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ORIGINAL ARTICLE

Effects of Resistive Diaphragmatic Training on the Pulmonary Functions in patients with Chronic Stroke

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ABSTRACT

Background: Stroke is the leading cause of death and disability worldwide. It is a cerebrovascular disease, characterized by decreased blood supply to the brain tissues. It is known that patients with stroke have respiratory muscle weakness.
Aim: To evaluate the effects of Resistive Diaphragmatic Breathing Exercises on the pulmonary functions in patients with chronic stroke.
Method: A randomized controlled trial was conducted. 20 subjects were recruited based on inclusion and exclusion criteria and were allocated to Group A and B. Assessment of Pulmonary Functions was undertaken by Digital incentive Spirometer. Group A received treatment with Digital Incentive Spirometer. Group B received Digital Incentive Spirometer training and also inspiratory Muscle training (IMT), Diaphragmatic Breathing Exercises. 3 sessions per week for 4 weeks were given to each patient. The two groups were reassessed after 3 weeks of treatment. Follow up was taken 4 weeks after completion of treatment. Data was analyzed by using SPSS 21.
Results: There was a statistically significant change within both groups in the VC, FVC, PEF, SPO2 and FEV1 and FEV1/FVC with p- value of < 0.05. Both were effective but using inspiratory Muscle training along with Digital incentive Spirometer training technique showed more improvement.
Conclusion: Resistive Diaphragmatic breathing exercises found better than the simple spirometer training for improving the pulmonary functions. Resistance through Thera bands at the sternal and costal level have found the better results. Resistive Diaphragmatic breathing have better results in VC and FVC, FEV. These techniques if incorporated in early rehabilitation protocol of stroke patient helps in early discharge.
Key words: Stroke, Inspiratory Muscle training, Spirometer training, diaphragmatic breathing

INTRODUCTION

The biggest cause of death and impairment in the world is Stroke[1]. Plaque formed due to low density lipoproteins that accumulates in the arteries of brain this condition is called Atherosclerosis. Due to plaque formation intracranial arteries were blocked and their diameter also reduced, resulting in Brain ischemia.They even rupture more often, the breakage of the plague results in platelet-attracting damage to underlying cholesterol crystals. The clot formed dislodged and cause stroke in distal arterial System. One of the causes of cardiac issues are due to embolus in cardiovascular system[2].

Cerebral and extracellular brain edema leads to swelling of the area due to necrosis resulting from insufficiency of arterial blood supply, also increase intracranial Hypertension(ICP). This leads to clearing of dead cells after the attack of phagocytic cells. Prolong phagocytosis causes the affected brain tissues to weaken and liquefy, with peak liquefaction occurring six months after stroke. After the stroke of several months' Astrocytic glial cells form a thick mesh network of glial fibers. Moreover, Cerebral Ischemia is due to Reduction in Blood flow that last from several seconds to Minutes. Due to lack of oxygen supply to brain tissues and also due to the poor energy, symptoms would appear. If these symptoms last only for twenty four hours then it is called "Transient ischemic attack in which the symptoms appear suddenly especially numbness and weakness occurs on the one side of the body then symptoms resolve in twenty four hours. But if the Symptoms last above the 24 hours then it is called stroke. There is another condition which is called "Cerebral Infarction that occurs due to the cell death and resulted in permanent disability and it occurs due to pressure on the surroundings tissues and extreme effect of the blood on the tissue. The criteria of actual Cell death and neurons deficit can be determined by the main destruction of the nervous tissue. There are the three main layers of the brain one is the outer dura matter second is the middle arachnoid and the third one is the inner most layer that is Pia matter that is in the direct contact of the brain. Due to Inflammation of these meninges, meningitis occurs. Blood supply to the brain due to circle of Willis in which two carotid arteries (right and left internal carotid arteries) and the two vertebral arteries (anterior cerebral and middle cerebral arteries).Through this overall 80% oxygen supplied to the brain tissues. And any insufficiency of this supply to the brain, stroke occurs[3,4].

Stroke ratio is higher in men than in women, although with growing age, this disparity is attenuated. Defined stroke risk factors, such as increased blood pressure, among men the risk of coronary artery diseases and smoking are higher, therefore the disparity of stroke is only partly explained. The risk of ischemic stroke and subarachnoid hemorrhage are increased due to continuous use of oral contraceptive pills, although it is not associated with an increased risk of intracerebral hemorrhage. Among people who use only one agent or combined hormone therapy, the risk of ischemic stroke is higher. To date, little consideration has been paid to the impact of sex-related risk factors other than oral contraceptive. Compared with current risk ratings, consideration of risk factors specific to men or women will increase the accuracy of stroke risk assessment[5].

In addition, patients with Chronic Stroke suffer reduced respiratory capacity because their diaphragm, intercostal muscles, and abdominal muscle are impaired due to physical inactivity and extended bed rest, which are responsible for decreasing the ability to perform physical tasks and independently walk as well as cardiorespiratory limitation[6].

Many studies have recently documented the effect of respiratory exercise on stroke patients for the improvement of physical function. A research concluded that respiratory exercise strengthens the functions of the lungs effectively[7].

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One of these studies stated that therapy incorporating diaphragm breathing and pursed lip breathing exercises commonly performed by patients with respiratory issues showed higher improvements compared the other exercises in the respiratory rate and oxygen intake of patients[8]. Another research examined the impact on respiratory function of chronic stroke patients showed that pulmonary function enhanced due abdominal muscle stimulation during IMT[9].

Whereas in a study carried out among chronic stroke survivors, some effects of the inspiratory strength and endurance were observed. These results have shown that IMT may support individuals with stroke[10].

According to a study conducted by Song et al, in 2015 reported that for improving pulmonary functions in stroke patients. Some resistive exercises are effective[11]. Resistive diaphragmatic training have found to be beneficial in improving pulmonary functions among COPD patients and those with respiratory muscle weaknesses due to different underlying pathology[12]. But up to date no such study found which investigated the effect of resisted diaphragmatic training upon patient with chronic stroke. In addition, the respiratory muscles, including the diaphragm, are paralyzed, making it difficult to properly dilate the lungs and thorax. The thoracic tissue may be shortened if this condition occurs, and the thoracic muscles may undergo fibrosis to decrease thoracic compliance. This in turn triggers numerous complications of the respiratory system, such as atelectasis, changes in muscle force that can directly and/or indirectly hinder the performance of daily living activities, and asymmetrical postures or modes of movement that can impair motion stability, making it difficult for fine extremity functions to perform[13].

Null hypothesis is there are no differences in resistive diaphragmatic training and spirometer training in chronic stroke patients on the pulmonary function test.

Alternate hypothesis is there are differences in resistive diaphragmatic training and spirometer training in chronic stroke patients on the pulmonary function test.

To evaluates the effects of Resistive diaphragmatic breathing on the pulmonary functions of stroke patients. To find the effects of Spirometer training technique with and without resistive Diaphragmatic breathing exercises on the pulmonary functions (VC, FEV, FEV/FVC .FVC) also SPO_2 in Chronic Stroke patients

MATERIAL AND METHODS

This study was Randomized Controlled trial and was approved by Research Ethical Committee. The study was conducted in District Hospital Sargodha also Mubarak hospital Sargodha from June 2020 to September 2020.

Sample size was calculated through epi tool. Total sample size is 20 and 10 participants in each group[14].

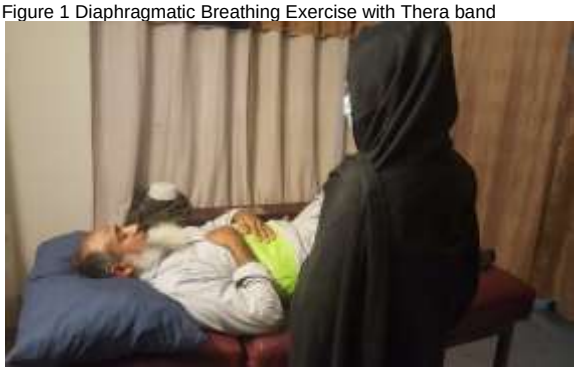
The purpose of the study was explained, written and informed consent was taken from willing participants which were in both English and Urdu. Non-probability convenient sampling technique was used to recruit the individuals for the study and then randomization was done by sealed envelope method to divide the individuals in control and experimental groups. Study was approved by ethical committee.

Age limit 40-50 yrs bothgenders, Stroke patients with compromised pulmonary functions in which there FVC was 1.91 liters, FEV1 was 1.71 liters & No serious Cognitive deficits i-e Standardized mini mental state examination 24 points or more, Chronic stroke patients with impaired Breathing and Chronic stroke patients with FVC<3.22,FEV1<2.79,FEV1/FVC<82% were included. Patients having any systemic illness, Patients who have any orthopedic disease such as funnel chest problems or rib fracture or deformation, Patients with stroke (less than 6 months duration) and Participation in any other rehabilitation study were excluded. Outcome measures studied were the Pulmonary Functions FEV1, FVC/FEV1, PEF, FVC, oxygen level, cognitive impairment in older adults. Digital incentive Spirometer was used for assessing the pulmonary Functions FEV1, FVC/FEV1, PEF, and FVC. Pulse oximetry is a technology used to measure the oxygen level in your blood and your heart rate. The Standardized Mini-Mental State Examination or Mini- Mental State Examination (MMSE) scale is used for assessment of cognitive impairment in older adults.

1. Experimental group (Diaphragmatic weight training and pulmonary function training)
2. Control Group (Pulmonary functions training)

Diaphragmatic Resistance training is based on the same principal as for the any other Skeletal Muscle training. The selection of 20 subjects divided equally and placed into an experimental group and a control group and the interventions would applied three times per week for four weeks. In each session, both groups receive Digital spirometer training for 15 minutes. In addition, experimental group receive diaphragm breathing exercises with resistance for 30 minutes. Resistance is Applied through Different Thera bands and then performing the Breathing Exercises. First of all resistance applied through yellow band(1-6pounds of resistance) and then red, Green and black which give (4-18 Pounds of resistance) The patient is asked to breath in deeply and slowly while not to move upper chest .Weight increased weekly as per patient's tolerance. Further digital spirometer training Perform to determine the Pulmonary Functions FVC, FEV1, FVC/FEV1, PEF and VC in both Control and Experimental Groups.

Figure 1 Diaphragmatic Breathing Exercise with Thera band



RESULTS

Participants were assessed on basis of inclusion and exclusion criteria. There were total 20 patients divided into control and experimental groups. There was no drop out and all the patients received their treatment. Baseline values of demographic data of both groups were comparable on basis of mean± std. deviation. In (Spirometer training) group the mean age of participants was 55.30±5.945 years and in (Spirometer training and IMT training) mean was years 50.10±3.213. There were 7 males (75%) and 3 (25%) females in control group and 8 males (75%) and 2(25%) females in experimental group. Normality of data was tested by Shapiro-Wilk test, it showed that data was normally distributed ($p>0.05$). Parametric tests were applied to compare the two population. Repeated measure ANOVA was applied to compare between group and within group analysis on outcome variables.

Table 1: Baseline measurement of outcome variables.

Variable	SPIROMETERY Mean ± SD	SPIROMETERY+IMT Mean ± SD	P value
FEV1	1.904±0.0206	1.93±.029	0.035
FVC	1.797± .014	1.836±.106	0.265
VC	2.89±.011	.0113±.212	0.130
PEF	3.514±.018	3.922±.506	0.031
SPO2	93.4±2.633	92.8±1.988	0.572
SMMSE	26.6±1.0749	26.6±.699	1.000
FEV1/FVC	79.3±3.6883	82.8±5.349	0.106

Both groups were similar in FEV1, FVC, VC, PO2 FEV1/FVC PEF and SSME at baseline treatment values with p>0.0 (Table 1).
After analysis, it was found that within group analysis showed a statistically significant (p< 0.001) improvement in all the outcome measures including FEV1, FVC, VC, PEF, SPO_2, SMMSE and FEV1/FVC over a period of 4 weeks in both groups (Table 2).

Table 2: Between group& within group comparison of FEV1, FVC, VC, PEF, SPO2, SMMSE and FEV1/FVC.

FEV1	SPIROMETERY (mean ±S.D)	SPIROMETERY+ IMT (mean ± S.D)	P-value
Pre- treatment	1.904±.0206	1.93±.02944	<0.001
Post-treatment	2.133±.0527	2.428±.11698	<0.0001
Follow up	2.152±.0332	2.562±.1468	<0.0001
P-value	≤0.001	≤0.001	
FVC			
Pre- treatment	1.797±.01418	1.836±.10617	<0.001
Post-treatment	2.027±.0221	3.123±.1542	<0.001
Follow up	2.3950±.1565	3.2980±.17054	<0.001
P-value	≤0.001	≤0.001	
VC			
Pre- treatment	2.898±.0113	2.786±.21267	0.002
Post-treatment	3.109±.0387	3.166±.05542	0.001
Follow up	3.139±.0172	3.378±.06477	0.001
P- value	≤0.001	≤0.001	
PEF			
Pre- treatment	3.514±.0183	3.9220±.506	0.000
Post-treatment	4.533±.0170	6.207±.5967	0.000
Follow up	5.056±.0594	6.942±.5518	0.000
P- value	≤0.001	≤0.001	
SPO2			
Pre- treatment	93.4±2.63	92.8±1.988	0.000
Post-treatment	94.2±2.39	95.7±1.251	0.000
Follow up	95.3±1.33	97.7±.948	0.000
P- value	≤0.001	≤0.001	
SMMSE			
Pre- treatment	26.00±1.074	26.6±.6992	0.002
Post-treatment	26.5±.971	27.6±1.505	0.001
Follow up	26.6±1.07	28.6±1.749	0.001
P- value	0.002	0.002	
FEV1/FVC			
Pre- treatment	79.30±3.68	82.80±5.349	0.003
Post-treatment	86.00±1.251	86.30±1.059	0.002
Follow up	87.30±.948	88.00±.8165	0.002
P- value	≤0.001	≤0.001	

The between-groups and within group analysis showed statistically significant differences in FEV1, FVC, VC, PEF, SPO2, SMMSE and FEV1/FVC with p-values of ≤0.001. (Table 2)

DISCUSSION

The objective of study was to evaluate the effects of Resistive diaphragmatic breathing on the pulmonary functions of stroke patients and to find the effects of Spirometer training technique with and without resistive Diaphragmatic breathing exercises on the pulmonary functions (VC,FEV,FEV/FVC.FVC) also SPO2 in Chronic Stroke patients. Results indicated significant improvement in both groups receiving intervention regarding all outcome measures.

The findings of this current Study are in accordance with the literature in which two studies have shown the combined chest resistance and expansion exercises in terms of improving the pulmonary function in patients with decreased respiratory muscle weakness. A study by Gui bin SonG, Eun Cho park in 2015 showed that there was remarkable improvement in lung volumes by these resistive chest exercises. In his study he used the combined chest resistance and expansion exercises to detremine the chest expansion,patient performed the breathing exercises by deep inspiration and forcefully expire then at the same time resistance is applied around the chest by taping. The results showed that there is remarkable improvement in the forced vital capacity, peak expiratory flow rate. This breathing exercises was more helpful for the Musculoskeletal system as it aslo helped the inspiratory and expiratory rates and trunk mobility. This also help in relaxing the tough connective tissues and all the other muscles for example rectus abdominis muscle.exrernal oblique muscle, internal oblique muscles. These combined exercises also helped the patient in maintaing the trunk mobilty and helped the chronic stroke patient in performimg the daily tasks,the most common is the independent walk, it also helped the patient for the thorax mobilization[10].

The research by BOSTANCI in 2019 also showed that 4 weeks of IMT substantially improved the smokers' inspiratory muscle strength and also pulmonary function[15]. The study by JUNG in 2014 stated that increasing residual capacity or decreasing lung volume in patients with stroke causes the both inspiratory muscle and expiratory muscle to weaken and also leads to decrease efficiency of Muscles. It is closely related to the muscles required to maintain posture and the muscles that function while performing the breathing activity[16]. In our study there significant differences among all the variables after the intervention.

The results of current study showed statistically significant difference between both groups and within each group with p value < 0.05.The research by (Jo, 2014) investigated the impact of a combined inspiratory diaphragm breathing exercises also spirometer training on the pulmonary functions of hemiplegic patients following four weeks of resistance and spirometer training with a therapist. In all things in the experimental group, respiratory functions improved more. Important variations in the pulmonary functions of patients in the study community were revealed by intragroup comparisons. Intergroup comparisons revealed that in the experimental group, pulmonary function increased more dramatically as compared to control group. Training of respiratory reinforcement in stroke patients has enhanced pulmonary function[17].

According to this current study, the resistive diaphragmatic breathing exercises by different Thera bands with different resistances were carried out in chronic stroke patients. Hence the findings of this study showed significant improvement in improving pulmonary functions KYO CHUL in 2013 revealed that these combined inspiratory diaphragmatic breathing and expiratory pursed lip breathing showed significant improving in FEV1/FVC,TV and IC but not in FEV1,FVC,VC and PEF. However, control group showed no significant differences[18].

CONCLUSION

Resistive Diaphragmatic breathing exercises found better than the simple spirometer training for improving the pulmonary functions. Resistance through Thera bands at the sternal and costal level have found the better results. Resistive Diaphragmatic breathing have better results in VC and FVC, FEV.

Limitations: Effects were not categorized according to chronicity of the condition.
Patient's participation is not satisfactory and faced problems in taking consent from patients.
Due to covid-19, was not able to take the complete sample size

Recommendations: More randomized controlled trials should be conducted to prove effects of diaphragmatic breathing therapy as an independent technique. More studies should be conducted with large sample size including various study settings.

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Disclaimer: This research has not been presented or published in any conference or book.

Conflict of interest: All authors have disclosed no conflicts of interest relevant to this paper.

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