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Training Impact with Inspiratory Muscle Trainer Versus Pranayama On Pulmonary Functions Of Hemodialysis Patients

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Abstract : Background: Exercise is often recommended for patients with chronic diseases to improve physical conditioning and reduce complications of diseases**. Aims:** The purpose of this study was to evaluate the effect of inspiratory muscle trainer (IMT) versus pranayama on pulmonary functions in hemodialysis patients(HD) This study examined the effect of 12week of exercise training pulmonary functions includes (Forced vital capacity(FVC), forced expiratory volume in one second (FEV1), Forced expiratory flow (FEF) 25-75%, andpeak expiratory flow(PEF) and in HD patients. **Subjects and methods:**Forty HD men and woman participated in the study, their ages ranged from 45-55years. They were divided randomly into two groups; 20 patients each: Group (A) received IMT and resistance exercises for 12 weeks, 3 sessions per week. Group (B) received pranayama and resistance exercises 12 weeks, 3 sessions per week with. **Results:** IMT had a significant improvement in pulmonary function increase in (FVC, FEV1, PEF) (p was 0.0001*) (FEF 25-75%, P was 0.034*) in pranayama had significant improvement in pulmonary functions (p was 0.0001*).**Conclusions:**supervised program of IMT, Pranayama, and resistance exercises 12 weeks in hemodialysis men and woman results in a significant improvement of pulmonary functions.
Key word : hemodialysis; inspiratory muscle trainer; pranayama; pulmonary function;; resistance exercises.

Introduction

Chronic kidney disease (CKD) associated with hemodialysis therapy can have many musculoskeletal complications, in addition to ventilator complications[1]**.** Muscles responsible for inspiration, (diaphragm and intercostals), can show decreases in strength and endurance properties because of uremic myopathy [2]**.** CKD patients undergoing hemodialysis (HD)have low quality of life (QOL), low cardiorespiratory fitness and less functional capacity which can affectdaily living activities, work and social life [3]**,** musculoskeletal complications which is common in HD patients increases with longer life expectancy. Also other complications musculoskeletal issues are responsible for rapid reduction of functional abilities required for living independent and diminished QOL [4]**,** also increase risk of mortality, hospitalization and morbidity in HD patients [5]**,** and lower health-related quality of life (HRQOL)**[6].**Inspiratory muscle trainer (IMT) is one method to train the respiratory muscles. IMT improves strength of these muscles [7]**.** Patients limited in their exercise performance by

pulmonary limitations and dyspnea because of weakness of inspiratory muscles. Also blood flow and oxygen transport to the working muscle are decreased, thereby exacerbating limb fatigue and affecting exercise performance so they can benefit from IMT training [8]**.** IMT may contributed to improved respiratory volumes by the tension–length ratio of the diaphragm get better through placing it in advantageous mechanical position, and diaphragm be more effective in contraction during respiratory cycle [9]**.** Reduction of sensation of difficulty of breathing lead to change of the SF-36 after IMT training, which it is essential in improving QOL of these patients [10]. IMT has good effects on functional capacity and QOL of HD population [11]**.** Pranayama is composing of deep inspiration and relaxation which have a good effect on blood pressure by relaxation the mind; so it reduce stress [12]**.**

Respiratory effects of pranayama techniques with physical movement decrease sympathetic stimulation, improve levels of gamma-amino butyric acid (GABA), also improve mood disorders byregulate the hypothalamic pituitary adrenal axis (HPA),so it affects stress, well-being and causes an anxiolytic effect [13]**.** Intradialytic exercises improve physical function, also cardiovascular disease markers and QOL [14]**.**

Resistance training (RT) improves biochemical and strength parameters of muscles, physical capacity, strength, and body composition and QOL of the HD patients [15]**.**

2. Materials And Methods

Participants

This study was conducted on forty volunteers of both sexes (20men and 20women) who underwent hemodialysis included in the study, aged from 40-55 years old and recruited from hemodialysis unit, Kasr –EL-Ainy hospital at faculty of medicine, Cairo University. They signed a consent form. The training program was carried in the duration from September 2015 to November 2015. The history and clinical examination were done for all participants. Subjects who fulfilled the following criteria were eligible for enrollment in the study; (1) all participants were clinically and medically stable when attending the study. (2) Physical and mental ability to complete fitness tests and fill out HRQOL questionnaires. (3)were able to participate in exercise program at least twice a week. (4) All the 40 participants were not highly conditioned or engaged into close, previous regular training and were instructed not to make any dietary changes throughout the study.(5) All of them were under medical control, receiving their physician-prescribed pharmacotherapy regularly.

Treatment

After exclusion of the subjects who not fulfilled the inclusion criteria, the participants were randomized into two groups of equal number as A and B (n=20) subjects in each group. Both groups performed intradialytic resistance exercises. Group A received IMT (threshold inspiratory muscle training device) and group B received pranayama .The ventilatory function (FVC, FEV1, FEF 25-75%, PEF) measured by Computerized electronic spirometer (pulmonary function machine semi-new brand model trans/flow) and QOL by using the short form-36 questionnaire "Medical Outcomes Study 36 (SF36) before and after 12 weeks..

Procedure

Participants in both groups received intradialytic exercises according to the following:

Intensity: 30% to40% of 1 repetition maximum (RM) for upper body exercises and 50% to 60% of 1RM for lower body exercises ,the resistance would increase incrementally based on the rate of perceived exertion (RPE) scored by the patient on the Borg Scale, **Frequency:** 3 times per week. **Time:** resistive exercises were be performed in second hour of hemodialysis

Training: 2 sets of 10 repetitions of 10 exercises targeting the major muscle groups of the upper and lower extremities (1-Shoulder press exercise, 2-Shoulder abduction exercise,3-Elbow flexion exercise, 4-Elbow extension exercise,5-Shoulder external rotation exercise,-Knee extension exercise,7-Hip abduction exercise,8-Ankle dorsiflexion exercise,9-Hip flexion exercise,10-Straight leg raised exercise**),** using free-weight dumbbells for upper body exercises, and weighted ankle cuffs for lower body exercises.

Each participant in group (A) would be receiving IMT. Starting resistance equal to 30% of their maximal inspiratory pressure (MIP), Session duration 15minutes, frequency3 times/weeks for 12 weeks. The resistance would increase incrementally based on RPE scored by the patient on the Borg Scale [17].

Each participant in group (B) would be receiving pranayama as following:

- Participants set comfortably and upright with back straight, head extends slightly upward. `

- participants inhaled deeply and slowly then exhaled slowly and quietly .There is no pause between inhalation and exhalation for 3 min then relaxed the patient for 1 min.

- Participants brought his/her hand up to nose used right thumb was used to close right nostril and the index finger was used to close left nostril (patient could use right or left hand).

- Participants closed right nostril by using right thumb and were asked to inhale completely through left nostril. Inhalation was slow, smooth, at the end of inhalation closed both nostrils and hold breath for a while (not more than 1-2 seconds). Keep left nostril closed and exhale through right nostril as quietly as possible [18].

- After exhaling completely, inhale slowly and quietly through right nostril. Close both nostril and wait for a while, then open left nostril and exhale slowly , this end of cycle of breathing repeated for 3 min, relax for 1 min.

- Participants inhaled through left nostril, they were asked to exhale completely through left nostril.

- Participants closed left nostril and inhaled from right nostril follow by exhalation from right nostril the inhalation and exhalation nostrils was reversed.

Statistical Analysis:

All statistical measures were performed using the Statistical Package for Social science (SPSS) program version 18 for windows. Prior to final analysis, data were screened for normality assumption, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculation of the analysis of difference and analysis of relationship measures. To determine similarity between the groups at base line, subject age, height, body mass index (BMI) and body weight were compared using independent t tests.

The current test involved two independent variables. The first one was the tested group which had two levels (group A & group B). The second one was the training periods which had two levels (pre and post). The dependent variables were pulmonary functions. Accordingly, 2×2 mixed design multivariate analysis of variance (MANOVA) was used to compare the tested variables of interest at different tested groups and training periods. MANOVA was conducted with the initial alpha level set at 0.05.

RESULTS

The study involved forty men and women hemodialysis patients. Their age ranged from 45 to 55 years. The patients were assigned into two groups equal in number: the first group (A) received IMT and intradialytic exercises 3 times per week for 12 week. The second group (B) received pranayama and intradialytic resistance exercises 3 times per week for 12 week in order to compare between the effect of IMT versus pranayama on pulmonary functions include (FVC, FEV1, FEF 25-75%, PEF) in both groups. (Table 1) represented non significance difference between both groups in (age, weight, height, and body mass index (BMI).

Table (2) represents descriptive statistic (mean ± SD) and multiple pairwise comparisons between pre and post treatment values of FVC, FEV1, PEF, and FEF 25-75% in both groups. Multiple pairwise comparison tests revealed that there were significant increase ($p < 0.05$) in FVC, FEV1, PEF, and FEF 25-75% in the post treatment condition compared with the pre- treatment one in both groups., with no significant differences in FVC, FEV1, and FEF 25-75% between both groups there were significant increase and high percent of improvement ($p < 0.05$) in group B compared with group. differences in other dependent variables between both groups.

So it can be concluded that both (IMT and pranayama)with intradialytic resistance exercises have a positive effect on pulmonary functions.

Participant's characteristics

Table 1: Descriptive statistics for comparing the mean age, weight, height, and BMIof group A and B

Groups	Group A	Group B	P-Value	Sig
Age (years)	52.55 ± 1.75	53 ± 4.09	0.60	NS
Weight (kg)	88 ± 3.14	87.55 ± 3.79	0.63	NS
Height (cm)	160.2 ± 2.73	162.75 ± 2.46	0.45	NS
BMI (kg/m²)	30.28 ± 0.83	31.35 ± 0.68	0.83	NS

Table 2.Descriptive statistics and multiple pairwise comparison tests (Post hoc tests)for the FVC, FEV1, PEF and FEF 25-75% in hemodialysis patients in pre and post treatment for both groups.

Dependent variables	Group A (N=15)		Group B (N=15)	
	Pre treatment	Post treatment	Pre treatment	Post treatment
FVC	56.1±9.84	71.3 ±11.26	53.55 ±2.41	67.65±12.43
FEV1	55.1±13.79	70.6 ±9.15	52.7 ±6.89	69.3±17.11
PEF	39.4±14.98	50.65 ±12.48	39.8 ±16.42	63.35±12.82
FEF 25-75%	53.15±22.21	64.6 ±13.18	47.8 ±11.88	70.25±21.99
Multiple pairwise comparisons between pre and post treatment values for all dependent variables				
Dependent variables	FVC	FEV1	PEF	FEF25-75%
Group A	0.0001*	0.0001*	0.0001*	0.034*
Group B	0.0001*	0.0001*	0.0001*	0.0001*

*Significant at the alpha level ($p < 0.05$).

Discussion

This study was conducted to assess the responses of pulmonary functions to inspiratory muscle trainer, pranayama and resistance training in hemodialysis (men and women). This study was conducted on forty hemodialysis patients' volunteer men and women their ages ranged from 45to 55 years old. They were divided into two groups equally in number, matched for measured variables: In this study, the measuring variables showed no significant differences in between both groups at the baseline ($P< 0.05$). The results showed that IMT had a significant improvement in pulmonary function increase in (FVC, FEV1, FEF 25-75%) (P was 0.0001*) (PEF, P was 0.034*), in pranayama had significant improvement in (FVC, FEV1, FEF 25-75%, PEF) (p was 0.0001*) .

-Effect of IMT

These results coincided with results achieved by **McConnell and Romer** who reported that IMT can strengthen the inspiratory muscles, so require less effort so dyspnea is decreased. IMT relieves dyspnea by decreasing dynamic hyperinflation of rib cage and increasing gas exchange, improving strength and endurance of the respiratory muscles, and maximizing the pattern of thoraco-abdominal motion [19]. These results coincided with results achieved by **Bosnak-Guclu et al.,** reported that sixteen patients received IMT at 40% of MIP, for 6 weeks. Functional capacity and balance, respiratory and peripheral muscle strength, dyspnea, depression were significantly improved in the treatment group compared with controls; quality of life and fatigue were improved ($p < 0.05$) [20]. **Shendy and Farag** studied effect of IMT on fifteen patients, second day post lung decortication surgery received 12 sessions of treatment, 6 each weeks, starting resistance was equal to 30% of MIP,. The results showed that IMT increased significantly ($P< 0.05$) FVC, FEV1, maximum voluntary ventilation (MVV)

[21]. Other studies have noted that, although small, the variation in predicted values on spirometry in CKD leads to a significant impact on physical capacity [22]**. Also Felix et al** who evaluated the effects IMT in patients with Ataxia Telangiectasiathe results showed significant increaseof ventilation, respiratory volumes, difficulty of breathing, inspiratory muscle strength, and QOL [11]. IMT is attributing to increases in both strength and endurance of inspiratory muscles might be related to adaptive structural changes of respiratory muscles, reduction of air trapping, increases in mitochondrial content may provide an improvement in the aerobic capacity of respiratory muscle and contribute to maximal work performance increase and the imposed load raises pressure generation capacity and flow and promotes an increase in lung volumes [23]**.**

Effect of pranayama

These results coincided with results achieved by **Tayyebi et al.,** [24] Pranayama exercises were performed after the initial training for one hour twice a week during two month.Analysis between the mean stress, anxiety and depression values andshowed significant increase in dialysis adequacy among hemodialysis patients **Bernardi et al** tested the hypothesis that a 4-month respiratory training program of pranayama improves respiratory function, cardiac sympathovagal balance and quality of life [25]. **Kondam et al** investigated the effect of pranayama onmany dynamic spirometric values after 6 months of a training program the vital capacity (VC), FVC, FEV1, FEV1/FVC, peak expiratory flow rate (PEFR), and FEF25–75% values were significantly change ($p < 0.05$) in the pranayama group .Pranayama causes more positive effects than physical exercise that affects sides of the thoracic cavity. Affect respiratory airways especially bronchioles and the alveoli mainly at the alveolo-capillary membrane to enhance diffusion and transport of gases. Alsoimprove oxygenation at tissue level [26]**. Shankarappa et al** studied effects of short- term pranayama (6 weeks) on the pulmonary function parameters,the FVC, FEV1, PEFR, FEF (25%-75%) For all the parameters, a P value of <0.001 was considered as statistically significant [27]. **Panwar et al** reported thatthere was significant increase in tidal volume (TV), vital capacity(VC), and MVV after three months of pranayama. Force expiratory parameters FVC, FEV1/FVC, PEFR, and FEF25-75% significant increase after three months of pranayama [28]. **Bijlani et al** studied the significant improve in FVC and PEFRafter 6 weeks of pranayama training [29]. Study show that regular practice of pranayama for six weeks increased parasympathetic tone, decreased sympathetic activity and improved respiratory functions. During Pranayama the ventilation increases in all zones of the lungs this increases the diffusion capacity of gases [30]**. Reddy et al** showed after 9 weeks of regular pranayama training FVC, PEFR and MVV respectively. 'P' values were significant. This may be due to beneficial effect of Pranayama on respiratory system [31].**Waghmare and Baji,** reported thatThere was significant decrease in respiratory rate (RR) while FVC, FEV1 PEFR, MVV were significantly increased in subjects after the practice of pranayama [32]**.**

Effect of resistance exercises

These results coincided with results achieved by **Heiwe and Jacobson ,** confirmed that resistive exercises at least three times/week for more than 30 minutes per session for CKD people was effective for enhancement physical fitness, walking capacity and HRQL [33]. **Marchesan et al** studied effect ofstrength training during HD,for three times/week, for 4 months. Improvement of QoL was observed in the following domains: physical functioning ($p<0.001$), physical role functioning ($p<0.003$), pain ($p<0.04$), general health ($p<0.02$), and emotional well-being ($p<0.01$) [34]. **Kouidi et al**showed training improved 42% muscle strength of lower limbs and decreased number of atrophic fibers and significant increases in cross-cutting areas in muscle fibers, especially in type II, which reflected in increased 48% in volume of oxygen (VO2) (peak) and 29% in exercise time [35]. **Molsted et al.,** Studied effects of resistance training in dialysis patients, the primary outcomes were changes in quality of life, physical performance, and both muscle power and strength, resistance training improves muscle strength in dialysis patients [36]. Also **Heiwe and Jacobson**performed progressive resistance training(PRT) for 30 minutes per session, 3 sessions a week, for 12 weeks with hemodialysis patients, Results: Skeletal muscle mass, grip, leg muscle strength, and quality of life all improved significantly in the exercise group [37]**. Segura-Orti et al** applied strength training for 24 weeks and improved scores for the quality of life questionnaire, SF-36-mental component summary scores (MCSS) [38]. **Chen et al** performed strength training and also noted an increase in the questionnaire score for QOL; SF 36- physical component summary scores PCSS [39]. **Cheema et al.,** found PRT significantly improved standardized muscular strength and HR-QOL; clinicians consider prescribing PRT for inducing skeletal muscle hypertrophy and increasing muscular strength and HR-QOL outcomes in patients with CKD.PRT elicited a statistically and clinically significant anabolic response in hemodialysis patients that was very similar to the response in healthy participants [40]. PRT increased strength in both hemodialysis patients and healthy participants. In contrast, PRT only enhanced lower body

functional capacity in the healthy participants [41]**. Ribeiro et al** observed improvement in QOL in all evaluated parameters sf-36, ($p < 0.001$). These results indicated that the resistance exercises program during HD was reliable in demonstrating an improved QOL [16]. The disagreement in the results of current study with other contradicting studies can be explained simply by suggestions that an intensity and duration were not sufficient to produce significant alterations in pulmonary function, quality of life and exercises program not companied with resistive exercises. **Silva et al., who** reported that eight weeks, IMT protocol was applied during hemodialysis sessions, with load set to 40% of PImax pulmonary function showed no statistically significant difference when comparing values before and after IMT [42]. **Kumar et al** found no statistically significant difference in PEFR after pranayama [43].

Conclusion

Finally it can be concluded that a supervised program of IMT, Pranayama, and resistance exercises 12 weeks in hemodialysis men and woman results in an improvement of pulmonary functions, and QOL. That may support the hypotheses suggesting the beneficial role of exercise in improving QOL in HD men and woman.

Compliance with ethical standards

Funding This research received no specific grant from any funding agency.

Conflict of interest the authors declare that they have no conflict of interest.

Consent form was obtained from patients included in this article.

Ethical approval The Ethical Committee of Faculty of Physical Therapy approved the study protocol before starting the study.

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