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PULMONARY REHABILITATION

Do the Benefits Gained Using a Short-Term Pulmonary Rehabilitation Program Remain in COPD Patients After Participation?

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Abstract The aim of this study was to evaluate the short-term benefits of a pulmonary rehabilitation program in chronic obstructive pulmonary disease (COPD) patients. The study was a randomized controlled trial that included 54 mild and moderate COPD patients. Patients were assigned to either an 8-week-long pulmonary rehabilitation program, which consisted of exercise plus education (rehabilitation group), or were controls. All the patients were evaluated at baseline at the completion of the 8th week of the program and one month after the completion of the pulmonary rehabilitation program using five instruments: arterial blood gas analysis, postbronchodilator pulmonary function test, 6-minute walk test (6MWT), Saint George Respiratory Questionnaire (SGRQ), and the dyspnea visual analog scale (VAS) There were no statistically significant differences in the pulmonary functions and pulmonary gas analysis between baseline, discharge (8th week), and the 12th-week visit in both groups ($p > 0.05$). Rehabilitation resulted in significant improvements in both the VAS and the 6MWT at the 8th week, but by the 12th week all of these improvements had deteriorated. All of the SGRQ domains improved both at the 8th and the 12th week, with a significant difference between the groups ($p < 0.05$). We conclude that rehabilitation resulted in improvements in exercise capacity, health status, and dyspnea. All of these benefits, however, tend to deteriorate in the first month after rehabilitation. Therefore, it is strongly recommended that all patients with COPD be kept motivated in order to continue with rehabilitation and maintain the benefits gained.

Keywords pulmonary rehabilitation · COPD, short term

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Introduction

Chronic obstructive pulmonary disease (COPD) is defined as progressive airway obstruction characterized by physical reconditioning and exercise intolerance, leading to a limitation in the ability to perform daily activities [1, 2]. Although there are a variety of drugs that reduce the symptoms of COPD, there is still no treatment that can restore pulmonary functions to a normal, predisease level. Pulmonary rehabilitation has therefore become an important scientifically based treatment option to restore both optimal daily functioning and increase the health-related quality of life. It has been shown in studies to improve both the tolerance toward exercise and the health status of patients with COPD [3]. Pulmonary rehabilitation (PR) must be provided to patients who have moderate to severe COPD according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines [4]. In recent years, more economical and effective alternatives to long-term PR protocols have been investigated in an effort to reduce the high burden of the disease. However, long-term success and maintenance have proven difficult to achieve after short-term treatments [5]. It is very common for the patients to lose their motivation after being discharged from the hospital. This is especially true for those patients who take part in unsupervised home programs.

We therefore conducted a randomized, controlled trial to determine to what extent the benefits gained during training

sessions in an 8-week-long rehabilitation program were sustained in patients one month after the completion of the program. Specifically, this study sought to determine whether the rehabilitation program leads to improvement in lung functions, arterial oxygenation, dyspnea, walking distance, and the health-related quality of life (HRQL) at the time of the patient's discharge (8th week), and to assess whether these improvements are still present at a follow-up (12th week after the beginning of the program).

Materials and Methods

Patients

Fifty-four stable COPD patients, 50–75 years old, were enrolled in the study. Patients were eligible for inclusion if they had a forced expiratory volume in 1 second (FEV_1) that was between 30% and 80% of the predicted value (according to the GOLD guideline), if their clinical condition was stable at the time of inclusion, and if they had not had any infections or COPD exacerbations in the preceding four weeks. Patients were also excluded if they had other severe medical problems such as heart failure, recent myocardial infarction, cerebrovascular disease, orthopedic problems, and severe liver or kidney problems.

Methods

The patients were randomized in a 1:1 ratio by using sealed envelopes to undergo either the conventional rehabilitation program (rehabilitation group) or no rehabilitation (control group). The patients in the rehabilitation group underwent an 8-week outpatient program that consisted of an education component and an exercise training component. The education component was consisted of 16 sessions of discussions (1 h/week) covering the following topics: respiratory physiology, disease education, dietary advice, healthy eating, relaxation, body positions to help reduce breathlessness, energy conservation, medication advice, chest clearance, breathing control techniques, home exercise education, coping strategies, and instructions on the equipment (nebulizers and home oxygen devices). The exercise training component consisted of aerobic exercises (walking), strength training exercises, breathing and relaxation exercises and was conducted by the same physiotherapist three times a week. Exercise intervention was started with a warm-up period (flexibility exercise) followed by 30 minutes of walking around the hospital as normal, with ratings of perceived dyspnea (RPE) of 3 (moderate to somewhat hard) based on the Borg scale. Following the aerobic workout, the patients completed abdominal, upper-limb, and lower-limb muscle activities, using progressively heavier ''light weights'' (300-500 g). Breathing exercises consisted of pursed-lip breathing, expiratory abdominal augmentation, and synchronization of thoracic and abdominal movement. At the end of the session all patients performed progressive muscle relaxation training according to the Jacobson technique. For the patients who had problems with clearing mucus, some physiotherapy techniques (postural drainage, percussion, and vibration) were taught to assist with this clearance. The medical treatment of the patients was optimized before entry into the rehabilitation program and was not changed during the rehabilitation period. All patients gave their written informed consent to participate in the study.

Assessments

The following assessment parameters were used at baseline, after the 8th week (at the end of the rehabilitation program) and after the 12th week:

Resting pulmonary function tests

Twenty minutes after being administered 400 μg of inhaled salbutamol at the clinic, a postbronchodilator pulmonary function test was performed on each patient. A dry spirometer (Sensor Medics 2400) was used to obtain the best of three technically satisfactory measurements of FEV_1 %, FVC %, and FEV_1/FVC %. Patients who were found to have reversibility values that were below 20% were included in the study. The severity of the disease was classified according to the GOLD guidelines [4], and patients were placed into one of the following four groups: FEV_1/FVC < 70% but $FEV_1 \geq 80\%$ predicted was classified as stage I (mild) COPD; $50\% \leq FEV_1 < 80\%$ predicted was classified as stage II (moderate) COPD; $30\% \leq FEV_1 < 50\%$ predicted was classified as stage III (severe) COPD; and $FEV_1 < 30\%$ predicted was classified as stage IV (very severe) COPD.

Arterial blood gas analysis

Arterial blood samples of at least 5 ml were taken from femoral arteries while patients were in a resting position at room temperature. The partial arterial pressures of oxygen (PaO_2), carbon dioxide ($PaCO_2$), and oxygen saturation were all measured using the Corning 238 pH gas analyzer. Patients were excluded from the study if they had a $PaO_2 < 50$ mmHg or a $PaCO_2 > 45$ mmHg.

Exercise capacity, dyspnea, and quality-of-life measurements

After the measurements of the functional parameters were taken, a 6-minute walk test (6MWT) was performed within the hospital corridors [6]. The principal investigator, accompanying the patients as they performed this test, encouraged them to walk as fast as possible and to continue if they stopped to rest. All of the patients were required to perform two 6MWT at each data collection visit, with a 30-minute rest period between the two walks. The higher of the two values was recorded. During the walk, oxygen saturation was monitored continuously. Dyspnea was measured at each visit (baseline, 8th week, and 12th week) using the visual analog scale (VAS), which is a self-reported device used for measuring subjective data [7]. Patients record a score on a 100-mm vertical line, where a score of 0 indicates ''no breathlessness'' and a score of 100 is ''the worst imaginable breathlessness.'' The quality of life was assessed in the entire study population using the Turkish version of the St. George's Respiratory Questionnaire (SGRQ), a standardized health status measurement [8]. It consists of 76 questions measuring the following domains: symptoms (wheeze, cough, and dyspnea), activity, impact, and the total score. Lower scores indicate better health status.

Statistical Analysis

Statistical analyses were performed with the Statistical Package for the Social Sciences 9.0 (SPSS Inc., Chicago, IL). All of the results are expressed as mean ± SD (standard deviation). A p value less than 0.05 was considered indicative of statistical significance. Baseline demographic and clinical characteristics were compared using the independent-samples t test for continuous data and Fisher's exact test for dichotomous data. The repeated-measures analysis of variance was used to evaluate parameters over the time of observation. In addition, the Bonferroni test was used for the comparison of groups.

Results

A total of 54 patients were enrolled in the study but 5 who would have been in the control group were eventually excluded from the study because they did not satisfy the inclusion criteria. Therefore, 49 patients, 27 in the rehabilitation group and 22 in the control group, were included in this study. Table 1 summarizes the characteristics of the patients at the start of the trial. No statistically significant differences in demographic and clinical data were found between the two groups.

Table 1 The baseline characteristics of the patients in both groups

	Rehabilitation group (n = 27)	Control group (n = 22)	p value
Age (yr) (±SD)	65.1 ± 9.4	66.6 ± 8.4	NS
Gender[a] (%)			
Male (%)	22 (81.5)	21 (95.5)	NS
Female (%)	5 (18.5)	1 (5.5)	NS
Smoking history (pack/yr) (±SD)	47.8 ± 31.3	42.6 ± 26.5	NS
Disease duration (yr) (±SD)	14.3 ± 11.3	12.1 ± 9.8	NS
Disease stage[a]			
Mild (%)	2 (7.4)	1 (4.5)	NS
Moderate (%)	15 (55.5)	13 (59.1)	NS
Severe (%)	10 (3.7)	8 (36.4)	NS
Pulmonary functions			
FVC, predicted %	69.9 ± 15.5	73.6 ± 17.4	NS
FEV_1, predicted %	54.8 ± 16.2	55.0 ± 15.7	NS
FEV_1/FVC (%)	57.5 ± 8.6	62.2 ± 14.3	NS
Arterial blood gases			
PaO_2 (mmHg)	80.4 ± 13.1	77.3 ± 10.6	NS
$PaCO_2$ (mmHg)	36.3 ± 6.3	37.3 ± 5.8	NS

NS = not significant

Comparisons were made using an independent t-test

[a] Fisher's exact test

One patient in the rehabilitation group and two patients in the control group did not complete the study because of noncompliance. In addition, one patient in the control group was referred to the Department of Pulmonary Disease for an attack of COPD, and therefore was unable to complete the study. The remaining 45 patients (26 in the rehabilitation group and 19 in the control group) all completed the study.

Arterial blood gases, like pulmonary functions, did not change from baseline for all patients during the course of the study (Table 2).

Table 3 shows the results of the clinical assessment parameters. In the rehabilitation group, dyspnea, when assessed by the VAS, showed an improvement at the 8th week ($p < 0.05$). Compared with the baseline, there was a slight but not significant improvement at the 12th week. The mean decrease of the VAS scores was found to be significantly different between the two groups for both evaluations ($p < 0.05$). A similar trend was seen for the 6MWT distance, with a significant improvement only in the rehabilitation group at the 8th week ($p < 0.05$). Comparison of the 8th and 12th weeks revealed a significant difference for both parameters in the rehabilitation group ($p < 0.05$). In other words, there was a worsening for these parameters at 12th week.

Table 2 Pulmonary function and arterial blood gas data for all recruited patients at baseline, discharge (8th week), and follow-up (12th week)

	Rehabilitation group (n = 26)			Control group (n = 19)		
	Baseline	Week 8	Week 12	Baseline	Week 8	Week 12
FVC,% pred	68.5 ± 15.5	75.0 ± 19.2	72.2 ± 18.7	74.2 ± 19.2	76.0 ± 14.0	70.5 ± 14.4
FEV_1 %pred	55.5 ± 15.8	55.9 ± 16.8	54.6 ± 17.9	54.6 ± 17.6	56.5 ± 18.0	54.0 ± 17.9
FEV_1/FVC %	59.7 ± 11.3	59.6 ± 9.4	59.8 ± 8.9	57.2 ± 11.7	57.4 ± 11.8	58.3 ± 11.3
PaO_2 (mmHg)	81.7 ± 12.5	80.3 ± 15	82.4 ± 14.6	77.4 ± 11.8	78.4 ± 14.6	76 ± 13.4
$PaCO_2$ (mmHg)	35.3 ± 5.8	36.5 ± 8.6	36.3 ± 6.2	37.7 ± 7.1	38.1 ± 3.7	37.2 ± 4.3

* $p < 0.05$, the repeated-measures analysis of variance

Table 3 The clinical evaluation parameters

	Rehabilitation group (n = 26)			Control group (n = 19)		
	Baseline	Week 8	Week 12	Baseline	Week 8	Week 12
VAS (mm)	5.9 ± 2.0	3.1 ± 1.6*#	4.1 ± 2.1*	5.3 ± 2.0	5.8 ± 1.8	6.1 ± 2.0
Walking distance (m)	261.6 ± 41.5	383.2 ± 50.4*#	308.6 ± 58.2*	226.8 ± 62.7	241.9 ± 57.4	215.7 ± 64.1
SGRQ scores						
Symptom	59.8 ± 23.3	37.5 ± 16.3*#	45.9 ± 24.7*#	60.1 ± 21.8	45.9 ± 24.7	59.0 ± 19.2
Activity	67.0 ± 19.5	42.5 ± 22.1*#	56.1 ± 21.1*#	70.5 ± 22.4	66.7 ± 24.0	66.2 ± 21.9
Impact	35.6 ± 22.8	17.2 ± 15.1*#	23.5 ± 20.5*#	33.4 ± 16.2	33.4 ± 16.8	31.5 ± 19.5
Total	45.1 ± 17.8	28.3 ± 15.2*#	35.6 ± 16.2*#	50.7 ± 15.7	47.0 ± 17.3	46.5 ± 17.5

VAS = visual analog scale

* $p < 0.05$, comparison of groups, Benferroni test

# $p < 0.05$, comparison of baseline values to follow-up values within treatment groups with the repeated variance measurements analysis

All of the domains of the SGRQ were found to have significantly decreased in the rehabilitation group at both evaluations ($p < 0.05$), while there was no significant improvement in the control group at either evaluation. Although these parameters significantly increased after the 8th week, the improvement was still significant at the 12th week ($p < 0.05$). Comparison of the groups also showed a statistically significant difference in favor of the rehabilitation group ($p < 0.05$).

Discussion

This study has demonstrated that rehabilitation can improve the quality of life, functional performance, and dyspnea in COPD patients. At the time of discharge, the dyspnea VAS score, 6MWT distance, and all of the SGRQ domains showed significant improvement in the patients who had received 8 weeks of rehabilitation, while there was no improvement observed among the patients in the control group. In addition, significant improvements were also seen in the SGRQ scores of the rehabilitation group at the 12th week.

As expected, the main goal of the treatment was to increase both the exercise performance and the quality of life and to decrease dyspnea [9]. To achieve these goals we used an aggressive 8-week-long rehabilitation program that included education, breathing training, and chest physiotherapy followed by aerobic and strength training exercises. As in previous studies, our results show that a pulmonary rehabilitation program with a skilled manual therapist leads to significant improvements among the patients [10].

We examined the impact of rehabilitation on the quality of life because we felt that it is important to see which of the clinical features is affected by rehabilitation [11, 12]. Our results showed that all of the domains on the SGRQ showed significant improvement at both the 8th and the 12th week, thereby demonstrating the positive effects of rehabilitation on the quality of life.

On the other hand, there was no significant difference in the physiologic parameters such as arterial blood gases and pulmonary functions between the two groups. This result is in accordance with previous studies that have demonstrated that the training benefits of rehabilitation are independent of underlying airflow limitations [13, 14].

This is probably because COPD is a chronic and progressive disease that results in no improvement in pulmonary function and arterial oxygenation with a rehabilitation program [9].

In this study a crucial finding is that the improvements in the dyspnea VAS score and the 6MWT distance were not found to be permanent at the 12th week, although there still was a significant difference between the two groups in favor of the rehabilitation group. In other words, these parameters began to deteriorate in the period after cessation of the rehabilitation. This finding therefore points to the importance of keeping the patient motivated after the rehabilitation program to maintain its benefits. Indeed, the loss of the benefits of rehabilitation following discharge has previously been reported [15]. It is not clear, however, whether this loss begins to occur immediately after the completion of the training program or later, because all of the previous studies evaluated the long-term effects of training and showed only that this deterioration begins within the first year after rehabilitation [16–19]. Our study showed that this deterioration may occur in a period as short as four weeks, even with extremely motivated patients. For this reason, more permanent supervision after the patient's discharge may be necessary to allow for long-term improvements in both exercise tolerance and quality of life.

In summary, this study demonstrates the short-term benefits of an aggressive rehabilitation program in COPD patients, as was expected. Most importantly, however, these effects were lost almost immediately after the time of discharge as a result of the lack of a supervised program after rehabilitation. Therefore, we recommend ways to improve motivation among patients to maintain the benefits of the rehabilitation programs. Nevertheless, it is important that these results be confirmed by further long-term controlled studies of rehabilitation among COPD patients.

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