Nordic walking as a new model of pulmonary rehabilitation for patients referred for lung transplantation – a preliminary report

Nordic walking jako nowy model rehabilitacji oddechowej pacjentów kwalifikowanych do transplantacji płuc – wstępne wyniki

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Abstract

The benefits of pulmonary rehabilitation (PR) in individuals with chronic lung diseases such as chronic obstructive pulmonary disease (COPD), cystic fibrosis (CF) and interstitial lung disease (ILD) have been well docu¬mented. Yet evidence-based guidelines for PR in pre- and post-lung transplant patients have not been developed. In this study the authors present preliminary results of an observational cohort study of pulmonary rehabilitation with Nordic walking (PR-NW) in patients referred for lung transplantation in Poland. In a small group of patients (10 pts), after 12 weeks of PR-NW the authors observed significant improvement in the distance walked in the 6min walk test (6MWT) without any adverse events. It appears that exercise is safe and benefi¬cial for people with severe end-stage chronic lung disease who are awaiting lung transplantation and Nordic walking should be recommended for future research in this patient population.

Key words: lung transplantation, pulmonary rehabilitation, nordic walking.

Streszczenie

Korzyści z rehabilitacji oddechowej osób z przewlekłymi chorobami płuc, takimi jak przewlekła obturacyjna choroba płuc, mukowiscydoza i śródmiąższowe włóknienie płuc, zostały opisane w piśmiennictwie. Oparte na dowodach wytyczne dotyczące ćwiczeń pacjentów przed transplantacją płuc i po transplantacji płuc nie zostały dotąd opracowane.

W obecnym badaniu autorzy przedstawiają wstępne wyniki rehabilitacji oddechowej przy użyciu techniki *Nordic walking* (PR-NW) u pacjentów kwalifikowanych do zabiegu transplantacji płuc w Polsce. Oceniając dziesięcioosobową grupę pacjentów po 12 tyg. PR-NW, autorzy zaobserwowali znaczną poprawę w tolerancji wysiłku (ocenianą w teście 6-minutowego marszu) przy braku efektów niepożądanych. Okazało się, że zalecone ćwiczenia są bezpieczne i korzystne dla pacjentów z krańcową postacią przewlekłej choroby płuc, którzy są kwalifikowani do przeszczepu płuc, a metoda *Nordic walking* powinna być przedmiotem przyszłych badań w tej grupie chorych.

Słowa kluczowe: transplantacja płuc, rehabilitacja oddechowa, Nordic walking.

Introduction

In 2003 the first successful lung transplant was performed in Poland. Soon after in 2006 a lung transplant program was started at the Silesian Centre for Heart Disease in Zabrze, Poland. Currently the Zabrze Lung Transplant Team performs approximately 10 lung transplants per year, it is the only medical centre in Poland which performs such procedures. Patients are referred for lung transplantation at the Dept. of Lung Diseases and Tuberculosis in Zabrze. Success of lung transplantation, expressed in life expectancy increase and quality of life improvement, depends on many factors. Most evidence supporting the effectiveness of pulmonary rehabilitation (PR) and guideline development come from studies in patients with

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COPD. Growing evidence also supports the effectiveness of PR in interstitial lung disease (ILD) and that PR is associated with significant improvement in dyspnoea and functional status. Little is known about the impact of a PR program in patients referred for LT. One should ask whether PR is at all beneficial in patients with end stage lung diseases referred for lung transplantation (LT). In this study we attempted to address this issue by prospectively examining the efficacy of nordic walking, a low cost, accessible and proven beneficial form of physical excercise as aform of PR in patients referred for LT. To the best knowledge of the authors, there is a lack of controlled studies on pulmonary rehabilitations programmes in patients referred for lung transplantation. In addition we perform a rehabilitation programme based on Nordic walking, which is a low tech and cheap form of exercise that can be done by practically anybody and therefore has an increasing number of users, particularly in Europe.

Material and methods

Study subjects

Between November 2009 and September 2010, 24 patients were referred for lung transplantation in the Department of Lung Diseases and Tuberculosis of the Silesian University Hospital in Zabrze. All of them fulfilled the ISHLT [1] criteria for lung transplantation. Those without exclusion criteria for PR were invited to take part in the study. Exclusion criteria included any comorbidities which precluded exercise training (such as unstable cardiac disease or orthopaedic deficits). Total of 15 patients gave written informed consent and the study was approved by the Bioethical Commission of the Medical Academy of Silesia. The final study group consisted of only men with a mean ageof 51.5 years oldpatients diagnosis included end-stage COPD (n = 5), idiopathic pulmonary fibrosis (IPF) (n = 7) and other than IPF forms of idiopathic interstitial pneumonia (IIP) (n = 3).

Physiological measurements

Physiological testing was completed on the same day as informed consent was obtained. Patients' age, weight, BMI, fat mass, fat % of total body weight, lung function tests and mobility were taken into consideration. Spirometry was performed using Jaeger-Masterlab (Erich Jaeger GmbH, Wurtzburg, Germany). Two lung function parameters were measured: forced vital capacity (FVC) and forced expira¬tory volume in one second (FEV1), and were normalized to the reference values proposed by the European Commu¬nity for Coal and Steel and presented as percentage of predicted (% pred.). Mobility was presented as the distance in 6-minute walking test(6MWT). The test was performed according to the guidelines with modified Bruce protocol [2]. Use of oxygen during the test was standardised and all follow-up walk tests were conducted using the same flow rate supplemental oxygen that had been used at baseline. The distance,, dyspnoea before and after 6MWT on Borg's scale, saturation of oxygen (SpO2) before and after 6MWT, and time and distance to desaturation to less than 80% were also recorded.

Rehabilitation programme

The training programme was conducted according to the same exercise prescription principles as those used for COPD [3]. The training programme consisted of two 6-week cycles. Each cycle consisted of 2 weeks of hospital-based, supervised rehabilitation and a 4-week home-based rehabilitation programme. The rehabilitation programme was based on Nordic walking, which is walking with specially constructed ski poles. Patients received one-hour instruction by a professional Nordic walking instructor. Heart rate (HR) and oxygen saturation (SpO2) were monitored by pulse oximeter during hospital-based training. Patients performed maximal exercise testing to obtain maximum heart rate. The preset goal for training efficiency was set at 75% of the initial maximum HR. Distance to walk was established according to distance achieved in 6MWT and depended on the distance when oxygen saturation dropped to 80%. Patients on home oxygen therapy (HOT) used supplemental O2 during intervention according to statement [3]. During training all patients were supervised and data were recorded by medical staff and walking speed was, if necessary, adapted to bearable dyspnoea and optimal oxygen saturation. All patients were equipped with a pedometer and recorded daily walking distance and events during training. During follow-up visits medical staff checked compliance of each patient during the rehabilitation programme.

Rating of dyspnoea

Three different clinical methods were used for rating dyspnoea at a set point in time: a modification of the Medical Research Council questionnaire (MRC) [4], baseline dyspnoea index (BDI) [5] and the Borg scale [6].

MRC is a 5-grade scale that grades degree of breathlessness related to activities. In our study, each patient was instructed to read the descriptive statements and then select the number which fitted best his shortness of breath. For descriptive and statistical reasons MRC was modified so that lack of breathlessness except with strenuous exercise was marked as grade 1 and the maximal level of dyspnoea, when too breathless to leave the house or breathless when dressing or undressing was marked as grade 5.

The BDI describes dyspnoea in five grades for each of three categories: disability of everyday activities (FI, functional impairment), difficulties in performing tasks (MT, magnitude of task), and difficulties in undertaking an effort (ME, magnitude of effort). This scale enables differentiation of extra-pulmonary causes of dyspnoea; e.g., osteoarthritic pain, chest pain, and situations where it is not possible to define the causes of dyspnoea. In such cases, the patient marks a relevant answer that is not classified in dyspnoea estimation.

The Visual Borg Scale rates patients' dyspnoea from

0 (rest) to 10, where 10 is the maximum ever experienced dyspnoea.

Quality of life

In estimation of quality of life the SF-36 questionnaire [7] generally describing quality of life was used. The SF-36 questionnaire consists of 36 questions, which includes basic domains describing the condition of health: 1) Physical Functioning /PF/, 2) Role Physical /RP/, 3) Bodily Pain /BP/, 4) General Health /GH/, 5) Vitality /VT/, 6) Social Functioning /SF/, 7) Role Emotional /RE/, 8) Mental Health /MH/. In the SF-36 scoring, the highest scores meant better general health status. Methodological rules and the analysis of data by SF-36 questionnaire have been described in a previous paper [8].

Statistical analysis

Results were expressed as mean ±SD. Spearman's rank correlation coefficient was used to measure statistical dependence. Correlation between results of dyspnoea tests and physiological testing, spirometric data, mobility, and quality of life questionnaires' domains were determined. Analysis was performed using the Statistica program. Statistical significance was defined as $p < 0.05$.

Results

Study populations

Out of 15 patients awaiting lung transplantation and qualified for the tests, 10 (67%) completed a 12-week pulmonary rehabilitation programme. Three participants withdrew after 6 weeks due to exacerbation of their disease and/or hospitalization and two other patients were excluded from the group as their oxygen saturation dropped below 80% at adistance below 50 m. Those participants underwent respiratory muscle rehabilitation excluding Nordic walking. Baseline characteristics of particular subjects of the study population are described in Table I.

6MWT distance and Borg Score

After 6 weeks of PR-NW we noticed a statistically significant increase of average distance walked in 6MWT from 288.90 ±125.17 to 336.00 ±119.58 (47.1 m increase). The most significant increase after 6 weeks – 150 metres (125%) –was noticed in patient KZ, whose initial 6MW result was 120 metres. Another patient, whose initial 6MWT result was the lowest in the whole group, achieved an increase of 75% (from 40 to 70 metres). In two patients (20%) there was a decrease in distance walked in the 6MWT after 6 weeks

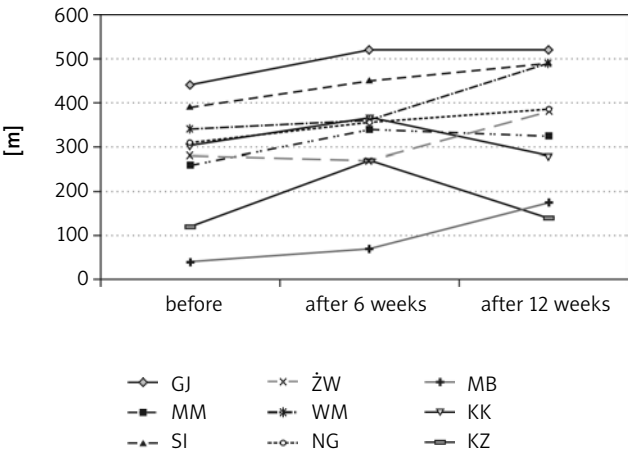
Tab. I. Baseline characteristics of particular subjects of study population

Initials	Diagnosis	Age	BMI	Fat %	FVC % pred.	FEV1 % pred.	6MWT [m]	Sat O_2 on baseline 6MWT	Daily distance NW [steps]	% realization of recommended distance
G.J.	IPF	53	26.5	20.8	55.0	65.0	440	93	2000	90
M.M.	IPF	54	19.3	17.5	46.1	35.8	260	97	2000	71
S.I.	IIP	53	32.6	34.9	71.7	65.4	390	96	2000	60
Ż.W.	IPF	60	25.7	14.2	87.0	88.0	280	88	2000	80
W.M.	Sarcoidosis	43	22.9	29.1	44.0	44.0	240	96	1000	64
N.G.	Histiocytosis	35	28.5	22.4	41.0	15.0	210	92	1000	100
M.B.	Anthracosis	54	30.0	30.7	40.0	24.5	40	89	100	71
K.K.	COPD	55	20.3	14.3	67.8	63.2	305	87	1000	84
K.Z.	IPF	52	26.8	32.1	25.6	31.7	120	88	2000	70
K.S.	COPD	56	22.0	16.7	50.0	18.0	404	95	1600	57

Tab. II. 6-Min Walk Distance and Dyspnoea (Borg Score) before, after 6 weeks and after 12 weeks of NW-PR

	before	After 6 weeks	After 12 weeks
6MWT distance [m]	288.90±125.17	336.00±119.58*	353.89±137.09**
Borg score 6MWT	1.30±2.21	1.20±2.25	0.22±0.44
Borg score after 6MWT	6.00±1.89	6.30±1.64	6.33±1.50
Saturation O2 before 6MWT [%]	92.10±3.84	92.20±3.71	91.78±4.55
Saturation O2 after 6MWT [%]	77.90±13.62	79.30±9.82	77.00±10.69
Time to Sat. O2 80% [sec]	102.00 ±137.12	115.60±51.00	124.00±138.79
Distance to Sat O2 80% [m]	143.75±52.18	110.00±56.12	172.00±175.16

** - qualification results vs after 6 weeks (p<0,05)*
***- qualification results vs after 12 weeks (p<0,05)*



Ryc. 1. 6-Min Walk Distance before, after 6 weeks and after 12 weeks of PR-NW

of rehabilitation. After 12 weeks of the programme those patients' 6MWT distance reached the level walked in the initial test. The results of 6MWT and dyspnoea evaluation results are in tTable II.

After 6 more weeks of PR-NW there was an increase of average distance to 353.89 ±137.09 m, which means a 64.99 m (22.4%) increase comparing to the initial test and 17.89 m (5.3%) compared to the test performed after 6 weeks of PR-NW.

The increase of walked distance both after 6 and 12 weeks compared to initial results is statistically significant ($p < 0.05$). Furthermore there was a clinically significant increase (> 54 m) after 12 weeks. Statistically significant changes in dyspnoea perception on the Borg scale before and after 6MWT after 6 and 12 weeks of PR-NW were not found. There was an increase in average distance (28.2 m) and time (22 seconds) in which saturation dropped to 80% after 12 weeks of rehabilitation.

Dyspnoea evaluation

The results of dyspnoea evaluation on the basis of MRC, BDI test and visual Borg scale are presented in chart 3. In MRC, BDI and Borg scale the decrease in the perception of dyspnoea was noticed after 6 weeks and 12 weeks. The BDI questionnaire showed the changing results of dyspnoea evaluation in the studied group. After weeks of PR-NW an improvement was observed in domain force impairment (FI). Worse opinion of ability to undertake physical effort was observed both in cumulated evaluation of dyspnoea (FI+MT+ME) and magnitude of effort (ME) estimating in detail the occurrence of dyspnoea executing tasks connected with an effort. These differences were not statistically significant.

Tab. III. Evaluation of dyspnoea

		before	After 6 weeks	After 12 weeks
	MRC	3.5 ±0.52	3.33 ±0.71	3.22 ±0.44
BDI	FI+MT+ME	12.4 ± 2.1	11.8 ±1.48*	11.9 ±1.45**
	FI	4.6 ±1.51	4.22 ±0.7	4.7 ±0.86
	MT	3.5 ±1.08	3.7 ±0.71	3.44 ±0.53
	ME	4.3 ±0.68	3.9 ± 0.33	3.8 ±0.44
	Borg's scale	5.3 ± 2.95	4.6 ±2.6	4.7 ±3.12

Quality of life evaluation (SGRQ, SF-36)

General quality of life evaluation in SF-36 questionnaire showed changing results in various domains (chart 4). In domains evaluating role physical (RF), bodily pain (Bp), general health (GH), social functioning (SF), mental health (MH) and cumulative physical score (PCS) there was noticed improvement both after 6 and 12 weeks of PR NW. IN Bp, SF and PCS the improvement was statistically significant after 12 weeks. There was a decrease of quality of life in vitality (Vit), role emotional (RE) and cumulative mental health score (MCS). However, that decrease was not significant statistically or clinically (< 20 pts).

Discussion

This study is a prospective cohort study investigating the effectiveness of pulmonary rehabilitation with a Nordic walking programme of 12 weeks in patients with end-stage lung diseases referred for lung transplantation. This preliminary report shows that pulmonary rehabilitation in patients referred for LT leads to clinically relevant improvement in mobility (distance in 6MWT), perception of dyspnoea and quality of life. Rehabilitation in patients referred for lung transplantation is difficult to perform because of various factors. Patients in end stage lung diseases are prone to exacerbations resulting from pathology of progressive diseases. In our study 2 patients (14%) were excluded due to exacerbations. Further the 3328% drop-out rate in our study is similar to other studies where the drop-out rate may reach up to 31% [9]. One of the strengths of the present study is that the

Tab. IV. Quality of life evaluation – SF-36 (mean ±SD)

	before	After 6 weeks	After 12 weeks
Pf	16.00 ±20.92	15.63 ±17.82	18.89 ±18.50
RP	0	0	2.78 ±8.33
Bp	46.60 ±28.21	52.75 ±37.26	65.56 ±29.37**
GH	20.00 ±12.47	23.38 ±14.03	23.00 ±13.41
Vit	33.50 ±16.34	29.38 ±18.21	29.44 ±15.09
SF	21.25 ±21.29	28.13 ±17.36	29.17 ±17.68**
RE	13.33 ±32.20	29.16 ±45.21	7.40 ±14.68
MH	56.80 ±9.39	58.00 ±14.18	57.33 ±14.70
PCS	24.51 ±7.89	24.55 ±7.07	28.47 ±6.00**
MCS	39.95 ±8.43	39.58 ±10.88	35.72 ±6.96

population was far more homogeneous and serious in terms of pulmonary restriction and functional deficit than the populations studied in all previous trials [10-12]. To the best knowledge of the authors it is the first study on pulmonary rehabilitation with Nordic walking in such a group of patients. Nordic walking is fitness walking using specially designed poles for the purpose of activating the upper body during walking [13]. By using the poles and the muscles in the upper body the length of each step is supposedly increased, resulting in a faster gain. Nordic walking appears to increase gait speed, cardiovascular metabolism and higher oxygen consumption [14]. Due to the specially constructed poles Nordic walking can be performed independently of ground quality, and a rehabilitation programme could be performed in hospital as well as at home. A particular challenge in interventions involving patients participation such as exercise therapy is the issue of compliance with the prescribed exercises. It is obvious that training and exercise therapy are slightly more effective if delivered under the supervision of an instructor. In our study, after two weeks of supervised rehabilitation patients were instructed to note everyday walking activity according to their personal pedometer. Thanks to that, the authors hope that out of hospital therapy with Nordic walking was "partially" supervised. Guidelines and most papers on pulmonary rehabilitation demonstrate that the results of the 6-minute walking test are one of the main predictors of effect of pulmonary rehabilitation, instead of improvement of dyspnoea and quality of life [3, 10-12, 15]. Moreover, baseline 6-minute walk distance predicts survival in lung transplant candidates [16, 17]. Martinu et al. [17] demonstrated that the best survival after lung transplantation was observed in patients who were able to walk more than 400 m (1200 ft) before surgery. In our study, 3 patients (33%) after PR-NW increased their walking ability to more than 400 m. Mean increase of walking ability in our study group was 64 m. It is similar to the results of other studies on pulmonary rehabilitation in patients with restrictive lung diseases. Ferreira et al. reported increase in 6MWT by 56 m after 8 weeks of PR in patients with different forms of interstitial lung disease [18]. In a recent study Salhi et al reported increase in 6MWT distance by 64 m after 12 weeks and 81 m after 24 weeks of PR [19]. Salhi in his study performed a multidisciplinary rehabilitation programme with occupational therapy, nutritional support, patient education and psychosocial support. In Salhi's study the exercise programme included peripheral muscle training on fitness equipment, stair climbing, treadmill walking and bicycle training. The authors of the present study are surprised that similar results of PR were achieved using simple, cheap, cost-effective and easy to use method of Nordic walking. Recent studies of PR presented by Holland et al [20], Nishiyama et al. [21] and Ferreira et al. [22] presented fewer than 50 m improvement in walking distance in the 6MWT, independent of time and manner of the rehabilitation programme. In our study, we also observed improvement in perception of dyspnoea and quality of life. Differences are not statisticaly significant mainly due to a small study population. So we can only point out that PR in patients referred for LT results in improvement in perception of dyspnoea and quality of life. We hope that future studies on a large cohort of patients referred for lung transplantation could in detail analyse the influence of PR on dyspnoea and quality of life.

In conclusion, our study demonstrates that PR with Nordic walking has a significant improvement in functional status in patients referred for lung transplantation. While emphasizing the need for further research, we strongly suggest that PR-NW should be considered as a standard of care for patients referred for lung transplantation.

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