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Inspiratory Muscle Training Versus Slow Deep Breathing on Blood Pressure in Essential Hypertensive Patients

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Abstract : objectives: the aim of this study was to investigate the efficacy of inspiratory muscle training versus slow deep breathing on blood pressure in essential hypertensive patients. **Methods:** Forty male patients with essential hypertension aging between 30 to 40 years with BMI between 24.01 to 28.08kg/m^2 participated in this study. They were assigned randomly into equal groups. Participants of the group (A) received inspiratory muscle training program, while the group (B) received slow deep breathing program lasting one month.Blood pressure (BP) was assessed by mercury sphygmomanometer and quality of life was assessed by the hypertension health related quality of life questionnaire (MINICHAL). The participants were tested twice; before and after the training program. **Results:** the statistical analysis revealed that there was a significant decrease of (BP) ingroup (A) more than group (B) in the post treatment condition compared with the pre-treatment one ($p<0.05$). Moreover, there was a significant improvement of quality of life in group (A) more than group (B) in the post treatment condition compared with the pre-treatment one ($p<0.05$). **Conclusions:** Inspiratory muscle training is more effective than slow deep breathing on decreasing blood pressure in essential hypertensive patients.
Keywords : essential hypertension; inspiratory muscle training; slow deep breathing;(MINICHAL)questionnaire.

Introduction

Hypertension is an important public health challenge in both economically developing and developed countries**.** Worldwide prevalence estimation for hypertension may be as much as 1 billion individuals and approximately 7.1 million deaths per year may be related to hypretension[1].

Hypertension is a widespread health problem and is called the "silent killer" because it often has no warning signs or symptoms and many people don't realize they have it[2].It is a major risk factor for cardiovascular disease as well as other maladies including renal disease, stroke, heart failure and peripheral artery disease. Also, it increases the risk of blindness and dementia and considered the number one cause of death in America[3].

Essential hypertension is the most prevalent type that affect 90-95% of hypertensive patients,[3]there is no single identifiable cause for this type of hypertension.It's pathogenesis is multifactorial, like genetic factors which play an important role and environmental factors such as sedentary lifestyle, stress, high salt intake, smoking and high alcohol intake. Other factors like Obesity, insulin resistance and ageing[4].Secondary hypertension is a less common, affects about 5 to 10 percent of hypertension cases which results from various conditions and medications[5]**.**

Previous studies have reported that autonomic cardiovascular control alterations with different breathing patterns implicating a ventilatory influence on hemodynamics[6]. So respiratory control exercises may be an applicable treatment option for hypertension with a more favorable side effect compared to pharmacology.[7]

Respiratory modulation is related to cardiovascular modulation and it plays a vital role in blood pressure control. This important interactivity is noticed by the generalized alteration that occurs in cardiovascular control in conjunction with respiratory pattern modifications. This relationship is likely related to baroreceptor and chemoreceptor sensitivity interaction and its influence on the mechanisms of blood pressure control[7]**.**

Slow breathing decreases baseline heart rate and blood pressure and this is associated by improving vagal tone and by decreasing sympathetic discharge. Improvement in both sympathetic and parasympathetic reactivity may be the mechanism that is associated in those practicing the slow breathing exercises[8]**.**

Inspiratory muscle training (IMT) may decrease work of breathing, metabolic costs of breathing and central nervous system's perception of inspiratory output so that dyspnea and exercise capacity would be improved[9].

Moreover, induction of inspiratory muscle fatigue in healthy humans results in an increase of muscle sympathetic nerve activity, heart rate ,mean arterial pressure and a gradual reduction in arterial blood flow to the resting limbs Therefore experimental research shows that a fatiguing diaphragm leads to increased sympathetic outflow[10]**.**

Inspiratory muscle training (IMT) which does impose an external resistance to the respiratory muscles has proved beneficial training effects in patients with cardiovascular disease specifically in patients with chronic heart failure[11].

Patients, instrumentation and intervention protocols

Patients

Forty male patients with mild essential hypertension, systolic blood pressure range (140 - 159 mm Hg) and diastolic blood pressure range (90 - 99 mm Hg) with no change in medications for at least 2 months preceding the study. Their ages ranged between30 to 40 years with BMI between 24.01 to 28.08kg/m^2 participated in this study. Patients were selected randomly fromEgyptian National Heart Institute.They were assigned randomly into two groups. Participants of the group (A) n= 20, while the group (B)n = 20lasting one month period. Patients with history ofischaemic heart disease, congestive heart failure, chronic atrial fibrillation, renal failure, diabetes mellitus, previous stroke, major organ failure, respiratory diseases, psychiatric disorders and Any Other Secondary causes of hypertension were excluded from this study.

Instrumentation

For evaluation

Mercury sphygmomanometer for measuring arterial blood pressure includes a stethoscope and a sphygmomanometer. The stethoscope tubing should be long enough to permit the practitioner to auscultate Korotk off sounds while viewing the manometer at eyelevel. The sphygmomanometer consists of a blood-pressure cuff containing a distensible bladder, a rubber bulb with an adjustable valve for inflation, tubing that connects the cuff to the bladder and a manometer[12].

Quality of life questionnaire: quality of life was assessed by the hypertension health related quality of life questionnaire (MINICHAL). MINICHAL is a multiple choice 16-question questionnaire organized in 2 factors: Mental Status (10 questions) and Somatic Manifestations (6 questions), and 1 question to assess the patient's perception of how hypertension and its treatment have influenced his/her quality of life[13].

For treatment

Inspiratory muscle trainer :Threshold inspiratory muscle trainer (IMT) provides an easy, convenient and practical way to train inspiratory muscle. Resistance is controlled by a dial selector to detect resistance level. It is packaged with a separate mouth piece, main body and nose clip .It used for strengthing inspiratory muscles.

Intervention protocols

For evaluation

Mercury sphygmomanometer for measuring arterial blood pressure: while patient in comfortable sitting position, Wrap the BP cuff snugly around the arm approximately 2 cm above the elbow crease, determine the pulse-obliteration pressure by palpating the radial pulse while rapidly inflating the cuff to approximately 80 mm Hg. Then slow the inflation rate to approximately 10 mm Hg every 2 to 3 seconds, taking note of the reading at which the pulse disappears. After the pulse has disappeared, deflate the cuff at a rate of 2 mm Hg per second, noting when the pulse reappears which confirms the obliteration pressure. Then place the stethoscope over the brachial artery, pumping the cuff bulb to a level 20 to 30 mm Hg above the pulse-obliteration pressure as you should hear no sounds through the stethoscope. Then deflate the cuff at a rate of 2 mm Hg persecond until hearing the first a clear, repetitive tapping sound (the systolic blood pressure)then continue in deflation until disappearance of sound(the diastolic blood pressure)[12].

Hypertension health related quality of life questionnaire (MINICHAL): The patient answered the questions before and after the treatment program. The answers in the domains are distributed on a Likert-type frequency scale, with four answer options from 0 (No, not at all) to 3 (Yes, very much). The Mental Status domain comprises questions 1 to 9, and its maximum score is 27. The Somatic Manifestations domain comprises questions 10 to 16, and its maximum score is 21. Question number 17, which assesses the patient's overall perception of his/her own health, is also scored with the Likert scale but is not included in either of the two domains. The closer the result is to 0 (zero), the better the quality of life[13].

For treatment

The patients performed IMT for 30minutes (one minute training followed by 2 minutes rest), twice per day, 5 days per week, for 4weeks using the Threshold Inspiratory Muscle Trainer (Philips, respironics). During training, subjects were instructed to maintain diaphragmatic breathing exercise(12-15 breath/min) while patients in comfortable half lying and knee slightly flexed and supported by pillow. Inspiratory load was set at 30% of maximal static inspiratory pressure (PImax), and the training loads were increased weekly 5% of PImax during all study period.

The patients performed slow deep breathing for 30minutes (one minute training followed by 2 minutes rest), twice per day, 5 days per week, for 4weeks.During training, subjects were instructed to perform 6 cycles per minutes while patients in comfortable half lying and knee slightly flexed and supported by pillow.The inspiration should be from the nose and expiration from mouth during exercises. The expiratory phase should longer than inspiratory phase.

Data analysis

It was intended to compare between the "pre- treatment" and "post- treatment" in inspiratory muscle training and slow deep breathing groups "between subject effect". Also it was intended to compare between the "pre- treatment" and "post- treatment" conditions "within subject effect" .T-tests were conducted to determine whether there were significant differences in the set of dependent variables across the two experimental groups.

Results

All statistical measures were performed using the statistical package for social science (SPSS) program version 19 for windows. Prior to final analysis, data were screened for normality assumption, and presence of extreme scores. This exploration was done as apre- requisite for parametric calculation of the analysis of the difference.

Demographic data of patients

As indicated by one-sample t-test, there were significant differences ($p<0.05$) in the mean values of age,weight, height and BMI between subjects in both groups. The demographic data of the participants are shown in (Table 1).

Table (1):one sample t-tests statistics for the demographic data of the participants in both groups.

Variable	Group A	t-value	p- value	Group B	t-value	p- value
Age (yrs)	35.4±3.03	52.19	0.0001	34.75±2.88	53.93	0.0001
Weight(kg)	73.95±7.35	44.98	0.0001	72.4±7.57	42.73	0.0001
Height(cm)	168.5±8.07	93.31	0.0001	166.7±6.29	118.48	0.0001
BMI(kg/m^2)	26.4±0.9	130.88	0.0001	25.97±1.19	97.59	0.0001

Statistical analysis using the results of paired t-test in Table(2) (3) (4) revealed that there was a significant difference between pre and post treatment in each group which there was a decrease in systolic blood pressure, diastolic blood pressure andMINICHALquestionnaireafter one month of treatment. Also the percentage of change was larger in group (A) than (B) which means that inspiratory muscle training was more effective than slow deep breathing.

Table (2): Comparison of systolic blood pressure before and after inspiratory muscle training and slow deep breathing treatment and relative percentage of change for both groups .

Group	systolic blood pressure (mmHg)		Percentage of change	T- value	P- value
	Baseline	After one month			
A	150 ± 6.92	139.8 ± 6.94	10.2 ± 1.15	39.6	P < 0.0001*
B	151.2 ± 7.29	144.4 ± 7.3	6.8 ± 1.1	27.52	P < 0.0001*

Level of significance at $p<0.05$ *= significant Plus-minus(±)values are mean standard deviation (SD)A:inspiratory muscle training B:slow deep breathing

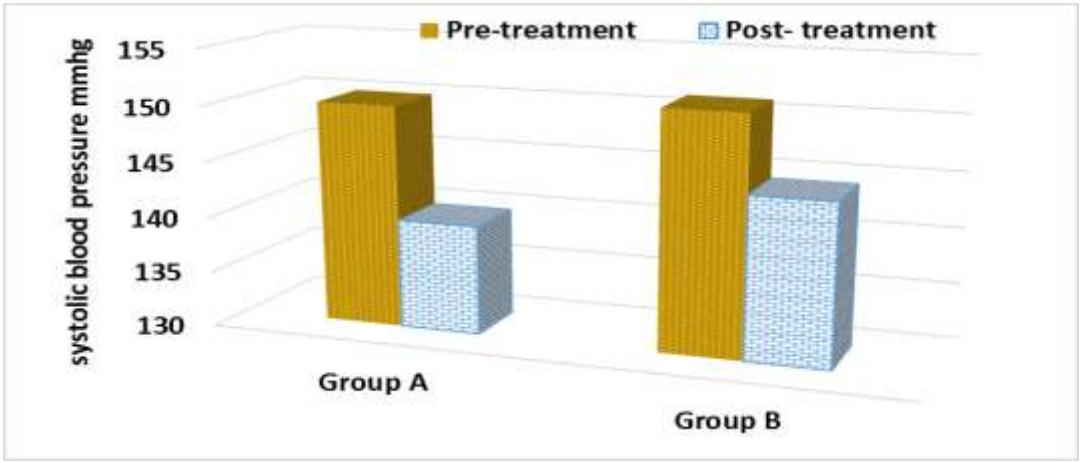

Figure (1): Comparison of systolic blood pressure before and after inspiratory muscle training and slow deep breathing treatment and relative percentage of change for both groups.

Table (3): Comparison of diastolic blood pressure before and after inspiratory muscle training and slow deep breathing treatment and relative percentage of change for both groups .

Group	Diastolic blood pressure (mmHg)		Percentage of change	T- value	P- value
	Baseline	After one month			
A	95.95 ± 3.79	90.7 ± 3.92	5.25 ± 1.06	21.94	P < 0.0001*
B	95.8 ± 3.47	92.85 ± 3.49	2.95 ± .75	17.37	P < 0.0001*

Level of significance at p<0.05 *= significant Plus-minus(±)values are mean SD
A:inspiratory muscle training B:slow deep breathing

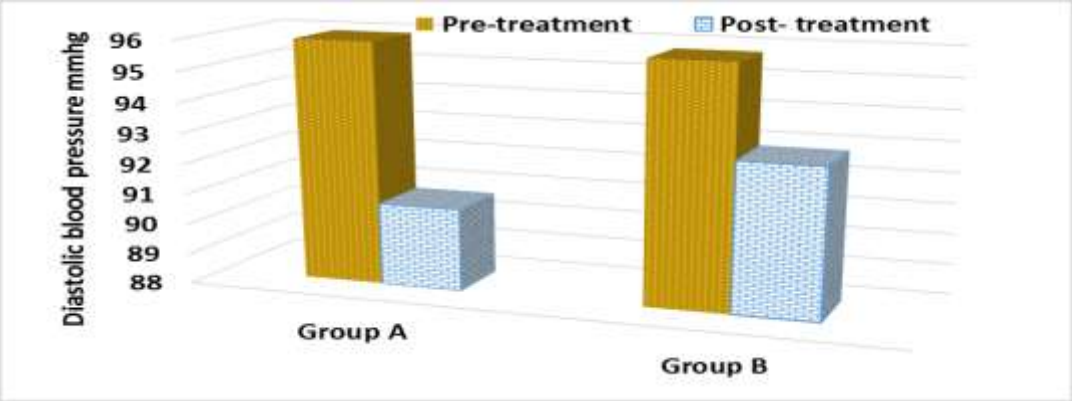

Figure (2): Comparison of diastolic blood pressure before and after inspiratory muscle training and slow deep breathing treatment and relative percentage of change for both groups.

Table (4): Comparison of MINICHALquestionnaire before and after inspiratory muscle training and slow deep breathing treatment and relative percentage of change for both groups.

Group	MINICHAL questionnaire		Percentage of change	T- value	P- value
	Baseline	After one month			
A	23.8 ± 3.01	3.75 ± 1.71	20.05 ± 1.35	66.11	P < 0.0001*
B	23.65 ± 4.41	12.85 ± 2.92	10.8 ± 2.94	16.38	P < 0.0001*

Level of significance at p<0.05 *= significant Plus-minus(±)values are mean SD
A:inspiratory muscle training B:slow deep breathing

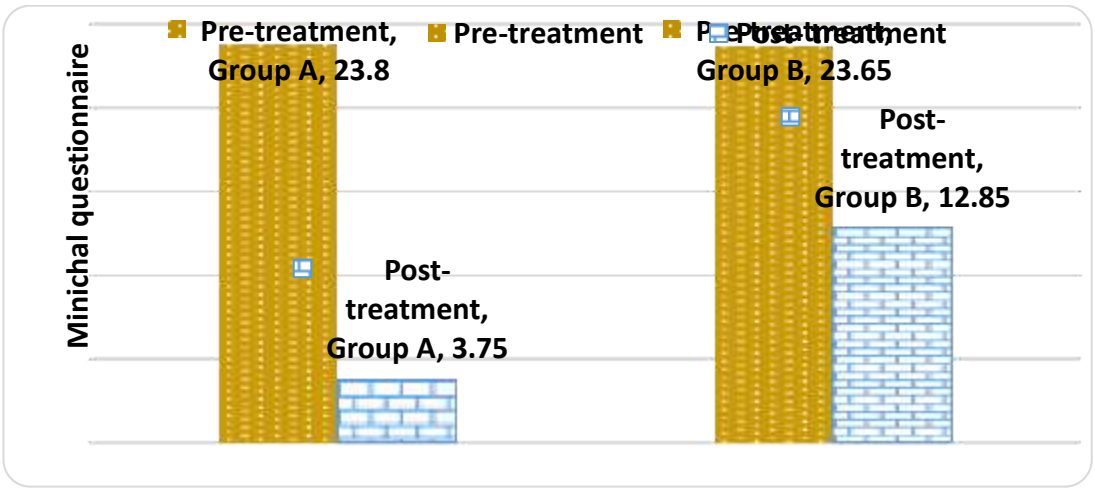

Figure (3): Comparison of MINICHALquestuionnaire before and after inspiratory muscle training and slow deep breathing treatment and relative percentage of change for both groups .

Discussion

The aim of the current study was to investigate the effect of Inspiratory Muscle Training Versus Slow Deep Breathing on Blood Pressure in Essential Hypertensive Patients. Blood pressure and Hypertension health related quality of life questionnaire (MINICHAL) was evaluated before and after the treatment.

The finding of our study revealed that the Inspiratory Muscle Training and Slow Deep Breathing can help to decrease Blood Pressure and improve and Hypertension health related quality of life questionnaire (MINICHAL)in Essential Hypertensive Patients. Also the significant decrease of blood pressure and improvement of Hypertension health related quality of life questionnaire (MINICHAL) in group (A) which received Inspiratory Muscle Training compared with group (B) which received Slow Deep Breathing, indicated that the Inspiratory Muscle Training had more effect on Blood Pressure than Slow Deep Breathing in Essential Hypertensive Patients.

The results of our study is consistent with the study of Jones et al. (2010) who performed slow deep breathing at home, either unloaded or breathing against a load of20 cmH_2O using a threshold-loaded breathing device for 30 min, twice daily for 8 weeks Thirty patients with essential hypertension Stage I or II. They found that systolic and diastolic blood pressure decreased significantly with unloaded breathing by means of 13.5 mmHg (95%CI 11.3 to 15.7) and7.0 mmHg (95% CI 5.5 to 8.5) , respectively (laboratory measures). With loaded breathing, the reductions were greater at 18.8 mmHg (95%CI 16.1 to 21.5) and 8.6 mmHg (95% CI 6.8 to 10.4), respectively. The improvement in systolic blood pressure was 5.3 mmHg(95%CI 1.0 to 9.6) greater than with unloaded breathing[14].

Ferreira et al. [7] studied the effect of Inspiratory muscle training on blood pressure in thirteen patients with essential hypertension were randomly assigned to an eight-week IMT program (6 patients) and a placebo-IMT (P-IMT, 7 patients) protocol. They recorded blood pressure by ambulatory blood pressure monitoring (ABPM) before and after the program and found that a reduction in 24-hour measurement of systolic (133.2±9.9 vs 125.2±13.0 mmHg, P=0.02)and diastolic (80.7±12.3 vs 75.2±1.0 mmHg, P=0.02) blood pressure, as well as in daytime systolic (136.8±12.2vs 127.6±14.2 mmHg, P=0.008) and diastolic (83.3±13.1 vs. 77.2±12.2mm Hg, P=0.01) blood pressure in the IMT group. They found the decrease in blood pressure caused by enhancement of respiratory muscle function by IMT that may increase fatigue resistance andlessen sympathetic outflow. Also they observed an increased parasympathetic modulation afterIMT compared to P-IMT[7].

Also our results was matched with the results of Joseph et al. [15] who mentioned a significant decrease in blood pressure in essential hypertensive patients pressures (from 149.7± 3.7 to 141.1 ± 4 mmHg and from 82.7± 3 to 77.8 ± 3.7 mm Hg respectively) by applying spontaneous and controlled breathing at slower (6/min)breathing rate[15].They mentioned many possible explanations for their findings that Slow breathing at 6 cycle/min has the effect of entrainingall RR interval fluctuations causing them tomerge at the rate of respiration and to increase greatly in amplitude. This increase in RR interval fluctuations (relativeto blood pressure changes) has the effect of enhancing the baroreflex efficiency[16] and contributed to decrease blood pressure. Additionally, slow breathing may reduce sympathetic activity by enhancing central inhibitoryrhythms[17] and consequently decrease the blood pressure while enhancing the baroreflex. Furthermore, thei ncrease in tidal volume activates the Hering–Breuer reflex which in turn reduces the chemoreflex sensitivity and thus might enhance the baroreflex with an additional effect on reducing blood pressure and sympathetic activity[18].

Conclusion

The Inspiratory Muscle Training had more effect on Blood Pressure than Slow Deep Breathing in Essential Hypertensive Patients.

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