PERCUTANEOUS LUMBAR DISCECTOMY

Thesis
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بسم الله الرحمن الرحيم

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SURGICAL ANATOMY
OF THE LUMBAR INTERVERTEBRAL DISC

The intervertebral discs are the strongest bond between the vertebral bodies. They unite mobility with great strength. About 20% of the height of the spinal cord is formed by the intervertebral discs, this ratio increases to about one-third in the mid-cervical and lower lumber regions where mobility of the spine is greatest.

In these regions they are thicker anteriorly and thus contribute to the development of the normal secondary spinal lordotic curvatures which develop as the growing child assumes an upright posture.

Each intervertebral disc is composed of three parts

- *Two cartilage plates.*
- *Annulus fibrosus.*
- *Nucleus pulposus.*

The Cartilage Plates

Two thin plates of hyaline cartilage which are the central non-ossified parts of the vertebral epiphyseal plates, cover the central parts of both upper and lower surface of each vertebral body.

Each plate ends abruptly in the anterior and lateral regions, when it abuts on the outer raised bony rim of the vertebral body called the epiphyseal ring. Posteriorly it extends to the margins of the vertebral body.

Blended intimately with these plates is a layer of fibrocartilage which gives attachment to the fibers of the annulus fibrosus and nucleus pulposus, *(Finneson, 1973)*.

Microscopically, these cartilage plates are composed of ordinary hyaline cartilage where the cells are arranged somewhat horizontally.

The cartilage plate is found over the perforated bony end, but not over the epiphyseal ring *(Turek, S. 1984)*.

Inoue 1981, demonstrated that the cartilage end plate contains no fibrillar connection with the collagen of the subchondral bone of the vertebra. This lack of interconnection between the end plate and the vertebra may render the disc biochemically weak against horizontal shearing forces.

He also demonstrated that the collagen fibrils in the outer two-thirds of the annulus fibrosus are firmly anchored into the vertebral bodies. Fig.(1)

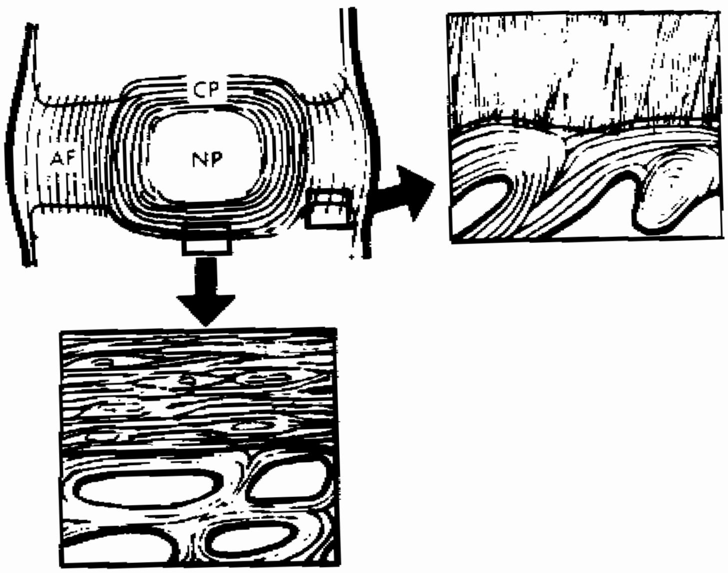


Fig. 1 : Quoted from Campbell, 1987

The Annulus Fibrosus

The annulus fibrosus forms a dense fibrocartilagenous retaining envelope for the nucleus pulposus. **Fig. (2)**

It is composed of approximately 12 concentric rings. Fibers in each ring cross radially, and the rings are attached to each other with additional diagonal fibers. The rings are thicker anteriorly than posteriorly.

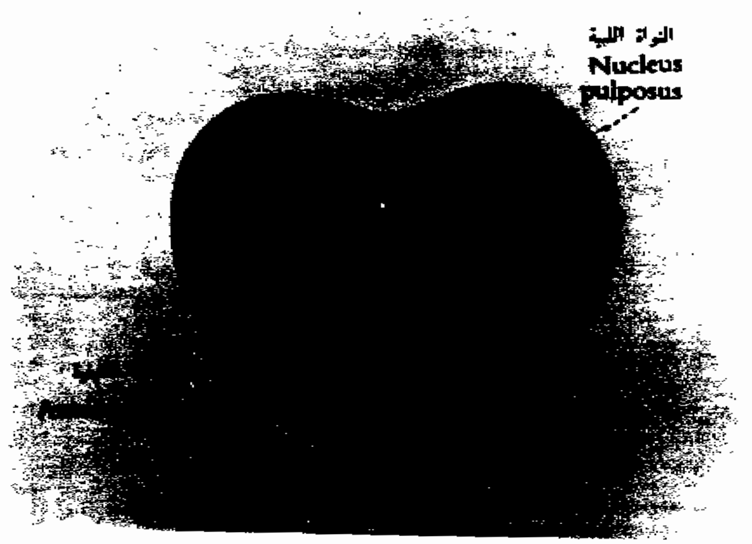


Fig. 2

Each layer runs at 45° to the one on either side of it. The arrangement of these fibers in the annulus makes it able to withstand strain in any direction *(Last, 1978)*.

The fibers of the annulus are attached to the cartilage plate, to the anterior and posterior longitudinal ligaments and into, the edges of the vertebral bodies like sharpey's fibres *(Turek, S. 1984)*.

The annulus fibrosus can be likened to a coiled spring, pulling the vertebral bodies and cartilage plates against the resilient resistance of the nucleus pulposus *(Macnab and Harris, 1954)*.

The Nucleus Pulposus

The nucleus pulposus is a white, glistening and slightly translucent body of semigelatinous consistency lying rather behind the center of the intervertebral disc in the lumber region, so when it penetrates it is easier to prolapse posteriorly.

It is enclosed in the annulus fibrosus under considerable tension.

Microscopically, the nucleus pulposus is composed of a loose network of fine strands of fibrous tissue arranged irregularly together with connective tissue cells and cartilage cells.

Biochemically, the matrix in which the collagen fibers of the nucleus pulposus are contained is a gel consisting of water held in protein-polysaccharide complexes containing hyaluronic acid, chondroitin sulphates A and C, and keratosulphate.

This gel has the property of imbibing water against resistance giving rise to an intrinsic tension within the nucleus pulposus which persists even in the absence of any weight bearing or muscular effort *(Mitchell, Hendry and Billewicz, 1961 and Maurice-Williams, 1981).*

Blood Supply of the Intervertebral Disc

In children and young adults, there are small vessels that pass from the vertebral bodies penetrating the cartilage plates to supply the disc.

These vessels gradually become obliterated so that, by the age of 20 or 30 years, the intervertebral disc is found to be completely avascular.

The disc's limited nutritional demands are probably fulfilled by the diffusion of lymph through minute perforations from the marrow cavity to the cartilage plates which permit a scanty lymph supply to diffuse through the intervertebral disc *(Finneson, 1973).*

Innervation of the Disc

At the level of intervertebral foramen is the dorsal root ganglion. Distal to the ganglion three distinct branches arise, the most prominent and important is the ventral ramus that supplies all structures ventral to the neural canal.

The second branch, the **sinu vertebral nerve**, is a small filamentous nerve that originate from the ventral ramus and progresses medially over the posterior aspect of the discs and vertebral bodies, innervating these structures and the posterior longitudinal ligament. The third branch is the dorsal ramus. This branch courses dorsally piercing the intertransverse ligament near the pars interarticularies.

Three branches from the dorsal ramus innervate the structures dorsal to the neural canal. The lateral and intermediate branches provide innervation to the posterior musculature and skin. The medial branch separates into three branches to innervate the facet joint at that level and the adjacent levels above and below. **Fig. (3)**

(Campbell, 1987)

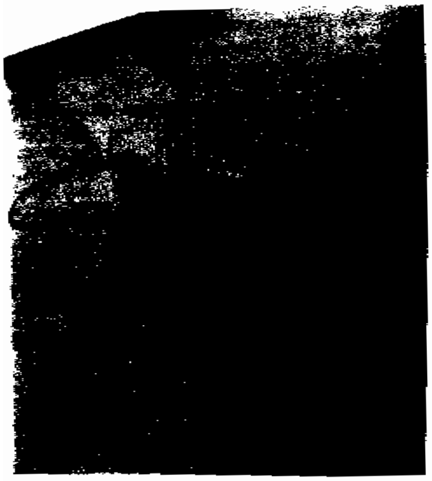
The annulus is the only part of the disc which has any innervation. Unmyelinated nerve fibers are found in the posterior longitudinal ligament and in the adjacent superficial fibers of the annulus.

These fibers transmit pain sensations from posterior annulus to the recurrent spinal nerve of Lushka (the sinu vertebral nerve).

Since the disc has no innervation except for the superficial part of the posterior annulus where it is related to the posterior longitudinal ligament, so it seems likely that disc degeneration cannot give rise to pain unless there is stretching of the posterior annulus and the posterior ligament by disc protrusion *(Maurice-Williams, 1981)*.

An annular bulge or an extruded fragment of the nucleus may cause stretch or compression of the nerve root causing pain. This depends not only on the size of the protrusion but also on the dimensions of the bony spinal canal.

The extruded lumber root may be affected either at its origin from the dural tube in the lateral recess by a posterolateral protrusion of the disc, the usual situation, or rarely at its foramen by an extreme lateral protrusion of the disc below.



A

B

Fig. 3

A. Dorsal view of lumbar spinal segment with lamina and facets removed. On the left side, dura and root exiting at that level remain. On the right side, dura has been resected and root is elevated, Sinu-vertebral nerve, A, with its course and innervation of the posterior longitudinal ligaments, B, is usually obscured by nerve root, C, and dura.

B. Cross sectional view at level of end plate and disc.

A: Sinu vertebral nerve.

E: Additional nerve branches from ventral ramus.

D: Dorsal ramus, arises from root immediately on leaving foramen.

This ramus divide into: Lateral (F)

Intermediate (G)

Medical (H)

(Quoted from Campbell, 1987)

The Disc Function

The disc as a whole serves as an articulation (amphiarthrosis) between two adjacent vertebrae which gives the spine its mobility *(Turek, 1977)*.

Dividing the intervertebral disc into its component parts:

1. The Cartilage Plates

The cartilage plates have many functions, they are the growth zone of immature vertebral bodies, they help to anchor the disc, and they act as a "barrier" between the nucleus pulposus and the spongiosa of the vertebrae *(MacNab and Harris, 1954)*.

The cartilage plates also permit nutrition of the disc by diffusion of lymph through them from the vertebral bodies to the disc *(Finneson, 1973)*.

2. The Nucleus Pulposus

The intact nucleus pulposus is essential for physiological movement of the spine.

The nucleus is an incompressible but mobile fulcrum about which the movement of two adjacent vertebrae occurs. It acts as a ball-bearing on which the vertebral bodies roll over it.

(MacNab and Harris, 1954).

As the nucleus can alter its shape but cannot be compressed, it acts as a shock absorber and equilizes the transmission of force acting along the spinal axis to the tissues around it, especially the annulus *(Maurice-Williams, 1981)*.

The nucleus pulposus gives an intrinsic stability for the spine through its imbibition pressure which tends to push the vertebral bodies apart against the ligaments which force the vertebral bodies together.

3. The Annulus Fibrosus

It is the "limiting membrane" surrounding the nucleus and serves as its capsule.

The annulus resists the displacement of the nucleus and prevents its deformation by the body weight.

The "turgor" of the nucleus pulposus is largely due to elasticity of the fibers of the annulus fibrosus which compress it.

These fibers run in various directions so that it is able to withstand strain in any direction.

The annulus fibrosus can be likened to a coil spring pulling the vertebral bodies and cartilage plates against the resilient resistance of the nucleus pulposus *(Macnab and Harris, 1954)*.

Disc Prolapse

The lumbar disc protrusions are most frequent at the lowest two lumbar discs, because they are more bulky and subjected to more movement and stresses than elsewhere.

(Maurice-Williams, 1981)

Fissures appear in the annulus and the nucleus begins to disintegrate. It is at this point that movement of the disc material may occur.

If a disc protrusion does not take place at this stage, the progression of the degenerative process eventually leads to a dense fibrous contracture of the whole disc. Thus a protrusion can only takes place at the intermediate stage of disc degeneration which usually occurs in the early adult life or middle age *(Maurice-Williams, 1981)*.

Pieces of loose nuclear material are pushed outwards against the fissuring annulus. The annulus tends to give way posteriorly where it is thinnest but the posterior longitudinal ligament usually deflects these posterior protrusion into a somewhat posterolateral direction. Only posterior or posterolateral protrusions are of clinical consequences for it is only in those directions that protrusions impinge on structures which will give rise to symptoms, the nerve roots and the heavily innervated posterior longitudinal ligament.

As the two potential weak points around the nucleus are the posterolateral annulus and the cartilage plates, extrusions of the nuclear material occur also through small defects in the cartilage plates which are very common and non symptomatic.

These extrusions are known as **Schmorl's nodes.**

Types of Disc Prolapse

Seven types of disc prolapse are encountered

1. Lateral Prolapse

This is the commonest lesion where the nucleus bulges through the weakest part of the disc either beneath the posterior ligament **(Fig. 4a)** or rupture through it **Fig. (4b)** and may compress the root against the opposite lamina or ligamentum flavum. Lateral adhesions may form.

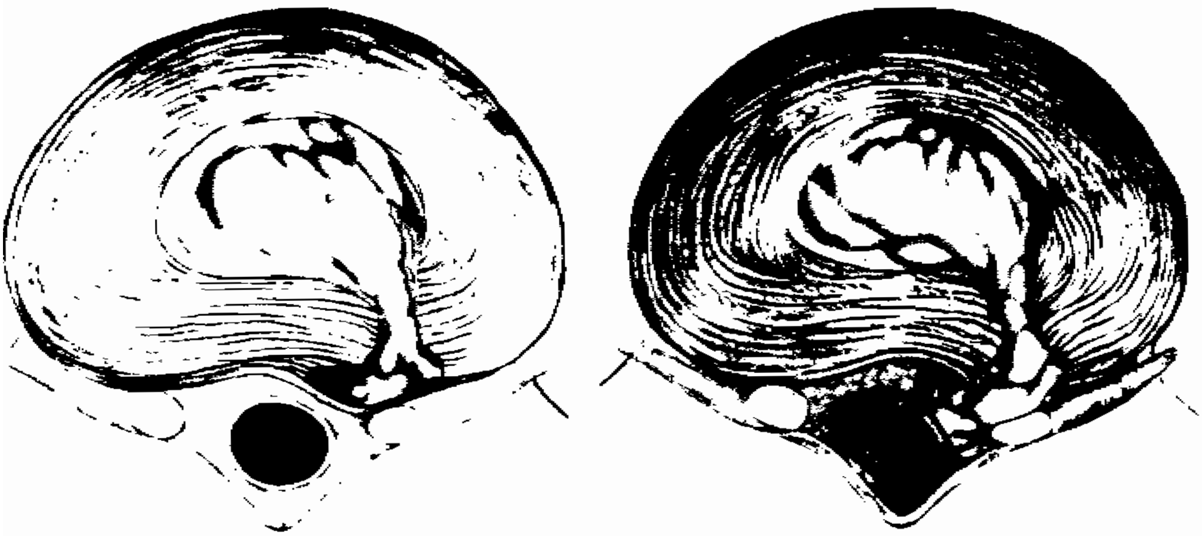


Fig. 4

a b

2. Intraformainal Prolapse

Disc may prolapse inside the corresponding foramen where root may be compressed, **Fig. (5)** straight leg raising will show marked limitation with more severe pain.

Fig. (5)