THE RELATION BETWEEN ORGAN ANATOMY AND PRE-EXISTENT VERTEBRAL ROTATION IN THE NORMAL SPINE – MRI STUDY IN PERSONS WITH SITUS INVERSUS TOTALIS (SIT)

**Kouwenhoven, J W M; Bartels, L W; Vincken, K L; Viergever, M A; Verbout, A J; Delhaas, T; Castelein, R M**

**University Medical Center Utrecht, Utrecht, The Netherlands**

J.W.M.Kouwenhoven@umcutrecht.nl

ABSTRACT INTRODUCTION:
Vertebral rotation is an important component of adolescent idiopathic scoliosis (AIS) – thoracic curves rotating to the right side predominate.

Recently, the authors demonstrated that a similar pattern of vertebral rotation is also an anatomical feature in the normal non-scoliotic spine, in humans as well as in quadrupeds. Apparently, humans and quadrupedal vertebrates share a common factor that causes this rotation. In both species, the thoracic organs (heart, lungs and aorta) are asymmetrically situated and in close contact with the vertebral column.

We postulate that this asymmetrical anatomy could play an important role in the development of this pre-existent rotation.

Therefore, the purpose of this study was to analyze vertebral rotation in the normal, non-scoliotic spine of humans with a complete mirror image reversal of the internal body organs – called situs inversus totalis (SIT).

METHODS:

Thirty-seven persons with SIT and a normal, non-scoliotic spine underwent MRI examination of the thoracic and lumbar spine. This group consisted of 20 males and 17 females with a mean age of 32.1 years (range 7-74 years). None of these persons had a history of scoliosis or other spinal pathology. Vertebral rotation was measured in the transverse plane from T2 to L5 using the same measurement method as used in our previous studies in humans and dogs.

Measuring Method

This method consisted of a semi-automated procedure using an in-house created, interactive application to calculate the rotation angles of the vertebrae. Vertebral rotation was defined as the angle between the longitudinal axis of each vertebra and the mid-sagittal axis of the trunk (= reference line). The reference line was defined as zero degrees rotation. Rotation to the right side of the subject was defined as a positive angle, to the left as a negative angle. The reference line was defined at level T5 as the line between the center of the spinal canal and the center of the anterior half of the vertebral body. In order to be able to calculate the rotation angle of each vertebra fully automatically, we needed to segment the vertebrae and the spinal canal in every selected slice.

Furthermore, at level T5 we also segmented the sternum (Figure 1). To determine the center points we calculated the Center Of Mass of these structures, because they accurately represent the center of these objects.

The intraclass correlation coefficient calculated for intraobserver and interobserver reliability of our method were, respectively, 0.91 ± 0.03 and 0.87 ± 0.10 (mean ± SD), which showed our method to be reliable and reproducible.

RESULTS:

Measurement of the vertebral rotation angles showed a significant positive angle, to the left = negative angle. The results of this study showed the existence of a pre-existent vertebral rotation in the normal, non-scoliotic spine of 37 persons with SIT. Rotation to the right = positive angle, to the left = negative angle.

DISCUSSION:

The results of this study showed the existence of a pre-existent pattern of vertebral rotation in the normal, non-scoliotic spine of humans with a situs inversus totalis. The mid and lower thoracic vertebrae showed a predominant rotation to the left side; the high thoracic and lumbar vertebrae to the right side. This pattern is exactly the opposite of what is seen in humans with normal organ anatomy.

Although other factors cannot be ruled out, we assume that the asymmetrical anatomy of the thoracic organs is likely to play an important role in the development of this built-in rotational tendency.

REFERENCES:


AFFILIATED INSTITUTIONS FOR CO-AUTHORS:

** University Hospital Maastricht, Maastricht, The Netherlands.