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Changing a "progressive" factor into a "corrective" factor: the effect of intervertebral disc modulation in treatment of idiopathic scoliosis

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Background

The rationale for management of scoliosis during skeletal growth assumes a biomechanical mode of deformity progression, based on the Hueter-Volkmann principle, whereby extra axial compression decelerates growth and reduced axial compression accelerates it. Wedging of the intervertebral disc (IVD) is known to contribute to the progression of idiopathic scoliotic (IS) curves. This report illustrates the effect of IVD modulation and its subsequent benefits in IS treatment. The proposed model is examined on conservative treatment (full- and night-time braces and exercises) and fusionless IS surgery with staples.

Materials and methods

A theoretical model of IVD's role in progressive IS pathobiomechanics is proposed. The imbibed water through the so called Gibbs-Donnan mechanism, mainly in the apical IVD but also in the adjacent discs, must occur in a greater amount in the convex side than in the concave due to convex-wise asymmetrical distribution of glycosaminoglycans (GAGs) in nucleolus pulposus collagen network type II. This asymmetrical pattern of water distribution in the scoliotic IVD, combined with the diurnal variation in the water content of IVDs, imposes asymmetrical, convex-wise, concentrated cyclical loads to the IVD and the adjacent immature vertebrae growth plates of the child during the 24 hours period. The convex side of the wedged IVD sustains greater amount of cyclic expansion than the concave side, leading to the sequela of asymmetrical growth of adjacent vertebrae (Hueter-Volkmann law).

Results

The IVD may be modulated by applying corrective forces on the curve thereby eliminating any asymmetrical accumulation of water in the apical and adjacent discs. This, in turn, restores a close-to-normal force application on the vertebral growth plates through the Hueter-Volkmann principle and consequently may prevent curve progression. The forces are now transmitted evenly to the growth plate increasing the rate of proliferation of chondrocytes at the corrected pressure side, the concave. All the stated treatment methods aim at alteration of the mechanical environment and modulation of the endochondral growth of the immature vertebrae. Application of appropriately directed forces, ideally opposite to the apex of the deformity, likely leads to optimal correction.

Discussion

The wedging of the elastic IVD in the immature scoliotic spine could be reversed by application of corrective forces on it. Reversal of IVD wedging is thus amended into a "corrective", rather than "progressive", factor of the deformity. Through the proposed mechanism, treatment of progressive IS with braces, exercises and fusionless surgery by anterior stapling could be effective.

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