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Evaluation of thoracic vertebrae rotation in patients with pectus excavatum

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ABSTRACT

Purpose: The aim of our study was to evaluate thoracic vertebrae rotation in patients with pectus excavatum. Moreover, we wanted to assess the prevalence, the severity and relationship between pectus excavatum and adolescent idiopathic scoliosis (AIS).
Methods: We performed retrospective analysis of 82 preoperative chest CT in children with pectus excavatum performed between January 2008 and December 2011. For each patient Haller Index and Cobb angle was measured. To evaluate the severity of thoracic scoliosis we measured vertebral rotation for Th8 and for vertebra at the level of highest chest deformation using Aaro-Dahlborn method.
Results: From the group of 54 patients with pectus excavatum enrolled in the study AIS was diagnosed in 8 patients (14,81%). In patients with symmetric deformation, Th8 rotation was found in 21 patients; the rotation of the apical vertebra was found in 20 patients. In patients with asymmetric deformation Th8 rotation was found in 10 patients; the rotation of the apical vertebra was found in 8 patients.
Conclusions: **1.** We have confirmed the higher prevalence of pectus excavatum in boys; **2.** We have found a significant relationship between pectus excavatum and adolescent idiopathic scoliosis; **3.** We have shown that deformation of the anterior chest wall enforces rotation of the thoracic spine; **4.** We haven't found the relationship between the severity of the chest deformity (HI measured) and severity of AIS (Cobb angle measured); **5.** We have shown a significant association between HI measured and rotation of thoracic vertebra at the level of highest chest deformation (apical vertebra) in symmetric pectus excavatum.
Level of evidence: Level IV, Diagnostic study.

Introduction

Pectus excavatum is the most common anterior wall chest deformity with incendence of 1–3 per 1000.[1] It occurs more frequently in boys than girls by a 4:1 ratio.[1,2] This deformity involves lower part of sternum (body of the sternum), which is displaced posteriorly into the chest. The cause of pectus excavatum has not been established. As a possible causes of this deformation suggests: disturbed growth of the sternum and the costal arches; biomechanical factors; connective tissue disorders and other musculoskeletal abnormalities. It is worth mentioning that there is a genetic predisposition in patients with family history of pectus excavatum. In most cases pectus excavatum is a cosmetic defect with no physiological consequences. In severe deformities, the decrease in thoracic volume is seen. This may lead to decreased pulmonary function and affect the function of the right ventricle). Funnel chest defects may lead to chest pain, shortness of breath, decreased cardiac output and decreased exercise capacity depending of the depth of the deformity. Adolescent idiopathic scoliosis (AIS) is a common deformity affecting 0.2–3% of the general population. The prevalence of AIS among patients with pectus excavatum is significantly higher than in the general population and ranges from 17,61 to 25,58% according to various authors.[1,3]

The aim of our study was to evaluate thoracic vertebrae rotation in patients with pectus excavatum. Moreover, we wanted to assess the prevalence, severity and relationship between pectus excavatum and thoracic vertebral rotation as well as adolescent idiopathic scoliosis.

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Material and methods

We performed retrospective analysis of 82 preoperative CT in children with pectus excavatum performed between January 2008 and December 2011. Examination was done using the Toshiba Aquilion with 5 mm slices and Siemens Somaton Plus 4 with 8 mm slices. For the image evaluation we use program Onis 2.4, Digital-Core Co. Ltd.

After the reviewing of the collected material, we qualified 54 patients with pectus excavatum for the purpose of the study. Patients with incomplete medical documentation (most commonly lack of radiological data) were excluded from the analysis. Patients with congenital deformities of the spine, connective tissue disorders and other musculoskeletal abnormalities also were excluded from the study.

All chest CT were performed in patients who were diagnosed clinically accepted for surgical correction of the deformity with the use the Nuss procedure. In order to assess the severity of chest deformity for each patient we measured Haller Index on axial CT scans (transverse diameter of chest divided by the anteroposterior diameter at the deepest portion of defect – Fig. 1). Our study group was divided into two groups depending on the chest deformation. The first group consisted of patients with symmetric pectus excavatum (symmetry was defined as difference less then 10 mm between left and right chest cavity vertical distance). The second group included patients with asymmetric pectus excavatum (asymmetry was defined as difference more then 10 mm between left and right chest cavity vertical distance – Fig. 2). There were **35** patients in the first group (7 girls, 28 boys) with mean age 12,57 (4–17) and **19** patients in the second group (4 girls, 15 boys) with mean age 14 (10–17). An overview of the study group is presented in Table 1. To identify and determine the severity of scoliosis we evaluated the classical radiograms (Figs. 3–4) by measuring the Cobb angle on the anteroposterior radiogram. Moreover, on axial CT scans we evaluated the rotation of the thoracic vertebral bodies, every time at two levels, for Th8 vertebra and for apical vertebra (vertebra at the level of highest chest deformation) to indicate rotation severity.

We chose Th 8 vertebra as a reference point for our analysis. Vertebral rotation angle was measured according to Aaro-Dahlborn method (vertebral rotation angle is an angle between anterior midline of body and the line through the dorsal central aspect of vertebral foramen Fig. 5).[4]

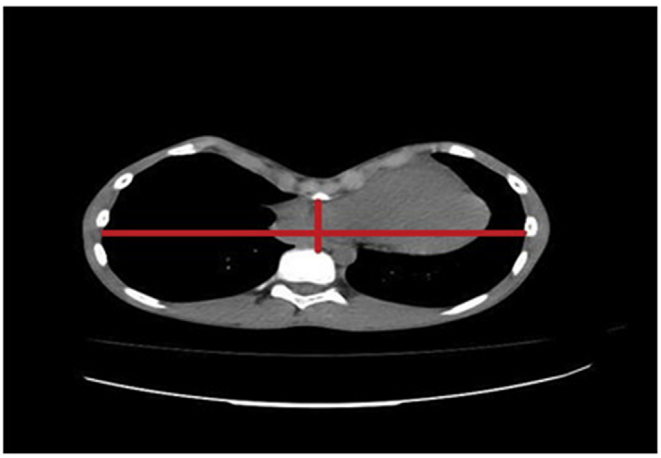

Fig. 1. Haller Index – ratio of the internal ribcage distance and distance between sternum and vertebrae.

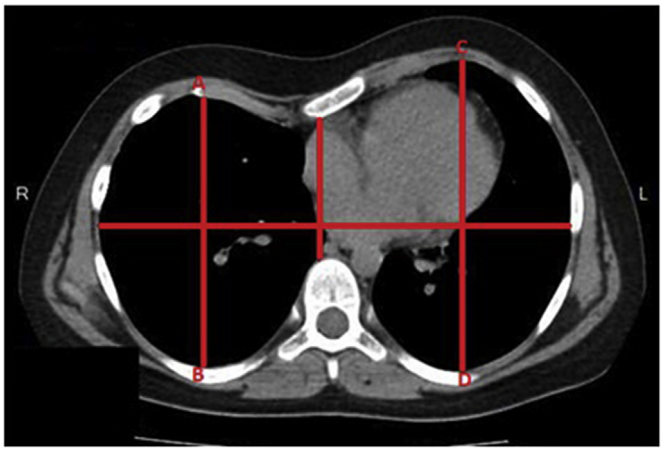

Fig. 2. Asymmetric pectus excavatum. Difference between AB and CD is more than 10 mm.

Statistical analysis

Tools of statistical analysis:

Due to the large differences in the assessed variables, Spearman's rank correlation coefficient and nonparametric Mann–Whitney *U* test were used to analyze the correlation. To analyze the significance of differences between the incidence of pectus excavatum in girls and boys we tested the significance of the difference between two means.

Statistical analysis was done using STATISTICA 12.5 system.

For all analysis we assumed the significance level equal to 0,05.

Tables

Statistical analysis.

Variable	Pectus excavatum (all patients)			
	Number	Mean	Median	Standard deviation
Age	54	13,07	14,00	3,02
HI	54	3,68	3,40	1,00
TH8 – rotation	54	3,58	3,01	5,01
Apical vertebra rotation	54	3,10	1,85	3,73
Cobb angle	54	2,74	0,00	5,55

Variable	Symmetric pectus excavatum			
	Number	Mean	Median	Standard deviation
Age	35	12,57	13,0000	3,43
HI	35	3,79	3,40	1,14
TH8 – rotation	35	4,24	3,50	5,88
Apical vertebra rotation	35	3,9140	4,07	4,15
Cobb angle	35	3,38	0,00	6,14

Variable	Asymmetric pectus excavatum			
	Number	Mean	Median	Standard deviation
Age	19	14,00	14,00	1,82
HI	19	3,50	3,40	0,67
TH8 – rotation	19	2,37	2,60	2,51
Apical vertebra rotation	19	1,60	0,00	2,17
Cobb angle	19	1,55	0,00	4,16

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