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Correlation between Rib Hump and Ventilatory Function in Adult Patients with Idiopathic Scoliosis

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Abstract

Background: The principal of scoliosis on pulmonary functions believed to be mechanical. The anatomical changes due to scoliosis in the chest wall causing impaired movement and reduced compliance that is demonstrable on pulmonary function testing (PFT).

Aim of Study: To find the correlation between rib hump and ventilatory function in adult patients with idiopathic scoliosis.

Material and Methods: Forty female adult patients with right thoracic idiopathic scoliosis enrolled in this study; they recruited from orthopedic outpatient clinics of Al Kasr Al-Aini Hospitals, Cairo University. The patient was asked to do Adam forward bend test which bend forward to bring the spine parallel with the floor, with the arms dangling, palms together, and knees forward, while the examiner inspected from behind for any thoracic or lumbar prominence that would signify scoliosis. Rip hump would be measured by scoliometer, then the patient would be given a spirometry to measure the ventilatory function.

Results: There was significant direct strong negative correlation between rotation and FVC, there was significant direct strong negative correlation between rotation and FEV 1 while there is a non-significant negative weak correlation between rotation and FEV 1/FVC ratio.

Conclusion: The degree of rotation of rib hump on patients with thoracic scoliosis correlate negatively with FVC, FEV 1 and no correlation between the rotation of the rib hump and the ratio between FEV1 / FVC.

Key Words: *Idiopathic scoliosis – Rib hump – Ventilatory function.*

Introduction

SCOLIOSIS is defined as a three-dimensional deformity of the spine associated with lateral deviation from the normal vertical direction and mostly with rotation of vertebras. The scoliosis research Society (SRS) has defined it as asymmetry in the forward bending test and Cobb angle greater than 10^0 **[1]**.

The ribs follow the rotation of the vertebra, the rip hump develops because the posterior ribs on the convex side are being pushed to posterior and the anterior ribs on the concave side are pushed anterior **[2]**.

The principal effect of scoliosis on pulmonary functions believed to be mechanical. The anatomic changes in the chest wall causing impaired movement and reduced compliance that is demonstrable on pulmonary function testing (PFT). Many studies have shown that PFTs of patients with idiopathic scoliosis reveal a restrictive defect. Defective mechanical coupling of inspiratory muscles to the chest wall leading to a decrease in respiratory muscle mechanics has been shown to contribute to the restrictive properties **[3]**.

Researchers have found that rib mobility on the concave side is restrained in scoliosis, which can lead to limitations and impaired respiratory ventilation **[4]**.

All these can be attributed to the fact that due to the complex relationship between the spine, sternum and ribs, the displacement and rotation of vertebras in the scoliosis affect the shape of the chest wall causing either convexity or concavity. The anteroposterior and transverse diameters on each side of the thorax are significantly different from each other, and thus inflation of the lungs will be asymmetric **[5]**. Furthermore, the expansion of the thoracic cavity will be limited because the

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motion of ribs prevents its mobility. Therefore, the chest wall motion diminishes and breathing becomes significantly more difficult even in the absence of any pulmonary disease, Generally, scoliosis is associated with preliminary restriction which manifests itself with diminished total capacity of the lungs in the pulmonary functional test. The reduction in the total lung capacity is often associated with increased residual volume leading to high residual volume to the total lung capacity ratio [5].

The correlation between scoliosis and pulmonary function was assessed mainly on the scoliosis features of the coronal, sagittal, and axial planes and even three-dimensional analysis these scoliosis features are expressed by radiological parameters, which exist independently and rarely reflect the common changes of the spine and thorax [6].

Patients and Methods

Forty female adult patients with right thoracic idiopathic scoliosis were enrolled in this study; they were recruited from outpatient clinics of Al Kasr Al-Aini Hospitals, Cairo University. This study duration between period of January 2021 to February 2022.All patients received a complete explanation of the objectives and procedures of the study. The Ethical Committee of Faculty of Physical Therapy, Cairo University, Egypt (No: P.T.REC-012-003097) reviewed and approved this study.

Patients were chosen under the following criteria: Female adult patients with right thoracic idiopathic scoliosis of age group between 18 to 30 years with Cobb's angle is either mild (10°-29°), moderate (30°-49°) and severe more than 50° and rib hump >7°. They were asymptomatic and had no medical or orthopedic problems other than chest deformity, Body mass index (BMI): 18 to 24.9.

Patients with one of the following criteria were excluded from the study: Chronic respiratory diseases history including chronic obstructive pulmonary disease (COPD) and asthma, Alcoholics, Smoker, Pregnancy, mentally handicapped. Ascites, active involved in any sport, Showing respiratory tract infection symptoms and other types of scoliosis such as (neurofibromatosis, congenital, neuromuscular).

Procedures:

1- *Standing anteroposterior (AP) radiographs of the spine:*

Standing anteroposterior (AP) radiographs (X-rays) of the spine were taken from all cases. The same techniques were used throughout the study. The radiographs were assessed for the position and type of curve. The angle of curvature was measured by the Cobb's method. Patients were divided into three groups based on the degree of Cobb's angle (mild 20-50, moderate 51-70, and severe >71) [7].

2- Adam forward bend test:

the patient stands upright while the examiner observed from behind for any obvious curvature. The patient was then asked to bend forward to bring the spine parallel with the floor, with the arms dangling, palms together, and knees forward, while the examiner inspected from behind for any thoracic or lumbar prominence that would signify scoliosis. rip hump would be measured by scoliometer [8].

3- Ventilatory function test:

The procedure will follow this process, the patient would:

1- Toke off tight clothing, jewelry, or other things that may cause a problem.
2- Empty the bladder before the procedure.
3- Sit in a chair, put a soft clip on his mouth and the breathing is done through mouth.
4- The patient will be instructed to inhale and exhale Various spirometry measurements (FVC, FEV1 and FEV1/FVC) were taken with a portable, computerized spirometry.

Results

Descriptive analysis in the form of mean and standard deviation. Spearman rank coefficient test to correlate between rib hump in mild, moderate and sever right thoracic idiopathic scoliosis and ventilatory function. All statistically significant differences will be determined with confidence interval of 95% and thus at $p<0.05$.

Subject characteristics:

Forty female patients with right thoracic scoliosis participated in this study. (Table 1) showed the subjects' characteristics of the study group.

Table (1): Demographic data of study group.

Study group (n=40)	Mean ±SD
Age (year)	23.3±3.4
Weight (kg)	59.5±4.7
Height (cm)	165.4±5.1
BMI (kg/m^2)	21.7±1.2

SD: Standard deviation.

Correlation between Cobb's angle and rotation:

As shown in Table (2) and Fig. (2), there was significant strong direct correlation between Cobb's angle and rotation (r=0.922) (p=0.001).

Table (2): Correlation between Cobb's angle and rotation.

Variables	Rotation
Cobb's angle:	
r	0.922
p-value	0.001*

r: Spearman correlation coefficient.
p-value: Probability value.
*: Significant.

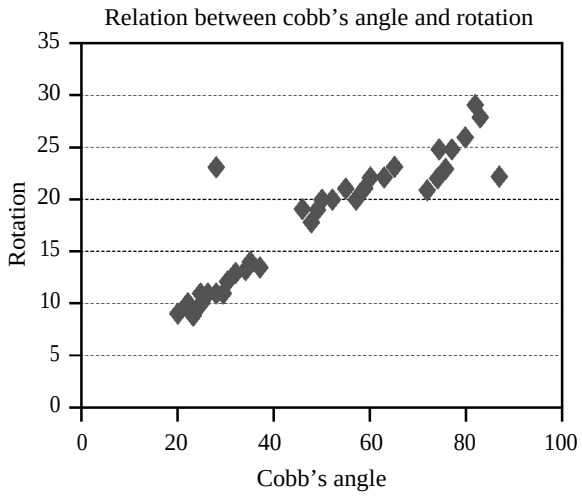

Fig. (2): Correlation between Cobb's angle and rotation.

Correlation between rotation and ventilatory function measures:

As shown in Table (3) there was significant direct strong negative correlation between rotation and FVC (r=–0.758) (p=0.669) Fig. (3). There was significant direct strong negative correlation between rotation and FEV 1 (r=–0.754) (p=0.000) Fig. (4), while there is a non-significant negative weak correlation between rotation and FEV1/FVC ratio (r=0.070) (p=0.669) Fig. (5).

Table (3): Correlation between rotation and ventilatory function measures.

Variables	FVC	FEV1	FEV1/FVC
Rotation:			
r	–0.758	–0.754	–0.070
p-value	0.000	0.000	0.669

r: Spearman correlation coefficient.
p-value: Probability value.

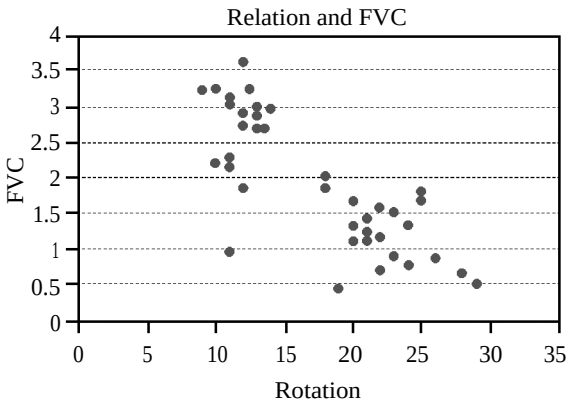

Fig. (3): Correlation between rotation and FVC.

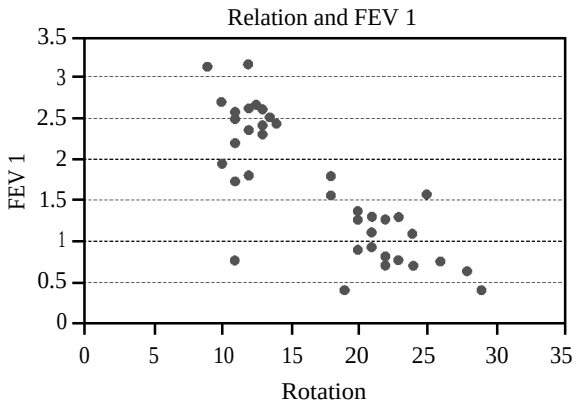

Fig. (4): Correlation between rotation and FEV 1.

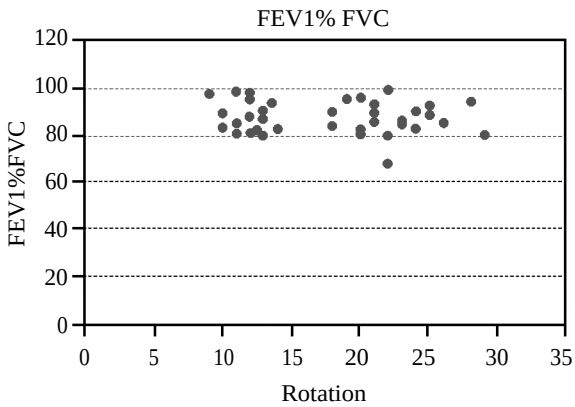

Fig. (5): Correlation between rotation and FEV1/FVC.

Discussion

The aim of this study was to find the correlation between rib hump and ventilatory function in adult patients with idiopathic scoliosis.

The result of the current study was in line with Muniyappanavar et al., (2017) **[9]** who investigated the Correlation of Cobb's angle with pulmonary function in idiopathic scoliosis, this research showed that patients with idiopathic scoliosis reduced lung volumes and capacity on PFT and

the pulmonary parameters show a strong inverse correlation with the severity of the spinal deformity (Cobb's angle). This may be due to abnormality of ventilatory mechanics and the reduction of chest wall compliance plays an important role in reducing lung volumes and correlates closely with the Cobb's angle and with the decrease in FVC.

The results of the current study agreed with the findings of the effects of the three-dimensional deformity of adolescent idiopathic scoliosis on pulmonary function that coincided with the results showed by Yaszay et al., (2016) **[10]** this research showed that Larger thoracic deformities increase the risk of pulmonary impairment in patients with AIS due to increase spinal deformity had greater discrepancy between their concave and convex lung volumes suggesting an effect on lung function.

Wang et al., (2019) **[11]** demonstrated the Correlation analysis between the pulmonary function test and the radiological parameters of the main right thoracic curve in adolescent idiopathic scoliosis, it showed that a spinal deformity is a change in the coronal and sagittal planes as well as the three-dimensional structure Specifically, this change is related to the decline in pulmonary function with the increase in the severity of spinal deformity.

The results of the current study also agreed with the findings of Farrell and Garrido, (2020) **[12]** who Predict preoperative pulmonary function in patients with thoracic adolescent idiopathic scoliosis from spinal and thoracic radiographic parameters, this result showed that in the digital X-ray, the results support the negative association between curve size and predicted FEV 1 or FVC.

Muniyappanavar et al., (2013) **[13]** demonstrated the Impact of Asymptomatic Idiopathic Scoliosis on Pulmonary Function, it showed that Scoliosis is characterized by lateral displacement of the spine and associated vertebral rotation. These two aspects along with the rib deformities tend to reduce the overall thoracic volume. The results of the current study in the line with Zhao et al., (2018) **[14]** who find Prediction of respiratory function in patients with severe scoliosis on the basis of the novel individualized spino-pelvic index, it showed that pulmonary function of patients with severe scoliosis was found to be significantly decreased, indicating that pulmonary function impairment was underestimated in patients with severe scoliosis.

Conclusion:

The current study reports the degree of rotation of rib hump on patients with thoracic scoliosis correlate negatively with FVC, FEV 1 and no correlation between the rotation of the rib hump and the ratio between FEV 1/FVC.

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العلاقة بين سنام الضلع ووظيفة التنفس الصناعى فى المرضى البالغين المصابين بالجنف مجهول السبب

الخلفية : يعتبر الجنف من أكثر تشوهات العمود الفقرى شيوعاً التى تؤثر على وظائف الرئة بسبب قدرتها على تغيير ميكانيكا الجهاز التنفسى. تقدمه مع تقدم العمر يثبت أنه قاتل بسبب مضاعفات مثل فشل الجهاز التنفسى.

الهدف : إيجاد العلاقة بين سنام الضلع ووظيفة التنفس الصناعى فى المرضى البالغين المضابين بالجنف مجهول السبب.

الطريقة : تم تسجيل أربعين أمراة تتراوح أعمارهن بين ١٨–٣٠ عاماً مصابات بالجنف الصدرى الأيمن مجهول السبب فى هذه الدراسة. تم أخذهم من العيادات الخارجية بمستشفيات القصر العينى بجامعة القاهرة. طلُب من المريض الانحناء للأمام لجعل العمود الفقرى موازياً للأرض، مع تد لى الذراعين والركبتين إلى الأمام، بينما قام الفاحص بفحص من الخلف بحثاً عن أى بروز صدرى أو قطنى من شأنه أن يدل على الجنف. يتم قياس بروز الظهر عن طريق مقياس الجنف، ثم يتم إعطاء المريض قياس التنفس لقياس وظيفة التنفس الصناعى.

الاستنتاج : أشارت نتائج الدراسة الحالية إلى وجود علاقة ارتباط موجبة بين دوران سنام الضلع وزاوية كوب، وارتباط سلبى بين دوران سنام الضلع ووارتباط سلبى بين دوران سنام الضلع ووعدم وجود علا قة ارتباط بين دوران سنام الضلع والنسبة FVC، وFEV1/FVC.