PATHOPHYSIOLOGY AND CLASSIFICATION OF INTERVERTEBRAL DISC HERNIATION

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Abstract: Intervertebral disc herniation (IDH) represents a common degenerative spinal condition affecting millions worldwide. This article reviews the structural anatomy of the intervertebral disc, mechanisms of degeneration, biomechanical factors contributing to herniation, and contemporary classification systems. Understanding the underlying pathophysiology is essential for accurate diagnosis and optimized therapeutic decision-making.

Keywords: intervertebral disc herniation; nucleus pulposus; annulus fibrosus; disc degeneration; Pfirrmann grade; spinal biomechanics.

Introduction

Intervertebral disc herniation is characterized by displacement of nucleus pulposus material through the annulus fibrosus, leading to nerve root irritation and neurological symptoms. It affects both cervical and lumbar regions, with lumbar herniation being most prevalent. The condition poses significant socioeconomic burden due to chronic pain, disability, and decreased productivity.

Anatomy of the Intervertebral Disc

The intervertebral disc is composed of three key structures:

1. Nucleus pulposus (NP) — gelatinous central region rich in proteoglycans.
2. Annulus fibrosus (AF) — concentric collagenous lamellae providing mechanical strength.
3. Cartilaginous endplates — interface between the disc and vertebral bodies, crucial for nutrient diffusion.

Degenerative changes including reduced hydration, proteoglycan loss, and annular tears predispose the disc to structural failure.

Pathophysiology of Disc Herniation

Disc herniation occurs due to a combination of biochemical and mechanical mechanisms:

- Progressive degeneration reduces NP hydration and elasticity.
- Annular fissures weaken structural integrity.
- Mechanical overload, repetitive microtrauma, and axial torsion create increased intradiscal pressure.
- Inflammatory mediators (TNF-α, IL-1β) exacerbate nerve root sensitization.

Classification of Herniation

Several classification systems exist:

1. Morphological Classification

- Bulging — diffuse extension beyond disc space.
- Protrusion — focal displacement with broad base.
- Extrusion — nucleus pulposus escapes through annular defect.
- Sequestration — free fragment migration.

2. Topographical Classification

Based on axial location:

- Central
- Paracentral
- Foraminal
- Extraforaminal

3. Severity Grading (MRI-based)

Graded according to nerve root compression and disc dehydration (Pfirrmann classification).

Conclusion

Understanding the multilevel degenerative processes and morphological variations in intervertebral disc herniation provides a foundation for accurate diagnosis and individualized management strategies.

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