RESEARCH ARTICLE

Impact of Asymptomatic Idiopathic Scoliosis on Pulmonary Function

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ABSTRACT

Background: Scoliosis is considered as one of the commonest spinal deformity to affect the pulmonary functions because of its ability to alter the respiratory mechanics. Its advancement with age proves fatal because of complications such as respiratory failure. Even though idiopathic scoliosis is also prevalent in India, the data regarding pulmonary function status of these individuals are scant. This necessitates a study on pulmonary functions in Idiopathic Scoliosis.

Aims & Objective: To study the pulmonary functions in individuals with idiopathic scoliosis and to compare the same with age and sex matched normal individuals.

Materials and Methods: In this study pulmonary functions such as slow vital capacity parameters and forced vital capacity parameters were studied in thirty individuals with Idiopathic Scoliosis in the age group of 15- 30 years. These parameters were compared with those recorded in equal number of age and sex matched apparently normal healthy individuals using unpaired t test.

Results: A significant reduction was observed in lung function parameters such as vital capacity, tidal volume, inspiratory/expiratory reserve volumes, inspiratory capacity, forced vital capacity(FVC) and forced expiratory volume in first second (FEV_1). However the ratio between FEV_1 and FVC were within normal limits in both the groups and did not show any significant change.

Conclusion: Observations of the present study is suggestive of a restrictive pattern of impairment in Scoliosis, which is mainly because of alteration in respiratory mechanics. These pulmonary deficits may not be evident as they are symptomless. However in future these may tip the balance towards respiratory complications. So study of pulmonary functions in scoliotics may give an idea regarding the extent of detriment of lung function and hence will be useful in planning the treatment options for Scoliosis.

KEY WORDS: Idiopathic Scoliosis; Pulmonary Function; Restrictive Lung Disorders; Vital Capacity

INTRODUCTION

It is a well-established fact that severe deformities of the spine often results in chronic pulmonary repercussions which may lead to premature death.[1] Scoliosis is the most common 3-dimensional deformation abnormality affecting the spine, with direct effects on the thoracic cage of the affected person.[2] Idiopathic scoliosis, which accounts for 80-85% of all lateral spine curvature abnormalities, causes distortion of the chest wall anatomy with consequent functional pulmonary disability. The associated loss of flexibility of the spine and costovertebral joints also impairs the respiratory mechanics. These structural changes are often quantified individually, but they have not been integrated together in a way that accurately reflects loss of respiratory function.[3]

Pulmonary function tests performed in adults and adolescents with idiopathic scoliosis have showed deficits in flow rates and also reductions in various lung volume compartments[4] as noted by many western authors[5,6]. Since scoliosis is also prevalent in India and the status of pulmonary function in scoliosis patients is scant in India, it is pertinent to study PFT status in scoliotic subjects. This is essential in view of the observations made by Waugh and Riseborough, who have suggested a complete analysis of PFT status in all patients with thoracic scoliosis.[7] So the present study was designed to study the effect of idiopathic scoliosis in the absence of other lung diseases on pulmonary function tests.

MATERIALS AND METHODS

This study was conducted in the department of physiology, Karnataka Institute of Medical Sciences, Hubli, after obtaining the institutional ethical clearance. The present study included thirty individuals with clinically recognizable idiopathic or structural scoliosis, aged between 15-30 years, who were attending the Orthopaedic Department of the hospital, they constituted the study group, of the thirty patients 24 were males and 6 were females. A similar number of age and sex matched persons were selected from general population as controls. The informed consent was taken after the detailed procedure and purpose of the study was explained.

Those with history of chronic respiratory disorders, cardiac disease, systemic disorders affecting respiratory system, mentally handicapped and smokers were excluded from the study. A thorough history taking & clinical examination was carried out to rule out the exclusion criteria and the vital data was recorded. Standing Height (Deformed in scoliotics) was measured without foot wear with subject's back in contact with the wall and with both heels together and touching the base of the wall. As the spine is distorted in scoliotic patients, their deformed (Actual) heights cannot be used for predicting lung volumes or selecting controls. Hence, the corrected height was calculated from arm span, with the method described by Hepper et al.[8] Measurement of arm span was obtained by having the patient stand against a wall and stretching his/her arms to attain the maximal distance between the tips of the middle fingers. Weight was recorded with light clothing using a digital weighing machine. Both the height and weight were measured to the nearest 0.1cm and 0.5 kg respectively. Body mass index (BMI) and body surface area (BSA) were calculated.

Pulmonary Function Testing

Spirometry was done on both control and study groups with portable, computerized spirolyzer – SPL 95(France International Medical, Lyon).The recordings were carried out between 10am-12noon. All the maneuvers were performed with the subjects in sitting position. Thorough instructions were given to each subject regarding the test and sufficient time was provided for them to practice the maneuvers. A soft nose clip was put over the nose to occlude the nostrils and disposable mouthpieces were used to minimize cross infection.

Slow Vital Capacity (SVC) Manoeuver

The 'VC' button on the menu pad was pressed with the sensor on the stand (in order to avoid

any positive/negative drift). Then the subject was asked to place the mouthpiece halfway through the mouth and above the tongue. Subject was instructed to close mouth tightly around the mouthpiece in order to prevent any leakage. Once the subject had assumed normal respiration, the start/stop button was pressed and after 3-4 cycles of normal respiration was recorded, the subject was asked to take a deep inspiration by maximal voluntary effort and then exhale it out completely and slowly (to record the VC). Then the start button is pressed again to stop the recording.

Forced Vital Capacity (FVC) Manoeuver

With the transducer on the stand, the "FVC" button on the menu pad was pressed. After sufficient rest was given to the subject, he/she was asked to place the mouthpiece properly. The start/ stop button was pressed and the subject was asked to take in air (inhale) as deeply as possible and then exhale it as forcefully and as completely as possible. This was followed by another complete inhalation, and then the start/stop button was pressed again to stop the test.

Statistical Analysis

The statistical analysis was carried out with SPSS 13. The data obtained were expressed as mean ± standard deviation and analyzed using the student unpaired t-test. A p value less than 0.05 was considered to be statistically significant.

RESULTS

The recorded anthropometric data in controls and study group did not show any statistical significance as shown in Table No.1. In the present study we noticed a significantly reduced VC, expiratory reserve volume (ERV), inspiratory reserve volume (IRV), tidal volume (TV) and inspiratory capacity (IC) in scoliotics ($p<0.001$) as shown in table number 2. Parameters obtained from the FVC maneuver, FVC and forced expiratory volume in first second ($FEV_{1)}$, were also significantly reduced in scoliotics compared to normal individuals. However FEV_1/VC and FEV_1/FVC did not show any significant differences and were found to be within normal limits in both the groups (Table No 3).

Table-1: Anthropometric Data

Parameters	Scoliosis Mean ± SD	Controls Mean ± SD	p Value	Signifi-cance
Age (yr)	23.10 ± 4.58	23.10 ± 4.75	-	NS
Height (cm)	160.43 ± 6.40	161.50 ± 6.75	>0.05	NS
Weight (kg)	47.50 ± 4.48	47.63 ± 3.96	>0.05	NS
BMI (wt /ht^2)	18.51 ± 2.01	18.28 ± 1.39	>0.05	NS
BSA (sqm)	1.47 ± 0.08	1.48 ± 0.09	>0.05	NS

NS- Not Significant

Table-2: Slow Vital Capacity Parameters

Parameters (in Litre)	Scoliosis Mean ± SD	Controls Mean ± SD	p Value	Signifi-cance
Vital Capacity	1.45 ± 0.46	2.48 ± 0.36	<0.001	HS
Expiratory Reserve Volume	0.43 ± 0.25	0.77 ± 0.27	<0.001	HS
Inspiratory Reserve Volume	0.77 ± 0.29	1.29 ± 0.32	<0.001	HS
Inspiratory Capacity	1.05 ± 0.32	1.69 ± 0.37	<0.001	HS
Tidal Volume	0.27 ± 0.06	0.41 ± 0.08	<0.001	HS

HS: Highly Significant

Table-3: Anthropometric Data

Parameters	Scoliosis Mean ± SD	Controls Mean ± SD	p Value	Signifi-cance
Forced Vital Capacity (L)	1.32 ± 0.44	2.23 ± 0.36	<0.001	HS
FEV_1 (L)	1.16 ± 0.40	1.95 ± 0.35	<0.001	HS
FEV_1 /VC	0.79 ± 0.10	0.78 ± 0.07	>0.05	NS
FEV_1 /FVC	0.88 ± 0.07	0.87 ± 0.06	>0.05	NS

NS- Not Significant; HS: Highly Significant

DISCUSSION

The present study noticed a reduction in the mean value of vital capacity at rest in study group and it was statistically highly significant in comparison with the group of normal individuals. Body size and deformity are considered as important determinants of lung volumes and mechanical properties respiratory system.[9] In the present study there was no difference observed between study group and controls with respect to body size variables as portrayed by the anthropometric data, hence the changes observed can be attributed to the chest deformity in scoliotics. Scoliosis is characterized by lateral displacement of the spine in the coronal plane and associated vertebral rotation. These two aspects along with the rib deformities tend to reduce the overall thoracic volume. An added feature of scoliosis namely increased

spinal/costovertebral rigidity impairs the expansion of the chest normally produced by elevation of the ribs. Therefore, not only are the pulmonary volumes decreased, but the mechanics of respiration are also impaired resulting in more resistance to respiratory excursions and necessitating more effort being required to breathe.[10]

IRV & ERV were also decreased in scoliotics. IRV/ERV is subdivisions of VC and is commonly reduced in patients with scoliosis because of diminution in total thoracic volume as a result of chest wall deformity. TV is also a subdivision of VC and may be reduced in scoliosis; due to decrease in total chest volume as previously alluded to. Further in this study, a few controls might have voluntarily put effort during the procedure as it is difficult to monitor the subject's performance (vis-à-vis TV part) during the maneuver. On the other hand in order to compensate for the increased load on the inspiratory muscles that exists in patients with scoliosis, they may adopt a rapid shallow breathing pattern, which may cause low tidal volumes and reduce the work of breathing. This mechanism adopted by the scoliotics has both advantages (reduction in inspiratory muscle fatigue) and also fraught with disadvantages (chances of microatelectasis, decreased alveolar ventilation and increased oxygen cost of breathing).[11]

The observed mean inspiratory capacity at rest in scoliotics was low. A reduction in IC occurs in scoliosis because inhaled volume by patients is reduced. By itself IC has little diagnostic importance.[12]

The mean forced vital capacity (FVC) and FEV_1 at rest in scoliotics was decreased. This may be due to impairment of respiratory mechanics[13], but the mean FEV_1/FVC and FEV_1/VC ratios at rest in scoliotics was comparable to controls and was within normal limits. There was no statistically significant difference between two groups as far as these variables are concerned. Many observers have also observed similar results.[1,7,13,14] So the observations of the present study are suggestive of a restrictive pattern of impairment in scoliosis, which is mainly because of alteration in respiratory mechanics due to the scoliosis.

CONCLUSION

Observations in our study showed that idiopathic scoliosis produces a restrictive type of pulmonary defect. These observations are in accordance with many western studies. The most important point brought out by our study is the apparent dissociation between subjective symptoms and objective evidence of pulmonary deficits in patients of this age with scoliosis. All patients with scoliosis are subject to infection/disease in later stages of their life which may, at that point in time, impose a serious burden on their respiratory reserve. It is also apparent from our study that appreciable pulmonary deficits do occur and these deficits may not necessarily cause symptoms but are easily detected by simple spirometry, a technique easily performed in hospitals.

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