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A New Buckling and Axial Loading Theory in Patho-mechanics of Syringomyelia: A Hypothesis, Concept & Review

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Introduction: A cavitation inside the spinal cord's material without an ependymal lining that can be either non-obstructive or obstructive is known as syringomyelia. The three primary pathophysiological theories widely accepted are abnormal pulse waves, craniospinal dissociation, and hydrodynamic theories. The author proposes a novel theory regarding how syringomyelia forms.

Methods: Hypothesis

Results: The vertebral canal is like a pipe containing flexible spinal cord tracts hanging inside it, supported by dentate ligaments. Buckling is nothing but instability resulting in reduced stiffness on axial compression of a cord, leading to displacements/rotations of its member. Axial compression and instability at the craniovertebral junction can lead to lateral buckling, creating a ballooning phenomenon in the cord tracts where CSF accumulates, creating the syrinx. CSF exerts positive pressure and leads to progression of syrinx. Lateral displacements of cords lead to the dissipation of CSF along the channels with the least resistance, mainly the anterior commissure. Resultant ballooning gives a bottleneck effect at the beginning and bottom of the instability. There are three types of buckling: flexural buckling, torsional buckling, and flexural-torsional buckling. The flexural-torsional buckling causes the weak axis of the cross-section to be deflected, resulting in permanent damage. The new hypothesis suggests that old theories are subsequent changes to the axial compression with rotatory instability at the craniovertebral and atlanto-axial junctions.

Conclusion: Literature suggests that the progression of the syringomyelia slows or halts with occipito-cervical or atlanto-axial fusion. Many authors suggest instability as the primary reason for syringomyelia development and progression; however, they failed to substantiate it with the mechanics hypothesis. We need further biomechanics and cadaveric studies to support the buckling and axial loading hypothesis