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Baricentricity of Spinal Alignment and Posture in Adolescent Idiopathic Scoliosis: Optical Diagnosis

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Summary

To avoid repetitive harmful effects of X-ray exposure in patients with Adolescent Idiopathic Scoliosis (AIS), new non-invasive approaches have been developed, with the aim to replace or reduce the need for X-ray imaging, especially in follow-up and monitoring stages. We recently developed ScolioSIM1.0, a software tool that produces 3D visualizations of the patient-specific deformity model and allows evaluation of AIS in a non-invasive manner. As it enables spatial visualization of the deformity, numerous geometrical parameters can be evaluated in all 3 body planes in 2D or 3D. One parameter of clinical importance is the barycenter (BC) of the spine, which describes the center point of the surface that envelops a projected Middle Spinal Alignment (MSA) in the plane normal to the local spinal axis DM-C7, located at L5's lower plate point.

Introduction

Traditional evaluation of AIS still relies on the 2D Cobb angle as a gold standard, which describes only one specific segment of the spinal curve in one plane, neglecting the 3D nature and spatial configuration of the deformity, especially axial projection of the MSA (Figure 1). In this study, we aim to determine transversal projections of the MSA and BC of the human spine using non-invasive optical techniques [1], as their shape and position can reveal important indicators of the deformity, as well as help clinicians to qualitatively describe a patient's posture [2].

Methods

We performed retrospective analysis of 26 3D optical samples of AIS patients' back surfaces using the ScolioSIM1.0 diagnostic tool (18 females and 8 males; 10.6±1.37 and 11.5±2.07 years old). For each patient, the BC location and surface area were calculated, and contour shapes were considered. Depending on the position of the BC from the local spinal axis (0,0), deformity may be left or right shifted. In addition, the BC was used to determine if the subjects' back posture deformities were flat (ventral) or sway (dorsal). As scoliosis is a 3D deformity, the BC was then placed in different quadrants in order to allow the pathology to be classified as an anterior shift, posterior shift, right or left shifted, or combined. Depending on the shape of projected contour, deformity could be qualified as isophasic (narrow contour) and anisophasic (rounded) (Figure 1).

Results and Discussion

Analysis of the collected datasets and parameters of BC points showed that the most dominant type of scoliosis in the selected population of patients were right (84.6%) and posteriorly (57.7%) shifted. As datasets contained AIS patients only, all projected contours indicated mainly anisophasic deformities.

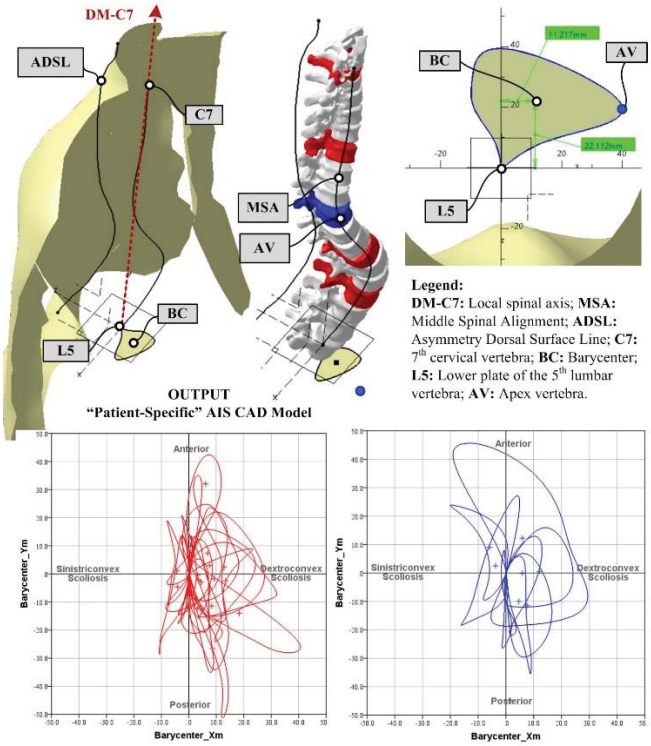

Figure 1: Barycenter points in pathological spines, presented for both female and male subjects

Conclusions

In many studies and current clinical practice, AIS is mainly diagnosed based on 2D frontal and sagittal plane parameters. Axial projection of the MSA is of crucial importance, and can now be accessed using optical techniques, hence providing access to the BC. Such approaches can clearly show balance of the patient and pave the way towards a new non-invasive 3D classification of scoliosis.

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References

[1] Ćuković S. (2015). *PhD Thesis*, Univ. of Kragujevac.
[2] Negrini et al. (2016). *Scoliosis*, **20**:1-16.