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# Effectiveness of Pulmonary Rehabilitation in Secondary Spontaneous Pneumothorax Patients

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**ABSTRACT**

Our aim in conducting this study is to examine the effect of bronchial hygiene techniques and respiratory retraining techniques on the duration of drain and hospital stay in patients undergoing tube thoracostomy due to secondary spontaneous pneumothorax.

Between April 2016 and April 2020, a total of 49 patients (36 males, 13 females; mean age: 53.1±9.95 years; range, 38 to 82 years) with the diagnosis of secondary spontaneous pneumothorax were included in the study. Two groups were formed. Bronchial hygiene and respiratory retraining techniques were applied to group 1 consisting of 26 patients.

Only bronchial hygiene techniques were applied to group 2 consisting of 23 patients. Patients' age, gender, smoking, duration of drain, length of hospital stay was evaluated.

There were no statistically significant differences in the age, sex, smoking between the groups ($p>0.05$). In the group 1, there was a statistically significant decrease in the duration of drain, length of hospital stay compared to the group 2 after the treatment ($p<0.05$).

Our study results show that the combination of bronchial hygiene and respiratory retraining techniques is more effective than performing bronchial hygiene techniques alone on duration of drain, length of hospital stay in patients with SSP.

**Keywords:** Secondary spontaneous pneumothorax, Bronchial hygiene techniques, Respiratory retraining techniques, Duration of drain, Length of hospital stay

## Introduction

Pneumothorax is a thoracic disease that occurs abnormally air collection in the pleural cavity (1, 2). Pneumothorax may result from blunt or penetrating thoracic trauma, medical complication, lung diseases (3). Spontaneous pneumothorax (SP) is a form of pneumothorax that develops without trauma (3, 4). Spontaneous pneumothorax is divided into primary spontaneous pneumothorax (PSP) and secondary spontaneouspneumothorax (SSP). Although there is no pathology in the lung structure in PSP, lung disease such as chronic obstructive pulmonary disease (COPD) and / or bullous emphysema is available in SSP (5). Since SSP patients have underlying chronic pulmonary diseases (CPD) and patients are generally of advanced age, the general condition of the patients is impaired and life threatening. Therefore, it requires early intervention (6, 7).

Oxygen therapy, needle aspiration, tube thoracostomy or surgical procedures can be applied in SSP treatment. In addition pulmonary rehabilitation (PR) can be applied to these treatments (8). Bronchial hygiene techniques (BHT) and respiratory retraining techniques (RRT) can be applied at the bedside, while resistant exercises, upper extremity shoulder girdle exercises, respiratory muscles exercises and in-water exercises can be applied in the rehabilitation unit (9-14).

In this study, we aimed to compare the effect of BHT and BHT / RRT combination on duration of drainage and hospital stay in patients with SSP.

## Materials and Methods

This retrospective clinical study was carried out at Thoracic Surgery Clinic between April 2016 and April 2020. A total of 49 patients (36 males, 13 females; mean age: 44.2 ± 11.94 years; range, 38 to 82 years) who were diagnosed with SSP were included in the study. Each patient was informed individually and consent form was obtained. Permission was obtained for the study protocol

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from the local ethics committee (12/06/2020 54132726-000-11236) and conducted according to the Declaration of Helsinki principles. Inclusion criteria were as follows: patients who were diagnosed with SSP by chest X-ray or computed tomography and underwent tube thoracostomy. Exclusion criteria: history of thoracic and cardiac surgery, history of tube thoracostomy, recurrence SSP, malignancy, pregnancy, pneumonia, empyema, pacemaker, skin infections, severe cardiac, renal neurological diseases. Patients who underwent tube thoracostomy for SSP were monitored for drainage and leakage. In case of leakage from the thoracic drain, lung expansion was evaluated by taking a chest radiograph. If the lung was expanded, the thoracic drain was removed. The patient was discharged one day later, if no pathology was detected with a control chest radiograph. Ten days later, the patient was called to the outpatient clinic and his first control was made.

**Outcome Measurements:** The effectiveness of pulmonary rehabilitation in SSP patients undergoing tube thoracostomy was evaluated using duration of drain and length of hospital stay.

**Interventions:** Tube thoracostomy was applied to all patients. While the patient is in a semi-sitting position on the bed, the arm on the side to which the tube will be attached is raised to head level. Aseptic technique was used to prevent site infection or secondary empyema. Full sterile technique is often unnecessary. Sterile gloves, gowns, equipment is sufficient. Effective skin cleanning was be done by using iodine or chlorhexidine. We used the ideal place for tube thoracostomy was mid-axillary line. After determining the place to insert the tube with thoracentesis, the skin, subcutaneous, intercostal muscles and pleural surface were done with a needle using a local anesthetic. After the tube size (16-36Fr) was determined, it was entered into the thorax by blunt dissection and the tube was placed. Usually the tube is detected with two sutures. The first is to close the wound after the suture tube was pulled and the second one was used to fix the tube. After the tube was fixed, it was connected to the closed underwater drainage system (15). Two groups were formed; group 1 was applied BHT and RRT, group 2 was applied only BHT. Respiratory rehabilitation was planned for each patient by choosing the most appropriate respiratory technique or techniques for that patient's treatment.

BHT included forced expiration techniques (the patient sits comfortably, exhales a deep breath after tilting his body forward, after holding his breath for a few seconds, they cough 2-3 times with their mouth open without breathing), active breathing techniques cycle (when the patients are sitting in a comfortable position, diaphragmatic breathing is followed by deep breathing 3 or 4 times. After each deep breath, the air is kept inside for 3 or 4 seconds and is gently dispensed. Deep breathing is followed by diaphragmatic breathing), positive expiratory pressure (expiration against a resistance), postural drainage (it facilitates the release of secretions with the effect of gravity by applying different degrees of rotation when patients are in the Trendelenburg position. It is applied 3-4 times a day) and percussion / vibration techniques (during postural drainage, it is performed by striking the chest wall with cup shaped hands for 1-5 minutes) (16, 17). RRT included pursed lip breathing (patients breathe through their nose several times while their mouth is closed, then slowly exhale through the mouth in the kissing position for 4-6 seconds), lateral costal breathing (in order to benefit from proprioceptive stimulations, pressure is applied to the appropriate areas of the chest wall), diaphragmatic breathing (patients lying in a supine position will slowly expiratory with pursed lip breathing by placing the dominant hand on the abdomen and the non-dominant hand on the chest), slow and deep breathing (breathing is taught with a constant rate of inspiration and expiration (1:2, 1:1, 2:1, 3:1 etc.)), frog breathing (patient take a deep breath through the mouth or nose and hold it inside. Then the patient opens their mouth, pull their tongue and throat muscles down, allowing air to enter the throat, following this movement, patient are asked to force the air downwards by using their tongue and throat muscles as a pump.Tongue and pharynx muscles push the air in the form of a bolus forward from the vocal cord) (16, 18).

**Sample Size Estimation:** G * Power (version 3.1.2) was used to calculate the sample size.
To estimate the impact of pulmonary rehabilitation corresponding to an estimated effect size of 0.38.

For statistical significance (alpha value of 0.05), 23 patients in each group are required to reach 80% statistical power. Thus, a total of 46 patients were planned to be included in both groups. Therefore, it was planned to include at least 46 patients in the study, 23 patients in each group.

**Statistical Analysis:** Statistical Package for the Social Sciences (SPSS) version 22.0 software (IBM Corp., Armonk, NY, USA) was used for statistical analysis. With the Kolmogorov Smirnov test, the

| | | Group 1 | Group 2 | |
|---|---|---|---|---|
| | | N:26 | N: 23 | (inter-group) p |
| Sex | Male | 20(%76,9) | 16(%69,6) | 0,747** |
| | Female | 6(%23,1) | 7(%30,4) | |
| Age (mean±SD) | | 53,3±10,1 | 52,9±9,92 | 0,903* |
| Smoking | + | 22(%84,6) | 19(%82,6) | 1,000** |
| | - | 4(%15,4) | 4(%17,4) | |
| Tube Duration Time (day)(mean±SD) | | 7,38±2,40 | 10,0±2,39 | 0,000* |
| Hospital stay (day) | | 8,53±2,85 | 11,6±3,36 | 0,001* |

* Mann-Whitney U test ** Chi-square Test p<0.05

distribution of data was normal. It was observed that it was not dispersed. When evaluating the study data, descriptive statistical methods (mean, standard deviation, frequency), chi-square and Mann Whitney U test were used for non-parametric data. Significance of results was evaluated according to p <0.05.

## Results

Of the 49 patients, 26 (53.06%) were included in group 1, and 23 (46.94%) in group 2. There was no statistically significant difference between the groups in terms of age, gender and smoking (p>0.05). However, there was a statistically significant decrease in the duration of drainage and hospital stay in group 1 compared to group 2 (p<0.001). The initial demographic characteristics, duration of drainage and hospital stay of the patients are shown in Table.

## Dıscussıon

In this study, we compared the duration of drain and hospital stay of patients with SSP who underwent only BHT and BHT /RRT techniques.

Needle aspiration is recommended before chest drain insertion for PSP, but SSP needs to be treated with tube thoracostomy(19). The patient who underwent tube thoracostomy is hospitalized and followed and treated until lung expansion is achieved. Pulmonary rehabilitation and / or extrathoracic session is used when necessary(20).

Many researchers have emphasized that the PR program has significant effects on limb functional status and quality of life in patients with COPD (21-24). Some researchers have stated that giving PR in patients with COPD during hospital stay or immediately after discharge is both more beneficial and more cost effective (25-27). Although the majority of patients who undergo PR have COPD, there are studies showing that it is beneficial in other CPD (28-30). Bragion et al., Falk et al., Mortensen et al. used BHT in cystic fibrosis patients. They found a decrease in the amount of dry and wet sputum and an increase in bronchial clearance (31-33). In the light of all this information, we also used BHT and RRT in our SSP patients. In patients we used BHT and RRT together, the duration of drain stay and hospital stay were found to be statistically lower than the patients we used only BHT. Unfortunately, there were some limitations in our article. Using more effective assessment methods in a larger patient population could increase the power of the research. Many prospective and randomized studies are needed on this subject.

In conclusion, these mixed (BHT + RRT) PR techniques, which were not used in previous studies, in SSP patients developing due to COPD and other CPD and underwent tube thoracostomy significantly, shortened the duration of drain and hospital stay.

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We declare that there is no person / organization that financially support the study and that the authors have no interest-based relationship.

Permission was obtained for the study protocol from the local ethics committee (12/06/2020 54132726-000-11236) and conducted according to the Declaration of Helsinki principles.

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