INTRODUCTION:

Pedicle screw (PS) constructs allow for better curve correction in the coronal plane as well as in the axial plane in patients with adolescent idiopathic scoliosis (AIS)[1, 2]. However, reduction of physiological kyphosis of the thoracic spine has been one of the problems associated with the PS constructs [3]. The hypothesis for the hypokyphogenesis is that the direct vertebral derotation obtained by PS can render the thoracic spine more straight in the sagittal plane. The purpose of this study was to prove this hypothesis by computer simulated corrections using a three-dimensional (3D) scoliosis model.

METHODS:

The simulated corrections of scoliosis were performed on segmented 3D models of the whole spine created using Mimics (Materialise NV, Belgium) based on preoperative CT scan data of 10 AIS patients with a Lenke type 1 curve (10 girls, mean age of 14.4±2.1 years). A mean Cobb angle of a main thoracic curve was 57±11° on preoperative X-ray films.

Two types of simulated correction were performed; 1) coronal correction only (C method); 2) coronal correction with derotation of vertebral bodies (C +D method).

In C method, manipulation of the vertebral bodies were constrained to an axis parallel to the sagittal plane of the spine (Figure 1), thus, repositions of the vertebral bodies occur only in the coronal plane.

In C+D method, simulations were performed as below (Figure 2).

1. **A reference plane of each vertebra** was defined as the plane consisting of three points; two points at the center of the posterior vertebral wall and a point at the central notch of the lamina.
2. **Intervertebral axis** was defined as the line intersecting the neighboring vertebral reference planes.
3. Correction of each vertebral body was performed by rotating the vertebral reference plane around the intervertebral axis until the neighboring vertebral reference planes became parallel (Figure 2). These manipulations resulted in complete coronal correction and derotation of the vertebral bodies (Figure 3).

T1-T12 kyphosis angle and radius of thoracic curvature, and vertebral rotation at the apex were measured before and after the two different simulated corrections.

RESULTS:

**Kyphosis (T1-T12 angle):** In C+D method, the mean kyphosis angle was significantly smaller than that in C method (15±7° vs. 3±10, p<0.01).

**Radius of curvature:** In C+D method, the mean radius of curvature was significantly larger than that in C method (12245 vs. 832, p<0.01).

**Vertebral rotation at the apex:** Preoperatively, the mean rotation of the apical vertebra was 15±5°. The rotation was completely corrected in C+D method (0°). While in C method, the rotation of the vertebrae was unchanged (18±4°).

DISCUSSION:

1. A reference plane of each vertebra was defined as the plane consisting of three points; two points at the center of the posterior vertebral wall and a point at the central notch of the lamina.
2. Intervertebral axis was defined as the line intersecting the neighboring vertebral reference planes.
3. Correction of each vertebral body was performed by rotating the vertebral reference plane around the intervertebral axis until the neighboring vertebral reference planes became parallel (Figure 2). These manipulations resulted in complete coronal correction and derotation of the vertebral bodies (Figure 3).

One of the etiologies of hypokyphogenesis by derotation of the vertebral bodies may be the wedge deformity of the vertebral bodies that has a larger height in the convex side than in the concave side. Vertebral derotation shifts the taller convex vertebral wall toward the ventral direction, thereby, elongating the anterior dimension of the thoracic spine, which ultimately makes the thoracic spine more straight.

**REFERENCES:**