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Effect of Diaphragmatic and Lateral Costal Expansion Exercises versus Cork Screw and Hip Twist with Flexed Elbow on Expiratory Flow Rate - A Comparative Study

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ABSTRACT

Breathing is the most vital function for maintenance of life. The present study was planned to know the effects on expiratory flow rate by two different methods, one is diaphragmatic and lateral costal expansion and other is cork screw and hip twist with flexed elbows.

Objectives: The main objective of this study was to evaluate that which group of exercises have more impact on lung function, thoraco-abdominal mobility, respiratory muscle strength and mainly expiratory flow rate.

Materials and Methods: Thirty volunteers were participated both male and female aged between 20 and 40 years and they were assigned in two groups. Group A were given Cork Screw and Hip twist with flexed elbow and group B were given Diaphragmatic and lateral 2 costal expansion exercises. Both groups received selected intervention for 43 weeks, 5 days in a week, 2 times a day, and 20 minutes per session. Pre and post- test measures of forced expiratory flow rate were taken by peak expiratory flow meter. Data was analysed using Statistical Package for Social Sciences (SPSS) version 17.0 software. The analysis was performed by using students paired t-test.

Results: Both groups (Group A and Group B) showed increase in expiratory flow rate with the help of standard deviation. Standard deviation of Group A is 98.038 and Group B is 115.750.

Conclusion: Our study concluded that Cork screw and Hip twist with flexed elbow exercises significantly increase expiratory flow rate as compared to Diaphragmatic breathing and Lateral costal expansion exercises.

Keywords: Peak expiratory flow meter, expiratory flow rate, Diaphragmatic breathing, Lateral costal expansion exercises, Pilates exercises, Cork screw, Hip twist with flexed elbow exercises

INTRODUCTION

Deep breathing is called “diaphragmatic” because it emphasizes the use of the diaphragm, the muscular sheet underlying the rib cage. When the diaphragm contracts, it pushes down on the internal organs of the abdomen, enlarging the space allotted to the thoracic cavity and causing the lungs to expand. The stronger is the contraction, the more air will be inhaled1,2.

Like other skeletal muscles, respiratory muscles respond to stimuli through physical training. For this purpose, regular practice of physical exercises is recommended. The breathing standard used in the Pilates method is known as “lateral breathing”, that is,

prevents the expansion of the abdominal region during inspirations. Using predominantly the chest and ribcage muscles, increases the room for pulmonary expansion and thus, influence lung volumes in healthy volumes in healthy individuals practitioners of the method3.

The peak expiratory flow rate (PEFR) test measures how fast a person can exhale. The PEFR test is also called peak flow. This test is commonly performed at home with a handheld device called a peak flow monitor4,5

Aim of the study:

The main objective of this study was to evaluate that which group of exercises have more impact on lung function, thoracoabdominal mobility, respiratory muscle strength and mainly expiratory flow rate.

MATERIALS & METHODS

Write here procedure/technique of your research study.

The present study is a pre- test post test experimental study, conducted in normal individuals. This is a randomized placebo-controlled clinical trial with 30 volunteers, who were allocated for convenience in two groups. The purpose of the study was explained to the volunteers in their language. All signed an institutionally approved informed consent statement prior to data collection. Thirty volunteers were assigned into two groups (group A and group B). Each group consisted of equal number (15) of volunteers. Study was approved by Institutional Review Board. T-test was used for calculation of the results

Procedure: Group A- Control Group

- **Diaphragmatic breathing exercise:** Subjects were asked to lie in supine position, placing the pillows under head and knees. Then, ask the subject to inhale through nose and exhale through mouth by placing one hand on the chest and other just below the rib cage. Instructions were given to subject to inhale through nose so that stomach moves out and in during respiration and to control the chest movements. This procedure was followed for 43 weeks (5 days in a week, 2 times a day for 20 minutes per session).

- **Lateral costal expansion exercise:** Position of the patient is same as the Diaphragmatic breathing exercises. Placing the hands over the lateral side of chest wall and ask the patient to inhale. During exhalation press firmly from the sides of chest. This procedure was followed for 43 weeks (5 days in a week, 2 times a day for 20 minutes per session).

Group B- Experimental group

- **Cork Screw exercise-** Lie on the mat in supine position. Bend both knees together towards the chest with the arms lying by your side. Then extend both legs towards the ceiling with heels together and toes apart. Then rotate the legs to the right side to the centre at 45degrees,then back to starting position by rotating the legs into left side. The next start from left side to right side. During the procedure inhale from nose and exhale from mouth. Inhale to the centre and exhale from centre to initial position. Eventually, hold legs in initial position, then flex the knees and place the foot on couch and then straight the legs. This procedure was followed for 43 weeks (5 days in a week, 2 times a day for 20 minutes per session).

- **Hip Twist with flexed elbow-** Lie down on mat and put the weight of upper body on flexed elbows. Scoop the navel and flex the legs to 90 degrees with knees extended straight toward ceiling with heels together and toes apart. In this exercise, exhale first when going down from 90 degrees but donot touch the mat and inhale while coming up. Start from right side to left side by rotating the legs, then from left side to right side. Then slowly lower the legs down on the mat. This procedure was followed for 43 weeks (5 days in a week, 2 times a day

for 20 minutes per session). Periodic assessment was taken every week to find out whether the individuals were doing the exercise daily or not.

How to take measurements with Peak Expiratory flow meter?

Instructions were given to the participants about how to use the peak-flow meter and trials were also allowed. The highest value of peak expiratory flow from three correctly performed blows was recorded. The test was performed in sitting position, with neck in neutral position. Mouth piece was attached to side marked in the arrows then side the indicatory to bottom of the numbered scale. Having taken a maximal inspiration, and after a maximum pause of 2 seconds at Total Lung Capacity (TLC), then the mouth piece was placed, the participant blowed as hard as possible in a single blow, maintaining an airtight seal between the lips and the mouthpiece, the final position was the indicator of peak flow.

You'll use a peak expiratory flow monitor to perform the PEFR test. This is a handheld instrument with a mouthpiece on one end and a scale on the other. When you blow air into the mouthpiece a small plastic arrow moves. This measures the airflow speed. To take the test it is explain to the subjects to breathe in as deeply as they can and blow into the mouthpiece as quickly and as hard as they can. But do not put your tongue in front of the mouthpiece. This procedure is performed three times and took the highest value of the three. If subject cough or sneeze while breathing out, then we need to start again. The subject must start expiration vigorously from the position of full inflation. Values are similar in the sitting and standing position [4,5].

STATISTICAL ANALYSIS

Assessment of the results: Study variable the peak expiratory flow rate was done before starting physiotherapy sessions and at the end of the study.

Statistical analysis was performed on the data obtained from 30patients. Descriptive statistics for all outcome measures were expressed as mean, standard deviations and test of significance such as paired 't' test used for comparing data within each group.

Outcomes Measures

Primary outcome measurement

Table 01. Mean and standard deviations of values of peak flow meter of Group A before exercise sessions using ANOVA test.

.	Group A		
Repeated ANOVA	**Peak flow meter value (Before)**		
	R1	**R2**	**R3**
Mean	228.00	232.00	252.67
S.D.	81.346	88.334	103.680
Median	200	210	250
Number	15	15	15
F Test	2.73		
P value	3.340		
Table Value	0.083		
Result	Not Significant		
Tukey's method for Pairwise comparison	R1		
Mean Difference & Result>	R2	4Sig	R2
	R3	24.67Sig	20.67Sig

Table 02. Mean and standard deviations of values of peak flow meter of Group B before exercise sessions using ANOVA test.

.	Group B		
Repeated ANOVA	**Peak flow meter value (Before)**		
	R1	**R2**	**R3**
Mean	336.00	384.67	394.67

S.D.	87.977	91.719	100.133
Median	300	360	380
Number	15	15	15
F Test	5.11		
P value	3.340		
Table Value	0.013		
Result	Significant		
Tukey's method for Pairwise comparison	R1		
Mean Difference & Result>	R2	48.67NSig	R2
	R3	58.67NSig	10NSig

Secondary Outcome Measures

Table 3. Mean and standard deviations of values of peak flow meter of Group B after exercise sessions using ANOVA test.

.	Group B		
Repeated ANOVA	**Peak flow meter value (After)**		
	R1	**R2**	**R3**
Mean	464.00	458.67	492.00
S.D.	105.951	115.750	92.520
Median	490	450	490
Number	15	15	15
F Test	5.40		
P value	3.340		
Table Value	0.010		
Result	Significant		
Tukey's method for Pairwise comparison	R1		
Mean Difference & Result>	R2	5.33NSig	R2
	R3	28NSig	33.33Sig

Table 4. Mean and Standard deviation of Peak flow meter values before exercise session within groups.

Unpaired T Test	**Peak flow meter value (Before)**					
	R1		**R2**		**R3**	
	Group A	**Group B**	**Group A**	**Group B**	**Group A**	**Group B**
Mean	228.00	336.00	232.00	384.67	252.67	394.67
S.D.	81.346	87.977	88.334	91.719	103.680	100.133
Number	15	15	15	15	15	15
Mean Difference	-108.00		-152.67		-142.00	
Unpaired T Test	3.491		4.643		3.815	
P value	0.0016		0.0001		0.0007	
Table Value at 0.05	2.05		2.05		2.05	
Result	Significant		Significant		Significant	

Table 05. Mean and Standard deviation of Peak flow meter values after exercise session within groups.

Unpaired T Test	**Peak flow meter value (After)**					
	R1		**R2**		**R3**	
	Group A	**Group B**	**Group A**	**Group B**	**Group A**	**Group B**
Mean	316.00	464.00	336.00	458.67	346.67	492.00
S.D.	88.463	105.951	98.038	115.750	91.391	92.520
Number	15	15	15	15	15	15
Mean Difference	-148.00		-122.67		-145.33	
Unpaired T Test	4.153		3.132		4.328	
P value	0.0003		0.0040		0.0002	
Table Value at 0.05	2.05		2.05		2.05	
Result	Significant		Significant		Significant	

RESULT

In our study, we took the details of subjects name, age, gender, weight, height. We recorded the values of peak flow meter before and after experiment three times in the form of R_1, R_2, R_3. We choose the highest value for comparison.

From the above data, we come to know that in Group A there were73.3% females while males were 26.75%. In Group B, the participation of females was 46.7% and 53.3% were males.

The highest value recorded in Group A before experiment was 103.680 and 100.133 in Group B in terms of Standard Deviation. After conducting the experiment the Standard Deviation values of Group A is 98.03 and 115.750 in Group B.

The resultant values show difference within Group A and Group B with Mean difference of -122 .67 with Standard Deviation of 115.750 in Group B and 98.038 in Group A.

DISCUSSION

'Breath' is one of the foundation principles in the Pilates method and is known as the 'engine' behind Pilates. Pilates focusses on 3 key methods during exercise; lateral breathing, set breathing patterns, and active breathing[2].

1. Lateral Breathing refers to the lateral expansion of the ribcage while maintaining abdominal contraction (a downward pull of the deep abdominal muscles) during breathing. This is different from diaphragmatic breathing and aims to maintain abdominal contraction in order to protect the spine during exercises/ movements.
2. Set breathing patterns are coordinated with each exercise or movement. Inhalation occurs during one phase of a specific movement/ exercise, and exhalation during another phase of the movement.
3. Active breathing or otherwise known as percussive breathing. Active breathing aims to consciously activate respiratory muscles to enable the lungs to expand and transport oxygen. This method of breathing assists contraction or activation of certain targeted muscles. Inhalation occurs through the nose and exhalation through the mouth with pursed lips[6,7].

Pilates can improve pulmonary function in the following ways:

1. Strengthens respiratory muscles: Literature indicates that Pilates can significantly improve maximal inspiratory - and maximum expiratory pressures. By combining movements and postures with breathing at a low pace but increased depth, the respiratory muscles have to be contracted while other muscles of the body perform movements. This, in turn, leads to improved respiratory muscle strength.
2. Improves pulmonary parameters: Studies found improved maximum voluntary ventilation (MVV), peak expiratory flow (PEF), and forced vital capacity (FVC) among individuals following Pilates training. Improved ventilation and perfusion are due to the respiratory rehabilitative method associated with pilates when coordinated breathing is utilized.
3. Improves cardio-respiratory parameters: Enhanced peak VO2, VO2max, respiratory exchange ratio (RER), oxygen equivalent (EQO2), maxEQO2, and maximum ventilation were observed among individuals following Pilates training. The fact that Pilates improves VO2 max means that it leads to cardiovascular changes, enhanced circulation, and vascularity to the muscles.
4. Improves Trunk stability & mobility: One of the fundamental principles in Pilates is the centre (the core/ trunk), and because all these segments are connected a stronger core/ trunk will lead to improved diaphragm function and respiratory efficiency8,9.

The PB technique differs to great extent from that of DB. To perform the exercises of the pilates method, it is necessary to breath deeply, maintaining the abdomen contracted by active contraction of the local and overall

stabilizing muscles of the lumbar spine, in addition to the diaphragm muscles and the pelvic floor muscles. The specific respiration of the pilates method is known as lateral breathing, which avoids expansion of the abdomen with the aim of using the thoracic and ribcage increasing the space for the lungs to expand and avoiding the movement of the abdomen so as not to leave the lumbar region unprotected. Thus it is clear that the objectives of the breathing techniques differ and that the diaphragm muscles in PB also acts as a stabilizer of the lumbar spine. It was possible to evidence in this study the increase in respiratory muscle strength with regular sessions of pilates methods since the breathing principle of the method require a maximum expiration during the exercises. This maximum expiration was accomplished by the following muscles: rectus abdominis external and internal oblique and transverses abdominis. Some studies have shown activation of these muscles during pilates exercises, primarily of the following muscles: rectus abdominis multifidus and external oblique. Possibly, in this study, the activation of these muscles culminated in increasing expiratory muscle strength. The major advantage of such exercises is that the increase in blood flow to the various organs results in distribution of more nutrients, thereby enhancing their functioning. Special attention is given to the vital organs of the body such as heart, brain, lungs to know the effect of exercise on these organs10,11.

In addition, because abdominal muscles are the major expiratory muscles, the benefits of abdominal muscle training may influence respiratory muscles, resulting in increased respiratory muscle strength. Abdominal muscles, as part of expiratory muscles are usually silent during quite breathing. Moreover, they speculated that physical activity involving the trunk and abdominal muscle raise the intraabdominal pressure; thus, enhancing respiratory muscle strength. Prior studies have reported that respiratory muscle training improves pulmonary function. The abdominal muscles are the principal muscle of expiration among the others. During high-intensity exercise, when the minute ventilation increases, the work of abdominal muscle is required to increase expiratory flow rate and tidal volume. The enhanced abdominal muscles activity during exercise helps expiration of air out of lungs which result in decrease in the end – expiratory lung volume. This can help inspiratory muscle to produce a larger force by improving their length-tension relationship and assist with lung expansion at the beginning of inspiration through passive recoil of the chest wall. It is rescannable to suggest that expiratory muscles are prone to fatigue that subsequently impairs pulmonary functions, expiratory muscle training, specially the abdominal muscles may improve pulmonary function exercise performance. Because respiratory muscles are morphologically and functionally skeletal muscles, their response to applied stimulus are similar as those in other skeletal muscles. According to the training theory, muscle performance may not improve if the training intensities are not sufficiently high12,13.

Diaphragmatic and lateral costal expansion

It should be pointed out that D.B. specifically promoted a breathing pattern with greater thoracic expansibility. An important issue to consider as regards Diaphragmatic Breathing is the thoracoabdominal coordination during the technique, which was shown to be increased. As expected of a respiratory technique that emphasizes greater use of the diaphragm and abdominal breathing components thus generating “asynchrony” during the respiratory cycle.In view of the foregoing discussion. Diaphragmatic Breathing showed positive effects such as an increase in lung volumes, respiratory motion. Normally the tidal volume is around 500ml, but in the deep breathing exercise it increases & rate is 12-18 cycles per minute but in deep breathing it decreases. Deep breathing relaxes the mind/body and relieves tension, emotional problems & improves cellular regeneration. Slow and deep breathing is

economical because it reduces dead space ventilation as well decreases the workload on the heart. It also renews air throughout the lungs in contrast with shallow breathing which renews air only at the base of the lungs. It is also suggested that the practice of deep breathing without breath holding phase, can also strengthen the respiratory muscles and increase the elastic properties of lungs and chest and thereby improve some of the ventilator functions of lungs. Deep breathing has also been documented to increase the alveolar ventilation14,15.

CONCLUSION

Our study concluded that Cork screw and Hip twist with flexed elbows exercises and Diaphragmatic and lateral costal expansion exercises both have their effect on expiratory flow rate. But diaphragmatic and lateral costal expansion mainly improves lung function and are very light, and emphasis mainly on diaphragm. But Pilates are strenuous activities have impact on lungs capacity, diaphragm, abdominal muscles. So it is more likely the Pilates have more impact on lung function, thoraco-abdominal mobility, respiratory muscle strength and mainly expiratory flow rate as compared with Diaphragmatic breathing exercises.

Declaration by Authors

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