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Research paper

Exercise training: which impact on COPD patients?

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Abstract

Introduction: Exercise training reactivates the aerobic pathway through physical exercise, thereby improving dyspnea and breaking deconditioning spiral in chronic obstructive pulmonary disease (COPD) patients.
Method: 60 COPD patients were selected to benefit from a four-week outpatient exercise training and muscle strengthening program, at a rate of 3 sessions per week, after excluding the following cases: patients who have contraindications to exercise training; severe patients or those receiving long-term oxygen therapy. The program combined exercise training on a bicycle ergometer for 45 min, muscle strengthening of the lower limbs and nutritional monitoring. Nutritional management included a diet based on nutritional status and the prescription of oral food supplements for malnourished COPD patients. Parameters assessed before and after training were bioimpedance analysis (BIA),6MWT, quadriceps isometric voluntary contraction (MVC) and dynamic endurance, and the quality-of-life questionnaire (Q11).
Result: Forty COPD patients (36 men and 4 women) aged 67.22 (± 10) years were able to complete the program. Amid them, 36 were non-smokers. Ten patients (GOLD I), 14 patients (GOLD II), 16 patients (GOLD III), no patients (GOLD IV). Dyspnea was stage 2 (± 1) m MRC. After training, quadriceps muscle function ((MVC) and endurance) improved significantly ($p < 0.0001$). The improvement in distance covered during 6MWT was also significant ($p < 0.0001$). A significant improvement in quality of life after training was noted on the total score of the Q11 questionnaire. No significant improvement in body composition after training in COPD patients.
Conclusion: this study has confirmed the beneficial effects of training mainly on muscle function, effort capacity and quality of life in COPD patients.

Keywords: *Chronic Obstructive Pulmonary Disease; Deconditioning Spiral; Exercise Training; Effort Capacity; Quality-of-Life.*

1. Introduction

Exercise training is the cornerstone of a respiratory rehabilitation program for COPD patients, as it optimizes physical performance, social integration, and autonomy.

2. Patients and methods

Stable COPD patients to benefit from four-week outpatient training and muscle strengthening program. at a rate of 3 sessions per week, after excluding patients with contraindications to exercise training and those with severe COPD or those on long-term oxygen therapy.
The program combines exercise training on a bicycle ergometer for 45 minutes per session, muscle-strengthening sessions for the lower limbs and nutritional monitoring.
The exercise training sessions lasted 45 minutes, at target heart rate on a cycle ergometer in interval training mode: 10 min of work at threshold heart rate followed by 5 min of active recovery.
The muscle-strengthening sessions focused on the muscles of the lower limbs, and lasted progressively for 1 hour per session, two to three times a week.

- 2 to 4 sets of 6 to 12 repetitions
- 50 to 85% MVC
- 2 to 3 minutes recovery

Nutritional management included a diet based on nutritional status and the prescription of oral food supplements for malnourished COPD patients.
Parameters measured before and after the training protocol:

- bioimpedance (BMI, FM, FFMI, leg muscle mass).
- 6MWT walking distance.
- Quadriceps strength (MVC).
- Quadriceps dynamic endurance.

- Quality of life questionnaire (Q11).

3. Results

3.1. Patients' characteristics

Only 40/60 (66%) patients were able to complete the duration of the program for the following reasons:
- Lost sight of :04 Patients
- Lack of motivation: 08 Patients
- Repeated acute exacerbations: 05 Patients
- Death: 03 Patients

Table 1: Patients' Characteristics

Characteristics	Results
Age (year)	67,22 (10)
Sex (F/M)	36/4
Smoking (S/NS)	6/34
m MRC	2(1)
FEV%:	60 (19.7)
Functional stages (GOLD)	I : [10] II :[14] III :[16] IV :[0]

3.2. Comorbidities in rehabilitated COPD patients

Comorbidities founded in COPD patients were high blood pressure in 27.5% of cases followed by cardiopathy in 15% of patients. The other comorbidities founded were diabetes in 22, 5% of cases followed by anemia in 8 (20%) patients, and metabolic syndrome in 6 (15%) cases.

Table 2: Distribution of Rehabilitated COPD Patients According to the Comorbidities

3	Number	Percentage
Diabetes	9	22,5 %
High blood pressure	11	27,5%
Cardiopathy	6	15%
Metabolic Sd	6	15%
Anemia	8	20%

3.3. After training outcomes

After training, quadriceps muscle function (FMV and endurance) improved significantly ($p<0.0001$) Table 3.
A significant improvement in quality of life after training was noted on the total score of the Q11 questionnaire ($P<0.002$) Table 3.
In our population, the difference before and after training with nutritional management on body composition (MMI, FM, BMI) was not significant ($P<0.067$), ($P<0.069$) ($P<0.92$) Table 3.

Table 3: Results of the Training Program

Parameters	Before	After	P (BI=95%)
Leg muscle mass (Kg)	7,03 (1,2)	7,12 (1,3)	<0,036
Endurance (min)	3,9 (1)	5,02 (1,23)	<0,0001
MVC(Nm)	93,3 (37,35)	105,1 (39,6)	<0,0001
6WMT(m)	452,80 (104,11)	486,83 (112,4)	<0,0001
Q11 (score total)	27,5 (9,3)	23,2(9,9)	<0,002
FFMI(Kg/m^2)	17,92 (2,02)	18,27(2,38)	<0,067
Fat mass (Kg)	15,42 (7,7)	14,17(7)	<0,069
BMI (Kg/m^2)	21,71(4,24)	21,7(3,9)	<0,92

4. Discussion

The principle of endurance training is to work at low-to-moderate intensity over long periods, which leads to a significant increase in muscle oxidative capacity [1] and changes in contractile proteins, enabling muscles to resist fatigue [2], [3]. Endurance increases the number of mitochondria, which in turn enhances oxidative capacity [4], [5].
The primary objective of training is to reactivate the aerobic pathway through physical activity, thereby improving dyspnea and breaking the spiral of deconditioning in COPD patients [1,6].
The exercise training protocol applied to COPD patients in our study is interval training, which is an alternative better tolerated by patients than continuous training [7 - 9], especially for the most severely affected patients or those unable to tolerate continuous training [10]. Progressive muscle strengthening is well tolerated by COPD patients, enabling them to achieve specific and significant functional improvements [11].
Chronic obstructive pulmonary disease (COPD) is associated with several comorbidities it is considerate as a systemic disease. Comorbidities should be actively identified before rehabilitation program. Several studies have focused on the impact of comorbidities on the results obtained following a rehabilitation program. However, most of these studies were conclude that comorbidities don't affects pulmonary rehabilitation outcomes [12], [13].

After training, quadriceps muscle function (MVC and endurance) was improved significantly (p<0.0001), with similar findings reported in other studies [14 - 16]. Segmental leg muscle mass was also improved, while a small but significant increase in mid-thigh muscle cross-sectional area and fat free body mass have been noted in other training programs [17], [18], but this may be due to the duration of training, or the effectiveness of the nutritional management associated with these programs. Increasing muscle mass in COPD patients requires a combination of training and effective nutritional management. Casaburi et al [17] described minimal improvement in mid-thigh cross-sectional area after training combined with testosterone administration, whereas we relied on a high-protein diet and dietary supplements in our patients. The minimum clinically significant difference recognized in 6 MWT is 35 meters [19], a difference noted in most of our patients (p< 0.0001). The improvement in exercise capacity assessed by 6MWT is found in most studies on the beneficial effects of respiratory rehabilitation in COPD patients [16,20]. A significant improvement in quality of life after training was noted on the total score of the Q11 questionnaire (P< 0.002). This has also been noted by other studies using other quality-of-life questionnaires such as the SCRQ and the QRC [21]. In our population, the difference before and after training in body composition (FFMI, Fat mass, BMI) was not significant (P<0.067), (P<0.069) (P<0.92). A minimal improvement in fat free mass after training was also noted by Bernard's team [18].
Several studies have investigated the impact of training alone or as part of a respiratory rehabilitation program on effort capacity, quality of life and body composition, as well as on other parameters such as dyspnoea. A comparison with the results of our study is shown in Table 4.

Table 4: Comparison with Other Training Studies

Studies	Characteristics	Parameters	Before	After	P
Menon & al	Subjects (n): 45	MVC	109(48.5)	129 (69.1)	0,024
(2012)	FEV%:47.3 (18.9)	Tdexa (g)	3908.5 (1104.1)	4122,1(1339,1)	0,0001
[22]	High intensity iso kinetic re-training 8 weeks	RFcsa (mm^2)	439.7 (117.9)	531,2(168,2)	0.0001
		Qt (mm)	21.5 (6.4)	23,8 (8.6)	0.000
Laviolette et al	Subjects(n): 157	Dif CET	198 (352)		0,001
(2014)	FEV% :45(15)		25 (52)		0,001
[23]	Respiratory rehabilitation program	Dif 6MWT	26.1 (17.1)		0,001
			25.9 (13.2)		0,001
	8-week program	Dif SGRQsymptoms	27.4 (12.7)		0,001
		Dif SGRQ Activity	26.9 (10.1)		0,001
		Dif SGRQ Impact			
		Dif SGRQ Total			
Djebaili et al	Number: 40	Leg muscle mass (Kg)	7,03(1,2)	7,12(1,3)	< 0,036
(2020)	Age: 67 (9)				
	Sex M/F: 36/4	Endurance (min)			
	FEV%: 60 (19.7)	MVC(Nm)	3,9 (1)	5,02 (1,23)	< 0,0001
	training	6WMT(m)	93,3(37,35)	105,1(39,6)	<0,0001
	and muscle strengthening	Q11 (total score)	452,80(104,11)	486,83(112,4)	< 0,0001
		FFMI	27,5(9,3)	23,2(9,9)	< 0,002
	4 weeks	FM	17,92(2,02)	18,27(2,38)	< 0,067
		BMI	15,42(7,7)	14,17(7)	< 0,069
			21,71(4,24)	21,7(3,9)	< 0,92

5. Conclusion

Exercise training has now become an integral part of the therapeutic management of COPD patients, leading to improved exercise tolerance and quality of life.

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