Sagittal spino-pelvic organization influences the biomechanical behavior of the intervertebral disc after idiopathic scoliosis surgery: a prospective study with minimum 2 years follow up

Kariman Abelin-Genevois[1], Pascal Swider[2], Erik Estivalezes[2], Jerome Sales De Gauzy[3]

[1] Hopital femme Mère enfant Université Claude Bernard Lyon I, Lyon, France
[2] Laboratoire de Biomécanique UMR CNRS 5502, Toulouse, France
[3] Children's Hospital, Toulouse, France

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Purpose: To analyse the biomechanical properties of the intervertebral disc after scoliosis surgery according to the underlying spino-pelvic organization.

Methods: We conducted a prospective MRI study in 45 patients with AIS with a minimum 2 years follow-up. Mean age at surgery was 15.1 years. Mean Cobb correction was 63 %. Fusion extended to L1 or L2 in 27 patients and to L3 or L4 in 18 patients. Total disc and nucleus volumes were extrapolated from 3D reconstruction using a custommade image processing software (Biomechlab®, Toulouse, France). Nucleus and external disc contours were semiautomatically detected on turbo spin echo T2 weighted sequences (3 mm sagittal cuts). Disc hydration was defined as the nucleus-disc volume ratio. Sagittal parameters were measured pre- and postoperatively on full spine standing views (pelvic incidence (PI), sacral slope, L1/S1 lumbar lordosis). Lumbar-pelvic congruity was represented by LL/SS ratio as described by Stagnara.

Results: Mean PI of the cohort was 55 (34–80). In low PI group (n = 24), mean loss of lordosis was 3_ (NS). Lumbo-pelvic congruity was reduced from 1.53 to 1.27 (p = 0.01). Disc volumes remained stable more than 2 years after the surgical correction. Significant increase of the nucleus volume and disc hydration level occured at the latest follow-up at each level. The highest changes concerned the intermediate levels (+25 %, p = 0.01). Longer follow-up (5 years, n = 13) confirmed the constant increase of disc hydration level, especially when selective fusions were performed (from +25 to 39 % at L5S1 level, p\0.001). In the high PI group (n = 21), disc volumes and nucleus size remained unchanged after the surgery. Lumbo-pelvic congruity was not modified after surgery (LL/SS = 1.46).

Conclusions: Pelvic orientation had a significant influence on the biomechanical behavior of the free motion lumbar spine after spinal fusion in AIS. Lumbo-pelvic parameters positively influenced the post operative hydration properties when PI was in the lower range. These results can be explained by reduced constraints in the flat sagittal profile. When PI is high, shear stresses maintain disc homeostasis disturbances under the fusion mass, whatever the coronal correction outcome. Pelvic morphology plays an important role in the biomechanical behavior of intervertebral discs after scoliosis surgery. Patients with high pelvic incidence may present a higher risk for accelerated disc degenerative changes after extended fusion.

Significance: This prospective MRI study in AIS patients showed a significant and sustainable improvement in disc hydration properties after surgery. These changes are clearly under the influence of the sagittal spino-pelvic organization.