Original Article

Soft Tissue Manipulation versus Traditional Physiotherapy Program on Spirometric Indices and Diaphragmatic Excursion in Asthmatic Patients

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Abstract

Asthma is an important worldwide health problem. This study aimed to investigate the effect of soft tissue manipulation versus traditional physiotherapy program on a diaphragmatic excursion in asthmatic patients. Forty subjects ranged from 20 to 40 years were randomly assigned into two groups, Group I (n=20) received soft tissue manipulation of the upper cervical region (C0-1), upper dorsal region (T3-4), and thoracolumbar junction followed by muscle energy once weekly for 3 weeks and Group II (n=20) received traditional physiotherapy program (pursed-lip breathing exercise, diaphragmatic breathing exercise) ten repetitions each exercise per session three times a week for 3 weeks. The mean values of FEV1, maximum inspiratory pressure PEF, and diaphragmatic excursion (RT,LT) were significantly ($p<0.001$) increased from 2.80±0.16, 117.6±10.27, and 199.8±20.92, (RT 3.48±0.43, LT3.78±0.28) to 2.92±0.08, 134.75±5.81, and 259±61.6 (RT 4.33±0.27, LT 4.41±0.27), respectively in Group I, and from 2.66 ±0.12, 112.8±9.61, and 198.2±19.53 (RT3.36±0.41, LT 3.58±0.37) to2.75±0.13, 119.7±8.31, and 204.8±20.97 (RT3.52±0.44, LT 3.92±0.58), respectively in Group II, with an advantage in Group I. These findings suggested that soft tissue manipulation is more effective than traditional physiotherapy program on the diaphragmatic excursion and lung function in mild asthmatic patients.

Keywords: Spinal manipulation, FEV1, Diaphragmatic Excursion, Asthma

INTRODUCTION

An estimated 235 million people worldwide are affected by asthma and lead to substantial health and economic burdens [1]. The prevalence of asthma in Egypt's Delta area has been reported to be 7.7% [2]. Asthma may develop when both genetic and environmental risk factors are present concurrently [3]. Several risk factors contribute to the development of asthma; inherited like positive family history, environmental as prolonged indoor allergens exposure (dust mites, mold and animal dander, carpets, pet hair) and outdoor allergens (pollens and molds, tobacco smoke, occupational chemical exposure, urbanization) can cause sensitization through prolonged exposure and trigger acute asthma. [4-6].

Diagnosis of asthma depends on the clinical symptoms if there is a history of frequent wheezing, coughing or difficulty breathing because the asthma pathogenesis is unclear and since bronchial hyper-response in allergic rhinitis, asthma, cystic fibrosis, and chronic obstructive pulmonary disease (COPD) is positive, there are no tests or biomarkers to definitively diagnose or differentiate asthma from other diseases [4, 7, 8].

Spirometry is one of the reliable measures used for asthma diagnosis and is confirmed when an FEV1 improvement of at least 12% and 200 mL following 15–20 minutes administration of an inhaled rapid-acting bronchodilator or an FEV1 improvement of at least 20% and 200 mL after two weeks of anti-inflammatory treatment [9, 10].

Several neural pathways are concerned with regulating the airway caliber, and neural control abnormalities can lead to

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narrowing of the airway in diseases such as COPD and asthma [11]. Tonic parasympathetic behavior results in partial contraction of smooth airway muscle by releasing acetylcholine, which acts directly on muscarinic acetylcholine receptors on smooth muscles of airways inducing broncho-constriction [12].

Sympathetic lung innervation from the dorsal spine (T1-6) is relatively minor compared to the more dominant parasympathetic nervous system innervating lungs via vagus nerves from the trachea to bronchioles [13].

There is a close relationship between inflammatory mediators and neurotransmitter release via sensory nerve activation. In turn, neural mechanisms can affect the inflammatory response nature, either exaggerating the inflammatory response or reducing inflammation [14].

In recent years, care for asthma has focused on pharmacological protocols, which have been designed to control asthma and the disease's inflammatory process. Many treatment strategies have been neglected to help control asthma [15].

A reduction in mobility of the thoracic spine is associated with a decrease in forced vital ability (FVC) and forced expiratory volume in the first second (FEV1). The increase in the chest wall rigidity influences the ventilatory pumping mechanism, reducing the rigidity level (increasing mobility of the chest wall), and is as a way to improve the function of the lung [16, 17].

There is an increasing interest around the world in non-pharmacological or alternative therapies for asthma including breathing exercises and manual work. Previous studies have shown that spinal manipulation is accepted as a treatment approach of musculoskeletal complaints and non-musculoskeletal complain [18, 19]. Spinal manipulation (SM) is a specialized therapeutic' hands-on' approach applied by various health professionals including osteopaths, chiropractors, and physiotherapists. Its effects go beyond biomechanical modifications and contribute to neurophysiological responses in the peripheral and central nervous systems [20], through normalizing autonomic control of the nervous system [21].

Muscle energy is an active and direct procedure, thus creating a restrictive barrier and requiring patient involvement for maximum effect [22]. Muscle energy technique may entail a range of biomechanical and neurological mechanisms including tissue fluid changes, motor control and programming, altered proprioception, and hypoalgesia [23, 24].

Breathing retraining focuses better breath control can be helpful for many asthma patients, as it normalizes breathing patterns, typically by adopting a slower respiratory rate with longer expiration and reduction in overall ventilation [25]. The physical therapist classifies diaphragmatic breathing and pursed-lip breathing as breathing retraining techniques [15].

Application of spinal manipulation and muscle energy technique to multiple spinal levels increased chest wall mobility and compliance by increasing vertebral mobility and decreasing local paravertebral muscle tone [26].

Spinal manipulative treatment combined with exercise improves the exercise capacity and lung function in mild COPD patients [27]. Seven manipulative treatment sessions for atlas subluxation improve FEV1 from 1.1 to 1.5, and forced expiratory flow (FEF) from 25-75% from .61 L/sec to .95 L/sec in patients suffered from lower back pain and COPD [28]. Upper cervical manipulation (C3) with or without T12 manipulation has a positive effect on maximum inspiratory pressure and maximum expiratory pressure [29], spinal manipulation directed to diaphragm crura can often restore or partially rehabilitate altered diaphragmatic function [30].

A single manual therapy approach (spinal manipulation, muscle energy technique, and myofascial release) has an immediate effect on lung function for people with severe and very severe COPD [31]. Thoracic spinal manipulation has a statistically significant improvement on FVC and FEV1 in stroke patients [32], and healthy subjects [33, 34] so asthmatic patients may benefit from this treatment approach method [35]. Therefore, the purpose of this study was to assess the effectiveness of soft tissue manipulation and traditional physiotherapy program on diaphragmatic excursion in asthmatic patients and also to compare the efficacy of soft tissue manipulation versus traditional physiotherapy program.

Materials and Methods

Subjects Characteristics and General Experimental Design

Study Subjects:

Forty asthmatic patients (15 women and 25 men) were selected from chest clinic -Radio and Television Union in Cairo, Egypt, their age ranged from 20 to 40 years. All patients suffered from mild asthma (FEV1 ≥80%), with persistent symptoms for at least 12 months and under medical control. They were free from any other chest diseases and cardiovascular problems. All patients provided their informed consent after receiving a detailed explanation of the study and were free to withdraw from the study at any time. The ethical committee of Research in the Faculty of Physical Therapy, Cairo University approved the study.

Evaluation Equipment:

For all participants, the following assessments were conducted before and after the treatment protocol:

Lung functions: Using Digital Spirometer (asma-1 4000) Forced Expired Volume (FEV1) in one second, Peak Expiratory Flow (PEF) was measured; Inspiratory muscle strength was calculated by Maximum inspiratory pressure device (VACU.MED 1505-120), while diaphragmatic excursion was evaluated by X-ray device (LISTEM –BLD-150RK)

Participants were randomly divided into two groups: **Group I**: received soft tissue manipulation; one session/week for three weeks. **Group II**: received breathing exercise; three sessions per week for three weeks. All sessions were supervised and participation assessed. After receiving a detailed explanation of the study, all patients provided their informed consent; and were free to withdraw from the study at any time. All of the participants' data were available for analysis. The detailed training protocol was as follows:

Soft tissue manipulation session including Spinal Manipulation

Upper cervical C0-C1 level:

This technique was first described by Fryette[36]. The patient lies supine the therapist contacts the transverse process C1 with the index finger's metacarpophalangeal joint while the other arm has stabilized the head and chin in opposite side bending. The force was medially directed to exert side-gliding action on the atlas through the MP joint contact, restoring side-bending of the C0-1 to the opposite side[37].

Upper dorsal spine at the level of T3-4level:

The patient laid supine with his/her arms folded across the chest, the therapist's right thinner eminence was placed under the marked transverse process of T4. The region is brought into flexion. The thrust is given towards the table in a rotational direction, towards the lesioned vertebra's transverse process. Thus the vertebra will rotate versus the underlying fixed vertebra [38].

Thoracolumbar junction level:

The patient was positioned in the side-lying, with triple flexion of the upper extremity, while the inferior one remained extended. At the T12 level, the therapist in front of the test subject, the lumbar column was then adjusted in flexion until the maximum tension at the T12 level was reached, then a high-speed and low-amplitude abrupt force (thrust) was applied in pelvic rotation [39].

Muscle energy technique

The therapist would place the subject according to their restricted active motion range. For example, if the subject had a restriction in extension, left rotation, and left side-bending, the practitioner would passively implement the extension, to the point of the restriction barrier. Each subject was then asked to produce for approximately five seconds a small isometric force away from the direction of restriction against the hand of the practitioner and then relax for 5-7 seconds, followed by a five-second stretch to a new range. The procedure was repeated three times in succession per session[40]. This approach is repeated in the same sequence in the following positions:

Upper cervical C0-C1 level:

The occiput was placed up to the muscular barrier of motion in flexion, right side bending, and left rotation. This position was sustained, and the patient was told to side bend to left and rotate right [41].

Upper dorsal spine T3-4 level:

The patient was in a sitting position and the therapist was standing behind, targeting T3-4 segment by bending forward the patient's head, the other hand engaging patient's head side-bending and rotation up to barriers, the therapist resisted side bending and rotation of the patient's head to the opposite direction [41].

Thoracolumbar junction level:

the patient was in sitting position with his/her right hand grasped the left shoulder and the therapist behind and grasp left shoulder, targeting T12 segment by engaging extension, right side-bending and rotation up to barriers, the therapist right arm resisted the opposing patient movement[41].

Breathing exercise:

Pursed lip breathing:

The patient was seated and performed this procedure by inhaling through the nose and making sure the mouth was closed. Then, pursuing the lips and gently exhaling for at least twice as long as the patient inhaled, this approach was repeated ten times a session [42].

Diaphragmatic breathing exercise:

The patient laid flat on the back, placing hands on the stomach then inhaled through the nose allowing the rise of the stomach, exhaled comfortably; repeated the technique 10 times every session[15].

Statistical Analysis:

Data were analyzed by Statistical Package for Social Science (SPSS) version 17. Descriptive statistics were conducted for age, weight, height, BMI, and duration of diabetes. Data were expressed as mean±SD for quantitative variables. Unpaired and paired t-test were considered statistically significant when $p<0.05$.

Results

Forty patients met the inclusion criteria and were classified into 2 groups; Group I: received soft tissue manipulation (n=20, 12 men and 8 women) and Group II: received breathing exercise (n=20, 13 men and 7 women). The two groups were age-matched ($p = 0.8$), with no significant difference between them regarding BMI, FEV1, maximum inspiratory pressure, PEF, and diaphragmatic excursion (RT, LT) (Table 1).

Table 1: Demographic features of the two studied groups

Variable	Group I (n=20)		Group II (n=20)		P-value	
Age (yr)	32± 4.98		30.8± 5		0.8	
BMI (kg/m²)	30.18± 3.66		31.28± 3.07		0.32	
FEV1	2.80± 0.16		2.66 ± 0.12.		0.27	
MIP	117.6± 10.27		112.8± 9.61.		0.81	
PEF	199.8± 20.92		198.2± 19.53		0.58	
diaphragmatic excursion	RT	LT	RT	LT	RT	LT
	3.48± 0.43	3.78± 0.28	3.36± 0.41	3.58± 0.37	0.63	0.71

Post-treatment assessment for the studied groups demonstrated that the spirometric indices (FEV1, PEF), Maximum inspiratory pressure and diaphragmatic excursion (RT, LT) were significantly improved in soft tissue manipulation and breathing exercise groups (Tables 2 & 3), with the statistical difference between both groups in advance within soft tissue manipulation group (Table 3).

Table 2: Mean values and Significance of Soft tissue manipulation in Group I before and after treatment

Variable	Pre-treatment		Post-treatment		P-value	
FEV1	2.80± 0.16		2.92±0.08*		0.001*	
MIP	117.6± 10.27		134.75±5.81*		0.001*	
PEF	199.8± 20.92		259±61.6*		0.001*	
diaphragmatic	RT	LT	RT	LT	RT	LT
excursion	3.48± 0.43	3.78± 0.28	4.33±0.27*	4.41±0.27*	0.001*	0.001*

Table 3: Mean values and Significance of Breathing exercise in Group II before and after treatment

Variable	Pre-treatment		Post-treatment		P-value	
FEV1	2.66 ± 0.12.		2.75±0.13*		0.001*	
MIP	112.8± 9.61.		119.7±8.31*		0.001*	
PEF	198.2± 19.53		204.8±20.97*		0.001*	
diaphragmatic excursion	RT	LT	RT	LT	RT	LT
	3.36± 0.41	3.58± 0.37	3.52±0.44*	3.92±0.58*	0.007*	0.02*

Table 4: Mean value and significance of FEV1, MIP, PEF, diaphragmatic excursion in the two groups after treatment

Variable	Group I(n=20)		Group II(n=20)		P-value	
FEV1	2.92±0.08*		2.75±0.13*		0.042*	
MIP	134.75±5.81*		119.7±8.31*		0.01	
PEF	259±61.6*		204.8±20.97*		0.001*	
diaphragmatic	RT	LT	RT	LT	RT	LT
excursion	4.33±0.27*	4.41±0.27*	3.52±0.44*	3.92±0.58*	0.047*	0.71

Discussion

The age of the studied groups was matched with male predominance in the current study, with no significant differences in spirometric indices (FEV1, PEF), maximal inspiratory pressure, and diaphragmatic excursion (RT, LT).

The main finding of the current research is that both soft tissue manipulation and breathing exercise substantially improved FEV1, PEF, Maximum Inspiratory Pressure, and Diaphragmatic Excursion (RT, LT) after 3 weeks in favor of Group I treatment plan.

The manual therapy approach provides a balance between parasympathetic and sympathetic nervous systems [43], which has a successful outcome in controlling various functions of the organ [44]. Spinal stimulation of the upper cervical and dorsal spine could enhance the response to adrenergic stimuli and neutralize sympathetic activity [45-47] by decreasing the secretion of acetylcholine, which in consequence relaxes the airway smooth muscle and reduces the secretion of mucous membranes [48]. Somato-visceral reflexes are triggered after spinal manipulation [49] by releasing mechanical compression on both peripheral nerves and ganglia where they pass through or lie in the intervertebral foramen, spinal cord, and brain stem where the latter extends into the neural canal through the foramen magnum [50].

The finding of the current study was confirmed by Dougherty et al. [51] who concluded that spinal manipulation may have the potential to improve lung function (FEV1 % predicted) by 12% after two weeks in COPD patients based on neurophysiological responses resulting from long-lasting biomechanical changes following the spinal manipulation. Shin and lee [52] also showed a little change in the FVC and FEV of experimental healthy volunteers sample after thoracic manipulation and their results could be much greater in individuals with respiratory dysfunction. The previous result was verified by Maji et al. [53] who concluded that thoracic spine manipulation at the level of (T4-8) had a significant effect on chest expansion and improved lung function spirometric measurements (FVC, FEV1, and FEV1/FVC) and suggested to be performed in patients with cardiopulmonary disorders. In a study by Da Silva et al. [54], it was concluded that cervical spine (C3) and thoracolumbar manipulation (T12) effectively increased maximum expiratory pressure and maximum inspiratory pressure as manipulation of (T12) is near diaphragm insertion; the finding of **Da Silva et al**. agreed with **Deakins**[55] who stated that manipulation to anatomical areas relating to the diaphragm could increase diaphragmatic excursion. Also, regarding chest mobility, **Cruz et al.** [56] concluded that a single application of a manual therapy procedure (muscle energy technique and myofascial release) could provide rapid lung function improvements for people with severe and very severe COPD**.** This came to an agreement with **Engel and Vemulpad**[57] who indicated that applying spinal manipulation and soft tissue therapy to a single vertebral joint complex would enhance joint movement and decrease muscle tone locally and would increase chest wall mobility and COPD compliance at multiple levels.

On the other hand, the results of the current study contrasted with Heneghan et al. [58] who reported decreased FVC in individuals with COPD when spinal manipulation was coupled with other manual techniques. Wall et al. [59] also discovered that no improvement in lung function in healthy adults was provided by a single thoracic manual therapy. However, Galletti et al. [60] stated that both spinal manipulation and diaphragm release techniques did not impact lung function or health-related quality of life; only functional exercise capacity in COPD was enhanced. The findings of Bronfort et al. [61] and Clar et al, [62] disproved the current study results because they concluded that spinal manipulation is not efficient for asthma because it does not have any major variations in respiratory parameters, symptoms or subjective measures.

Researches on respiratory training documented its benefits in increasing lung parameters such as FEV1 [63], enhancing daily activity by 67.6% and reducing rescue inhaler usage by 66.1% in subjects with mild to moderate asthma [64].**Sachdeva et al.** [65] documented that pursed-lip breathing through mouth mask showed significantly higher improvement in dyspnea relief and increased functional capacity, and with Buteyko breathing exercise improved patient symptoms and PEFR [66] through improved ventilation over time and decreased $PaCO_2$ due to prolonged exhalation [67], decreased residual volume and increased physical activity tolerance [68].**Wedri et al.** [69] agreed with the findings of the current study as they reported that diaphragmatic breathing exercise had a positive impact on Peak Expiratory Flow during the acute episode of asthma following nebulization, and **Agarwal et al.** [70] concluded that breathing exercise improves the spirometric measurement (FVC, FEV1, PEF) that affects breathlessness, wheezing, and nocturnal symptoms [71], **Sakhaei et al.** [72] added that pursed-lip breathing is a vital technique in improving oxygenation and physiological indicators in patients with COPD.

Contrary to the findings of the current research, **Ubolnuar et al**. [73] concluded in a systematic review and meta-analysis that there is no substantial difference in outcomes using respiratory exercises related to dyspnea symptoms in reference to the control group and added that respiratory exercise should be carefully designed for COPD patients, Many studies also indicated that the efficacy of pursed-lip breathing in pulmonary recovery is not conclusive, and some studies have failed to provide reliable results that PLB enhances lung function [74].

Conclusion

It was concluded that both soft tissue manipulation and traditional physiotherapy program are successful in treating asthmatic patients, but soft tissue manipulation is more beneficial than traditional physiotherapy program. These findings may be used as a guide for therapists to incorporate spinal manipulation as an additional tool in treating asthma patients in conjunction with conventional methods.

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