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Original article

Pulmonary Flow Rates In Adolescent Idiopathic Scoliosis

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ABSTRACT

Introduction: The end result of scoliosis often is severe cardiopulmonary failure occurring relatively in early adult life. This end phase of natural history of scoliosis is well studied. However scoliosis is a disease that usually begins in early life, and reports on assessment of pulmonary function in scoliosis patients is scant in India. **Aims and Objectives**: To study the pulmonary flow rates in individuals with asymptomatic idiopathic scoliosis and to compare the same with matched normal individuals. **Materials and Methods**: In this study pulmonary functions such as forced vital capacity parameters were studied in 38 individuals with Idiopathic Scoliosis in the age group of 16- 28 years. These parameters were compared with those recorded in equal number of matched apparently normal healthy individuals using student's unpaired t test. **Results**: The present study noticed significantly reduced forced vital capacity parameters like (FVC) (P=0.0368), FEV_1 (P=0.0384), MMEF (P=0.0205), MEF_{75} (P=0.0309), MEF_{50} (P=0.0214), MEF_{25} (P=0.0181), PEFR (P=0.0057), and MVV) (P=0.0036), in cases than controls. There was no significant difference in FEV_1/FVC ratio (P=0.9566) in cases and controls. **Conclusion**: The observations of the present study are in accordance with many western studies. Thus it can be concluded that idiopathic scoliosis produces restrictive type of pulmonary defect. The important point brought out is the apparent dissociation between subjective symptom and objective evidence of pulmonary deficits in patients of this age with scoliosis.

KEYWORDS: MVV, PEFR, Pulmonary flow rates, Scoliosis.

INTRODUCTION

Scoliosis can be acquired or idiopathic. Idiopathic scoliosis is the commonest type of scoliosis and is usually found in young people including children. Radiography is the most objective method of examining the scoliotic spine. Curve assessment is done frequently by Cobb's curve measurement on the radiographs to determine the extent of its progression [1].

Scoliosis, defined as a lateral curvature of the spine associated with vertebral rotation, results in chest deformity, back pain, ventilatory restriction, respiratory muscle weakness, exercise limitation and the subsequent impairment of health-related quality of life [2].

Many investigators have reported that pulmonary function tests of patients with idiopathic scoliosis reveal a restrictive defect [3,4]. 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 [5]. Some previous studies have reported obstructive defect in idiopathic scoliosis [1,6-9]. Airway obstruction may occur though uncommon. Rotation of the chest can cause displacement/rotation of the intrathoracic and main stem bronchi, or compression of a main stem bronchus against vertebra and mediastinal structures, causing mechanical airway obstruction, reduce expiratory flow rates and increase airway resistance [6,7].

Lower airway obstruction may develop as the disease worsens. This indicates presence of airway hyper-responsiveness attributed to chronic airway inflammation secondary to poor clearance of secretions [8].

The present study was designed to study the effect of idiopathic scoliosis in the absence of other lung diseases on pulmonary flow rates. 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.

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 38 individuals with clinically recognizable idiopathic or structural scoliosis, aged between 16-28 years, who were attending the Orthopaedic Department of the hospital, they constituted the study group, Of the 38 patients 25 were males and 13 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 subjects 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 [9].

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 kgs respectively. Body mass index (BMI) and body surface area(BSA) were calculated.

Various spirometric measurements were made on both control and study groups with a portable, computerized spirolyzer – SPL 95(France International Medical, Lyon).The recordings were carried out between 10am-12noon. All the maneuvers were performed in sitting position. Thorough instructions were given to each subject regarding the test and sufficient time was provided 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.

Statistical analysis

The data obtained were expressed as mean $\pm$ 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. The present study noticed significantly reduced forced vital capacity (FVC) (P=0.0368), Forced expiratory volume in first second (FEV_1) (P=0.0384), MMEF(Maximum Mid Expiratory Flow Rate) (P=0.0205) , MEF_{75}(Mid Expiratory Flow) (P=0.0309), MEF_{50} (P=0.0214), MEF_{25} (P=0.0181), Peak Expiratory Flow Rate (PEFR) (P=0.0057), and Maximum Voluntary Ventilation (MVV) (P=0.0036), in case than controls.There was no significant difference in FEV_1/FVC ratio (P=0.9566) in cases and controls as shown in Table 2.

Table 1: Age & Anthropometric Data for scoliotic Cases & Controls

Parameters	Cases (Mean $\pm$ SD)	Controls (Mean $\pm$ SD)	'p' Value
Age (yrs)	22.30 $\pm$ 5.37	21.80 $\pm$ 5.34	0.6852
Height (cms)	162.51 $\pm$ 4.32	163.31 $\pm$ 5.36	0.4760
Weight (kgs)	49.46 $\pm$ 5.33	50.58 $\pm$ 6.18	0.4003
Body Mass Index	19.26 $\pm$ 4.23	20.33 $\pm$ 5.22	0.3294
BSA (sqm)	1.57 $\pm$ 0.08	1.58 $\pm$ 0.09	0.6102

Table 2: Pulmonary Function Parameters of Scoliotic Cases & Controls

Parameters	Cases Mean ± SD	Controls Mean ± SD	'p' Value
Forced Vital Capacity (L)	1.62±2.54	2.83±2.42	0.0368
FEV_1 (L)	1.30±1.38	2.25±2.41	0.0384
FEV_1 /FVC	0.80±0.54	0.79±0.99	0.9566
MMEF (L/sec)	1.74±1.63	2.67±1.79	0.0205
Mid Expiratory Flow Rate-75 (MEF_{75}) (L/Sec)	2.91+1.45	3.61+1.32	0.0309
MEF_{50} (L/Sec)	2.31+0.72	2.86+1.25	0.0214
MEF_{25} (L/Sec)	1.25+0.37	1.54+0.64	0.0181
PEFR (L/Sec)	3.82+0.99	4.62+1.42	0.0057
MVV (L/min)	83.31+13.62	93.71+16.42	0.0036

DISCUSSION

Scoliosis is caused by the lateral displacement and rotation of the vertebral bodies. It is most common during periods of rapid somatic growth. Scoliosis impedes on the movement of the ribs, places the respiratory muscles at a mechanical disadvantage and displaces the various organs of the thoracic cavity. Scoliosis decreases the chest wall compliance directly and the lung compliance indirectly (due to progressive atelectasis and air-trapping), causing a significant increase in the work of breathing that, because of the associated respiratory muscle weakness may lead to chronic respiratory failure [10].

The observations of the present study are in accordance with many earlier western studies. The mean forced vital capacity (FVC) and FEV_1 at rest in idiopathic scoliotics were decreased. This may be due to impairment of respiratory mechanics [4]. But the mean FEV_1/FVC ratio at rest in cases was comparable to controls and is within normal limits. There was no statistically significant difference between two groups. Many observers have got similar results [3,4,11]. So the observations of the current study are suggestive of a restrictive defect in scoliosis, which is mainly due to alteration in respiratory mechanics due to the scoliosis.

The mean flow rates MMEF, MEF_{75}, MEF_{50} and MEF_{25} were significantly low in cases than controls. Initial portion of the forced expiratory volume is effort dependent. PEFR, MMEF, MEF_{25}, & MEF_{50} fall in this portion [3]. It has been shown by Fry and Hyatt that in normal subjects gas flow changes proportionately with the degree of inflation of the lungs. Since inflation capacity of the lung in some patients with thoracic deformity is reduced, decrease in flow rate is expected [12].

The reduction in expiratory flow rates that are seen in scoliosis reflect the overall restrictive process and are usually not related to intrinsic airway diseases. Because total lung capacity may be markedly reduced with relative preservation of residual volume, the RV/TLC ratio may be elevated. The combination of reduced expiratory flow rates and an increased RV/TLC ratio may at times be mistakenly attributed to a superimposed obstructive process. Specific airway conductance however is usually normal or even elevated despite the reduction in flow rates [13]. Therefore it seems probable that a decrease in forced expiratory flow rates in presence of normal FEV1/FVC, is due to small lung volumes rather than to airway obstruction.

MVV and PEFR were significantly low in scoliotics than controls. Ting ER and Lyons got similar result. They showed 50% reduction in MVV and attributed this to reduced lung volumes, fixed thoracic cages, and loss of musculoskeletal power which are characteristics of scoliosis. Low values of PEFR in the absence of other indication of airway obstruction were probably evidence of a reduction in ventilatory power intrinsic in the musculoskeletal thoracic deformity of scoliosis or an increase in the work of breathing or both [14]. In the present study there was no difference observed between study group and controls with respect to body size variables. So the changes observed can be attributed to the chest deformity in idiopathic scoliosis patients.

CONCLUSIONS

The observations of the present study are in accordance with many western studies. Thus it can be concluded that idiopathic scoliosis produces restrictive type of pulmonary defect. The most important point brought out is the apparent dissociation between subjective symptom and objective evidence of pulmonary deficits in patients of this age with scoliosis. All patients with scoliosis are subject to infection or disease in later life which may, at that time, impose a serious burden on their respiratory reserve. Therefore routine screening should start early and continue until the child reaches skeletal maturation. Pulmonary function testing can provide an easy and reliable means for the evaluation and follow-up of the condition.

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