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Effect of the Cervicothoracic Fascia Stretch on Thoracic Mobility in Elderly Women

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SUMMARY

Background. Kyphosis is a prevalent condition in older women that can significantly impact their mobility. Various therapeutic approaches and modalities can be used to treat hyperkyphosis. Cervicothoracic fascia stretching reduces kyphotic angle, decreases cervical pain, and improves various dimensions of thoracic mobility.

Purpose of the study. The aim of this study is to evaluate the effect of the cervicothoracic fascia stretch on the thoracic mobility of older women.

Subjects and methods. Sixty older women with non-specific neck discomfort, whose ages ranged from 60 to 70, were recruited from the outpatient clinics at Heliopolis University. The recruited patients were randomly divided into two groups of equal numbers of subjects: Group A included 30 patients who underwent cervicothoracic fascia stretching, and 30 patients were included in Group B who underwent diaphragmatic breathing exercises three times a week for four weeks. The neck pain was assessed utilizing the Neck Pain and Disability Scale (NPAD), while thoracic kyphosis was assessed utilizing a flexion curve ruler. Moreover, thoracic circumference excursion was measured using tape, while transverse and latero-lateral dimensions of the thorax were assessed using a chest depth caliper.

Results. The comparison between pre- and post-study results showed a significant enhancement in all measured variables, including neck pain, thoracic circumference, chest width dimension, chest depth dimension, and kyphotic angle in both groups. Our findings indicated a statistically significant decrease in neck pain and kyphotic angle. Conversely, there was a statistically significant increase in thoracic circumference and chest width dimension for the cervicothoracic stretch group after treatment.

Conclusions. Both interventions, such as intrathoracic fascia stretch and diaphragmatic breathing exercises exhibited extraordinary effectiveness in the management of reduced thoracic mobility and neck pain in older women with better results in favor of cervicothoracic stretch.

KEY WORDS

Cervicothoracic fascia; elderly; chest dimensions; thoracic mobility; fascia properties.

INTRODUCTION

The aging process is associated with gradual alterations in the physiology of the musculoskeletal system, resulting in excessive bone destruction, vertebral fractures, muscle weakness, and degenerative disorders that result in thoracic hyperkyphosis (1). Hyperkyphosis is defined as excessive concavity of the thoracic spine (> 40 degrees) and affects 20-40% of the elderly population worldwide (2).

Limited mobility in the thoracic spine has been recognized as a predictor of neck pain due to the close anatomical link between the cervical and thoracic spines (3). Fascia generates network connections all over the body parts and also connects the muscular and non-muscular parts (4). In the event that the fascia is subjected to tension from a particular area, it will result in the displacement of other interconnected anatomical structures in relation to this tension (5). Endothoracic fascia originates in the deep and median cervical fascia (6). It runs from the occipital pharyngeal tubercle to the inner surface of the thoracic region; strongly connected to the pleural, the middle cervical fascia stretched into the front thorax to cover the pleural dome (7). The endothoracic fascia is also connected to the subclavian artery sheath in the frontal region, establishing a link with the cervical fascia (8). The coastal insertions of the diaphragm act as a barrier between the base of the lower endothoracic, which covers the diaphragm, and the abdominal wall, which is connected to it by the fascia transversalis (9). This fascia has a direct relationship to the pleura, pericardium, and diaphragm (10). The fascia also has a solid connection to the spine vertebra, affecting the alignment of the spine (5). The interior of the fascia is firmly fused to the parietal pleura (11). Around the mediastinum, it is thick and velvety (6). The typical locations between the endothoracic fascia and the pleura membrane are directly connected to the vertebral column, the thoracic wall anteriorly in the sternum, and posteriorly between the posterior angle of the ribs the vertebral column (12).

Many different techniques have been used to manage thoracic mobility and chest expansion, including rib mobilization, thoracic vertebral manipulation, thoracic muscle stretching, breathing exercises, and recoil manipulation of the sternum (3). The technique of stretching the intrathoracic fascia has been found to be an effective means of enhancing motor function, restoring mobility, and alleviating discomfort (13). Restoring the correct tension between the various linked anatomical places helps increase thoracic mobility and chest expansion, enhances motion range and flexibility, and improves optimal spine alignment and tension balance in chest muscles (14).

To date, only a limited number of studies have explored the correlation between fascia and the kyphotic curve of the thoracic neck, as well as its width, depth, neck discomfort, and thoracic excursion (15). The study was hypothesized that there is no significant effect of cervicothoracic fascia stretch on thoracic mobility in elderly women. Consequently, the comparability of our findings with those of prior studies on all pertinent aspects was limited.

MATERIALS AND METHODS

Study design

A six-month randomized controlled trial was conducted in orthopedic outpatient clinics of Orthopedic Heliopolis University (February 2021 to July 2021). The patients received a detailed explanation of the treatment program and measurement devices and provided their written informed consent prior to the start of our trial. The study was approved by the ethics committee of the physical therapy faculty at Cairo University (P.T.REC/012/003586 – date of approval: January 04, 2022).

Participants

The patients were included according to the following criteria: 60 older women with non-specific neck pain, their age between 60 and 70 years, body mass index (BMI) was 25-29.9 kg/m^2, osteopenia level was between -1.0 and -2.5. The patients were included only if their vital signs were controlled and deemed medically and clinically stable during the study. To avoid type II error, sample size calculation was performed using G*POWER statistical software (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany) [F tests- MANOVA-repeated measures, within and between interaction, $\alpha = 0.05$, power = 80%, effect size = 0.19] and revealed that the appropriate sample size for this study was n = 60 (**figure 1**).

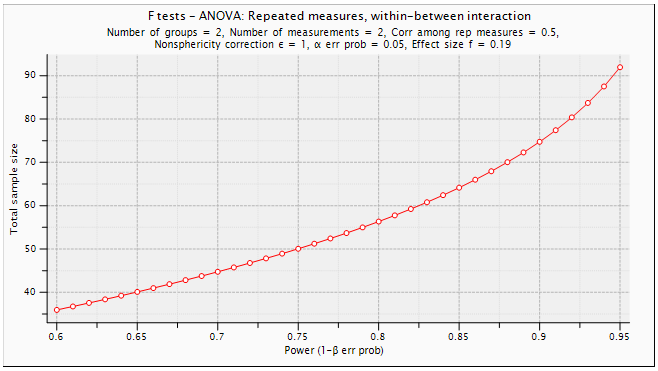


Figure 1. Power analysis.

Patients were excluded from the study if they met any of the following criteria

Acute cervical disc problem, spinal cord indentation, acute spinal fracture, acute infection, recent trauma, local acute inflammation, and osteoporosis T-score below -2.5. All participants were randomly divided into two groups, group A included 30 female patients who received a cervicothoracic fascia stretch; physiotherapy treatment was

administered to all patients three days a week for one month; group B included 30 female patients who received diaphragmatic breathing exercises and physical therapy treatment was administered to all patients three days a week for one month.

Measurement procedures

Measurement and assessment were performed before and four weeks after the initiation of the treatment protocol for all patients in both groups. The experimental protocol was thoroughly explained to each patient before the initial assessment, and written consent was obtained from all recruited subjects. The treated patients were advised to disclose any side effects experienced during treatment sessions.

The chest depth caliper is a flexible opening tool to measure different chest dimensions in depth and width in centimeters; it was used to measure the different chest expansions, including anteroposterior and transverse dimensions which is considered as good reliability tool (16). The kyphotic angle is measured by the flexion curve ruler, which is made of plastic material and a flexible tool that can be molded on the thoracic spine curve from C7 to T12 (17). The Flexion curve method is as reliable and valid method to measure thoracic kyphosis, which is a technique that can be easily applied in both clinical and human posture research contexts (17). Chest circumference is measured by tap measurement; it measures the circumference of the chest during the thoracic excursion which is reliable method for healthy, asthma and COPD patients (17). The Neck Pain and Disability Scale (NPAD) was used to measure the intensity of neck pain, limitations in activity, and restricted motion during usual daily living and working times (18). Each patient's measurements were obtained three times in order to ensure accuracy and attain intarrater reliability.

Treatment procedures

This study was conducted to evaluate the efficacy of cervicothoracic fascia stretch *versus* diaphragmatic breathing on thoracic mobility among elderly women using multiple assessments, including chest depth Caliper, flexion curve ruler, neck pain disability scale, and tape measurement to measure chest width and depth dimension, kyphosis curve, pain level, as well as chest excursion, respectively.

Group A

Patient preparation

The patients were positioned in a supine position on the T2-3 level, legs straight, both shoulders held against the table, and arms straight beside the patient's body. Each patient in this group received an intrathoracic fascia stretching technique on the cervicothoracic fascia for three weekly sessions for four weeks (19). Prior to beginning treatment, patients were evaluated for previous medical histories such as cardiovascular, renal, hepatic, and musculoskeletal diseases.

The intra-thoracic fascia stretch technique

The intrathoracic fascia stretch technique was for the central and two lateral fascia chains. For central fascia stretch, patients were placed supine with the patient's head out of the plinth and held under the occiput bone to start little traction. The patients were asked to take deep breaths, and then traction was performed from the occiput bone in a straight upward direction while maintaining deep breathing. During abdominal inhalation, downward pressure of the diaphragm was observed, the ribs displaced laterally, and the sternum moved in ventrally/cranial motion. The head was positioned on the opposite side of the lateral fascia, bending with ipsilateral-lateral rotation to the body side. Traction was administered under the occiput, and the patient was asked to take a deep inhalation through the abdomen; then, the traction was performed by pulling gradually with the maintenance of the head position. Repeated the gradual occiput traction on both fascia chains (20).

Group B

Patient preparation

The participants were given instructions to remove any form-fitting shirts and replace them with looser clothes. Prior to beginning treatment, patients were evaluated for previous medical histories such as cardiovascular, renal, hepatic, and musculoskeletal diseases.

Signs should be observed during diaphragmatic breathing

The patient's abdomen should rise and fall while breathing, but the upper chest should be relatively still. Patients should not use accessory breathing muscles to concentrate on diaphragm muscle training. The regular breathing was observed to prevent irregular patterns. Patients should not eat for two hours prior to treatment (21).

Diaphragmatic breathing technique

The recruited subjects were seated in a comfortable position and instructed to take slow and deep breaths, inhale through the nose and exhale through the mouth. Before the beginning of the therapeutic intervention, patients were instructed to "place one hand on their abdomen to

expand it during inhalation and the other hand on the upper chest to control thoracic motion". The hands under the ribs gave light resistance. All patients started with a set breathing cycle: natural breathing for 5 min, followed by the deep breathing phase for 5 min, and then more than 5 min of natural breathing. Each patient took four sets, and the rest time was 1-2 minutes between sets for three weekly sessions for four weeks (22).

Statistical analysis

Unpaired t-tests were utilized to compare subject characteristics between groups. The Shapiro-Wilk test was utilized to confirm the normal distribution of data, while Levene's test was conducted to assess the homogeneity of variances between groups. Mixed MANOVA was used to examine the impact of treatment on the thoracic circumference, chest depth, chest width, NPAD, and kyphotic angle. Subsequent multiple comparisons were conducted utilizing post hoc tests with Bonferroni correction. The significance level for all statistical tests was set at $p < 0.05$. All statistical analyses were done utilizing IBM SPSS V.25 for Windows.

RESULTS

Subject characteristics

Our findings revealed that there were no significant differences between the two groups in relation to age, weight, height, and BMI ($p > 0.05$) (**table I**).

Effect of treatment on thoracic circumference excursion, chest depth, chest width, NPAD, and kyphotic angle

There was a significant increase in thoracic circumference excursion, chest depth, and width post-treatment in both groups compared to pre-treatment ($p > 0.001$). Group A exhibited a percentage increase of 123.72%, 29.33%, and 36.38% in the thoracic circumference, chest depth, and width excursion, respectively. In contrast, Group B demonstrated a percentage increase of 73.53%, 25.81%, and Both study groups demonstrated a statistically significant reduction in NPAD and kyphotic angle following the intervention in comparison to their respective baseline measurements ($p > 0.001$). The findings indicate that the percentage of decrease between NPAD and kyphotic angle for group A was 25.89% and 16.93%, respectively. For group B, the corresponding percentages were 6.76% and 7.9%, accordingly (**table II**).

Between groups

Before the initiation of the intervention, no statistically significant distinctions were observed among the cohorts ($p > 0.05$). However, post-treatment comparison indicated a significant increase in thoracic circumference excursion and chest width for group A compared to group B ($p < 0.01$). Conversely, there was no significant difference in chest depth ($p > 0.05$). Moreover, the NPAD and kyphotic angle of group A exhibited a significant decrease in post-treatment as compared to group B ($p < 0.001$).

DISCUSSION

The aim of the present investigation was to evaluate the impact of intra-thoracic fascia stretching on thoracic mobility among elderly females. The present investigation revealed that there were no significant dissimilarities in weight or height among the two groups that were matched for age. The present study's results pertaining to the influence of intrathoracic fascia stretching on chest dimensions indicate that a 4-week stretching intervention resulted in a statistically significant enhancement in chest width, exhibiting a percentage change of 36.38%, and an improvement in depth, demonstrating a percentage change of 29.33%.

The present findings align with the research conducted by kevin Coulier *et al.* (23), which documented an improvement in lung function and thoracic mobility among adult patients with chronic respiratory diseases who underwent

Table I. Comparison of subject characteristics between the group A and B.

	Group A	Group B	MD	t- value	P-value
	Mean ± SD	Mean ± SD			
Age (years)	64.2 ± 3.31	64.33 ± 3.34	-0.13	-0.15	0.87
Weight (kg)	73.2 ± 6.68	74.96 ± 8.08	-1.76	-0.92	0.36
Height (cm)	162.73 ± 5.83	163.7 ± 8.07	-0.97	-0.53	0.59
BMI (kg/m²)	27.46 ± 2.47	28.03 ± 1.52	-0.57	-1.07	0.28

SD: standard deviation; MD: mean difference; P-value: probability value.

Table II. Statistical analysis of data between Groups A and B.

	Pre-treatment	Post-treatment	MD	% of change	P-value
	Mean ± SD	Mean ± SD			
Thoracic circumference excursion (cm)					
Group A	2.53 ± 0.67	5.66 ± 1.71	-3.13	123.72	0.001
Group B	2.72 ± 0.52	4.72 ± 1.1	-2	73.53	0.001
MD	-0.19	0.94			
	p = 0.21	p = 0.01			
Chest depth (cm					
Group A	18.14 ± 1.67	23.46 ± 1.59	-5.32	29.33	0.001
Group B	18.6 ± 1.22	23.4 ± 1.24	-4.8	25.81	0.001
MD	-0.46	0.06			
	p = 0.23	p = 0.85			
Chest width (cm)					
Group A	16.63 ± 1.86	22.68 ± 1.69	-6.05	36.38	0.001
Group B	16.6 ± 1.54	21.53 ± 1.47	-4.93	29.70	0.001
MD	0.03	1.15			
	p = 0.94	p = 0.007			
NPAD					
Group A	26.26 ± 3.89	19.46 ± 4.47	6.8	25.89	0.001
Group B	27.2 ± 3.49	25.36 ± 4.11	1.84	6.76	0.001
MD	-0.94	-5.9			
	p = 0.33	p = 0.001			
Kyphotic angle (degrees)					
Group A	15.48 ± 1.51	12.86 ± 1.34	2.62	16.93	0.001
Group B	15.56 ± 1.43	14.33 ± 1.42	1.23	7.90	0.001
MD	-0.08	-1.47			
	p = 0.83	p = 0.001			

SD: standard deviation; MD: mean difference.

upper thoracic and rib therapy alongside intrathoracic fascia stretching. However, the present research contradicts the results of Heneghan *et al.* (24), as they observed that rib mobilization was more effective in enhancing thoracic mobility in patients with respiratory issues than the myofascial release of increased modulation of joint structure and more efficient enhancement of mobility function. The Heneghan study's sample size and health conditions differed from the current study's, which resulted in the conclusion that rib mobilization is preferred to fascial release. Therefore, the primary factors elucidating the varied effects of cervicothoracic fascia stretching on thoracic mobility are the sample size, sex, and health condition of the patients (24). Moreover, the present study indicates a significant improvement in chest circumference due to the stretching of intrathoracic fascia, with a percentage change of 123.72%.

Bordoni *et al.* (25) stated that although the study did not explore the impact of stretching the endothoracic (cervicothoracic) fascia on individuals with respiratory limitations, their outcomes revealed that the structure of the fascia could be a contributing factor to the ongoing restriction of thoracic excursion. Furthermore, Bordoni *et al.* (25) suggests that when the fascia is stretched, it triggers the activation of mechanical and nociceptive receptors, which subsequently impacts the pain threshold and mobility of the fascia; additional, they have reported that the cervicothoracic (endo thoracic) can be stretched by targeting the deep fascial layer.

However, the current findings were in conflict with those of Swapna *et al.* (26), who found no appreciable improvement in dyspnea and expansion of chest circumference in restricted respiratory patients after the myofascial release of the structure of the soft tissue of the chest. Herein, the intrathoracic fascia stretches also showed statistically significant improvements in the kyphotic angle curve with percentage changes of 16.93% and 25.89%, as well as cervical pain. This result is in agreement with Mousavi *et al.* (27), who found that corrective exercise and stretching of the soft myofascial pectoral region combined had a more significant impact than exercise alone in reducing the kyphotic curve and neck pain. Moreover, Rodrguez-Huguet *et al.* (28) reported that patients with neck pain who underwent cervical myofascial release experienced a significant improvement in their neck pain. However, Kim *et al.* (29) discovered that cervical myofascial release had no statistically significant impact on neck discomfort and head forward posture. The diaphragmatic breathing exercise led to statistically significant improvements in chest depth and width motions, with a percentage change of 25.81% and 29.7%, respectively. Furthermore, the diaphragmatic breathing exercises positively impacted asthmatic patients' chest dimensions, according to the findings reported by Shaw & Shaw (30). Our conclusions indicated that diaphragmatic breathing exercises significantly increased intraabdominal pressure, which in turn caused the lower ribs to migrate laterally upward and outward, thus widening the chest, the upper ribs, and the sternum to shift anteriorly and posteriorly, consequently deepening the chest. Herein, the diaphragmatic breathing exercise resulted in a post-treatment statistically significant improvement in thoracic circumference excursion, with a percent change of 73.53%. Consistently, Kim *et al.* (22) found that the utilization of diaphragmatic breathing exercises and mobilization of the rib cage led to the activation of parasympathetic nerves and suppression of sympathetic nerves. Diaphragmatic breathing exercises showed a statistically significant post-treatment reduction in neck discomfort in the current trial, with a percent change of 6.76% and 7.9% in the kyphotic angle. Studies have indicated that practicing diaphragmatic breathing techniques can improve posture by decreasing spinal kyphosis and promoting relaxation of the inflexible rib cage. Therefore, there is a belief that they may be a viable treatment option for individuals who suffer from chronic non-specific neck pain (31).

The current investigation utilized identical variables to conduct a comparative analysis between the two groups. The research findings concluded no statistically significant variation in chest depth between the two groups. However, it is significant that the intrathoracic stretch group exhibited superior performance in all other measures compared to the diaphragmatic breathing group. The observed phenomenon could potentially be attributed to the activation of fascial mechanoreceptors resulting from the stretching of the intrathoracic fascia, leading to a modification in the distribution of fascial forces across the chest region (32). The augmentation of blood circulation and elongation of the fascia spanning from the cervical to the thoracic region resulted in an enhancement of thoracic mobility (33). The present study centers on the utilization of intrathoracic fascia stretching in combination with other therapeutic modalities to enhance the rehabilitative outcomes of elderly patients (34). One of the study's limitations was the small sample size. Another limitation of the study was its restricted emphasis on women and a certain age range. Our study aimed to assess the efficacy of intrathoracic fascia stretching in comparison to various intervention techniques, as well as to identify the most successful treatment ways for various medical diseases. It was also recommended to include people of all ages and a large sample size in order to find the correlation between the cervicothoracic fascia stretch with other modalities and how the combination will affect different samples.

CONCLUSIONS

The study's findings suggest incorporating intrathoracic fascia stretching into treatment plans can effectively address thoracic mobility restriction, chest expansion of varying dimensions, and thoracic kyphotic angle in elderly female patients. The implementation of intrathoracic fascia as a therapeutic option may be considered a safe and effective approach to address complications in older women within a treatment program.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

NGE, SAFE, AME: conceptualization, methodology, writing - review & editing, supervision. RAHY: resources, investigation, writing – original draft.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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