

LASER DISC DECOMPRESSION IN PROLAPSED LUMBAR DISC

ESSAY

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قَالَ رَبِّ اشْرَحْ لِي صَدْرِي وَيَسِّرْ لِي أَمْرِي وَاحْلُلْ
عِقْدِيَ كَمَا يُبْحِرُ الْفُلُ

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INTRODUCTION

Recently there has been increased interest in less invasive spinal surgery techniques.

This has led to the development of Laser techniques, which have offered new chances for better treatment of lumbar disc disorders.

During mid eighties the idea began to be discussed, and in September 1988 the first Laser decompression of symptomatic contained disc prolapse was performed in the United States and since that time the process is progressing foreword for developing new techniques, doses and better LASER emitters.

AIM OF THE WORK

In this work we aim to review the Laser Disc Decompression concerning its technique, results, complications and its advantages over other modalities in the treatment of disc herniation without ignoring its drawbacks and limitations.

CHAPTER I

ANATOMY OF THE INTERVERTEBRAL DISC

The inter-vertebral disc is a secondary cartilaginous joint or symphysis. The upper and lower surfaces of each vertebral body are covered completely by a thin plate of hyaline cartilage united by a peripheral ring of fibrous tissue called the annulus fibrosus (AF) (Fig. 1)⁽⁴⁰⁾.

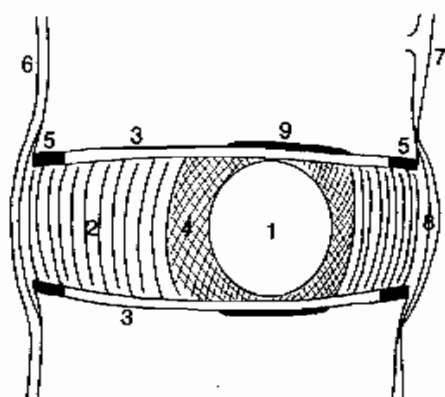


Fig.1: This diagrammatic representation of the intervertebral disc, in addition to presenting the customary nucleus pulposus (1), annulus fibrosus (2), and cartilaginous end plates (3), also presents the zone of irregular connective tissues surrounding the nucleus (4), the epiphyseal rim (5), the anterior longitudinal ligament being continuous with the periosteum (6) and the posterior longitudinal ligament separating from the concave posterior vertebral body (7), the presence of Sharpey's fibers (8), and a thickened calcified layer capping the nucleus (9).

The (AF) consists of concentric laminae, the fibers of which lie at 25° - 45° with the bodies of the vertebrae. Alternate layer of the annulus contain fibers

lying at right angles to each other. This pattern of fibrous arrangement renders the (AF) strong enough to withstand strain in any direction⁽⁴⁰⁾.

The fibers of the annulus are attached to each other with additional diagonal fibers. The ring or laminae of the annulus are thicker anteriorly than posteriorly due to the posterior placement of the nucleus pulposus⁽⁶⁷⁾.

The nucleus pulposus (NP) is composed of a loose, non-oriented collagen fibril frame-work supporting a network of cells resembling fibrocytes and chondrocytes, imbedded in a gelatinous matrix⁽⁷⁰⁾.

The (NP) is derived from the embryonic notochord and lies at the center of the disc in the embryonic life. Subsequent growth of the vertebral bodies and discs makes the nucleus pulposus lie nearest to the back of the disc in the adult life⁽²⁾. The (NP) contains about 90% water at birth, and this diminishes to about 70% in old age. The water content keeps the nucleus under constant pressure since its proteoglycan component has the property of imbibing and retaining water⁽⁴⁰⁾.

Nutrition of IVD (Fig. 2)

The healthy adult disc apart from its capsule is devoid of blood supply. Therefore it receives its nutrition by the colloid properties of the nucleus, attracting by osmosis tissue fluid into it when the pressures on the disc are reduced. This imbibing of fluid normally takes place at night. During the day, the discal fluid is expressed from the disc to complete the nutrient cycle⁽⁶⁶⁾.

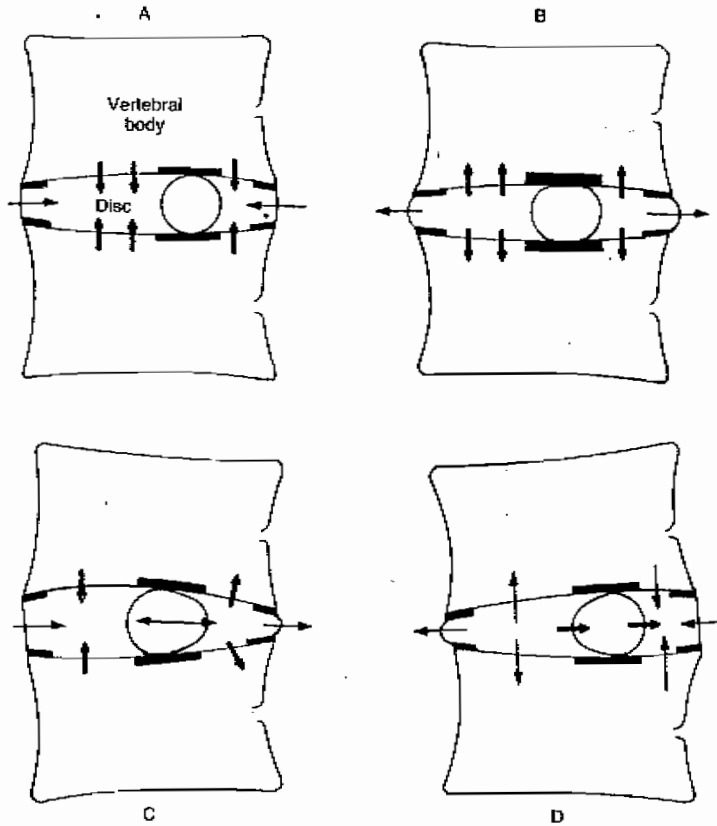


Fig.2: The nutrient cycle to the disc is schematically depicted. A. The weight is off the disc, permitting the polysaccharide molecules to imbibe fluids essential for nutrition. B. The weight-bearing phase is represented, and the fluid is shown as being expressed from the disc. C. Illustrated is backward bending, which may take place even at rest on an overly firm mattress. Here, while the front of the disc absorbs nutrient fluids, the back of the disc is unable to do so. D. Forward bending, the reverse of figure 3C, is illustrated. An additional feature of forward bending is that with sufficient fluid moving posteriorly, hydrodynamics of the disc are upset and the patient may become fixed in flexion.

Innervation of the IVD (Fig. 3)

The mixed spinal nerve forms within the intervertebral foramen just lateral to the dorsal root ganglion. Soon thereafter it divides into an anterior primary ramus that proceeds to the lumbar and sacral plexus and a smaller posterior ramus that principally innervates the posterior structures.

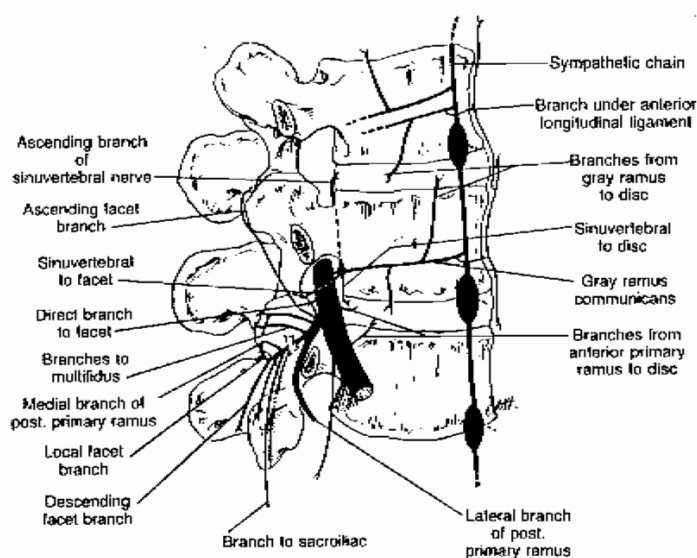


Fig.3: Segmental distribution of innervation

While in the intervertebral foramen, the mixed spinal nerve gives off a branch that joins with another from the ramus communicans and forms the recurrent sinuvertebral nerve. This nerve re-enters the spinal canal and sends branches to the posterior longitudinal ligament, posterior and posterior lateral disc, the anterior meninges, and the nerve root sleeves as far out as the foramen. In addition, it

sends a direct dorsal branch to the ligamentum flavum and the anterior facet joint.

The mixed spinal nerve also sends a direct branch to the facet joint via the superior articular recess and may on occasion send a direct branch to the posterior lateral disc.

The anterior primary ramus is mainly concerned with forming the lumbar and sacral plexus. It also sends one or two, relatively long, ascending branches to the posterior lateral and lateral aspects of the intervertebral disc.

Disk innervation is augmented by branches from the recurrent nerve and from the gray ramus communicans, the branch from the sympathetic chain⁽⁶⁶⁾.

The spinal nerve and its relation to the IVD (Fig. 4)

The nerve root complex takes a long, steeply oblique course through a long, mobile, osseoligamentous tunnel, the root canal. The root canal is divided into the following zones: An entrance zone, a pedicle zone and an exit zone⁽⁴⁹⁾.

Lateral disc herniations may compress, kink or constrict the lumbar nerves beyond the foraminal outlet, i.e., the exit zone in the post canal zone⁽⁴⁶⁾.

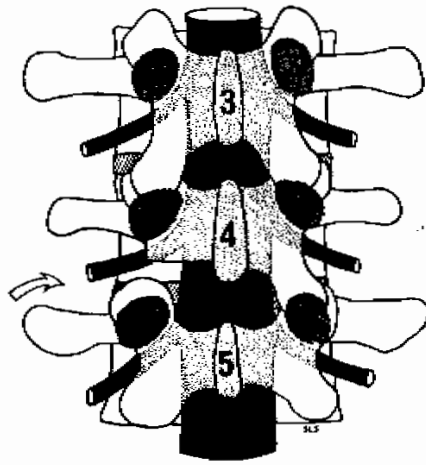


Fig.4: Anatomy of the central and lateral spinal canals

Below L1 vertebra the roots pass almost vertically down wards through the subarachnoid space, forming the cauda equina; the lumbar intervertebral foramina are the apertures through which the lumbar roots leave the spinal canal. They are roughly quadrilateral in shape with the upper and lower borders formed by the pedicles. The posterior wall formed by the articular processes of the posterior intervertebral joint and the anterior wall formed by the posterolateral discs, which means that the spinal root only comes in contact with the posterolateral surface of the intervertebral disc as it leaves the foramen ⁽⁵⁾.

CHAPTER II

BIOMECHANICS OF THE INTERVERTEBRAL DISC

The mechanical forces add a further dimension to understanding degeneration in the lumbosacral region. The fact that we do not see extensive degenerative disc disease in the younger population suggests that most of the biomechanical effects on the spine are the result of accumulated, rather than momentary, trauma. If at autopsy one takes a normal disc and makes a longitudinal incision in the posterior part of the annulus through the nucleus and loads the specimen, no disc herniation occurs⁽¹⁷⁾.

There are six basic deformation modes to which the intervertebral disc is submitted:

1. Compression, exerting a displacement of each endplate perpendicularly towards the midline.
2. Flexion-extension, exerting a tilt of each endplate anteriorly and posteriorly respectively.
3. Lateral bending, exerting a tilt of each end-plate, such that the disc height increases at the one side and decreases at the other side.
4. Axial rotation, exerting a clockwise rotation of each end-plate seen from the disc interior.

5. Anterior-posterior shear, exerting an anterior displacement of the upper end-plate and equal displacement posteriorly of the lower one.
6. Lateral shear, exerting a lateral displacement of the upper end-plate and an equal displacement of the lower one towards the other side⁽⁸⁾.

Within normal physiological limits, bending, shear, or axial rotation alone does not seem to constitute a risk of fibre ruptures. These ruptures could happen when these loads are combined with very high axial loads. On the other hand, at pure compression the likelihood of fibre rupture is not very great because end-plate failure occurs earlier⁽⁴⁷⁾.

A high axial load combined for instance, with a large amount of shear could perhaps lead to fibre rupture before end-plate failure, since such a combination gives higher fibre forces at the same nucleus pressure than the purely axial load⁽⁸⁾.

Whenever actual compression or asymmetric forces, i.e., extension, flexion, lateral flexion, axial rotation-are applied to the disc, the internal pressure of the disc increases and stretches the fibers of the annulus. The relative movement of the disc that results from the applied loads is resisted by the resulting tension in the annulus fibres that restore the system to its initial state⁽¹⁶⁾.