Preoperation MRI analysis in 149 Patients with Adolescent Idiopathic Scoliosis

Z. Chen[1], L. Lao[2], J. Shen[3], and X. Li[4]

[1]Department of Radiology, First Hospital of Tsinghua University, Beijing, Beijing, China, People's Republic of, [2]Department of Orthopaedic, Renji Hospital, School of Medicine, Shanghai Jiaotong University, Shanghai, Shanghai, China, People's Republic of, [3]Department of Orthopedics, Peking Union Medical College Hospital, Peking Union Medical College, Beijing, Beijing, China, People's Republic of, [4]Department of Radiology, Peking Union Medical College Hospital, Peking Union Medical College, Beijing, China, People's Republic of

Introduction. Adolescent Idiopathic Scoliosis (AIS) is present in 2-4% of children between 10-16 years of age[1-2]. It is defined as a lateral and rotational spinal curvature greater than 10 degrees in the absence of associated congenital or neurologic abnormalities[1]. It often occurs in an otherwise healthy child with no clear underlying causes. The main risk factors for curve progression are a large curve magnitude, skeletal immaturity and female gender[3-4]. Traditionally AIS was evaluated using standing posteroanterior radiographs of the full spine to assess lateral curvature with the Cobb method[2], but it is visualized on 2D coronal plane-only evaluating system, ignoring the 3D nature of AIS[3]. MRI and computer-generated 3D images of the spine is a noninvasive procedure which could be used to evaluate completely the functional morphology in whole spine. As some authors' report, it may be one of AIS etiopathogenesis because of disproportional growth between neural and skeletal system[4]. To validate this hypothesis a MRI study was performed in patients with AIS. The purpose of this study is (1) to evaluate the functional morphology and relative position of the spinal cord and vertebral column of the AIS patients in cross-, sagittal- and coronal-sectional planes, and (2) to make in comparison with health age-matched controls at the corresponding levels; and (3) to determine the MR measuring results and their correlation in different groups with mild, moderate and severe Cobb's Angle.

Materials and Methods. MRI and 3D reconstruction of the spine and hindbrain was performed in 149 preoperative patients with AIS with a average Cobb angle of 47.2 degrees on X-ray coronal plane (aged 11 to 18 years old, 19 male, 130 female; 118 AIS with right-sided thoracic/thoracolumbar curve), and 41 age-matched controls (aged 11 to 17 years old, 18 male, 23 female). Both of them displayed neurologically normal upon physical examinations. Informed consent form was signed by every subjects or his/her supervisor, which was approved by the institutional ethical committee.

All MRI measurements were performed on 1.5-T scanner with a spine array coil. The T1-weighted and the T2-weighted, sagittal spin-echo images of the whole spine were obtained from foramen magnum to sacrum on both of AIS patients and healthy controls. The T2-weighted, axial spin-echo images of the spine were acquired at the level of the cervical, thoracic column (at the level of the most obvious curvature of spine in AIS), and at the level of the conus medullaris. According to a standard method described previously[4], the following parameters were measured: (1) the cord length, the vertebral column length, the ratio of the cord length to the vertebral column length; (2) the cord area, the vertebral canal area, the ratio of the cord area to the vertebral canal area; (3) the distance at the cerebellar tonsillar level to the basion-opsithion (BO) line, the distance at the odontoid process level to the BO line; (4) the angle between axis of cervical cord and medulla oblongata(α), the angle between axis of basion-opsithion (BO) line and medulla oblongata(β); (5) the position of the conus medullaris relative to lumbar vertebrae; (6) the ratio of anteroposterior (AP) and transverse (TS) diameter of the cord; (7)the concave and convex lateral cord space (LCS) at the apical level in AIS subjects. The shape and location of abnormal signal was observed in the subarachnoid space. The correlations between the all of the above-parameters and Cobb's angle were made.

Results. AP, TS, the AP/TS and LCS ratio were increased in AIS subjects with lowing positiong of cerebellar tonsillar level, upper-lifting of medullary conus to about middle 1/3 of L1, decreased β angle and cord/vertebral length ratio and increased cord/vertebral area ratio when compared with normal controls (P<0.01). AP, AP/TS and LCS ratio were correlated significantly with Cobb's angle (Pearson Correlation Coefficient>0.19 , P<0.05). The variant characteristics of MRI in AIS groups with mild, moderate and severe Cobb's Angle see in Table 1. The subarachnoid space looks to be more asymmetric, and the subarachnoid plaque shows a little bit high signal intensity in AIS compared to the health controls (P<0.01).

Table 1. Comparison between Variant Characteristics of MRI in AIS with different Cobb' angle (One-Way ANOVA Test)

	Control (n=41)	Mild (n=41)	Moderate (n=81)	Severe (n=27)
Cobb'Angle	0	30.37*	47.41*	72.15*
AP(mm)	5.76	6.12*	6.58*	7.26*
TS(mm)	6.87	7.25	7.23	7.50
AP/TS	0.86	0.86	0.96	0.98†
LCS(mm)	1.05	4.47*	4. 46*	4.26*
Position of medullary conus	6.02	-1.47*	-1.46*	-1.73*
Cerebellar tonsillar level(mm)	3.97	0.49*	1.05*	0.85*
Odontoid process level(mm)	5.39	6.12	6.80	5.99
Cervical medulla angle(α)	19.88	20.21	22.02	24.92
BO medulla angle(β)	68.66	63.57*	65.02†	62.25*
Area of thoracic spine cord (mm2)	31.25	35.77	38.82	43.25*
Area of thoracic vertebral canal(mm2)	227.62	257.85	250.47	246.51
Ratio of area of spine cord to vertebral canal	0.14	0.14	0.24	0.20

Mild：Cobb<40°；Moderate：40°≤Cobb<60°；Severe：Cobb≥60°

*LSC(ANOVA)test(P<0.01),compared with control

†LSC(ANOVA)test(P<0.05),compared with control

Conclusion. Our study revealed it is significantly abnormal in cross-sectional morphology of spinal cord and spine in AIS, and some variant characteristics are significantly relevant with Cobb's angle. There is abnormal signal visualized in the subarachnoid space in AIS. Along the longitudinal axis of spine, there is tethering of the spinal cord suggesting the presence of disproportional growth between the neural and skeletal system, which may indicate pathogenesis of AIS.

Reference.1.Yawn BP, et al. **JAMA** 1999;282: 1427-32. 2. Allen Greiner K. **Am Fam Physician** 2002;65:1817-22. 3. Asher MA, et al. **Scoliosis** 2006, 1:2. 4. Winnie CW et al. **Spine** 2006 Jan 1;31(1):E19-25.