Intervertebral disc changes in an animal model representing altered mechanics in scoliosis

4 Groups of animals

- **Group A** – Angulation only
- **Group B** – Both Compression and Angulation
- **Group C** – Compression only
- **Group D** – Reduced mobility only

RESULTS:

**Geometrical:** Disc narrowing at the intervention levels was evident in micro-CT images. In the first micro-CT scan (2 days post-instrumentation), compressed discs (groups B and C) had lesser disc space (mean 0.60 mm) relative to the uncompressed groups A and D (mean 0.66 mm), representing 8.5% immediate narrowing. There was subsequent loss of disc space in all groups over the 5-week duration of the loading. Average disc space loss as a percent of the initial values over the 5 weeks was 15%, 36%, 32% and 16% in the four groups. The amount of disc narrowing did not differ significantly between groups (p>0.05). Loss of disc space at control levels averaged 2% over the 5-week experiment.

**Mechanical:** Increased lateral bending stiffness relative to within-animal controls was observed at all groups. Stiffness averaged 55, 204, 51, 91 x 10^5 Nmm/deg in Groups A,B,C,D respectively. The minimum stiffness at distal control levels was 50 x 10^5 Nmm/deg. The minimum stiffness was recorded at an angle close to the in vivo value (mean angle less than 1 degree in all groups), indicating that angulated discs had adapted to the imposed deformity.

**Histology (Collagen crimping):** At the intervention levels of the Group B (angulated and compressed) discs there was a small non-significant difference in the amount of collagen crimping in the disc annulus between concave and convex sides (mean crimp periods 28.3 and 29.6 ± 6.8 µm). This was consistent with the collagen having remodeled to a similar strain condition on each side of these angulated discs. The crimp periods at these levels was significantly less than at the within-animal control discs, where the crimp period averaged 38.7 µm. This is consistent with the fact that the intervention level discs were fixed with the apparatus in place, preventing swelling of the discs.

**DISCUSSION:**

All interventions (permutations of angulation, compression and reduced mobility) produced substantial changes in the intervertebral discs of these growing animals over the five-week experiment. This five-week period corresponded to a large proportion of the post-natal growth of the animals (bodyweight typically increased from 125 to 400 g). The changes included narrowed disc space and increased lateral bending stiffness, and there was evidence of collagen remodeling to accommodate the deformed position, also compatible with the observation that minimum lateral bending stiffness was measured close to the in vivo ‘bent-tail’ configuration in angulated discs.

‘Reduced mobility’ was present in all interventions, and the changes in the discs with reduced mobility alone were comparable with those in loaded and angulated discs. This suggests that reduced mobility is the major source of disc changes, and may be a factor in disc degeneration in scoliosis. Further studies are in progress to characterize gene expression, matrix protein synthesis and composition in these discs.

It is concluded that the five-week growth period of these rats produces substantial disc tissue changes, probably comparable with secondary, biomechanically induced changes occurring during the adolescent growth phase in patients with scoliosis. Since the disc dimensions and properties were altered at the intervention levels of all four Groups, the reduced mobility that was present in all groups appears to be the major cause of the observed changes. The application of the rings and springs in Group D cannot be considered as a sham intervention, probably because it produces reduced mobility of the disc.

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REFERENCES:

