Unlocking The Axial Plane in Spinal Deformity: Three Dimensional Analysis of AIS and ASD Patients

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INTRODUCTION: Spinal deformity (SD) surgery has a high rate of revision when compared to other orthopedic procedures. In fact, while SD is a 3D process, the axial plane was never fully explored in this entity which could potentially explain the high revision rate. This study aims to investigate how axial plane displacement can affect sagittal alignment in SD patients.

METHODS:

SD patients with no previous spine surgery underwent full-body x-rays and a detailed 3D reconstruction of the spine in standing position pre-op. Axial translation in the anteroposterior (APtr) and right/left was investigated for each vertebra (figure). T9 was shown to have the least variance of APtr and patients were divided into 3 groups based on the T9 translation (Tr): G1: <40% (More posteriorly translated), G2: 40-60% (average), and G3: >60% (Less posteriorly translated). 2D Radiographic parameters were compared between the 3 groups.

RESULTS:

150 patients were included with a mean age of 43 yrs and 69% females. 40% were AIS and 60% were ASD. Mean PT was 18.2°, PI-LL 9.6, SVA 44.7mm, T1PA 16.4° and T9 spinopelvic inclination (SPi) -8.2°. In the thoracic spine, T9 had the lowest range of AP axial Tr being 233.5 mm, and L5 in the lumbar spine with a range of 132.1 mm (Figure). T9SPi was shown to correlate with T9 APTr (r=.78, p<.001), SVA with T1 AP Tr (r=.85, p<.001), PI-LL with L1 AP Tr (r=-.32, p<.001), T4PA with T4 AP Tr (r=.37, p<.001), T1PA with T1 AP Tr (r=.47, p<.001), but T9PA, L1PA, and L4PA did not correlate with T9, L1 and L4 AP Tr. Pt in the least posteriorly translated group had higher thoracolumbar scoliosis (G1:-1.0, G2:7.0, G3:38.9°), highest SVA (G1:26.5, G2:38.0, G3:65.2mm) and lower PT (G1:22.6, G2:15.3, G3: 15.3°) and lowest T9SPi (G1:-13.5, G2:-6.9, G3:-3.6°), p<.05.

DISCUSSION AND CONCLUSION:

When analyzing the axial plane in spinal deformity and plotting each vertebral translation, the human body attempts to keep T9 and L5 as the least translated vertebrae in the anterior/posterior direction. Not every traditional sagittal parameter correlated with the anterior/posterior translation of the associated vertebra. The shape of the spine in axial translation is a cone in the right/left direction, and narrows at T9 in the anterior posterior direction (Figure). This study revealed that the axial plane is its own entity in spinal deformity and worth exploring interpedently.