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The effect of cervical spondylosis on diaphragmatic thickness and excursion in nonsmoking adults

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Abstract

Background

Cervical spondylosis is defined as a series of signs and symptoms that result in anatomical and physiological changes in the vertebral column that may impair phrenic nerve function by compressing the C3/C5 that affect diaphragmatic movements.

Purpose

The purpose of this study was to investigate the effect of cervical spondylosis on diaphragmatic thickness and excursion in nonsmoking adults by using ultrasonographic evaluation of the diaphragm. Eighty-four nonsmoking volunteers participated in this study and were divided into two equal groups: group A, patients with cervical spondylosis and group B, healthy volunteers with a normal cervical spine. Both groups were evaluated by the same methods.

Results

The results f this study showed that there was a statistically significant decrease ($P < 0.05$) in diaphragmatic thickness, diaphragmatic rest, and deep-excursion means in favor of group A compared with its corresponding value in group B.

Conclusion

The present study revealed that the cervical spondylosis has an effect on diaphragmatic thickness and excursion in nonsmoking adults.

Keywords: Cervical spondylosis, diaphragmatic excursion, phrenic nerve, ultrasonography

Body

Cervical spondylosis is a musculoskeletal condition that affects motor control of the cervical region and related structures [1].

Almost everyone develops radiographic evidence of cervical spine degeneration as they become older; however, not everyone suffers the typical symptoms of neck stiffness or neurologic deficits that are caused by the mechanical compression of neural components. At first, nonsurgical therapeutic options are used to treat symptomatic cervical spondylosis. It is possible that surgery will be required, if the cervical spine is becoming progressively unstable or distorted, or if there is clinically considerable neurologic impairment [2].

Neuromuscular respiratory problems may be caused by cervical spine spondylosis because cervical spondylosis can compress the nerves of the phrenic and accessory inspiratory muscles on both sides, diaphragmatic muscular atrophy and thickening can occur [3].

The diaphragm is the skeletal muscle that separates between the chest and the abdominal cavity. It is considered the most important muscle for respiration and its main role is maintaining the respiration process. Muscle dysfunction can arise in a variety of diseases, including myelopathy

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of the cervical spine, myopathies, and neuropathies, using mechanical ventilation, surgeries and trauma, malignancies, metabolic problems, and chronic lung illness, leading to reduce inspiratory capacity and respiratory muscle endurance result and maximal muscular force generation [4].

Ultrasound is now being used to evaluate diaphragmatic function. Ultrasound provides a number of advantages, including safety, radiation avoidance, and bedside availability [5].

Various ultrasonographic techniques, such as two-dimensional (BD) or M-mode measurement of diaphragmatic excursions and changes in diaphragm thickness during inspiration, have been proposed. The technique for evaluating diaphragmatic function using ultrasound has been well defined. In situations or disorders where the phrenic nerve or diaphragm muscle may be affected, ultrasound can provide a simple solution [6].

According to population-based research, by the age of 50, around 80–90% of adults demonstrate disc degeneration on MRI. Spondylosis symptoms are more common in males than in females, with a peak prevalence for both males and females of 40 and 60 [2].

One of the top 10 reasons of years spent disabled was neck pain. It was ranked fourth in the world. Cervical spondylosis not only reduces the quality of life, but it also adds to the financial load [7].

The exact prevalence and incidence of cervical spondylosis are unknown. However, because cervical spondylosis is a disease caused by deterioration of the spinal tissues, the elderly are the ones who are most impacted. According to recent research, males are more affected by cervical spondylosis than females, with a ratio of 2.7: 1. Nearly 60% of individuals over the age of 40 had disc degeneration, and 20% had foraminal stenosis, resulting in compression of the spinal cord. It affects 1.5–2.4% of the Caucasian population and 1.9–4.3% of the Asian population over the age of 50, who have adult cervical diseases. Cervical stenosis is expected to affect 4.9% of the adult population, 6.8% of the population 50 years and older, and 9% of the population 70 years and older [8].

By pressing the C3/C4 nerves that control diaphragmatic motions, cervical spondylosis, a common illness, can affect phrenic nerve function [9] (Fig. 1).

So, the purpose of this study was to investigate the effect of cervical spondylosis on diaphragmatic thickness and excursion in nonsmoking adults by using ultrasonographic evaluation of the diaphragm that may affect respiratory and diaphragmatic function. If there is an effect of cervical spondylosis on the diaphragmatic excursion and thickness, then a pulmonary rehabilitation program and breathing exercises should be added to musculoskeletal rehabilitation program of patients with cervical spondylosis and chronic neck pain.

Patients, materials, and methods

There were 84 nonsmoking volunteers, their ages were between 40 and 50 years. Their BMI was between 18.5 and 29.9 kg/m^2.

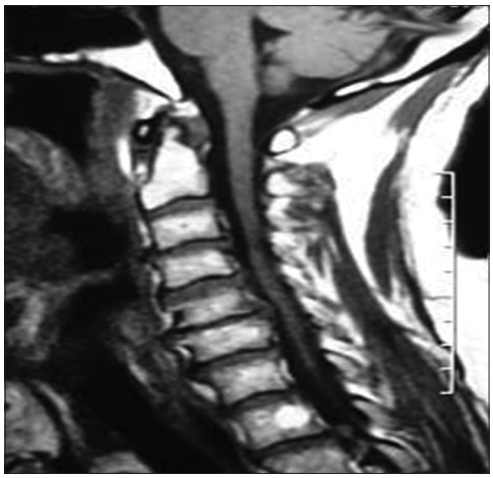

Figure 1: T1-weighted sagittal MRI image shows multiple cervical vertebral degeneration (SpineUniverse.com.).

Forty-two nonsmoking volunteer patients (group A) referred with cervical spondylosis and chronic neck pain symptoms and they were selected from the outpatient orthopedic clinic of Al-Mataria Teaching Hospital and Emergency Department and 42 nonsmoking healthy volunteers (group B).

Inclusion criteria

All volunteer ages ranged between 40 and 50 years, their BMI between 18.5 and 29.9 kg/m^2, their sex males and females have no previous chest diseases, and female patients should not be pregnant.

Exclusion criteria

The exclusion criteria were lack of patient's informed consent, age below 40 or above 50 years, if there is any chest disease or central obesity, patients with multiple comorbidities, one or more organ failure, neurological disease, and pregnant females.

Informed consent form was signed by each patient in both groups (A and B). This study was approved by the Ethical Committee of the Faculty of Physical Therapy, Cairo University (No.): P.T.REC/012/002977.

Instrumentation

Evaluation equipment

(1) Diagnostic ultrasonography: Philips affinity 50 G, (philips ultrasound,inc.22100 botheil everett highway bothell.WA 98021-8431.USA) which was made in the United States, with serial number (US017D0452). It was used to prove the diagnosis of the structure and function of the diaphragm for all volunteers in both groups
(2) Weight/height scale: it was used to measure the weight and the height of all volunteers in both groups (A and B) to calculate their BMI.

Procedures of the study

The evaluative procedures

(1) Initially a careful history was taken from each in the two groups.

(2) BMI and the weight and height of each volunteer in both groups (A and B) were measured, while the volunteer wore light clothes and bare feet, to calculate the BMI.
(3) Diaphragmatic ultrasonography is a type of ultrasound that is used to assess the anatomy and function of the diaphragm on the right side. It is most typically utilized in evaluations where the descending lung can hide the diaphragm during inspiration. This is an especially common occurrence on the left side.

Diaphragm thickness

B-mode ultrasound was used to measure the diaphragm-apposition zone near the costo phrenic angle between the right anterior and mid-axillary lines, with a linear transducer (6–13 MHz) placed over the diaphragm-apposition zone close to the costo phrenic angle between the right anterior and mid-axillary lines, from the most superficial hyperechoic line (pleural line) to the deepest hyperechoic line (peritoneal line) (Fig. 2).

Diaphragm excursion during quiet and deep breathing

At supine position, we use (M mode) of the ultrasound, measuring the amplitude of the craniocaudal excursion of the diaphragm during quiet and deep breathing. The excursion of the diaphragm was measured on the vertical axis. We measure the distance between the baseline and the point of maximum inspiration height on the graph.

Statistical analysis

Independent-group *t* test was used for comparison of diaphragm thickness, diaphragmatic excursion during rest breathing, and diaphragmatic excursion during deep breathing between both groups. The level of significance for all statistical tests was set at *P* value less than 0.05. All statistical measures were performed through the Statistical Package for Social Studies (SPSS), version (19) for Windows (IBM SPSS Statistics Company.Chicago, U.S.A) (Figs. 3 and 4).

Results

Diaphragmatic thickness

There was a statistical significant decrease in the mean value of diaphragmatic thickness in group A (study group) (0.47 ± 0.08) when compared with its corresponding value in group B (control group) (0.53 ± 0.07) with *t* value = −3.21 and *P* value = 0.002 (Table 1 and Fig. 5).

Rest-breathing diaphragmatic excursion

There was a statistical significant decrease in the mean value of rest-breathing diaphragmatic excursion in group A

Table 1: Mean value diaphragmatic ultrasound examination in the two groups

	Group A (*n*=42)	Group B (*n*=42)	*t*	*P*
Diaphragmatic thickness	0.47±0.08	0.53±0.07	−3.21	0.002 (S)
Rest excursion	1.96±0.56	2.54±0.83	−3.74	0.001 (S)
Deep excursion	3.32±0.90	4.07±1.06	−3.50	0.001 (S)

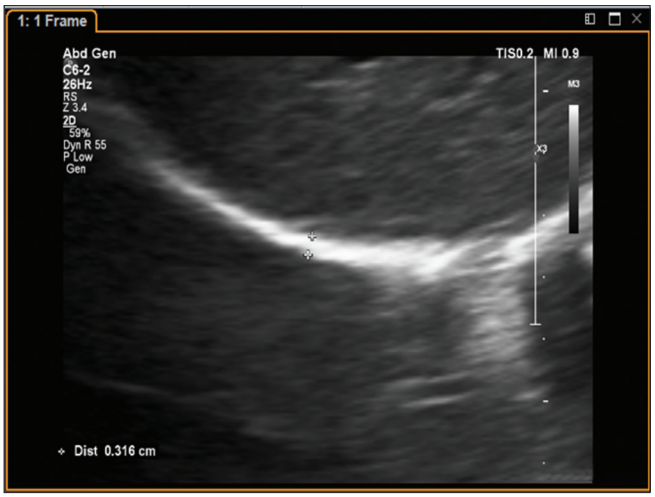

Figure 2: Diaphragmatic thickness by US examination. US, ultrasound.

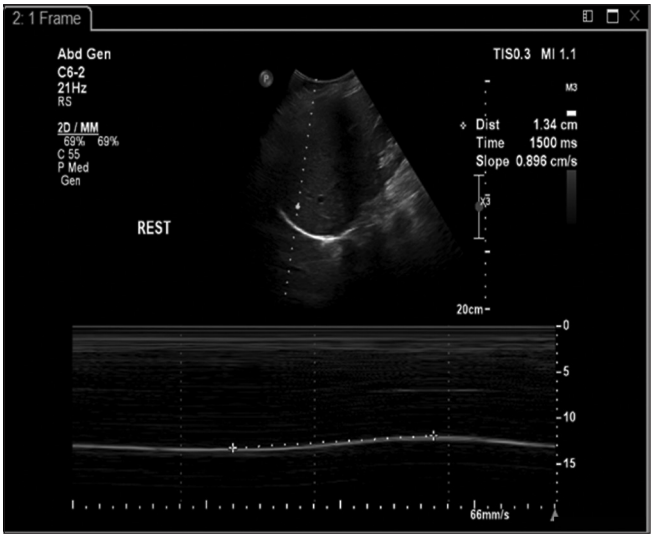

Figure 3: Diaphragmatic excursion at rest by ultrasonography examination.

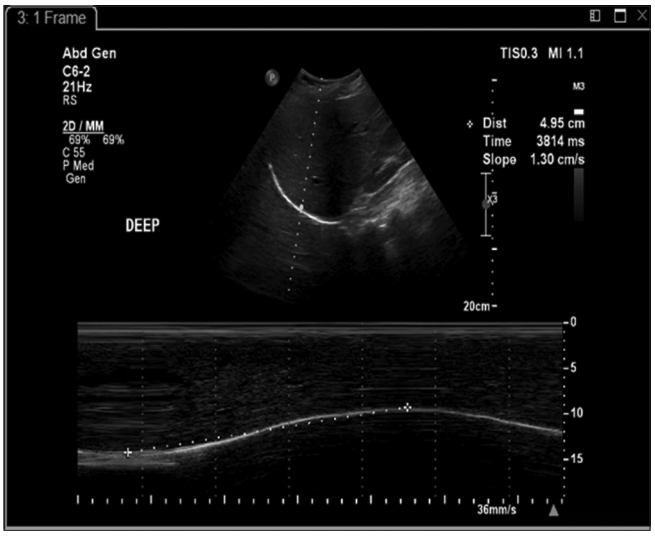

Figure 4: Diaphragmatic excursion during deep breathing and time of contraction.

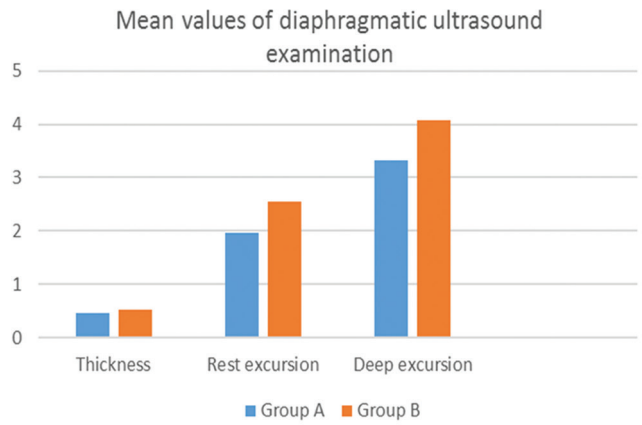

Figure 5: Illustrating the percentage of difference in diaphragmatic thickness, rest excursion, and deep excursion in both groups (A and B).

(study group) (1.96 ± 0.56) when compared with its corresponding value in group B (control group) (2.54 ± 0.83) with *t* value=−3.74 and *P* value = 0.001 (Table 1 and Fig. 5).

Deep-breathing diaphragmatic excursion

There was a statistical significant decrease in the mean value of deep-breathing diaphragmatic excursion in group A (study group) (3.32 ± 0.90) when compared with its corresponding value in group B (control group) (4.07 ± 1.06) with *t* value=−3.50 and *P* value = 0.001 (Table 1; Fig. 5).

Discussion

According to population-based study, nearly 80–90% of adults show disc degeneration on magnetic resonance imaging by the age of 50. Every year, more than a third of a billion people suffer from mechanical neck pain for at least 3 months, which might impact the phrenic nerve, which innervates the diaphragm and influences its thickness and excursion. So this study was conducted to determine if the cervical spondylosis affects diaphragmatic thickness and excursion in nonsmoking adults.

Comparison between both groups (A and B)

Statistical analysis revealed a significant decrease in the mean value of diaphragmatic thickness in group A (study group) when compared with its corresponding value in group B (control group). This study came in agreement with Hawkes and Rabinstein [3] who studied the cervical spine spondylosis as a possible cause of neuromuscular respiratory failure and reported that cervical spondylosis can compress the nerves of the phrenic and accessory inspiratory muscles on both sides, causing diaphragmatic muscular atrophy and decreasing thickness.

Also, this study came in agreement with Boussuges *et al*. [10] who studied the diaphragmatic motion recorded by M-mode ultrasonography and reported that in patients suffering from paralysis of the hemidiaphragm, on the paralyzed side, the hemidiaphragm did not thicken significantly or it even became thinner.

Statistical analysis revealed a significant decrease in the mean value of rest and deep-breathing diaphragmatic excursion in group A (study group) when compared with its corresponding value in group B (control group). This study came in agreement with Fahad *et al*. [11] who studied the effect of cervical spinal stenosis and risk of pulmonary dysfunction and reported that chronic cervical spondylosis leads to subclinical pulmonary dysfunction due to the involvement of the phrenic nerve.

On the other hand, the results of the present study were in disagreement with Laghi *et al*. [12] who studied the ultrasound and nonultrasound-imaging techniques in the assessment of diaphragmatic dysfunction and reported that the association between diaphragm excursion and thickening is very weak and that between diaphragm excursions and pressure output is weak to absent.

To my point of search, I did not find any scientific papers that contradict with the results of this study, especially in the effect of cervical spondylosis on the phrenic nerve, on the thickness of the diaphragm, or the amount of its excursion.

So, it can be concluded that the cervical spondylosis affects diaphragmatic thickness and excursion in nonsmoking adults.

Further study is recommended to evaluate if cervical spondylosis affects diaphragmatic excursion in other age groups, and to evaluate the effect of the decrease in diaphragmatic excursion in patients with cervical spondylosis on pulmonary functions.

Also, studies are needed to detect the effect of cervical spondylosis on diaphragmatic excursion in obese patients.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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