discharged in 8.63 ± 3.86 days on the average. In the comparison of the discharge day numbers of patients, it was statistically determined that the patients in group P were discharged earlier ($P < 0.001$). The Burford pain thermometer survey averages performed on the IS patient group were determined as 4.1 ± 1.35 on the postoperative 1st day and as 7.4 ± 2.87 on the postoperative 3rd day. The Burford pain thermometer survey averages performed on the P patient group were determined as 4.4 ± 2.1 on the postoperative 1st day and as 8.6 ± 2.64 on the postoperative 3rd day. Based on the Burford pain thermometer survey results of both groups, it was determined that the group P felt lesser pain with a statistically significant difference ($P < 0.005$).

Discussion

In the last five decades, thoracic surgery has seen major developments in minimally invasive techniques. Accordingly, there have been decreases in complications and mortality experienced in thoracic surgery, and measures have been taken against these complications. We can include respiratory physiotherapy among the measures to decrease postoperative pulmonary complications. Although intensive work has been carried out in postoperative respiratory physiotherapy in other large surgical groups, there are very few literature reports that analyze respiratory physiotherapy after thoracic surgery.[1-3,8]

Besides the disorders observed in respiratory function after surgery and anesthesia, the rarity of secretion excretion increases the complication incidence as well.[8,9,19,20] Therefore, scholars have researched the effects of different chest physiotherapy methods on the incidence of complications in order to prevent pulmonary complications.[8] In work carried out with IS, Gosselink *et al*. showed that this provided additional benefit in decreasing postoperative pulmonary complications in patients who underwent thoracic surgery.[21] We also deemed the use of IS to be suitable as an efficient physiotherapy method alternative for group PP.

In our study, we determined that there was a difference between the IS and PP groups only for changes in FEV_1 values. Pulmonary function tests is the most frequently used method in the diagnosis and treatment of respiratory diseases for determining the severity and for following the course of the disease. The most frequently used parameter in follow-up with this method is FEV_1. FEV_1 is the amount of air emitted in the first second. A change in FEV_1 is evidence indicating that the patient breathes more comfortably, and accordingly, the PP method is more efficient than IS.

In addition, it is possible to prevent and diagnose postoperative complications early with the training of nurses and allied health personnel.[1] In our study, we faced the same situation and found that we obtained more advantageous results with the personnel we trained before the study.

In some studies carried out on postoperative physiotherapy intervention, the role of preoperative physiotherapy in patients undergoing a major operation, including thoracic surgery, could not be completely understood.[22,23] In their study, Stigt *et al*. determined that they could not provide better life quality with rehabilitation carried out after Adjuvan KT.[24] In spite of partially supporting these theories, our results could not determine differences in some parameters measured in our study. Among these parameters were FVC, pH, PO_2, PCO_2 and SPO_2 values. In a study by Nagarajan *et al*., they found a significant recovery in FVC values with physiotherapy of patients who underwent pulmonary resection and proved that the exercise capacity of patients with major thoracic surgery increased.[25] However, it is known that changes in FVC, which is defined as the air breathed out from the lungs during the compelling expiratory maneuver, and ABG, occur after a long period. Since our study was short-term, we did not find any changes in these values. When we examined our research retrospectively, we think that we could have obtained different results if we had repeated the same measurements in the postoperative 1st month. Again, in the cost analysis performed by Nagarajan *et al*., they showed a decrease in general treatment expenditures in the physiotherapy group.[25] In our study, we could not determine a difference between the two groups with regard to cost ($P > 0.005$). However, although the early discharge of the group implementing PP resulted in decreased expenditures, a difference was not determined between the two groups when adding the charge paid to physiotherapist, who dealt with the patients, to the total cost. More importantly than all these values, patient comfort, pain control and satisfaction were clearly higher in patients implementing PP.

Conclusions

Based on the outcome of this study, respiratory physiotherapy methods carried out by a respiratory physiotherapist is more effective in acute cardiothoracic conditions after thoracotomy compared to IS by patients.

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Conflicts of interest
There are no conflicts of interest.

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