# DYNAMIC ANALYSIS OF TRUNK DEFORMATION BY BREATHING OF SCOLIOSIS PATIENTS

Koji Kato PhD[1]*, Yuji Atsuta MD[2], Hiroshi Ito MD[2]

[1] *Department of Complex and Intelligent, 116-2 Kamedanakano-cho, Hakodate 041-8655, Japan.

[2] Department of Orthopaedic Surgery, Asahikawa Medical University, Higashi 2-1-1-1, Midorigaoka, Asahikawa 078-8510, Japan.

## INTRODUCTION

Scoliosis is a disease that spine is curved sideways when viewed from the front. Most of cause is idiopathic in adolescence. Scoliosis effect progresses thoracic deformity, affect the respiratory and cardiovascular. Early detection of scoliosis is important for patients. Ready-made diagnosis scoliosis research (Seno 2013) has exposure from X-ray or ambiguous evaluation. It is known to clinically that relationship of thoracic deformity and scoliosis are dynamically changed constantly by the respiratory motion. The detection systems of the respiratory motion were developed (Eun Mi C 2008)(Gorton George E 2012) but they need large-scaled exclusive equipments and evaluate the relationship using only still images. Therefore it is difficult to obtain the change of the shape continually and could not perform an accurate evaluation. We applied a finite element method for the 3D models of a backbone and ribs of scoliosis patient. In this paper, we described a relationship between the breathing movement and the scoliosis dynamically from the result.

## MATERIALS AND METHODS

In this research, using 3D models of the backbone and the ribs made from CT images, we simulated the breathing movement and we estimated the stress distribution of the ribs by using a finite element method (FEM).

We analyze the stress distribution of the backbone and ribs by the following steps.

1) Detecting the backbone and the ribs from CT images using computer vision technique.
2) Making 3D mesh models of these and storing these models as STL file format.
3) Applying FEM to the backbone and the ribs models by using ANSYS software.

We should simulate ribs overall model to perform an exact evaluation. In this paper, however, the stress analysis in the 3D model takes complicated calculation and needs much time. Therefore we modeled a part of the backbone and the ribs and evaluated them.

## RESULTS

In 3D model of Figure 1, we analyzed the stress distribution when we applied load from the backbone side like breathing movement. In this experiment, we used Young's modulus 12GPa, Poisson ratio 0.30. These parameters are quoted from an article of Keyak JH (Keyak 1998). Moreover, numbers of the meshes for applying FEM were about 23000.

At first we obtained a change in time for the stress distribution with the breathing movement as a movie. Then, we chose a state that the stress became biggest in the movie and obtained a result image of the stress distribution. In respiratory movement, the stress became biggest when the lungs swelled out (at the time of intake) from this simulation result.

Figure 2 show a result of the simulation. This figure shows the backbone and the ribs of the scoliosis patient in a face-down posture upwardly from a foot section.

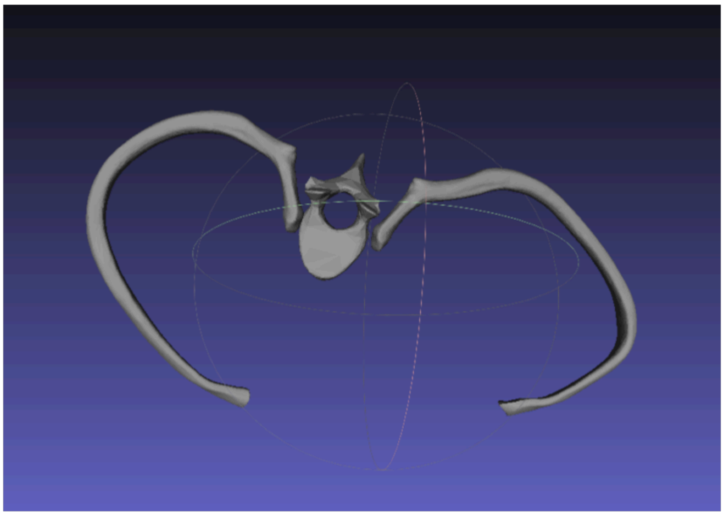

**Figure 1: 3D mesh model of the backbone and the ribs.**

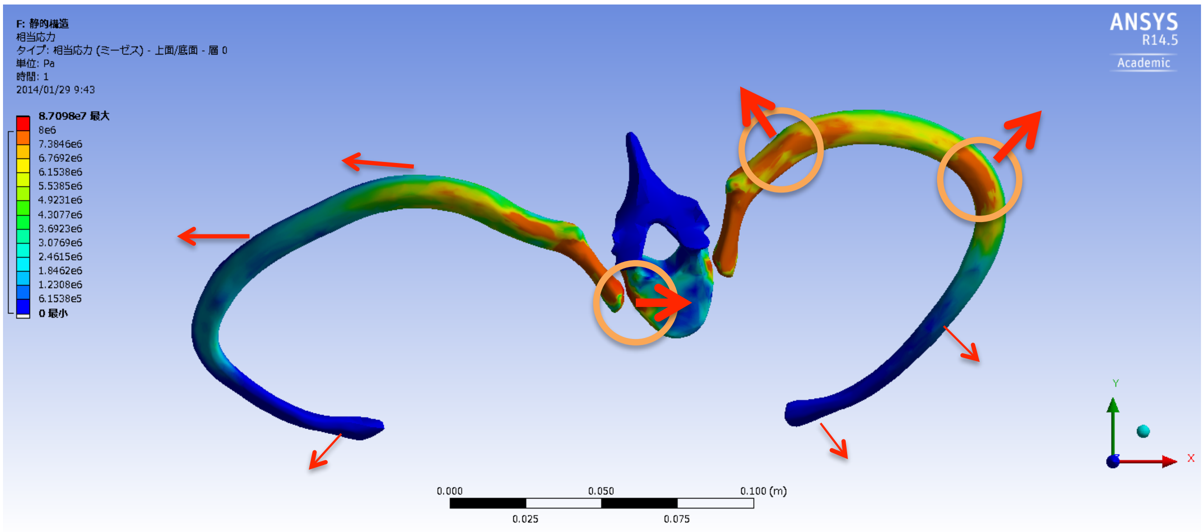


**Figure 2: Simulation result.**

## DISCUSSION

As shown in Figure 2, we can confirm three characteristic powers. One is a power to transform the right rib into a circular shape. Second is a pulling power of a lateral direction to left rib. Third is a power that twist the backbone counterclockwise.
Thus, we can expect that the powers to let scoliosis progress continue to work by breathing.
As a result, we can consider the breathing movement is a one of the factors to let scoliosis progress. Thus, we may be able to delay progress if we hold down places surrounded in circles in Figure 1 with human trunk harness. About this human trunk harness, it is designed to suppress the clinically same place and accords with the result of this experiment.
Our method can evaluate breathing movement exactly in comparison with conventional methods (Eun Mi C 2008)(Gorton George E 2012) to get the deformation of the trunk continually. As a result, this method is effective for the evaluation of the scoliosis.

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