Introduction: A mathematical algorithm was used to compare shape and curve differences between supine CT and weight bearing upright EOS models of large curve AIS patients. Three dimensional reconstructions of computed tomography (CT) scans is the gold standard in assessing the 3D reconstruction. Routine CT scans, however, are not a viable option in adolescent idiopathic scoliosis (AIS) due to the fact that CT is obtained in the supine position and due to the high radiation exposure associated with CT. It is expected that a laying position will modify the curves of the vertebral column compared to the upright position. EOS allows for 3D reconstructions of the patient in upright position. The current study will investigate the change of spinal curvature when a patient is placed in supine position compared to the anatomical correct weight-bearing upright position. We hypothesize that the supine position will significantly change the curvature of the spine, making supine modalities for 3D spinal assessment unusable for curvature and treatment assessment. Secondarily, we believe this comparison will allow validation of the capacity of EOS to accurately generate the 3D shape of each vertebra.

Methods: Retrospective analysis was performed on 8 juvenile patients with scoliosis whose spines had been scanned both with computed tomography (CT) and with biplanar EOS imaging. Images were reconstructed in 3D and evaluated using custom MATLAB software.

Morphological Comparison: To assess the shape accuracy of EOS vertebral reconstructions, EOS vertebrae were aligned with their CT counterparts and the differences between them were quantified. Each vertebra was divided into six morphological regions: articular processes, transverse processes, spinous process, endplates, vertebral body, and pedicles. Mean distances were calculated for each region of each vertebra, and for each vertebra in its entirety.

Spinal Contour Comparison: After vertebral registration, each whole EOS® spine was registered onto its CT counterpart and aligned at the L5 so that the difference between them was zero. Spinal curve differences between standing EOS and supine CT were then evaluated.

Position Accuracy: To calculate vertebral position differences between EOS® and CT, the vector differences between EOS® centroids and the CT centroids were calculated. Those distances represent the differences between the position of the vertebrae as determined EOS® compared to the positions obtained using CT and are further referred to as an offset.

Results: Morphological Comparison: The mean reconstruction error was larger at level L5 than any other level (3.59mm), but there was no significant difference between the reconstruction errors of any levels (p=0.4). No significant difference was found between the reconstruction accuracies of each vertebral morphological region (p=0.6).

Spinal Contour Comparison: Analysis of the full spine contour has shown difference between the CT and EOS models. We can see difference of up to 25mm in posterior-anterior direction (PA) at level T3, about 17.5mm in right-left (RL) direction and 21mm in inferior-superior direction (IS).

Discussion: Previous studies have shown that EOS provides for accurate 3D representations of the scoliotic spine and present a low radiation alternative for obtaining accurate spinal measurements for clinical and research purposes (Glaser et al, 2012). Our study showed that it also has the added advantage of images taken in upright position presenting a better representation of the spine when compared to a patient placed in supine position.

Significance: The current study has shown that while EOS is similarly good for the morphology reconstruction of each individual vertebrae as the CT gold standard. However, EOS presents some advantages to CT. First, it exposes the patient with very low radiation which is even less than an x-ray and second, it takes the images in standing weight bearing position. The present study
showed that this is particularly important as there are large differences between supine and standing. Due to differences found here, patient spine curvature shall be analyzed in standing position only.

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