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Role of Pulmonary Rehabilitation in Patients with Pulmonary Arterial Hypertension

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ABSTRACT

Background: Pulmonary rehabilitation is considered as a comprehensive intervention that advised as a therapeutic option for patients of chronic respiratory disorders. Pulmonary rehabilitation has role in reducing dyspnea, increasing exercise capacity and improving quality of life.
Aim of The Work: To assess PAH patients undergone pulmonary rehabilitation program while receiving medications compared with patients only received medical treatment.
Patients and Methods: Thirty patients with idiopathic pulmonary arterial hypertension (NYHA Class II-III) according to clinical, radiological and their pulmonary artery catheter data were randomized equally into two groups with ability and acceptance to be enrolled in 3 weekly rehabilitation sessions for 12 weeks while receiving their prescribed current PAH-specific medication for 3 months prior to participation.
Results: Statistically significant improvement after 12-weeks rehabilitation program as regard six-minutes walk distance (6MWD), blood Oxygen saturation (SO2%), heart rate (HR), dyspnea score and psychological condition.
Conclusion: Pulmonary rehabilitation program in PAH patients with functional class II-III in addition to medical therapy is safe and improve quality of life and exercise capacity.

Keywords: *Pulmonary arterial hypertension; pulmonary rehabilitation; Pulmonary artery catheter.*

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INTRODUCTION

Pulmonary hypertension (PH) is defined as progressive vascular disease characterized by remodeling of the pulmonary vasculature resulting in narrowing of arterial lumen. Confirming diagnosis of PH is done via right heart catheterization as patients have ≥ 25 mmHg resting mean pulmonary artery pressure (PAP) and < 15 mmHg pulmonary artery wedge pressure (PAWP) with pulmonary vascular resistance (PVR) > 3 Wood Units (WU) [1]

Pulmonary rehabilitation is designed to improve physical and psychological condition of patients through comprehensive intervention based on patient-tailored therapies including exercise education, training, and behavior changes. [2]

PATIENTS AND METHODS

A randomized controlled comparative study among 30 patients with PAH, based on clinical, radiological and right heart catheter data in Kobry Al-Kobba military Chest hospital randomized equally into two groups. Group (1) included 15 patients recruited in 12-weeks exercise based pulmonary rehabilitation program while receiving medications and Group (2) included 15 patients only received medical treatment.

Exclusion criteria: PAH Group II, III, IV and V, New York Heart Association (NYHA) Class I or IV, Any uncontrolled non-respiratory medical diseases that may interfere with completion of rehabilitation, e.g., DM, renal failure, liver cell failure or musculoskeletal disorders, Enrollment in another rehabilitation program within 6 months before participation in the study.

Inclusion criteria: Right heart catheter data: Mean PAP ≥ 25mmHg, PVR > 3 Wood Units and PCWP < 15mmHg, Functional Class (NYHA) II-III, Acceptance and capability to participate in 3 rehabilitation sessions per week including medical follow-up, Stable and regular dose of prescribed PAH-specific medication for 3 months before enrollment.

Methods: The study was approved by The Ethics Committee of faculty of medicine, Al-Azhar university. After explanation of the procedure to the patients, a written or verbal consent for participation in this study was obtained by every patient. The thirty participants were subjected to full history taking, clinical examination, routine laboratory testing, imaging assessment, 6MWD, right side heart catheterization and Beck depression inventory (BDI) to measure depression symptoms and severity.

Group (1) patients underwent exercise and functional training (aerobic and strength training elements), self-management education and nutritional observation. Aerobic activities included walking, bike riding, jogging, aerobic classes and these activities are all low in intensity but long in duration. It was done for a period of 20-30 minutes while maintaining 60 to 80% of the maximum heart rate. Upper and lower limbs training by walking, stationary cycling, bicycling, shoulder wheel, stair climbing for lower-extremity training. Aerobic regimens (e.g., arm cycle ergometer) and resistance training for upper extremity through free weights and elastic bands. The strengthening program started with light weights by using pulleys, dumbbells, weighted wands and elastic bands then advanced by increasing the number of repetitions. The pulmonary rehabilitation program varied from 30 to 90 minutes per session, 3 sessions per week and extended over a period of 3 months. Self-management education involved airway clearance techniques, breathing strategies including pursed-lip breathing, active expiration, diaphragmatic breathing and coordinating paced breathing with activities. The nutritional assessment included calculation of BMI and documentation of weight change. Psychosocial assessment depended on Beck depression inventory (BDI).

Statistical analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20. Qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviations and ranges.

RESULTS

Statistically significant difference between studied groups as regard improvement in 6MWD after rehabilitation program (P-value = 0.008) (Table 1).

6MWD (m)		Group I (N = 15)	Group II (N = 15)	Stat. test	P-value
Before	Mean	384.2	382.8	T = 0.035	0.972 NS
	±SD	104.1	111.9		
After	Mean	479.7	370.4	T = 2.88	0.008 S
	±SD	75.1	126.3		

Table 1: Comparison between studied groups as regard 6MWD (m)

Highly statistically significant difference between studied groups as regard improvement in SO2% after rehabilitation program (P-value = 0.014) (Table 2).

ABG		Group I (N = 15)	Group II (N = 15)	Stat. test	P-value
PaO_2 (before)	Mean	64.5	63.8	T = 0.24	0.809 NS
	±SD	9.4	6.9		
SO_2% (before)	Mean	89.2	89.3	T = 043	0.966 NS
	±SD	4.3	4.3		
PaO_2 (after)	Mean	74.1	65.0	T = 2.95	0.006 HS
	±SD	9.6	7.2		
SO_2% (after)	Mean	93.3	89.0	T = 2.62	0.014 S

Table 2: Comparison between studied groups as regard arterial blood gases (ABG)

Highly statistically significant difference between studied groups as regard dyspnea score after rehabilitation program (P-value = 0.014) (Table 3).

Dyspnea score		Group I (N = 15)		Group II (N = 15)		Stat. test	P-value
Before	Grade 0	1	6.7%	3	20%	1.97	0.740 NS
	Grade I	3	20%	2	13.3%		
	Grade II	4	26.7%	5	33.3%		
	Grade III	3	20%	3	20%		
	Grade IV	4	26.7%	2	13.3%		
After	Grade 0	6	40%	1	6.7%	12.5	0.014 S
	Grade I	3	20%	1	6.7%		
	Grade II	4	26.7%	2	13.3%		
	Grade III	2	13.3%	5	33.3%		
	Grade IV	0	0%	6	40%		

Table 3: Comparison between studied groups as regard dyspnea score by Modified medical research council (mMRCD) scale.

Statistically significant difference between studied groups as regard heart rate after rehabilitation program (P-value = 0.006) (Table 4).

Heart rate		Group I (N = 15)	Group II (N = 15)	Stat. test	P-value
Before	Mean	80.7	77.7	T = 0.76	0.449 NS
	±SD	11.6	9.7		
After	Mean	68.2	79.8	T = 2.9	0.006 S
	±SD	6.9	13.6		

Table 4: Comparison between the studied groups as regard heart rate.

Highly statistically significant negative correlation found between mean PA pressure by echocardiography versus 6MWD and SO2% after the rehabilitation program in Group (1) patients; on the other hand, in Group (2) patients there was no significant negative correlation found between mean PA pressure by echocardiography versus 6MWD while significant negative correlation versus SO2% was found (Table 5).

Variables	Group I		Group II	
	r	p-value	r	p-value
Pulmonary artery pressure vs 6MWD	- 0.8	< 0.001 HS	- 0.41	0.121 NS
Pulmonary artery pressure vs SO_2%	- 0.8	< 0.001 HS	- 0.74	0.001 S

Table 5: Descriptive correlation between mean PA pressure versus 6MWD and SO2% in both studied groups after rehabilitation program.

Statistically significant difference between studied groups as regard psychological condition according to Beck depression inventory (BDI) after rehabilitation program (P-value = 0.005) (Table 6).

BECK Evaluation		Group I (N = 15)		Group II (N = 15)		X^2	P-value
Before	Minimal	2	13.3%	2	13.3%	0.18	0.979 NS
	Mild	5	33.3%	4	26.7%		
	Moderate	6	40%	7	46.7%		
	Severe	2	13.3%	2	13.3%		
After	Minimal	11	73.3%	5	33.3%	13.1	0.005 S
	Mild	4	26.7%	1	6.7%		
	Moderate	0	0%	7	46.7%		
	Severe	0	0%	2	13.3%		

Table 6: Comparison between the studied groups as regard Beck depression inventory.

DISCUSSION

PAH patients were advised not to practice strenuous activities because of a possible risk of sudden cardiac death that is due to increased pulmonary remodeling and worsening of right heart failure resulting from stressful activities. [3]

Symptoms of PAH include shortness of breath, recurrent syncopes, excessive fatigue and low physical activity. [4]

Right heart catheterization is confirmatory investigation in which the PAH patient has a resting mean pulmonary artery pressure of greater than 25 mmHg and pulmonary artery wedge pressure of less than 15 mmHg. [5]

In updated guidelines of 2018, highly specialized PAH rehabilitation is recommended for stable patients on optimized pharmacological treatment. [6]

Regarding the data of the included patients in Group (1), there were five male patients (33.3%) and ten female patients (66.6%), with mean age 40.2 ± 10.5 years. Data of the included patients in Group (2) revealed four males (26.7%) and eleven females (73.3%), with mean age 43.1± 12.8 years. In our study there was female sex predominance which was in accordance with Humbert et al. [7] showing female predominance (female to male ratio of 1.7:1) in idiopathic PAH.

Our study showed a statistically significant improvement after rehabilitation program in Group (1) patients as regard 6MWD, from 384.2 ± 104.1 to 479.7 ± 75.1 meters, while there was no significant improvement for patients in Group (2). This result was in agreement with Mainguy et al. [8] who assessed 5 patients with IPAH before and after a 12-week rehabilitation program showing improvement of 6MWD from 441 (75) to 499 (85) m, (P-value = 0.01). Results also coincide with those of Grünig et al. [9] who studied 47 patients with IPAH before and after a 15-week rehabilitation program. In week 15, results showed a highly significant improvement compared to baseline from 440 ± 90 to 527± 74 m. Our study matched with Bussotti et al. [10] who studied 15 patients affected by PAH. After only 4-week rehabilitation program, 6MWD increasing from 455 ± 115 to 487 ± 120 m.

Our study showed a highly statistically significant improvement as regard SO_2% from 89.2± 4.3 to 93.3± 3.7 in Group (1) patients, while the improvement of SO_2% in Group (2) patients was not significant from 89.3± 4.3 to 89.0± 5.1. Result was in agreement with those of Grünig et al. [9] who showed improvement of SO_2% after a 15-weeks rehabilitation program on 21 patients with PAH. Result also matched with those of Ehlken et al. [11] who studied 87 PAH patients and showed significant improvement of SO_2% in the training Group patients after a 15-weeks rehabilitation program.

Our study showed highly statistically significant difference between studied groups as regard dyspnea score after rehabilitation program (P-value = 0.014). This result matched with those of Sahni et al. [12] that showed improved dyspnea score from 2.9 ± 0.5 to 2.6 ± 0.6 (P-value < 0.01).

In our study there was a highly statistically significant negative correlation found between mean PA pressure and 6MWD ($r = -0.8$, P-value < 0.001), SO_2% ($r = -0.8$, P-value < 0.001). This result was in accordance with those of Nishiyama et al. [13] who found a negative correlation between mean PA pressure and 6MWD. Yan et al. [14] also proved the negative correlation between mean PA pressure and SO_2% after studied 28 patients with PH ($r = -0.416$, P-value < 0.001).

Our study showed a statistically significant positive correlation between mean PA pressure and dyspnea score that matched with those of Yan et al. [14] who recorded a positive correlation between mean PA pressure and dyspnea score ($r = 0.467$, $P < 0.001$)

Our study showed a statistically significant difference between studied groups as regard psychological condition according to Beck depression inventory (BDI) after rehabilitation program (P-value = 0.005) which coincides with those of Olsson et al. [15] that was carried on 217 patients with PAH from two German referral centres and revealed that 23.0% have major depressive disorder.

In our study no clinical status deterioration or adverse events were observed during training sessions. This was in accordance with those of El-Assal et al. [16]; Pandey et al. [17] and Bussotti et al. [10].

Absence of adverse events might due to the small cohort of patients, good selection of cases with functional classes II and III and proper supervised exercise program. In contrast, Ehlken et al. [(11)] recorded infections, breathlessness, syncope or presyncope as adverse events that occurred in 13% of patients after applied rehabilitation program on 183 patients with PH. These adverse events might be detected due to the large cohort of participants with different functional classes of pulmonary hypertension.

CONCLUSION

12-weeks exercise based pulmonary rehabilitation program, in a closely supervised setting, in addition to medications for PAH patients with functional class II-III is safe to improve exercise capacity and quality of life. Low workload exercise protocol with careful individual adjustments is essential to avoid adverse events and overloading of patients**.**

Limitations of this study are related to its relatively small sample size. Right sided heart catheter (RHC) has been not done after completion of the rehabilitation program as many patients refused to do it so it was not used as an indicator of the improvement. Further studies are recommended for detecting training programs effects on RHC results improvement after a rehabilitation program. Also, further studies should be applied to confirm results of our study on WHO functional class IV and other types of pulmonary hypertension patients.

Conflict of interest : none

REFERENCES

1- Humbert, M., Farber, H. W., Ghofrani, H. A., Benza, R. L., Busse, D., Meier, C., and Hoeper, M. M, Risk assessment in pulmonary arterial hypertension and chronic thromboembolic pulmonary hypertension. *European Respiratory Journal.* 2019; 53(6).

2- Dalla Vecchia, L. A., and Bussotti, M, Exercise training in pulmonary arterial hypertension. *Journal of thoracic disease*. 2018; 10(1), 508.

3- Avazmohammadi, R., Hill, M., Simon, M., and Sacks and M, Transmural remodeling of right ventricular myocardium in response to pulmonary arterial hypertension. *APL Bioeng*. 2017; 1:016105. doi: 10.1063/1.5011639

4- Mandras, S. A., Ventura, H. O., and Corris, P. A, Breaking down the barriers: why the delay in referral for pulmonary arterial hypertension. *Ochsner Journal.* 2016; 16(3), 257-62.

5- Hoeper, M. M., Bogaard, H. J., Condliffe, R., Frantz, R., Khanna, D., Kurzyna, M. and Badesch, D. B, Definitions and diagnosis of pulmonary hypertension. *Journal of the American College of Cardiology*. 2013; 62(25S), D42-D50.

6- Galiè, N., Channick, R. N., Frantz, R. P., Grünig, E., Jing, Z. C., Moiseeva, O. and McLaughlin, V. V, Risk stratification and medical therapy of pulmonary arterial hypertension. *European Respiratory Journal*. 2019; 53(1).

7- Humbert, M., Sitbon, O., Chaouat, A., Bertocchi, M., Habib, G., Gressin, V and Simonneau, G, Survival in patients with idiopathic, familial, and anorexigen-associated pulmonary arterial hypertension in the modern management era. *Circulation*. 2010; 122(2), 156-63.

8- Mainguy, V., Maltais, F., Saey, D., Gagnon, P., Martel, S., Simon, M., & Provencher, S, Peripheral muscle dysfunction in idiopathic pulmonary arterial hypertension. *Thorax*. 2010; 65(2), 113-7.

9- Grünig, E., Maier, F., Ehlken, N., Fischer, C., Lichtblau, M., Blank, N and Nagel, C, Exercise training in pulmonary arterial hypertension associated with connective tissue diseases. *Arthritis research & therapy*. 2012; 14(3).

10- Bussotti, M., Gremigni, P., FE Pedretti, R., Kransinska, P., Di Marco, S., Corbo, P, Sommaruga and M, Effects of an outpatient service rehabilitation program in patients affected by pulmonary arterial hypertension: an observational study. Cardiovascular &Haematological Disorders-Drug *Targets (Formerly Current Drug Targets-Cardiovascular & Hematological Disorders)*. 2017; 17(1), 3-10.

11- Ehlken, N., Lichtblau, M., Klose, H., Weidenhammer, J., Fischer, C., Nechwatal, R and Grünig, E, Exercise training improves peak oxygen consumption and haemodynamics in patients with severe pulmonary arterial hypertension and inoperable chronic thrombo-embolic pulmonary hypertension: a prospective, rand omized, controlled trial. *European heart journal*. 2016; 37(1), 35-44.

12- Sahni, S., Capozzi, B., Iftikhar, A., Sgouras, V., Ojrzanowski, M., & Talwar, A, Pulmonary rehabilitation and exercise in pulmonary arterial hypertension: An underutilized intervention. *Journal of exercise rehabilitation*. 2015; 11(2), 74.

13- Nishiyama, O., Yamazaki, R., Sano, H., Iwanaga, T., Higashimoto, Y., Kume, H., &Tohda, Y, Pulmonary hemodynamics and six-minute walk test outcomes in patients with interstitial lung disease. *Canadian respiratory journal.* 2016; 10(3).

14- Yan, W., Peng, L. Y., Ban, C. J., Xu, X. F., Zhu, M., Liu, Y and Dai, H. P, Incidence and clinical characteristics of pulmonary hypertension in patients with idiopathic pulmonary fibrosis. *Chinese medical journal.* 2015; 128(7), 896.

15- Olsson, K. M., Meltendorf, T., Fuge, J., Kamp, J. C., Park, D. H., Richter, M. J and Kahl, K. G, Prevalence of Mental Disorders and Impact on Quality of Life in Patients with Pulmonary Arterial Hypertension. *Frontiers in Psychiatry*. 2021; 12.

16- El-Assal, G. M., Farghaly, A. A., Osman, N. M., & Elghafar, M. H, Role of pulmonary rehabilitation in patients with pulmonary arterial hypertension. *The Egyptian Journal of Chest Diseases and Tuberculosis.* 2018; 67(4), 401.

17- Pandey, A., Garg, S., Khunger, M., Garg, S., Kumbhani, D. J., Chin, K. M., & Berry, J. D, Efficacy and safety of exercise training in chronic pulmonary hypertension: systematic review and meta-analysis. *Circulation: Heart Failure*. 2015; 8(6), 1032-43.