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Original Article

Effect of 8-week Pulmonary Rehabilitation Program on Dyspnea and Functional Capacity of Patients on Waiting List for Lung Transplantation

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Abstract

OBJECTIVES: The aim of this study was to evaluate the effect of comprehensive, 8-week outpatient pulmonary rehabilitation (PR) programme consisting of 60-min sessions twice a week under supervision on dyspnea and exercise capacity of patients who were lung transplantation (LTx) candidates.

MATERIALS AND METHODS: Between March 2012 and December 2014, medical data of 23 patients on the waiting list for LTx who were referred to our PR unit and completed 16-session outpatient under direct supervision were retrospectively analyzed. Data on exercise capacity as assessed by 6-minute walking test (6MWT) and the rate of perceived dyspnea as assessed by the Borg scale and Medical Research Council (MRC) dyspnea scale were recorded.

RESULTS: Of 23 patients 57% were males; the mean age was 35±10 (range: 16–48) years. Four patients were operated early, as an appropriate donor was available. Diagnosis was as follows: bronchiectasis (n=10, 44%), silicosis (n=7, 30%), sarcoidosis (n=2, 9%), idiopathic pulmonary fibrosis (n=1, 4%), chronic obstructive pulmonary disease (n=1, 4%), and others (n=2, 9%). At the end of the program, there was a significant improvement (median: 60 m) in 6MWT scores (360 [70–254] m vs. 300 [139–489] m; p=0.018). In addition, a clinical improvement was observed in Borg (p=0.000) and MRC scores (p=0.008).

CONCLUSION: Our study results suggest that 8-week outpatient PR programme consisting of training twice a week is effective to decrease perceived dyspnea and to improve exercise capacity in patients who are on the waiting list for LTx.

KEYWORDS: Dyspnea, lung transplantation, muscle weakness, rehabilitation

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INTRODUCTION

Lung transplantation (LTx) is the only therapeutic option for end-stage chronic lung diseases refractory to most medical treatments and is associated with improved quality of life (QoL) and survival [1]. Owing to the limited number of donors, LTx candidates might have to be on the waiting list wait for a long time [2]. As a consequence, dyspnea and fatigue increase with decreased exercise capacity owing to unpreventable disease progression. Increasing exercise capacity and improving QoL are of utmost importance for a successful transplantation in these patients who are scheduled for a complex surgery [1, 3].

In recent years, there is a growing number of publications on pulmonary rehabilitation (PR). Moreover, PR is recommended in patients with chronic obstructive pulmonary disease (COPD), in those with chronic lung diseases with decreased exercise capacity due to dyspnea and fatigue (i.e., interstitial lung diseases, cystic fibrosis, bronchiectasis, and thoracic deformities) and before and after LTx, and in those undergoing lung volume reduction surgery [3-6].

Although many studies showing the benefits of exercise training in patients with end-stage chronic lung diseases have been published, there are a limited number of studies investigating the efficacy and safety of exercise in patients who are on the waiting list for LTx [6-9].

Physical and emotional preparation of a LTx candidate before surgery may reduce the risk for postoperative complications and improve patient-centered outcomes [1, 10, 11]. In addition, such an attempt for well-being may accelerate postoperative healing and increase survival [12]. In particular, exercise training is essential to optimize functional capacity and crossmatch testing before transplantation and to improve QoL and patient outcomes after surgery [13]. Although PR is recommended before and after LTx in many transplantation centers, there are no established clinical

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practice guidelines for PR for LTx candidates and recipients [14, 15]. In daily practice, an effective and a safe exercise program can be implemented depending on the physiological alterations in patients and current exercise training guidelines [15].

In the literature, randomized studies showing the efficacy of the duration of program and number and intensity of sessions under supervision mostly include patients with COPD, and there are a limited number of studies on the content and optimal duration of the program in LTx candidates [11, 16, 17]. PR programs (PRPs) with varying contents and intensities can be applied under direct supervision in the outpatient or inpatient setting or in a combined setting [18-21]. The content and organization of PR programmes substantially vary depending on each country and even on each center in a single country [18, 22]. The optimal duration of PR programmes has not been well established yet, and it might range from 6 weeks to 6 months [18]. Although a few guidelines are available, there is no standard content and optimal duration for PRPs [23, 24].

In the present study, we aimed to evaluate the effect of a comprehensive 8-week, outpatient-based PR programme consisting of exercise training twice a week under direct supervision at our center and home-based training thrice a week without supervision on dyspnea and exercise capacity of patients on the waiting list for LTx.

MATERIALS AND METHODS

Between March 2012 and December 2014, medical data of 23 patients who were on the waiting list for LTx, who were referred to the PR unit of Training and Research Hospital, and who completed the 8-week, outpatient-based PR programme twice a week under direct supervision were retrospectively analyzed. All patients received an individual PR programme consisting of physical exercise training, psychological consultation, and nutritional intervention. Exercise capacity was assessed using the 6-minute walking test (6MWT) at baseline and at week 8, whereas the rate of perceived dyspnea was assessed using the Borg scale and Medical Research Council (MRC) dyspnea scale at baseline and at the beginning and end of each session. In all cases, 6MWT was performed under oxygen support.

A written informed consent was obtained from each patient. The study protocol was approved by the local ethic committee of the Istanbul Training and Research Hospital (14.9.2018-1415). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Content of PR Programme

Clinical evaluation and exercise protocol

All patients underwent clinical evaluation by an experienced pulmonologist in the PR unit and received information on their disease and treatment options. In addition, the patients were given psychological support to decrease anxiety for undergoing LTx. All patients received education on daily practice encouraging healthy behaviors, such as regular physical activity, healthy diet, reasonable drug use, compliance to treatment, and disease self-management, as well as psychological support, including effective strategies to overcome chronic conditions. Patients who were in need of medical treatment were consulted to a psychiatrist. In addition, training was provided on the utilization of home oxygen delivery systems, inhaled drugs, and strategies to overcome dyspnea and relaxation exercises.

Exercise program

All patients received exercise training twice a week under direct supervision at our clinic. Exercise training included treadmill exercises, cycle ergometer exercises, light aerobic exercises, and upper extremity weight bearing. Each session took 60 min and was supervised by a single physiotherapist. The intensity of training was chosen at 60% of the peak heartbeat using 6MWT. During the exercise, oxygen support was delivered through a nasal cannula to maintain an oxygen saturation of ≥88%. Before and after exercise, the blood pressure was measured; moreover, the heart rate was monitored during the exercise. The Borg scale was used before and after each session.

Home-based exercise program

In addition to the supervised exercise program that was administered twice a week in the hospital setting, all patients were instructed to perform a home-based exercise program three days a week. The program included breathing exercises (local expansion exercises, diaphragmatic breathing, and pursed lip breathing), free walking, and upper and lower extremity strengthening exercises with TheraBand. To ensure that the home-based exercise program was conducted, a patient home-based exercise follow-up chart was given to each patient, and chart follow-ups were carried out on a weekly basis by the physiotherapist.

Diet

Each patient received nutritional consultation by the hospital dietician according to body composition evaluation, and nutritional supplements were given, when necessary.

MAIN POINTS

- Owing to the limited number of donors, LTx candidates might have to be on the waiting list wait for a long time, therefore dyspnea and fatigue increase with decreased exercise capacity owing to unpreventable disease progression.
- PR is useful in reducing dyspnea and that inspiratory muscle training, in particular, significantly improves the MRC dyspnea score.
- Physical and emotional preparation of a LTx candidate before surgery may reduce the risk for postoperative complications and improve patient-centered outcomes.
- In conclusion, our study results suggest that an 8-week outpatient-based PR programme consisting of training twice a week under supervision is effective to decrease perceived dyspnea and fatigue and to improve exercise capacity in patients who are on the waiting list for LTx.

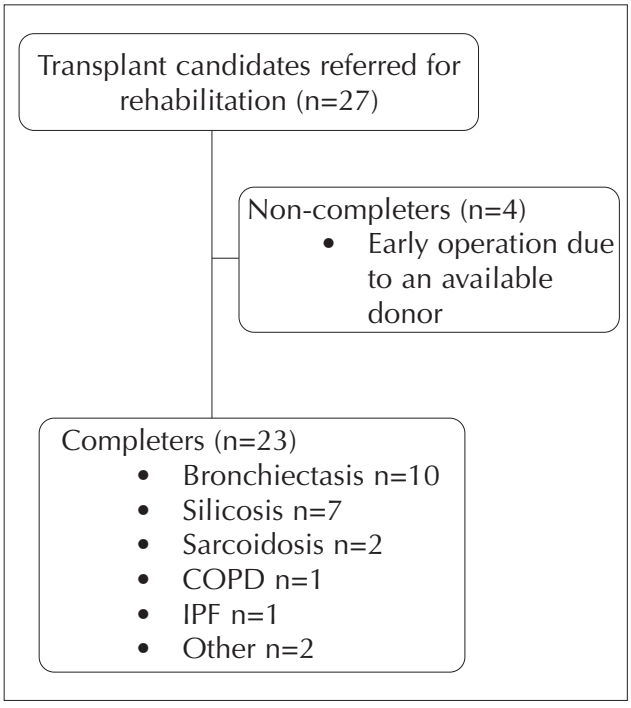

Figure 1. Diagram of the study population
IPF: idiopathic pulmonary fibrosis; COPD: chronic obstructive pulmonary disease

Table 1. Baseline demographic characteristics of patients

Variable	
Demographics	
Sex, n (%)	
Female	10
Male	13
Age, year (mean ± SD)	35±10
BMI, kg/m^2, mean (minimum–maximum)	18.8 (13.2–26.2)
Diagnosis, n (%)	
Bronchiectasis	10
Silicosis	7
Others	6
Pulmonary Functions, median (range)	
FVC (L)	1.1 (0.7–2)
FEV_1 (L)	0.7 (0.5–1.4)
FVC%	33 (18–47)
FEV_1%	22 (15–43)

SD: standard deviation; BMI: body mass index; FVC: forced vital capacity; FEV_1: forced expiratory volume in one second

Table 2. Effects of PR programme on dyspnea and exercise capacity

Variable	Before PR median (minimum–maximum)	After PR median (minimum–maximum)	p
6MWT distance (m)	300 (70–524)	360 (139–489)	0.018
MRC scores (1–5)	4 (2–5)	4 (2–5)	0.008
Borg scores			
Resting	2 (0–4)	0.5 (0–3)	0.000
Postexercise	4 (0–10)	3 (0.5–8)	0.000

PR: pulmonary rehabilitation program; 6MWT: 6-minute walking test; MRC: Medical Research Council

Outcome measurements

6MWT

6MWT was conducted in a 30-m corridor in accordance with the American Thoracic Society (ATS) guidelines. The patients were instructed to walk as fast as they could. Before and after the test, Borg fatigue rating and walking distance were recorded [25, 26].

MRC Dyspnea Scale

The MRC dyspnea scale was used to evaluate perceived dyspnea during daily living activities [27].

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences version 15.0 statistical software (SPSS Inc., Chicago, IL, USA). Descriptive data were expressed as means and standard deviations, medians (minimum-maximum), numbers, and frequencies. Normality was assessed using the Shapiro-Wilk test. The Wilcoxon test was used to compare pre- and postexercise results. A p value of <0.05 was considered statistically significant.

RESULTS

Of the 27 LTx candidates who were referred to our unit, 23 completed the 8-week outpatient-based PR programme. Of the 23 patients 57% were males; the mean age of patients was 35±10 (range: 16-48) years. Four patients were operated early, as an appropriate donor was available (Figure 1). The distribution of diagnosis in patients was as follows: bronchiectasis (n=10, 44%), silicosis (n=7, 30%), sarcoidosis (n=2, 9%), idiopathic pulmonary fibrosis (n=1, 4%), COPD (n=1, 4%), and others (n=2, 9%) (Table 1). At the end of the treatment, there was a significant improvement (median: 60 m) in 6MWT scores (360 [70-254] m vs. 300 [139-489] m; p=0.018). In addition, a clinical improvement was observed in Borg (p=0.000) and MRC scores (p=0.008). The median baseline resting and post-exercise Borg scores were 2 (0-4) and 4 (0-10), respectively. The median post-exercise resting Borg score was 0.5 (0-3), and the median post-exercise Borg score was 3 (0.5-8) (p=0.000 for both). There was also a statistically significant difference in the median pre- and post-exercise MRC scores (p=0.008) (Table 2). All patients were under long-term oxygen therapylong-term oxygen therapy (LTOT). Only one patient had a history of long-term smoking (patient with COPD), and two patients had a very short duration of smoking; no other patient had used smoked. There were no serious comorbidities affecting the programme because patients who have serious comorbidities before LTx are evaluated in detail and are usually excluded.

DISCUSSION

In the present study, we evaluated the effect of an 8-week outpatient-based PR programme twice a week under direct supervision and home-based training thrice a week without supervision on dyspnea and exercise capacity of patients on the waiting list for LTx. We found a clinical improvement in dyspnea scores and exercise capacity in our study population: the median distance in 6MWT was 300 (70-524) m before the exercise and the median postexercise value increased to 360 m (60 m increase) (p=0.018). We also observed a statistically significant clinical improvement in perceived dyspnea and rating scores after the exercise.

Dyspnea is a common symptom in LTx candidates who have end-stage lung disease [28]. It has been reported that PR is useful in reducing dyspnea [21] and that inspiratory muscle training, in particular, significantly improves the MRC dyspnea score [29]. Although pre- and post-PR median MRC scores were similar in our study, the distribution of scores varied. Thus, there was also a statistically significant difference in the median pre- and postexercise MRC scores (p=0.008).

In the literature, most patients referred to the transplantation centers are patients with COPD (7); however, our study is remarkable as almost all patients are patients without COPD. This can be attributed to the fact that younger patients with a higher life expectancy following transplantation were mostly previously selected for LTx [30]. However, the expected increase in referral of patients with COPD to LTx centers has not been achieved. This situation suggests that pulmonologists in Turkey, particularly working in regional hospitals, do not have enough knowledge about the transplantation or do not show the necessary importance [31].

Although there are no established reference ranges for LTx candidates till date, the increase in 6MWT was higher than the minimal clinically important difference (MCID, 25-33 m) recommended by the American Thoracic Society / European Respiratory Society (ERS) [26]. In the literature, studies showing MCID values for an effective PR programme have mostly involved patients with COPD; however, these values can be used for LTx candidates as both the conditions involve the lungs. Some authors have also advocated that survival rates of these candidates considerably increase following transplantation, as evidenced by an increase in 6MWT scores from those at baseline [1].

Many outpatient-based PR programmes, which are applied for 6-8 weeks twice or thrice a week, for LTx candidates are compliant with the general recommendations of PR. However, the optimal duration of PR programmes has not been established, although a minimum 8-week program offers more benefits in the long term [32]. In the literature, there are studies showing that an 8-week PR programme twice a week under direct supervision is not effective [33]; however, the British Thoracic Society recommends a 6-week exercise program twice a week under supervision [34]. In our study, despite increased distance in 6MWT after PR programme, the patients experienced less muscle weakness at the end of the test. Current evidence has also suggested that PR programmes may offer greater benefits for patients who are referred in the early stage of the disease [35].

In a study, Florian et al. [1] showed a significant decrease in perceived dyspnea scores (p=0.001) with a mean increase in the distance of 72 m as assessed by 6MWT (p=0.001) in patients undergoing a 36-week PR programme. In our study, we achieved a statistically significant increase in the exercise capacity of patients undergoing a comprehensive, 8-week (total, 16 sessions) PR programme, which was relatively shorter than the aforementioned study and is one of the strengths of our study.

In another study, the effectiveness of a once-weekly supervised PR programme with a standard twice-weekly program was compared; the once-weekly supervision yielded equivalent improvements in the exercise tolerance as the twice-weekly program [36]. However, the health-related QoL outcomes were poorer for once-weekly program in this study. In addition, the aforementioned study did not include transplant candidates. On the basis of the previous findings and our results, we recommend PR programme twice or thrice a week under direct supervision to achieve successful results, as LTx candidates may undergo surgery earlier than expected if an appropriate donor becomes available and because of the possibility of rapid progression of the disease. Similarly, four patients were operated early and excluded from the study as an appropriate donor became available. Of these patients, one attended the PR programme for only for 1 week, whereas the remaining patients were administered the program for approximately 3-4 weeks. Although the duration of PR programme and the number of sessions vary depending on the available means at the facility, PR programme is recommended for LTx candidates, considering its health benefits before and after surgery [5, 6, 12, 14].

Nonetheless, there are some limitations to this study. First, our sample size was small, and the number of the patients decreased throughout the study. Therefore, we were unable to compare the efficacy of short-term and long-term PR programme in our study. Second, we were unable to evaluate emotional aspects and health-related QoL in our study. QoL was also evaluated using the Short Form-36 and completed at baseline for each patient; however, it was not included in the analysis owing to missing data at the end of intervention. We recommend further comprehensive, large-scale, long-term studies to confirm our findings.

The benefits of PR programme have not been well-documented in patients who are on the waiting list for LTx. To date, a few number of studies are available with heterogeneous sampling and nonstandardized protocols [1, 12, 19, 37]. Our study is also consistent with these previous studies with similar limitations.

In conclusion, our study results suggest that an 8-week outpatient-based PR programme consisting of training twice a week under supervision is effective to decrease perceived dyspnea and fatigue and to improve exercise capacity in patients who are on the waiting list for LTx. However, it should be noted that PR programme encompasses the whole period until surgery, and patients should be educated that adherence/compliance to the program would improve the results. Finally, further large-scale, multicenter studies are

needed to establish the optimal duration and content of a PR programme in LTx candidates.

Ethics Committee Approval: Ethics committee approval was received for this study from the local ethic committee of the Istanbul Training and Research Hospital (Date: 14.9.2018; No: 1415).

Informed Consent: A written informed consent was obtained from all patients who participated in this study.

Peer-review: None

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Conflict of Interest: The authors have no conflicts of interest to declare.

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