



Universitas Carolina
Univerzita Karlova v Praze



CHARLES UNIVERSITY IN PRAGUE
FACULTY OF PHYSICAL EDUCATION AND SPORT

Lumbar Disc Herniation
Conservative versus Non-conservative Treatment

Master Thesis

Author:

Iakovos Diogenous

Supervisor:

Ass. Prof. PaedDr. Dagmar Pavlů, CSc.



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Abstract

Objectives: The purpose of this Thesis is to create a general review to describe methods, results and conclusion of treatments for lumbar disc herniation. To compare conservative with non conservative treatment by meaning of using systematic reviews literature and clinical trials.

Selection Criteria: We independently assessed each title and abstract using predetermined inclusion criteria based on intervention, population, outcome measures, and study design criteria. Full papers, reports, and meeting abstracts that met inclusion criteria were retrieved and reviewed independently.

Results: A significant improvement in surgery in evaluation in the first six months which follows in a slight decrease the first 2 years comparing with conservative approach. Microdiscectomy effectiveness is comparable with standard discectomy. A stiff and flat back has a good prognosis after lumbar disc surgery. Conservative treatments can improve patient but there were no statistical significant however good results were shown in evaluation and exercise by mckenzie also physical therapy had some good results with exercises, traction with greater result with chiropractic approach. Conservative is needed after surgery for better and longer timing results. By MRI finding there was conclusion that only with natural history and conservative approach a disc herniation can relapse.

Key Words: Spinal disc herniation, surgery, conservative, sciatica, radiculopathy, back-leg pain.

Declaration

Herewith I declare that I worked on this thesis on my own and independently I researched the list of literature and data's, which included in this work. I elaborated using the literatures listed and attached in the reference section and the knowledge I have gain during my study time at Charles University.

IAKOVOS DIOGENOUS

Prague 2011

Dedication

I dedicate this diploma to my parents Andreas and Gianoulla Diogenous who have helped me through my years of studies. I owe them everythin what i have achieved so far.

Acknowledgment

I would like to acknowledge all of my family, my parents and my sisters family for their support. Special thanks to all my friends for the support and their long lasting friendship namely i will like to thank Giannis Polyviou and Apeslidis Theodoros.

I like to thank all my professors during my study time in Faculty of Physical Education. Grateful thanks to my supervisor Ass. Prof. PaedDr. Dagmar Pavlů, CSc, for her guidance during my studies and during my diploma thesis

Also grateful thanks to Doc. MUDr. František Věle, CSc. who explained us a great deal of knowledge during my studies, he connected all the physiotherapy knowledge and described in the most interesting way for a better understanding for us students.

Herewith I primate to lend my diploma thesis, for study purpose, I encourage my Colleagues' to quote and cite from this thesis.

Aims and Goals

Aim

To find evidence to compare conservative and non-conservative treatments for lumbar disc herniations (mainly mentioned, L4/5 – L5/S1).

Goals

- To determine if conservative is more or less beneficial from non-conservative treatment.
- Individualizing conservative treatments and finding their efficient potentials
- To find the amount of relapses of disc herniation after surgery, with comparing untreated herniations after conservative treatments.
- To differentiate stages of herniation with treatment benefit
- Role of body function with disc herniation
- A general evaluation of our findings and making a general conclusion for a lumbar herniated disc treatment if possible.

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Introduction

In the majority of patients (over 80%), there is no specific pathoanatomical diagnosis made. Low back pain is one of the most common reasons for people to seek medical help; its prevalence ranges from 60–90%.⁽⁶⁹⁾ Although the natural history of acute low back pain (lumbago) is favorable in the majority of patients, the successful management of patients with chronic symptoms remains an enigma.⁽⁴⁾

Sciatica and lumbago are not the same; **Lumbago** is a general term referring for low back pain while **Sciatica** is a name given to pain in the area of distribution of the sciatic nerve (L4 to S3) which is commonly felt in the buttock and over the posterolateral aspects of the leg.⁽⁵⁾

The most common cause of sciatica is **lumbar disc herniation** which may result from **acute traumatic injury** or from preceding **degenerative changes** within the lumbar disc.⁽⁵⁶⁾ The lifetime prevalence of a lumbar disc herniation is approximately 2%. The natural history of sciatica secondary to lumbar disc herniation is spontaneous improvement in the majority of cases. Among patients with radiculopathy secondary to lumbar herniation, approximately 10–25% (0.5 of the population) experience persistent symptoms.⁽¹⁷⁾

Although of all the conservative treatments available for lumbar disc herniation it still remains the most common lumbar problem being treated by surgery.⁽⁵⁸⁾ In a computer aided analysis of 2504 operations for disc herniation, Spangfort reported that the average age was 40.8 years (range, 15–74 years). Males were operated more than twice as often as female patients (sex ratio 2:1) and surgery was done most often at the level of L5/S1 (50.5%) and L4/5 (47.5%).⁽²⁶⁾

The complex of function of the spinal column with the importance of human posture, movement and balance of itself by having an influence of lumbar disc herniation is the main reason that a good overview of anatomy, biomechanics will be described the better understanding of the nature of the lumbar spine and intervertebral discs.

Evaluating procedures will be viewed of physical examinations and imaging methods for diagnosing disc herniation. Description of the most common conservative and non-conservative therapies will be described and their efficacy will be the main focused in the systematic review in the special part.

This thesis is a systematic review of literature and trial on the efficacy of the most common conservative treatments and non-conservative treatment of disc herniations in the levels of the lower lumbar spines which provokes sciatica. This study will provide important findings necessary for the patients but also for the future researchers of the efficacy of non-conservative treatments for sciatica.

1. A General overview of the Vertebral Column

1.1. The Spinal Column

The spinal column (or vertebral column) extends from the skull to the pelvis and is made up of 33 individual bones (24 functional bones) termed vertebrae which are subdivided into five groups based on morphology and location: seven cervical, twelve thoracic, five lumbar with a total fusion of five sacral, and four coccygeal vertebrae. ^(28, 12, 44)

The articulations between adjacent vertebral bodies are symphysis joints which connect with fibrocartilaginous discs that act as cushion. Healthy intervertebral discs in an adult account for approximately one-fourth of the height of the spine. When the trunk is erect, the differences in the anterior and posterior thicknesses of the discs produce the lumbar, thoracic, and cervical curves of the spine. ⁽¹⁹⁾

A typical vertebra consists of a vertebral body and a posterior vertebral arch. Extending from the vertebral arch is a number of processes for muscle attachment and articulation with adjacent bone. Associated muscle interconnect the vertebrae and ribs with the pelvic and skull. The back contains the spinal cord and proximal parts of the spinal nerves, which send and receive information to and from the most of the body.

Anteriorly the vertebral bodies are separated by the intervertebral disc and are held together by the anterior and posterior longitudinal ligaments. Posteriorly the articular processes from the zygapophysial joints and consecutive vertebrae are held together by the supraspinous, interspinous and intertransverse ligaments and the ligamenta flava. ^(3, 4)

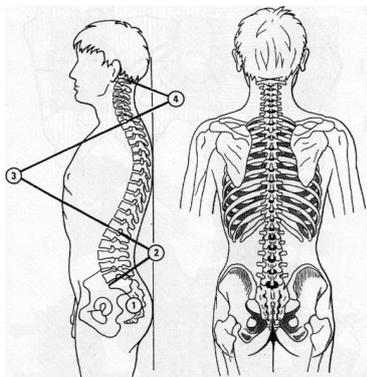


Figure 1: Curvatures of the vertebral column.

1.2. Central and peripheral nervous systems

The brain and spinal cord constitute the central nervous system (CNS); the cranial nerves and spinal nerves form the peripheral nervous systems (PNS). The vertebral column and associated soft tissue of the back contain the spinal cord and proximal parts of the spinal nerves. ⁽⁵⁾

The spinal cord lies within a bony canal formed by adjacent vertebrae and soft tissue elements (the vertebral canal): The anterior wall is formed by the vertebral bodies of the vertebrae, intervertebral disc, and associated elements; the lateral wall and roof are formed by vertebral arches and ligaments.

There 31 pairs of spinal nerves that are segmental in distribution and emerge from the vertebral canal between the pedicles of adjacent vertebrae. There are eight pairs of cervical nerves (C1 to C8), twelve thoracic (T1 to T12), five lumbar (L1 to L5), five sacral (S1 to S5), and one coccygeal (C0). Each nerve is attached to the spinal cord by a posterior root and an anterior root.

Each spinal nerve exits the vertebral canal laterally through an intervertebral foramen. The foramen is formed between adjacent vertebral arches and is closely related to intervertebral joints. ⁽⁵⁾

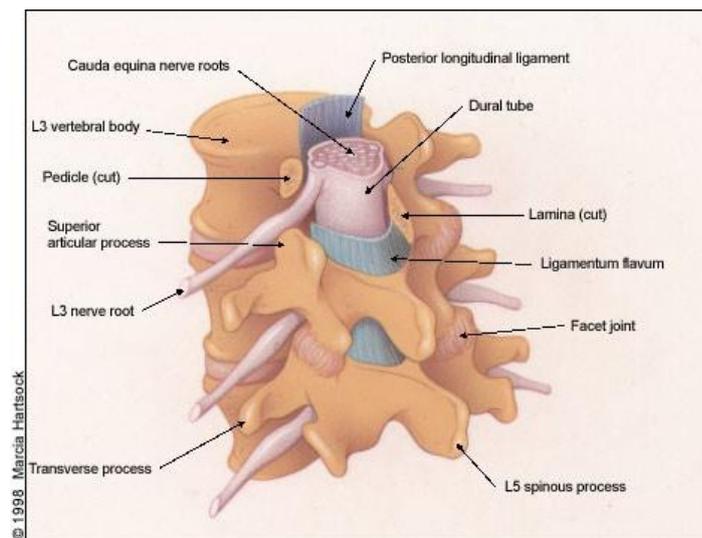


Figure 2: Anatomic structure of lumbar spine (third through fifth lumbar)

In the lumbar regions, the cone-shaped terminus of the spinal cord (conus medullaris) normally ends at about the L1 or L2 level in adults. Caudal to these levels, the roots of the cauda equina are contained within the subarachnoid space of the dura-enclosed. Thus pathologies (stenosis, herniation) under these levels results in **nerve root dysfunction** rather than spinal cord dysfunction. ⁽⁷⁸⁾

1.3. The sciatic nerve

The lumbar intervertebral foramen (neural passageways) is relatively larger but nerve root compression is more common than in the thoracic spine. Nerve roots exit the spinal canal through small passageways between the vertebrae and discs. Pain and other symptoms can develop when the damaged disc pushes into the spinal canal or nerve roots. ⁽⁴⁴⁾

The sciatic nerve is the largest nerve of the body and carries contributions for **L4 to S3**. It forms on the anterior surface of the piriformis muscle and leaves the pelvic cavity through the greater sciatic foramen inferior to piriformis. ⁽¹²⁾

Passes through the gluteal region into the thigh, where it divides into its two major branches, the common fibular nerve (common peroneal nerve) and the tibial nerve - dorsal division of L4, L5, S1, and S2 are carried in common fibular part of the nerve and the ventral divisions of L4, L5, S1, S2, and S3 are carried in the tibial part. Innervates muscles in the posterior compartment of the thigh and muscles in the leg and foot and carries fibers from the skin of the foot and lateral leg. ⁽¹²⁾



Figure 3: Sciatic nerve ⁽¹²⁾

1.4. Biomechanics of the Vertebral Column and the Lumbar Spine

The spine builds the axis of the body. It is not straight as a rod but it is curved. It implies cervical lordosis, thoracic kyphosis, and lumbar lordosis. Slight spinal curvatures represent static spine with overloading intervertebral discs and tendency to disc protrusion. Increased spinal curvatures represent dynamic spine; loading more the hip joint than the spine. ⁽⁷¹⁾

By being curved, the lumbar spine is protected to an appreciable extent from compressive forces and shocks. In a straight lumbar spine, an axial compressive force would be transmitted through the vertebral bodies and intervertebral disc, and the only mechanism to protect the lumbar vertebrae would be the shock-absorbing capacity of the intervertebral discs. ^(3, 4)

The lumbar vertebrae graduate in size from L1 through L5. The pedicles are longer and wider than those in the thoracic spine. The spinous processes are horizontal and more squared in shape. The discs of the lumbar spine are approximately 7–10 mm thick and 40 mm in diameter (anterior-posterior), representing one-third of the height of the spine. ⁽⁵⁾

In an anteroposterior view the lumbar column is straight and symmetrical along the interspinous line. ⁽¹²⁾ The lumbar spine ‘stands’ on the sacrum, which first vertebra is tilted 30° down to the horizontal line. The anterior rim of the upper vertebral plate of the lumbar 5th vertebra forms the promontory (here is concentrated the weight of the trunk – COP). ⁽⁷¹⁾

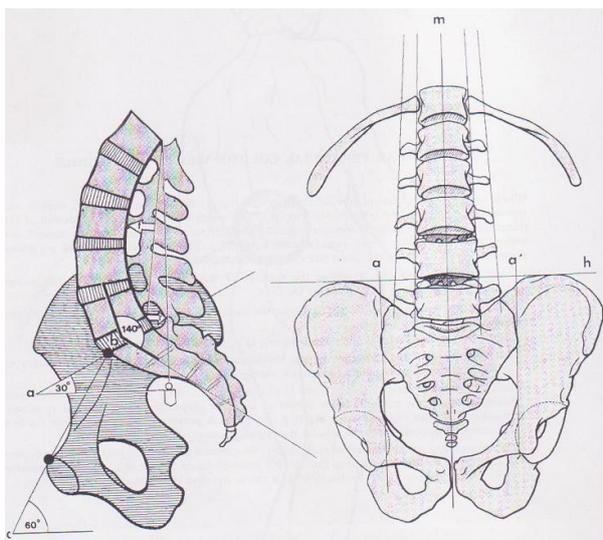


Figure 4: The Lumbar Vertebral Column ⁽²⁸⁾

1.5. Functional components of the vertebral column

The spine has one anterior massive support pillar and two posterior thinner pillars. Anterior pillar comprises bodies of vertebrae and posterior pillar include intervertebral joints. ⁽⁷¹⁾ The **anterior pillar** plays a **static role** while the **posterior pillar** has a **dynamic role**. They work like a double arm lever (with articular process as a fulcrum). ⁽²⁸⁾ A passive segment (I) is formed by vertebral itself and active segment (II) consists of the intervertebral disc, the intervertebral foramen, the articular process, the ligamentum flavum and the interspinous ligament. ⁽⁷¹⁾

The articular processes (1) constitute the fulcrum. This level system allows the absorption of axial compression forces applied to the vertebral column: direct and passive absorption at the level of the intervertebral disc (2); indirect and active absorption at the level of the paravertebral muscle (3), as a result of the lever system constituted by each vertebra arch. Therefore the absorption of compression forces is simultaneously passive and active.

Under an axial compression force of 600kg the anterior part of the vertebral body is crushed, leading to a compression fracture. A force to 800kg is required to fracture the whole vertebra and make the posterior part give. ⁽²⁸⁾

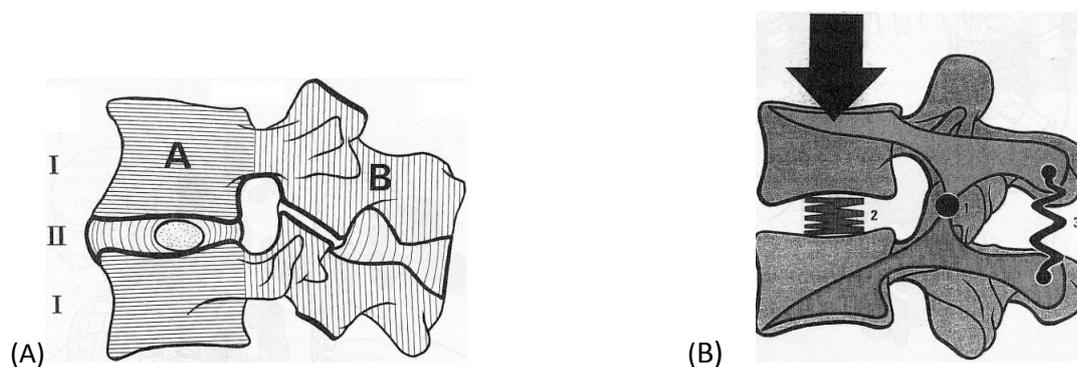


Figure 5: (A) Functional components (B) Functional link ⁽²⁸⁾

1.6. Movements of the Lumbar Vertebrae

During flexion and extension, the vertebral bodies roll over the nucleus while the facet joints guide the movements. ⁽¹⁹⁾ The greatest motion in the lumbar spine occurs between L4/L5 and L5/S1. There is considerable individual variability in the range of motion of the lumbar spine. In reality, little obvious movement occurs in the lumbar spine as a result of the shape of the facet joints, tightness of the ligaments, intervertebral discs and size of the vertebral.

For flexion (forward bending) the maximum of the range of motion is 40° to 60°. Extension (backward bending) is normally limited to 20° to 35° in the lumbar spine. Lateral (side) flexion is approximately 15° to 20° in the lumbar spine. Rotation of lumbar spine is normally 3° to 18° to the left and right and is accomplished by a shearing movement of the lumbar vertebrae on each other. ⁽⁴⁴⁾

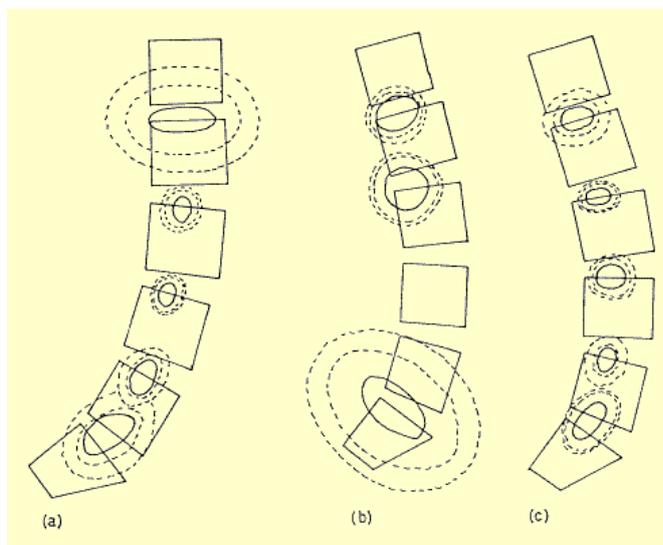


Figure 6: The **centres of rotation of the movements** (a) flexion from upright, (b) extension from upright and (c) flexion from extension. The inner ellipses (with solid lines) depict two standard deviations from the mean centre of rotation of 10 subjects. The intermediate and outer ellipses (with dotted lines) indicate the 95% confidence limits for the within- and between observer errors respectively. (After Pearcy and Bogduk, 1988)

1.7. Muscles of the spine

The spine is an elastic column, with enhanced stability due to the complex curvature of the spine (kyphosis and lordosis), the support of the longitudinal ligaments, the elasticity of the ligamentum flavum, and most importantly the active muscle forces. In cadaver spines have been shown to buckle with the application of very low vertical loads (20–40 N), however the **extrinsic support stabilizes** and redistributes loading on the spine are the trunk muscles making the spine to withstand loads several times the body weight.

The spatial distribution of muscles generally determines their function. The trunk musculature can be divided functionally into extensors and flexors. The main flexors are the **abdominal muscles** (rectus abdominis, internal and external oblique and transverse abdominal muscle) and the psoas muscles.

The main extensors are the **sacrospinalis group, transversospinal group, and short back muscle group**. Symmetric contraction of extensor muscles produces extension of the spine, while asymmetric contraction induces lateral bending or twisting. The most superficial layer of trunk muscles on the posterior and lateral walls are broad, connecting to the shoulder blades, head and upper extremities (rhomboids, latissimus dorsi, pectoralis, and trapezius).

Some lower trunk muscles connect to a strong superficial fascial sheet, the lumbodorsal fascia, which is a tensile-bearing structure attached to the upper borders of the pelvis e.g. transversus abdominis. The iliopsoas muscle originates on the anterior aspect of the lumbar spine and passes over the hip joint to the inside of the femur. Vertebral muscle is composed of 50–60% type I muscle fibers, also called “slow twitch”, fatigue-resistant muscle fibers found in most postural muscles. ⁽⁵⁾

Along with the rotators (**transversospinalis group**), the **multifidus** is primarily a postural muscle and stabilizes the lumbar spinal joints. A bilateral contraction extends the vertebral column from the prone or the forward bent position and, conversely, performs in controlled forward bending (eccentric contraction). In the lumbar spine during rotation, the contralateral group is more active. A bilateral contraction may produce a posterior force on the pelvis through its attachments with the erector spinae, the posterior superior iliac spine (PSIS), and the posterior sacroiliac ligaments. A unilateral contraction may produce a posterior rotation of the vertebrae on that side.

The importance of the **abdominals** in relation to the lumbar spine and the pelvis is in lifting. By exerting pressure internally (**Valsalva**), the abdominals significantly reduce axial compressive forces. The abdominals resist the shear forces produced by the multifidus and the psoas on the lumbar facets. A bilateral contraction, especially of the rectus abdominis, produces a posterior rotation of the pelvis when the vertebral column and the sternum are fixed. Lack of abdominal tone will result in increased lumbar lordosis and an increased sacral flexion position. ⁽⁵⁸⁾

1.8. The Spinal Stabilization System

Understanding the **postural program** provides a key in correction of recurrent back pain. A special program stored in the central nervous system (CNS) controls postural muscles. Its function is to control and stabilize posture, protect spinal joints, and prevent the effects of micro-trauma. The postural program adapts to its environment e.g. prolonged sitting, altered movement patterns. It is needed for repair to prevent repeated micro-trauma damage on joint structures. ⁽⁷⁸⁾

The Spinal Stabilizing System can be thought to be consisted of three subsystems: **spinal column; muscles surrounding the spine; and the motor control unit.**

The spinal column carries the loads and provides information about the position, motion, and loads of the spinal column. This information is transformed into action by the control unit by evaluating and determining the requirements for stability and coordinating the muscle response. The action is provided by the muscles, which must take into consideration the spinal column, but also the dynamic changes in spinal posture and loads. ⁽⁴⁷⁾

Panjabi (1992) redefined spinal instability in terms of a region of laxity around the neutral position of spinal segment called the “**neutral zone**”. The neutral zone is shown to be increased with intersegmental injury and intervertebral disc degeneration (Panjabi et al. 1989; Mimura et al. 1994; Kaigle et al. 1995) and decreased with simulated muscle forces across a motion segment (Panjabi et al. 1989; Kaigle et al. 1995; Wike et al. 1995). The neutral zone is considered an important measure of spinal stability which is influenced with what Panjabi (1992) describe as the passive, active and neural control systems:

- The **passive system** constitutes the vertebrae, intervertebral disc, zygapophyseal joints and ligaments;
- The **active system** constitutes the muscles and tendons surrounding and acting on the spinal column;
- The **neural system** constitutes the nerves and central nervous system which direct and control the active system in providing dynamic stability.

Cholewicki and McGill developed a comprehensive mathematical model to estimate the mechanical stability of the human lumbar spine in vivo, taking in account the **external load** on the body and the EMG signals of various muscles. Young healthy were tested, while performing trunk flexion, extension, lateral bending and twisting. In a heavy external load the recruitment of many muscles with the stability being greater and in a lighter external load the opposite was true. Therefore if the system is challenged by a sudden increase in the external load, e.g. a miss step or an awkward spinal movement, then the spine may be at **more risk for injury while lightly loaded.** ⁽⁴⁷⁾

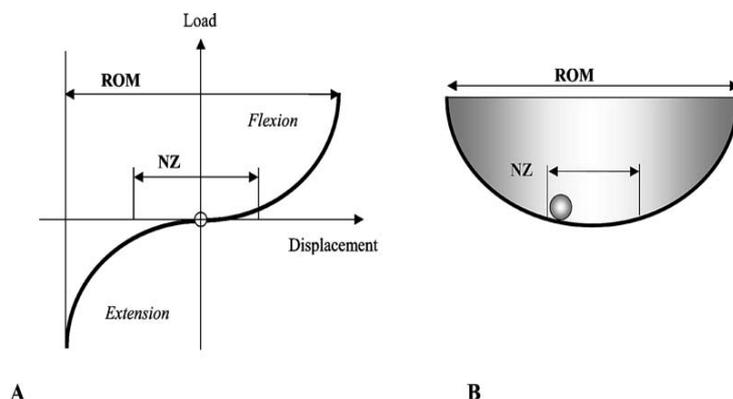


Figure 7: Load–displacement curve. (A) Spine segment subjected to flexion and extension loads exhibits a nonlinear load displacement curve, indicating a changing relationship between the applied load and the displacements produced. Addition of NZ parameters, representing laxity of the spine segment around neutral position, to the ROM parameter better describes the nonlinearity of the spinal characteristics. (B) A ball in a bowl is a graphic analogue of the load–displacement curve. ⁽⁴⁷⁾

Bergmark (1989) hypothesized the presence of two muscle systems that act for maintenance of spinal stability. The **Global muscle system** consists of large torque producing muscle that act on the trunk and spine without directly attaching to it. These muscles include rectus abdominus, obliquus abdominus externus and the thoracic part of lumbar iliocostalis and provide general trunk stabilization, but are not capable of having a direct segmental influence on the spine.

The **Local muscle system** consists of muscles that directly attach to the lumbar vertebrae, and are responsible for providing segmental stability and directly controlling the lumbar segments. These muscles are lumbar multifidus, psoas major, quadratus lumborum, the lumbar parts of the lumbar iliocostalis and longissimus, transverses abdominus, the diaphragm and the posterior fibres of obliquus abdominus internus all form part of this local muscle system.

While the global muscle system provides the bulk of stiffness to the spinal column, the activity of the **local muscle system** is necessary to maintain the **segmental stability** of the spine. ⁽⁴⁵⁾

The **transverse abdominis, multifidus, pelvic floor, and diaphragm muscles** all contract with a low-level, continuous tonic contraction that precedes the contraction of the prime mover during arm or leg movements that may jeopardize stability of the trunk (Richardson et al. 1999). ⁽²²⁾

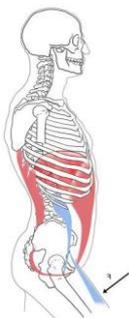


Figure 8: “Feed-forward stabilization mechanism”, prior to any phasic or dynamic movement (e.g. hip flexion) the stabilizers must be activated, i.e. the integrated function of the spinal stabilizing muscles – indicated in RED (diaphragm, pelvic floor, all parts of the abdominal all and spinal extensors) precedes the activation of the hip flexors (indicated in BLUE) for dynamic hip flexion. ⁽³⁰⁾

Activation of these muscles during any movement is automatic – subconscious, the muscle coordination is not fully under our control; therefore often compromised. ⁽²⁰⁾

Anatomical arrangement of muscle control around the spine, coupled with critically important patterns of activation, enables the spine to bear a much higher compressive load as it stiffens and becomes more resistant to buckling but because of the stiffening of the muscle activity the spine bears even more load. ⁽⁷⁸⁾

Postural muscles have different functions in stabilizing posture. Short inter-segmental muscles, close to the joint, stabilize individual segments providing flexible stability. Having the long superficial muscle to stabilize larger sections of the spine and give a rigid stability. **Abdominal breathing** provides flexible stability and has been shown by experiment after external impact that **flexible stabilization system** is more dominant than the rigid stability.

The diaphragm, inter-costal muscles, transversus abdominis (TrA), muscles of pelvic floor and the deep intrinsic muscle of the spine are all muscles with either a horizontal or an oblique orientation that segmentally can be activated. They participate as **core stabilizers** in **respiratory mechanics** as well as in **postural function**. ⁽⁷⁸⁾

Inspiration tends to extension and to thoracic inflation; expiration tends to flexion and to thoracic deflation. Breathing is connected with periodic changes of **intra-abdominal** and **intra-thoracic pressure**. These changes influence continuously the stabilization of the upright posture. ⁽⁷¹⁾

Internal positive pressure creates functional strength and contributes to stability. Positive pressure is regulated by intrabdominal pressure (IAP) which is generated and maintained by trunk and abdominal muscles. ⁽³⁰⁾

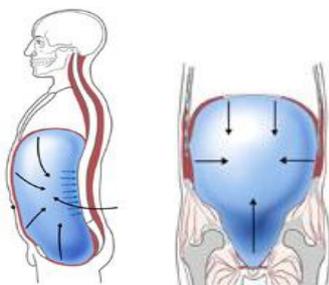


Figure 9: Diaphragm flattens during inspiration, provides anterior stabilization

When the diaphragm flattens during inspiration it acts against the resistance of the abdominal wall. Synergistic action of the diaphragm, with the abdominal, and the pelvic floor controls the intr-abdominal pressure (IAP) to provide anterior stabilization of the Lumbosacral spine.

(30)

To lift 10 kg bag with flexed knees and trunk held vertically, dorsal muscles exert the force of 141 kg (1400N). The same lifting with extended knees from the flexed position of the trunk requires a force of 250 kg (2500N). If the bag is carried with extended arms the lifting force rises to 363kg. By using the “**Valsalva maneuver**” (closing glottis at the end of inspiration and holding this position) the exerted load of axial force is substantially reduced. ⁽⁷¹⁾

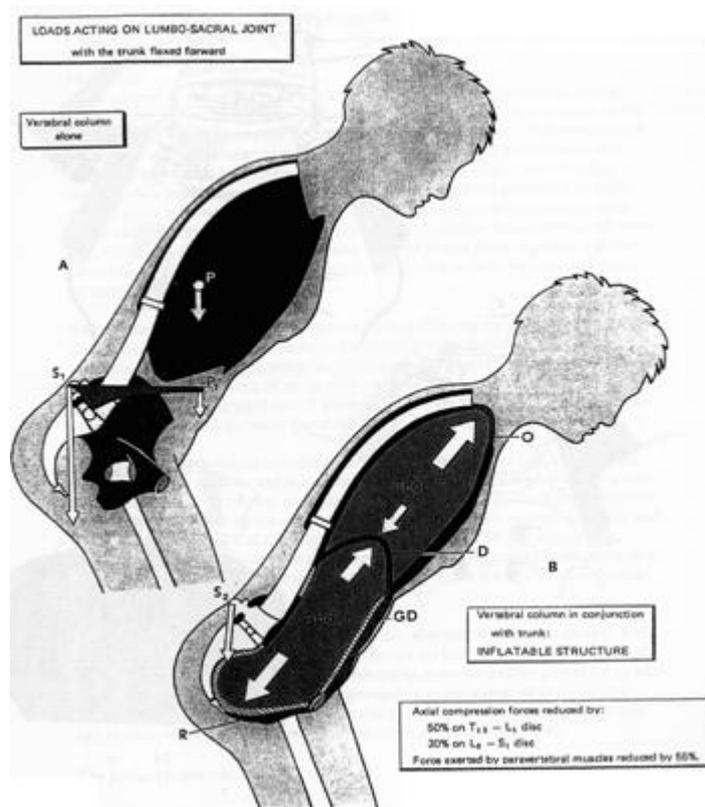


Figure 10: Inflatable structure ⁽²⁸⁾

It has been shown that in axial pressure was reduced at the level **Th12 – L1 by 50%** and at the level **L5 –S1 by 30%** and force is also reducing in the dorsal muscles by 50%. This mechanism is very useful in protecting the vertebral column and preventing the disc protrusion. ⁽⁷¹⁾

1.9. A General overview of the Intervertebral Disc

1.9.1. Structure of the intervertebral disc

The symphysis between adjacent vertebral bodies is formed by a layer of **hyaline cartilage** on each vertebral body and an **intervertebral disc**, which lays between the layers. The intervertebral discs consist of **an outer annulus fibrosus**, which surrounds a **central nucleus pulposus**.⁽²⁸⁾ The anterior aspect of the disc is slightly convex, whilst the posterior aspect is flat or slightly concave.⁽²⁰⁾

Nucleus Pulposus is a transparent jelly containing 88 per cent water; it is strongly hydrophilic and chemically is made up of a mucopolysaccharide matrix containing protein-bound chondroitin sulphate, hyaluronic acid and keratin sulphate. Histologically the nucleus is comprised of collagenous fibres, cells resembling chondrocytes, connective tissue cells and very few clusters of mature cartilage cells. No blood vessels or nerves penetrate the nucleus which is tightly bounded peripherally by fibrous tracts.⁽²⁸⁾ The extremely high fluid content of the nucleus makes it resistant to compression.⁽¹⁹⁾

The annulus consists of about 90 concentric bands of collagenous tissue that are bonded together. The collagen fibers of the annulus crisscross vertically at about 30 degree angles to each other (a), making the structure more sensitive to rotational strain than to compression, tension, and shear.⁽¹⁹⁾ The fibres are seen to be **vertical peripherally** and become more **oblique towards the center** (b)⁽¹²⁾ with this arrangement of fibers it limits rotation between vertebrae.⁽¹²⁾

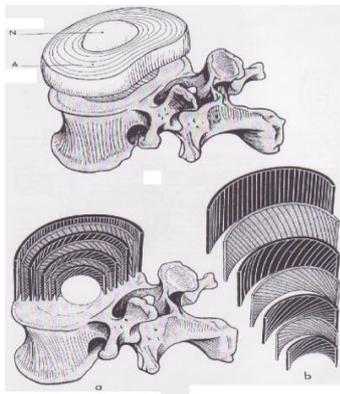


Figure 11: Intervertebral disc structure⁽²⁸⁾

The posterior part of the annulus is the weakest part: the anterior and lateral portions are approximately twice as thick as the posterior portion, where the layers appear to be narrower and less numerous, the fibers in adjacent layers are oriented more nearly parallel to each other, and there is less binding substance. ⁽¹⁵⁾

1.9.2. Biomechanics of the intervertebral disc

Mechanically, the **annulus** acts as a **coiled spring** whose tension holds the vertebral bodies together against the resistance of the nucleus pulposus, and the **nucleus pulposus** acts like a **ball bearing** composed of an incompressible gel.

The intervertebral discs have a blood supply up to about the age of 8 years, but after that the disc must rely on a mechanically based means for maintaining a healthy nutritional status. Intermittent changes in posture and body position after internal disc pressure, causing a pumping action in the disc.

The inflow and outflow of water transport nutrients in and flushes metabolic waste products out, basically fulfilling the same function that the circulatory system provides for vascularized structures within the body. Maintaining even an extremely comfortable fixed body position over a period of time curtails this pumping action and can negatively affect disc health. ⁽¹⁹⁾

Compression is assumed greater when the disc is closer to the sacrum, which supports the bulk of the body weight. For a man weighing 80kg the head weighs 3kg, the upper limbs 14kg and the trunk 30kg. If it is assumed that at the level of the disc L5-S1 the column supports only two-thirds of the trunk, the weight borne is 37kg, which is nearly the half the body weight. To this must be added the force exerted by the tone of the paravertebral muscle necessary to maintain the trunk in the erect position at rest.

Disc height loss occurs during the first 30 minutes after getting up in the morning. During the day a body's height may decrease 2 cm. When pressure on the discs is relieved, the discs quickly reabsorb water and disc volumes and heights are increased. ⁽³⁵⁾ This difference decreases with increasing age. ⁽⁷¹⁾

When a disc is loaded in compression, it tends to simultaneously lose water and absorb until its internal electrolyte concentration is sufficient to prevent further water loss. ⁽¹⁹⁾ When this chemical equilibrium is achieved, internal disc pressure is equal to the external pressure. Continued loading over a period of several hours results in a further slight decrease in disc hydration. ⁽²⁸⁾

The loss of thickness of the disc depends on whether the disc is healthy or diseased. If a healthy (A) disc is applied with a weight of 100 kg it is flattened by a distance of 1.4 mm and becomes wider (B). If diseased and similar loaded the disc will be flattened by 2 mm this (C).

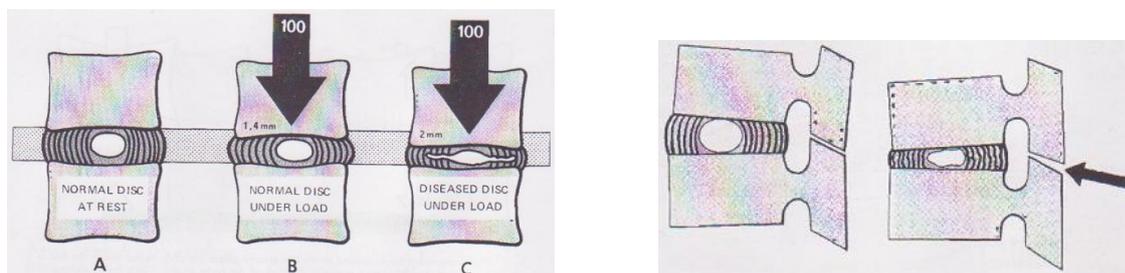


Figure 12: a) disc under load

b) Progressive flattening ⁽²⁸⁾

1.9.3. Compression applied to the discs

In the position of rest (A), it has been shown that the fibres of the annulus are already under tension as a result of the preload of the nucleus. When the column is elongated the bodies tend to move apart increasing the disc height. This increase in disc height reduces the **internal pressure**; hence the rationale underlying the treatment of disc prolapses by spinal traction.

When the column is elongated (B) the vertebral bodies tend to move apart and the gelatinous substance of the disc moves back into its casing. However, this result is not always achieved because under certain condition the inner fibres of the annulus may in fact raise the internal pressure of the nucleus. ⁽²⁸⁾

During axial compression (C) the disc is flattened and widened, the nucleus becomes flatter; raising appreciably its **internal pressure**, which is transmitted to the innermost of the

annulus. Thus the vertical force, is transformed into lateral forces tightening up the annular fibres. ⁽²⁸⁾

In axial compression forces, it has been worked out that when a vertebral plateau presses on the intervertebral disc the nucleus bears 75 per cent of the force and the annulus 25 per cent, so that for a force equal to 20 kg; a 15 kg force is exerted on the nucleus and a 5kg force on the annulus. However in the horizontal plane, the nucleus acts to transmit some of the force to the annulus. ⁽²⁸⁾ Axial pressure on the vertebral body increases during bending forward to 58 kg/cm² and in straightening back loads the plate with 107 kg/cm². ⁽⁷¹⁾

Therefore the **annulus** and the **nucleus** constitute a **functional couple** whose effectiveness depends on the integrity of each component. If the internal pressure of the nucleus decreases or if the tightness of the annulus is impaired, this functional couple immediately loses its effectiveness. ⁽²⁸⁾

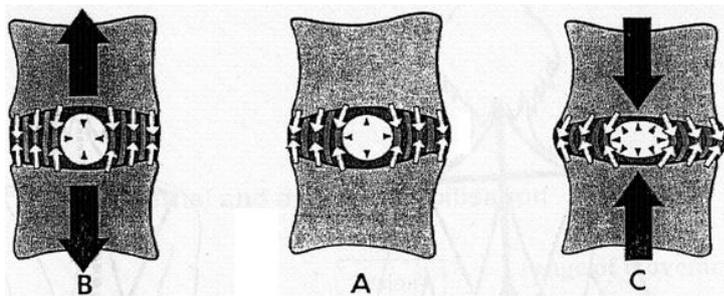


Figure 13: Disc behaviour in (A) Rest position; (B) spinal elongation and (C) axial compression ⁽²⁸⁾

1.9.4. Disc behavior during simple movements

The nucleus pulposus is roughly spherical and can be considered as a ball placed between two planes. It has **six degrees** of freedom: flexion and extension, lateral flexion, gliding in the sagittal plane, gliding in the frontal plane, rotation right and left. Each of these movements has a small range and sizeable movements are only obtained by the simultaneous participation of multiple intervertebral joints.

During extension the upper vertebra moves posteriorly reducing the interspace posteriorly and driving the nucleus anteriorly. The nucleus presses on the anterior fibres of the annulus increasing their tension and this tends to restore the upper vertebra to its original position.

During flexion the upper vertebra moves anteriorly reducing the interspace anteriorly and driving the nucleus posteriorly. The nucleus now presses on the posterior fibres of the annulus increasing their tension. Once more one sees the process of self stabilization due to the concerted action of the nucleus-annulus couple.

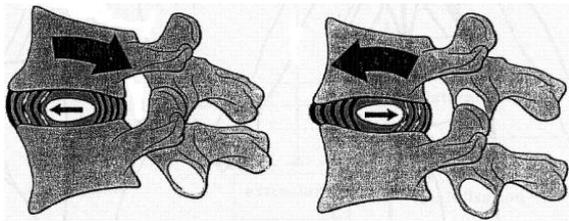


Figure 14: Disc behaviour during extension and flexion ⁽²⁸⁾

In lateral flexion the upper vertebra tilts to the side of flexion and the nucleus is drive to the opposite side. When asymmetrical load is applied axially to a disc the upper vertebra plateau tilts toward the overloaded side making an angle with the horizontal. Thus the fibre on opposite will be stretched but, at the same time the internal pressure of the nucleus maximal goes in the opposite direction and will bring back the fibre to its normal position and restoring the vertebral plateau to its original position.

During axial rotation, the oblique fibres, running counter to the direction of movement, are stretched while the intermediate fibres with opposite orientation are relaxed. The tension reaches a maximum in the central fibres of the annulus which ar the most oblique. The nucleus is therefore strongly compressed and the internal pressure rises in proportion to the angle of rotation.

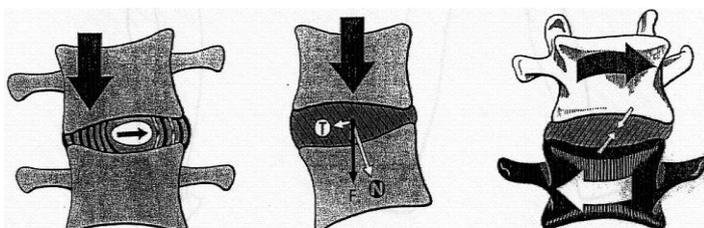


Figure 15: Disc behaviour: during lateral flexion; during static force applied slightly obliquely; during axial rotation. ⁽²⁸⁾

2. A General Overview of Lumbar Disc Herniation

2.1 Lumbar Disc Herniation

The lumbar intervertebral discs are much more susceptible to symptomatic herniation than either the cervical or the thoracic discs. Lumbar disc herniation usually presents with radicular sciatica which most are **dorsolateral** and therefore compress the nerve root that exits **one level lower**. However a lateral herniation can compress the spinal nerve of the same level. ⁽¹⁸⁾

Ruptured Discs in the Low Back may provoke shooting; stabbing pain that shoots from the back or buttocks into the leg, this is called **sciatica** or radiculopathy. It can be associated with numbness or weakness in the leg and foot. The most frequent cause of this condition is a ruptured disc in the lower back. A herniation may develop suddenly or gradually over weeks or months. The **four stages** to a **herniated disc** include: ⁽⁶¹⁾

1) Disc Degeneration: from chemical changes associated with aging causes discs to weaken, without a herniation.

2) Prolapse: the form or position of the disc changes with some slight impingement into the spinal canal. Also called a bulge or protrusion

3) Extrusion: the gel-like nucleus pulposus breaks through the tire-like wall (annulus fibrosus) but remains within the disc.

4) Sequestration or Sequestered Disc: the nucleus pulposus breaks through the annulus fibrosus and lies outside the disc in the spinal canal (HNP). ⁽¹⁵⁾

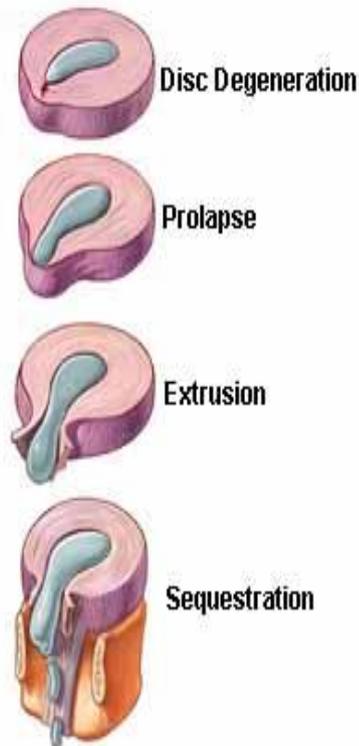


Figure 16: Disc herniation stages

Degenerative changes cause the posterior annular fibers of the lumbar disc to become incompetent and subsequently allow nuclear material from within the disc to extend into the area of the spinal canal, causing nerve compression. Lumbar disc herniations may occur in relation to traumatic injury, but they do not necessarily require traumatic injury to occur. Lumbar disc herniations may occur with various degrees of severity. ⁽⁵⁸⁾

The disc protrusion happens in the lumbar spine in two ways. The protruded fluid disc-matter (pulpous nucleus) becomes fixed to the wall of the spinal canal and may heal here and pains may slowly disappear. Or the disc matter may freely move in the spinal canal as a foreign body irritating steadily the meninges and nerve roots, which is very painful. In such a case the protruded disc matter must be evacuated surgically. This depends on the development of the symptoms, as well as on the structural situation in the spinal canal revealed by nuclear resonance examination. ⁽⁷¹⁾

Small herniations are often referred to as "bulges of the disc." These frequently do not cause nerve compression, but they may be a source of back pain. Larger disc herniations frequently cause compression of spinal nerves or the cauda equina in the lumbar spinal canal and may be the source of significant leg pain.

The term extruded fragment refers to lumbar disc nuclear material which herniates beyond the limits of the annulus fibrosis and frequently beyond the limits of the posterior longitudinal ligament to cause direct compression of nerve elements at a distance from the area of the disc itself. ⁽⁵⁸⁾

Loss of mechanical competence and flattening of the disc may generate diffuse bulging, which should be differentiated for focal bulges or true herniations, characterized macroscopically by nuclear migration through radial fissure of the disc. Disc herniation requires pre-existing age-related degenerative changes. Ageing and degeneration are also associated with dramatic changes in vascularization and innervations of the disc.

A normal healthy adult disc is avascular, apart from vascularization at the outer part of the annulus. Presence of blood vessels has been demonstrated in degenerated disc and the herniated disc tissue. Penetration of blood vessel through the rim lesion is promoted by angiogenesis factors. Inflammatory cells as well as macrophages also invade the degenerated disc. ⁽¹⁾

2.2 Factors and genetic risks for disc herniation

2.2.1. Factors for disc herniation

Many factors increase the risk for disc herniation:

- 1) **Lifestyle** choices such as tobacco use, lack of regular exercise, and inadequate nutrition substantially contribute to poor disc health.
- 2) As the **body ages**, natural biochemical changes cause discs to gradually dry out affecting disc strength and resiliency.
- 3) **Poor posture** combined with the habitual use of incorrect body mechanics stresses the lumbar spine and affects its normal ability to carry the bulk of the body's weight. ⁽²⁰⁾

2.2.2. Genetic influences for disc degeneration

Several recent studies have reported a strong familial predisposition for disc degeneration and herniation. Heritability for disc herniation exceeded 60%. Genetic predisposition has been confirmed by recent findings of associations between disc degeneration and polymorphisms in various classes of genes: ⁽⁵⁾

Genes Encoding for Matrix Components

- aggrecan
- collagen type IX
- collagen type I
- cartilage intermediate layer protein (CILP)

Genes Encoding for Cytokines

- interleukin-1 (IL-1)
- interleukin-6 (IL-6)

Genes Encoding for Proteinases

- matrix metalloproteinase-3 (MMP-3)

Genes Encoding for Miscellaneous Proteins

- vitamin D receptor

2.3 The process of disc degeneration and disc herniation

Disc degeneration has a profound effect on the mechanism of load transfer through the disc. With degeneration, dehydration of the disc leads to a lower elasticity and viscoelasticity. Loads are less evenly distributed, and the capacity of the disc to store and dissipate energy decreases.

Using the technique of “stress profilometry”, it has been shown that age-related changes to the disc composition result in a shift of load from the nucleus to the annulus. Therefore, structural changes in the annulus and endplate with degeneration may lead to a **transfer of load from the nucleus to the posterior annulus**, which may cause pain and also lead to annular rupture. ⁽⁵⁾

Annulus fibres begin to degenerate after 25 years of age allowing tearing of fibres within each of its layers. ⁽²⁰⁾ Aging causes a loss of disc height and compression of the vertebral body. The bone attempts to cushion itself by forming a lip or extra rim around the periphery of the endplate. This lipping can extend far enough to obstruct the opening to the vertebral canal.

At the same time, the ligamentum flavum begins to hypertrophy or thicken and osteophytes (bone spurs) may develop. Degenerative disease can cause the apophyseal (facet) joints to flatten out or become misshapen. Any or all of these variables can contribute to **spinal stenosis**. ⁽⁴⁾ Stenosis of the spinal canal is strictly related to disc herniation not only from the pathologic point of view, since the condition coexists, but also for the historical evolution of the knowledge of the disease. ⁽¹⁶⁾

The emerging nerve root exits through a shallow lateral recess and also may be compressed easily. Any combination of degenerative changes, such as disc protrusion, osteophyte formation, and ligamentous thickening, reduces the space needed for the spinal cord and its nerve roots. ⁽¹⁷⁾

Injury and aging irreversibly reduce the water-absorption capacity of the discs, with a concomitant decrease in shock-absorbing capability. The fluid content of the disc begins to diminish around the second decade of life. A typical geriatric disc has a fluid content that is reduced by approximately 35%.

As this normal degenerative change occurs, abnormal movements occur between adjacent vertebral bodies, and more of the compressive, tensile, and shear loads on the spine must be assumed by other structures – particularly the facets and joint capsules. Results include reduced height of the spinal structures that are forced to assume the discs loads. **Postural alterations** may also occur. The normal lordotic curve of the lumbar region may be reduced as an individual attempts to relieve compression on the facet joints by maintaining a posture of spinal flexion. Factors such as habitual smoking and exposure to vibration can negatively affect disc nutrition whereas regular exercise can improve it. ⁽¹⁹⁾

In a hypothesis by Kirkaldy-Willis describing degeneration; in the first stage of may result in some spinal dysfunction but no instability. In the third stage the spine is restabilized probably because of ligament calcification and osteophytes. However in the **second stage**, which occurs between the ages of 40 and 50 years, the disc degeneration has progressed to the point where the nucleus is still mobile. This the **instability phase** and at this stage is increased risk of disc prolapse at the L4-L5 or L5-S1 levels because of traumatic overload of the spine.

It is not unreasonable to speculate that the high incidence of clinically evident disc disease at L4-L5 and L5-S1 may be related to mechanics. These two areas bear the highest loads and tend to undergo the most motion in the sagittal plane. ⁽³⁰⁾

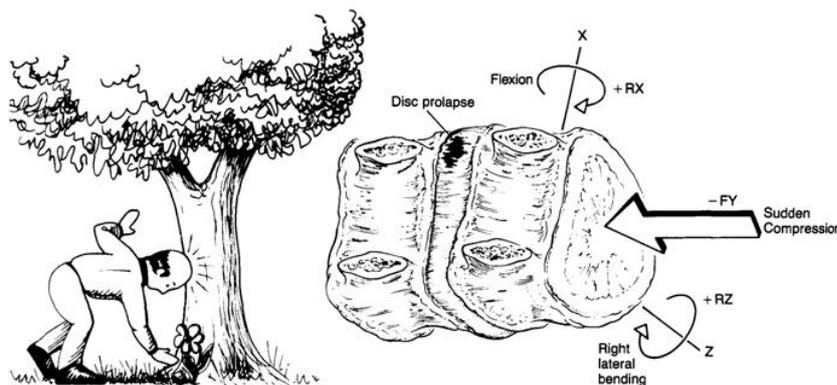


Figure 17: A mechanism of sudden disc prolapse

In a lumbar spine specimens experiment it was observed a certain pattern disc prolapse. The specimen prolapsed disc came most likely in (L4-L5 or L5-S1), age 40-50 years old and degeneration with the grade 2. The method consisted by placing the specimen in full flexion and lateral bent posture with adding a sudden compression load. The prolapsed was produced on the opposite side of lateral bending and was produced in 43% of experimental trials. Since

the majority of the low back patients with disc prolapse seen clinically do not report a traumatic event but one may conclude that the **gradual disc prolapse** maybe the result of a combination of factors, such as weaken posterior disc annulus, relatively degenerated annulus with fissures, and another kind of loading(e.g., bending and twisting).⁽³⁰⁾

This initial acute lumbago can regress spontaneously with or without treatment but, as a result of repeated trauma, the hernia grows in size and protrudes more and more into the vertebral canal. At this point it comes into contact with a nerve root, often one of the nerve roots of the sciatic nerve.

In fact the hernia usually protrudes posterolaterally where the **posterior longitudinal ligament** is at its **weakest** and progressively pushes the nerve root away until the latter is jammed against the posterior wall of the intervertebral foremen formed by the joint between the articular process, its anterior capsular ligament and the lateral border of the ligamentum flavum. The compressed now nerve root will give rise to pain felt in the spinal segment corresponding to the root and finally to impaired reflexes (loss of the Achilles tendon reflex) and to motor disturbances, as in sciatica with paralysis.⁽²⁸⁾

2.4. Disc prolapse and the mechanism of nerve root compression

The covering plates of lumbar vertebrae are very flat and axial pressure combined with shearing forces are the very cause of lumbar disc protrusions. This occurs particularly, if a heavy burden is heaved from the bottom thru erection of the bent trunk with extended knees in combination with synchronous quick twist movement. This torsion produces shearing force added to existing axial pressure. These both forces together damage the disc.

Forward bending of the trunk pushes the disc toward the spinal canal and if combined with additional torsion, the disc bursts and the rests of the pulpous nucleus protrude into the spinal canal and irritate the meninges and the roots of spinal nerves (usually L4-L5 or L5-S1). This disc protrusion endangers not the spinal cord, but affects only meninges (pia mater, dura

mater arachnoidea) and the roots of spinal nerves which provoke sciatica exactly the radicular lumbar symptoms with positive Lasegue sign and lower back pains. ⁽⁷¹⁾

It is now generally believed that disc prolapse occurs in **three phases in lifting a weight**. It usually occurs if the **disc deteriorated** as a result of repeated microtraumas and if the annulus fibres have started to degenerate. Disc prolapse usually follows lifting of a weight with the trunk flexed forward.

During the **first phase trunk flexion (A)** flattens the discs anteriorly and opens out the intervertebral space posteriorly. During the **second phase (B)**, as soon as the **weight is lifted**, the increased axial compression force crushes the whole disc and violently drives the nuclear substance posteriorly until it reaches the deep surface of the posterior longitudinal ligament.

During the **third phase (C)** with the trunk nearly straight, the path taken by the herniating mass is closed by the pressure of the vertebral plateaus and the hernia remains trapped under the posterior longitudinal ligament. This cause the acute pain felt in the loin or lumbago which corresponds to the initial phase of the lumbago-sciatica complex. ⁽²⁸⁾

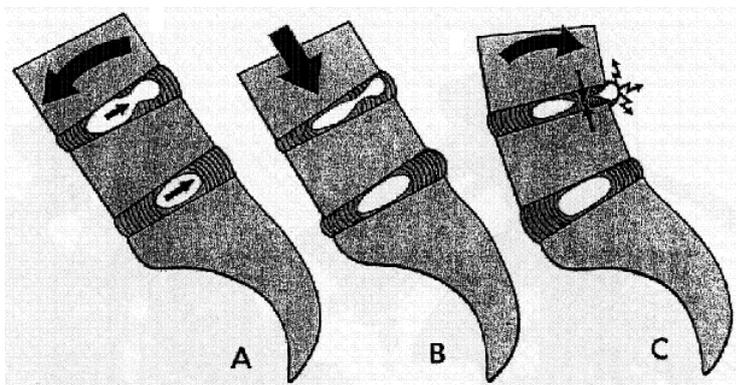


Figure 18: Mechanism of disc prolapse ⁽²⁸⁾

2.5. Disc herniation provoking radicular syndrome

Neurogenic pain is not easily differentiated; radicular pain results from irritation of axons of a spinal nerve or neurons in the dorsal root ganglion whereas referred pain results from activation of nociceptive free nerve endings (nociceptors) in somatic or visceral tissue.

Neurologic signs are produced by conduction block in motor or sensory nerves, but conduction block does not cause pain. Thus, even in a client with back pain and neurologic signs, whatever causes the **neurologic signs is not causing the back pain by the same mechanism**. Therefore, finding the cause of neurologic signs does not always identify the cause of the back pain. The therapist must look further. ⁽⁸⁰⁾

Nor is disc herniation the only possible cause of pain in radicular syndromes of the lower limbs; in operation statistics no disc herniation is found in about 10% of the cases; many radicular syndrome resolve without operation, and this is true even of cases which medical imaging had found a herniated disc. Disc herniation may sometime persist after the symptoms have disappeared, although **resorption is also possible**. Clinical images (CT and MRI) also reveal a herniated disc in healthy individuals in whom it is of little relevance. It is only **significant when it correlates with clinical findings**.

The mechanical compression of a nerve does not itself cause pain but anesthesia, paresthesia, and paresis. However, we should bear in mind that the herniated disc causing the compression cannot impinge on the nerve fibers until after it has affected the dura and the dural sheaths, which are richly supplied with pain receptor, and that every movement of the legs and trunk the dura is being rubbed against the disc. ⁽³⁵⁾

The lumbar intervertebral disc (IVD) plays a central role in the development of low back – related leg pain and radiculopathy (Yoshizawa et al., 1995). The pathomechanisms involved are internal disc disruption, fissure formation and nucleus pulposus (NP) prolapse or sequestration leading to inflammation of the nerve root, and subsequent pain of nerve origin, even without mechanical compression. Inflammation caused by biomechanical substance from the NP plays a significant role in the development of low back-related leg pain (Olmaker et al., 1993; Olmarke 1997; Brisby, 2003). ⁽¹⁾

Degenerative changes of the IVD, associated with internal disc disruption, commonly lead to fissures in the annulus, which allow inflammatory mediators to disperse through the disc and contact the innervated outer third of the annulus (Videman and Nurminen, 2004; Peng et al. 2005). These chemicals may cause excitation of nociceptive afferents and thereby discogenic pain, which may then refer into the lower limb (O'Neil et al., 2002). In case of a fuller annular rupture, NP material and inflammatory mediators may leak into the spinal canal, contact nerve tissues such as transiting of exiting nerve roots and lead to inflammation of these structure (Videman and Nurminen, 2004).⁽¹⁾

2.6. Differential diagnosis in Sciatic pain⁽¹⁷⁾

2.6.1. Neuromuscular causes

Discogenic Disorders

Disc herniation: low back pain with radiculopathy and paravertebral muscle spasm; valsalv's maneuver and sciatic stretch reproduce symptoms.

Lateral entrapment syndrome (spinal stenosis): buttock and leg pain with radiculopathy; pain often relieved by sitting, aggravated by extension of the spine.

Nondiscogenic disorders

Sacroilitis: low back and buttock pain. Physical signs: Tender sacroiliac joint; positive lateral compression test; positive Patrick's test.

Piriformis syndrome: low back and buttock pain with referred pain down the leg to the ankle or midfoot. Physical signs: pain and weakness on resisted abduction/external rotation of the thigh.

Iliolumbar syndrome: pain in iliolumbar ligament area (posterior iliac crest); referred leg pain. Physical signs: tender iliac crest and increased pain with lateral or side bending.
Trochanteric bursitis: buttock and lateral thigh pain; worse at night and with activity. Physical

signs: tender greater trochanter; rule out associated leglength discrepancy; positive “jump sign” when pressure is applied over the greater trochanter.

Greater trochanteric pain syndrome: mimics lumbar nerve root compression.

Physical signs: low back, buttock, or lateral thigh pain; may radiate down the leg to the iliotibial tract insertion on the proximal tibia; inability to sleep on the involved side.

Ischiogluteal bursitis: buttock and posterior thigh pain; worse with sitting.

Physical signs: tender ischial tuberosity; positive SLR and Patrick’s sign test’s; rule out associated leg-length discrepancy.

Posterior facet syndrome: low back pain.

Physical signs: lateral bending in spinal extension increases pain; side bending and rotation to the opposite side are restricted at the involved level.

Fibromyalgia: back pain, difficulty sleeping, anxiety, and depression.

Physical signs: multiple tender points.

2.6.2. Systemic/ extraspinal causes ⁽¹⁷⁾

Vascular disorders

- Ischemia of sciatic nerve
- Peripheral vascular disease
- Intrapelvic aneurysm (internal iliac artery)
- Neoplasm (primary or metastatic)
- Diabetes mellitus (diabetic neuropathy)
- Megacolon
- Pregnancy; vaginal delivery
- Infections
 - Bacterial endocarditis
 - Wound contamination

- Herpes zoster (shingles)
- Psoas muscle abscess
- Reiter's syndrome
- Total hip replacement
- Endometriosis
- Deep venous thrombosis (blood clot)

2.6.3. Risk factors for sciatica

Musculoskeletal or neuromuscular factors

- Previous low back injury or trauma; direct fall on buttock(s); gunshot wound
- Total hip arthroplasty
- Pregnancy
- Work- or occupation- related postures or movements
- Fibromyalgia
- Leg-length discrepancy
- Congenital hip dysplasia; hip dislocation
- Degenerative disc disease
- Piriformis syndrome
- Spinal

Systemically induced factors

- Tobacco use
- History of diabetes mellitus
- Atherosclerosis
- Previous history of cancer (metastases)
- Presence of intra-abdominal or peritoneal inflammatory disease (abscess):

Crohn's disease, Pelvic inflammatory disease, Diverticulitis

Endometriosis of the sciatic nerve

Radiation therapy (delayed effects; rare)

Recent spinal surgery, especially with instrumentation

2.7. Differential classifications for low back pain and sciatica

2.7.1. Mechanical pain syndromes described by Mckenzie ⁽⁴³⁾

The postural syndrome:

This is caused by mechanical deformation of soft tissues as a result of postural stresses. Maintenance of certain postures or positions which place some soft tissues under prolonged stress will eventually be productive of pain. Thus, the postural syndrome is characterised by intermittent pain brought on by particular postures or positions, and usually some time must pass before the pain becomes apparent. The pain ceases only with a change of position or after postural correction.

The dysfunction syndrome:

This is caused by mechanical deformation of soft tissues affected by adaptive shortening. Adaptive shortening may occur for a variety of reasons. It leads to a loss of movement in certain directions and causes pain to be produced before normal full range of movement is achieved. Thus, the dysfunction syndrome is characterised by intermittent pain and a partial loss of movement. The pain is brought on as soon as shortened structures are stressed by end positioning or end movement and ceases almost immediately when the stress is released.

The derangement syndrome:

This is caused by mechanical deformation of soft tissues as a result of **internal derangement**. Alteration of the position of the fluid nucleus within the disc, and possibly the surrounding annulus, causes a disturbance in the normal resting position of the two vertebrae enclosing the disc involved. Various forms and degrees of internal derangement are possible, and each presents a somewhat different set of signs and symptoms.

Thus, the derangement syndrome is usually characterised by constant pain, but intermittent pain may occur depending on the size and location of the derangement. There is a partial loss

of movement, some movements being full range and others partially or completely blocked. This causes the deformities in kyphosis and scoliosis so typical of the syndrome in the acute stage.

The three syndromes presented are totally different from each other, and each syndrome must be treated as an entity on its own, requiring special procedures which are often unsuitable for the other syndromes. In order to identify which syndrome is present in a particular patient a history must be established and an examination must be performed.

2.7.2. Patho-mechanism classification for back related leg pain

A proposed patho-mechanism based approach for differentiating different sources of radiating leg pain in 4 groups which is important to make the appropriate diagnosis (Schafer et al. 2007). The **first subgroup** is **central sensitization** with mainly positive symptoms such as hyperalgesia; the **second subgroup** involves **denervation** with significant axonal damage showing predominantly negative sensory symptoms and possibly motor loss and the **third subgroup** involves **peripheral nerve sensitization** with enhanced nerve trunk mechano-sensitization. The **fourth subgroup** features **somatic referred pain** from musculoskeletal structures, such as the intervertebral disc or facet joints.

There has been a separation into four groups with of patients with low back-related leg pain, but in reality there may be considerable overlap between them. Peripheral sensitization of nerve tissue can trigger central sensitization, and inflammatory products released during denervation may also alter the properties of intact nerve fibres. Many of radicular disorders are mixture of nociceptive and neuropathic pain (Baron and Binder, 2004). This mechanism of differentiation is evaluated by the patients complaints and to be identified it is need a thorough physical examination protocol. ⁽⁶²⁾

2.7.3. Radicular syndromes in the lower extremities

Although radicular syndromes share many common features with other vertebrogenic disorder, they possess certain special characteristics. The first is that, in most cases, pain radiating into the lower extremity is **preceded by low-back pain**. This is why disc herniation is thought to be the main cause not only of radicular pain, but also of low-back pain.

However, because low back pain occurs much more frequently than radicular syndromes this merely indicates low-back pain caused by disc herniation but is likely to be a precursor of radicular syndromes. There are, however, radicular syndromes in which the pain **starts in the legs** and is never preceded by low-back pain. In such cases, low back pain usually appears only later, if at all. Pain felt in the buttocks occurs commonly, hence the old term ‘sciatica’.

Radicular pain may have a sudden onset after a lifting injury or when getting out of bed in the morning. It may also begin so insidiously that the patient cannot remember precisely when it started. For best advice to be given in individual cases, it is important to elicit from the patient details of those circumstances that aggravate symptoms and that bring relief.

Radicular pain differs from simple referred pain in that **pain numbness** radiate down as far as the toes; the pain is accompanied by the **paresthesia with pins and needles or numbness**; and patients have the feeling they cannot reliably control the affected leg. Sometimes patients are also aware of weakness. ⁽³⁵⁾

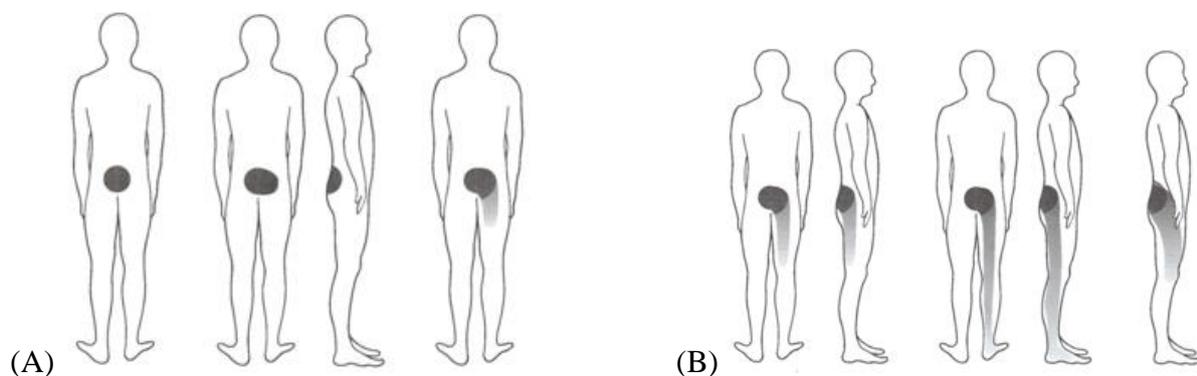


Figure 19: (A) First incident of pain

(B) Subsequent pain attacks ⁽⁴²⁾

2.7.4. Clinical signs and characteristics of disc herniation

The patient is often able to describe the pattern of **pain and paresthesia** on the affected **extremity**. The typical **antalgic posture** is frequently encountered when the patient is examined in the standing position. Here, too, however there are exceptions: for example, patients who adopt an extremely erect posture and are entirely unable to bend forward. The more common antalgic posture, is **Anteflexion** with the **pelvic deviating toward the painful side**, is easily explained because it is the position that keep the intervertebral foramen as wide as possible. The lordotic posture has been explained in terms of the position of the herniated disc relative to the dural sac and the nerve root.

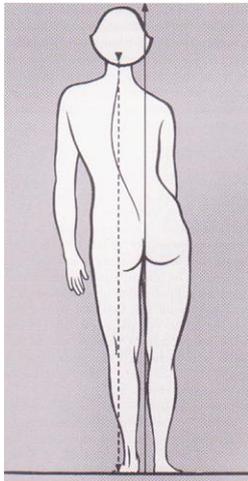


Figure 20: Typical antalgic posture in acute intervertebral disc herniation. ⁽³⁵⁾

If the **straight-leg raising test is positive**, the Anteflexion in the standing position with straight legs will also be restricted. In patients with an exaggeratedly erect posture, trunk anteflexion will often be impaired, even when the patient is seated with knees bent. In less acute cases, posture when standing at ease may be more or less normal but anteflexion with straight legs will be reduced as along as **straight-leg raising** is impaired. Anteflexion in the seated position should then also be tested. Another sign is painful arc described by Cyriax. **Springing test** of the lumbar spine is painful even after a restriction has been released.

Major significance is the neurological signs of root involvement, such as **motor weakness** and **hypoesthesia**, without which the diagnosis of true radicular syndrome inconclusive because of the often highly deceptive nature of referred pain. For this reason, even minimal weakness of a muscle, hypotonus, or hypoesthesia consistent with the segment in question may be highly significant and should be carefully looked for. ⁽³⁵⁾

Pain is typically felt on **coughing, sneezing, defecation**, and, sometimes, **laughing**. Except in acute cases, walking tends to alleviate the pain. However, if patients complain of pain when walking, it is essential to ask whether they have to stop after a certain distance and what position they then adopt. This is the only way to identify intermittent claudication. ⁽³⁵⁾

2.7.5. Problems in diagnosing radicular syndromes

In clinical terms, a radicular syndrome can be reliably distinguished from referred pain; however, establishing when a radicular syndrome is caused by disc herniation is far more difficult. A herniated disc may be clinically '**silent**' and radicular compression may be caused by a narrow spinal canal, a narrow lateral recess, or a space-occupying lesions. **Localization** can also be more problematic that would appear at first sight. ⁽³⁵⁾

Conditions such as radiculitis may cause both pain and neurologic signs but in that case the pain occurs in the lower limb, not in the back. If root inflammation also happens to involve the nerve root sleeve, neck or back pain might also arise. In such a case the individual will have three problems each with a different mechanism: neurologic signs due to conduction block, radicular pain due to nerve-root inflammation, and back pain due to inflammation of the dura. Identifying a **mechanical cause** of pain does not always rule out serious spinal pathology. For example neurogenic pain can be caused by a metastatic lesion applying pressure or traction on any of the neural components. The therapist must rely on **history, clinical presentation**, and the presence of any associated **signs** and **symptoms** to make a determination about the need for medical referral. ⁽¹⁷⁾

Anomalies are encountered along the course of nerve roots, and computed tomography (or magnetic resonance imaging) often exposes more than one herniated disc. Only one of these will probably be relevant clinically. Patients who have been immobilized for long periods

often develop thrombophlebitis, the pain of which must not be confused with radicular pain and must be treated specifically. ⁽³⁵⁾

Confusion with spinal stenosis syndromes may occur when atheromatous change in the internal iliac artery results in ischemia to the sciatic nerve. The subsequent sciatic pain with vascular claudication like symptoms may go unrecognized as a vascular problem. The therapist may be able to recognize the need for medical intervention by combining a careful **subjective** and **objective examination** with knowledge of vascular and neurogenic pain patterns. This is especially true in the treatment of unusual cases of sciatica or back pain with leg pain. ⁽¹⁷⁾

If surgery is indicated, the diagnosis must first be confirmed by imaging techniques. However, even these are not infallible. Although imaging may **reveal more than one** herniated disc, it can provide **little information** regarding their **clinical relevance**. ⁽³⁵⁾

Sciatica alone or sciatica accompanying back pain is an important but unreliable symptom. For example, diabetic neuropathy can cause nerve root irritation. Prostatic metastases to the lumbar and pelvic regions or other neoplasm's of the spine can create a clinical picture that is indistinguishable from sciatica of musculoskeletal origin. This similarity may lead to long and serious delays in diagnosis. Such a situation may require persistence on the part of the therapist and client in requesting further medical follow up. ⁽¹⁷⁾

Spinal stenosis caused by narrowing of the spinal canal, nerve root canals, or intervertebral foramina may produce neurogenic claudication. The canal tends to be narrow at the lumbosacral junction, and the nerve roots in the cauda equina are tightly packed. Pressure on the cauda equina from tumor, disc protrusion, infection, or inflammation can result in cauda equina syndrome, which is a medical emergency. ⁽³⁵⁾

Even without surgery the great majority of radicular syndromes heal as a result of functional compensation and resorption of the intervertebral disc. This is also why conservative treatment is so often successful, that is traction, manipulation, various types of reflex therapy, remedial exercise, and stabilization methods. However surgery in isolation fails more often than not it is not followed by **appropriate rehabilitation** that is if we do not help to **restore normal function**. ⁽³⁵⁾

3. Clinical evaluation and treatment procedure for lumbar disc herniation

3.1. Examination procedure

- **History taking**

Taking an accurate history is the most important part of the initial consultation when one is dealing with any medical or surgical problem. Unfortunately, when the mechanical lesion is involved there is still lack of understanding regarding the nature of the questions that should be asked, the reasons for asking them, and the conclusions to be drawn from the answers.

Where is the present pain being felt?

We need to know all the details about the location of the pain, because this will give us some indication of the level and extent of the lesion and the severity of the condition. If there are any associated symptoms such as anaesthesia, paraesthesiae and numbness, their location must be noted as well. Referred pain indicates that derangement is likely.

How long has the pain been present?

It is important to find out whether we are dealing with an acute, a subacute or chronic condition. In recurrent low back pain we are not interested in an answer based on the length of time since the first attack; at this stage of the examination we want to know how long the present episode has been evident.

How did the pain commence?

Basically we want to find out if there was an apparent or no apparent reason for the onset of the pain. Most of the histories commonly state that the pain appeared for no apparent reason. Two of every three patients fall into this category, and only one patient will recognise a causative strain.

Is the pain constant or intermittent?

This is the most important question we must ask patients with low back pain. If in patients referred for mechanical therapy the pain is found to be constant, it is usually produced by constant mechanical deformation. However, we must keep in mind that constant pain can also be caused by chemical irritation. Intermittent pain is always produced by mechanical deformation.

What makes the pain worse and what makes the pain better?

We must specifically ask about sitting, standing, walking, lying, and activities which involve stooping or prolonged stooping. In these positions the joint mechanics of the lumbar spine are relatively well understood, and therefore we will be able to determine which situations increase and which decrease mechanical deformation. We must carefully record any position or activity reported to reduce or relieve the pain, as we will utilise this information in our initial treatment.

Have there been previous episodes of low back pain?

We should enquire about the nature of any similar or other low back pain episodes, the time span over which they occurred, and their frequency. At this stage we should also find out about previous treatments and their results. Episodic history indicates derangement.⁽¹⁵⁾

- Pain on cough/sneeze?
- Disturbed sleep?
- Pain on arising in the morning?
- Recent X-Rays? - Results?
- On medication at present?
- On steroids, in past or at present?
- General health? - Recent weight loss?
- Major surgery or accident, recently or previously?
- Saddle anaesthesia? – Bladder control?

The disc appears to live and thrive on movement, and to change and die slowly through lack of it. The **objective examination** covers the following factors: ⁽²¹⁾

- Observation of posture and gait
- Active movements of the spine
- Passive movements of the spine
- Accessory movements of the spine
- Tests for muscle function (e.g., weakness, lack of coordination, or muscle pain)
- Tests of other joints (e.g., sacroiliac, hip, knee, and ankle)
- Neurologic tests (e.g., reflexes, sensation, and motor power)
- Dural tension signs tested singly or in combination (e.g., passive neck flexion, straight leg raise, prone knee flexion, and slumped sitting)

3.2. Symptoms and clinical findings of lumbar radicular syndromes

- **L4 radicular syndrome**

Pain radiates over the **ventral aspect of the thigh** to the knee and can radiate further on the anteromedial aspect of the leg down to the media malleolous. In this syndrome, the straight-leg raising test is often only mildly positive, whereas the **femoral nerve stretch test** is always strongly positive.

There is **weakness of the quadriceps femoris** and of the hip flexors (**rectus femoris**) when the patient is seated and the **patellar reflex** is weakened or absent. Where major weakness is present, walking down stairs is troublesome, as is straightening up from the knees bent position while loading the lesion leg. The patients's gait may be unsteady. Hypoesthesia may be present on the anterior aspect of the thigh. ⁽³⁵⁾

- **L5 radicular syndrome**

Pain and **paresthesia** radiate **laterally over the buttocks** and **down the thigh** and lower leg as far as the **lateral malleolous** and then over the instep to the **big toe** where the hypoesthesia is also found. None of the routinely tested tendon reflexes is altered. The muscles most commonly affected by weakness are the **extensor hallucis longus** and the **extensor digitorum brevis**. Aside from weakness of these muscles, their reduced tonus can be easily palpable close to the tibial margin and above the lateral malleolous.

In severe cases the **tibialis anterior** is also weakened and hence also dorsiflexion at the talocrural joint and dorsiflexion of the toes. This is clearly apparent during heel-walking owing to the **dorsiflexion weakness** of the **foot**. Severe weakness may be seen in the very acute stage, so that the patient's foot hangs flaccidly, producing a steppage gait. This should not be confused with the far rarer condition of peroneal nerve weakness. Internal rotation of the hip is also weakened (Horacek 2000).

A valuable neurological sign is **increased resistance** when **stretching the skin** of the **interdigital fold** between the **first (big)** and **second toes**, and between the **second and third toes**, as well as increased **resistance on dorsoplantar movement** of the first metatarsal bone

against the second, and the second against the third, especially in patients whom pain radiates as far as the toes. The painful key muscle (TrP) is the Piriformis. And hence the patient will report pain in the hip. ⁽³⁵⁾

- **S1 radicular syndrome**

Pain and paresthesia radiate **dorsally over the buttock and thigh** as far as the **lateral malleolous** and then **laterally** along the foot to the **little toe**. **Hypesthesia** is consistent with this pattern. The weakened muscles are the **fibularis** (Peroneus), the **triceps surae** (especially the lateral part), and the gluteal muscles, causing lowering of the gluteal fold in the standing position (hypotonos).

According to Vele an early sign is the weakened reaction of the **toe flexors** when the patients lean forward (but without standing on tiptoe). Characteristically there is no toe flexion on the side of the radicular syndrome. The weakness is also clearly evident when the patient tries to walk on tiptoe. The **Achilles tendon reflex** is weakened or abolished.

This syndrome is also often characterized by a definite **disturbance of proprioception**. A comparison of both sides reveals that the patient notices passive movement of the lateral toes later on the lesioned side than on the healthy side. In this syndrome, too, we find **increased resistance to stretching** of the **interdigital fold of skin** between the **third and fourth and fifth toes**, and increased resistance on **dorsoplantar movement** of the third **metacarpal bone** against the fourth, and the fourth against the fifth. ⁽³⁵⁾



Figure 21: (A) nerve root compression caused by disc herniation, (B) referred pain from an irritated or compressed S-1 nerve root. ⁽⁶²⁾

3.3. Physical examinations of lumbar disc herniation

Nerve root tension test: L5, S1, S2 roots

- **Straight leg raising test (SLRT)**

Lasegue test is aimed to differentiate sciatic from hip pain. It consists from two parts the first is in raising the lower limb with fully extended; and the second the patient's place the foot on the bed and the hip is further flexed. Positively the first maneuver is an expression known of sciatic pain. Persistence or appearance in the second part of the maneuver indicates a pathologic condition of the hip. ⁽³³⁾

This tests correspond to the first part of lasegue's maneuver. The patient is place supine with the hips and knees in full extension and the ankles in a relaxed position. The examiner takes the heel with one hand, while exerting, with the other a slight pressure on the knee to avoid it bending when raising the limb. Normally the limb can be raised at least 60 degrees without causing the patient any discomfort.

Patients with radicular pain experience a progressive increase in discomfort, upon limb raising, to which they begin to resist as soon as pain becomes severe. Resistance is affected initially by contracting the hamstrings and then by raising the homologous hemipelvis from the bed. Numerous studies have evaluated the sensitivity of SLRT in patients with disc herniation: the values range from 80% to 99%. Specificity however does not exceed 40%. ⁽³³⁾

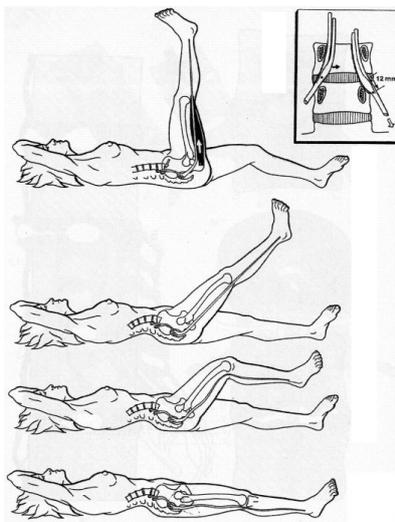


Figure 22: Lasegue sign

Charnley showed that **Nerve root glides** freely through the intervertebral foramina and during elevation of the extended lower limb, nerve roots are pulled out for a distance up to 12 mm at L5 level.

Signs of root tension such as limitation in straight leg raising are common in disc prolapse but generally absent in pure degenerative stenosis. If however a stenotic patient develops a small disc prolapse the straight leg raise test may convert to positive. ⁽³²⁾

In lifting the lower limb with the knee extended, the ankle is dorsiflexed (Braggard sign) by applying the hand which raises the limb on the heel or sole of the foot. The sciatic nerve is thus further stretched through the tibialis posterior nerve and pain, may therefore, be elicited when SLRT is negative or, anyway, at lower degrees of leg raising. This may be helpful when the standard maneuver is only slightly positive.

Similar maneuver is the so-called ankle dorsiflexion maneuver; the limb is raised until the patient feels radiated pain and then is **lowered until the pain decreases or disappears**. At this point, a force ankle dorsiflexion is performed, which again elicits radiated pain, when the maneuver is positive. This clinical test, which is less sensitive than the former, may confirm the positivity of SLRT. Its practical usefulness, however, is very limited. ⁽³³⁾

- **Pathogenic mechanism of SLRT**

In several studies on cadavers, the motion of the lumbosacral roots was examined upon SLR. Observation that both nerve root (or radicular nerve) and the dura mater undergo translation and lengthening movements. Between 0 and 30 degrees motion is very limited; between 30 and 60 degrees the root moves in the vertical direction; and between 60 and 90 degrees the displacement occurs perpendicularly to the direction of the root; toward the pedicle.

- **Knee extension in the sitting position (Slump test - simpler form as Flip test)**

The patient sits with knees over the side of the bed and the leg is raised until the knee is fully extended. When the test is positive, the greater the nerve-root tension, the less the knee extension and the greater the radiated pain felt by the patient. Furthermore the patient will

simultaneously throw back his trunk and take his/ her hand away from the edge of the bed. This maneuver, described by Oppenheim, has the same clinical significance as the SLRT. However it is less sensitive, and may, thus, be negative or weakly positive when the SLRT is clearly positive. The flip test may be useful in those patients with severe lumboradiculopathy who have difficulty in taking up a supine position.

- **Cross-leg SLRT**

Rising of the asymptomatic leg may cause pain on the symptomatic side. The patients who most frequently present a positive crossed-leg SLRT are those with a paramedian herniation. In these cases, stretching of the contralateral nerve roots involves traction on the thecal sac and, through this, the compressed nerve root. The latter tend to displace toward the midline, and is thus compressed by herniation. However, contralateral pain lifting the asymptomatic leg may also be observed in patients with midline or posterolateral herniation. The sensitivity of crossed-leg SLRT is only 25% - 44%, but specificity is as high as 90%.

This maneuver is extremely reliable for diagnosis not only of disc herniation, but particularly of herniation responsible for marked-nerve root compression. Most patients with crossed-leg SLRT, in fact have a medium-sized or large contained herniation, or an extruded or migrated herniated disc.^(33, 64)

- Neurodynamic tests

Nerve-root tension tests: L2, L3, L4 roots

- **Femoral nerve stretch test (FNST)**

The femoral nerve stretch test may be carried out in various ways, with the patient in the prone position. The simplest modality, described by Wassermann is to bend the knee until pain appears on the anterior aspect of the thigh. It is positive as soon as 90 degrees are reached and pain becomes progressively more severe if knee flexion is increased even slightly. The test can be reinforced if the hip is extended by placing a hand under the knee to raise the thigh.

An alternative method is to extend the hip, while keeping the knee extended. This is done by placing one hand on the buttock to keep the pelvis in position, whilst the other hand, placed under the knee, raises the limb.

Stretching on the femoral nerve on the healthy side may cause anterior thigh pain on the symptomatic side. The crossed-leg FNST is much more rarely positive than the crossed leg SLRT.

Other tests and signs:

‘Painful arc’ described by **Cyriax** (1978): during anteflexion, often shortly after beginning to bend forward, the patient feels considerable pain. An evasive movement of the spinal column can often be seen, as if the patient is working around some obstacle, after which the action continues quite normally. On the straightening again the pain reappears and there is an evasive reaction at the same point. This sign indicates disc herniation.

If the **springing test** produces pain in the lumbar spine and joint restriction is either absent or has been resolved, this indicates a disc lesion. ⁽³⁵⁾

Increase intra-abdominal pressure provokes sometime pain in patients with disc herniation. ⁽⁶⁴⁾

Vele test by providing this test we evaluate the stability of a patient’s foot flexors by providing of loss of action may evaluate of compression of nerve of any reason. ⁽⁷¹⁾

Unilateral blocking of nutation movement in sacroiliac joint causes the distortion of the pelvis. But also if **gluteus maximus on one side is weak**, the subgluteal line is lowered and intergluteal line is tilted to one side. Such shifting in sacroiliac joints is painful and can be suggested as a sign for sciatica. ⁽⁷¹⁾

- **Lumbar traction test and mobilization**

The patient stands with feet slightly apart, and the lumbar spine in the resting position. Therapist stands behind the patient. May need to stand on a stool to position he’s arms at or above the height of the patient’s arms. Holding the patient just below the rib cage, with the arms in an interlocked grip and leaning slightly backward to apply a Grade I, II, or III traction force. Testing lumbar traction is for alleviation of provoking the pain. ⁽⁵⁾

- **Lumbar Compression test**

The patient stands with feet slightly apart and the lumbar spine in the resting position. Standing behind the patient the therapist places his hands on to the patient's shoulders or grip around the lower part of the patient's rib cage. Pressing the patient's shoulders (or trunk) in a caudal direction may provoke pain and increase radicular symptoms. ⁽⁵⁾

- **Waddell signs nonorganic signs:**

- Superficial tenderness to light pinch
- Nonanatomic tenderness which is not localized and often extends from the lumbar spine to thorax or pelvis.
- Axial loading pain, when low back pain is reported with vertical loading to the patient's head.
- Pain with whole body rotation, when shoulders and pelvis are rotated in the same plane
- Discrepancy between seated and lying straight leg raise
- Give-way or cogwheel weakness that cannot be explained on a localized neurologic basis
- Sensory disturbances in a stocking rather than a dermatomal distribution
- Disproportionate verbalization and facial expressions during examination

Lumbar instability tests:

- **Segmental stabilization tests** are in general passive accessory motion tests.

- Anterior shear test
- Posterior shear test
- Torsion test

- **Local stabilizing tests**

- Transversus abdominis test (biofeedback pressure)
- Segmental lumbar multifidus

- **Global stabilizing system tests** ⁽⁶⁶⁾

3.4. Imaging techniques diagnosing lumbar disc herniation

MRI and/or CT scans, Myelogram, X rays of the spine can be ordered to help the spine specialist make the correct diagnosis. ⁽¹⁷⁾

X-rays of the spine are essential to rule out other abnormalities but may not diagnose herniated disc because marked disc prolapse can be present despite a normal X-ray. A thorough check of the patient's peripheral vascular status - including posterior tibial and dorsalis pedis pulses and skin temperature of extremities - helps rule out ischemic disease, another cause of leg pain or numbness.

After physical examination and X-rays, myelography, computed tomography scans, and **magnetic resonance imaging (MRI)** provide the **most specific diagnostic information**, showing spinal canal compression by herniated disc material. MRI is the method of choice to **confirm the diagnosis** and determine the exact level of herniation. The MRI as other imaging tests may reveal anatomical anomalies without provoking any pain. ⁽²¹⁾ Disc herniation, disc bulging, spinal stenosis, and disc degeneration can all commonly be found. These findings occur more frequently with increase in age. MRI with contrast is the imaging test of choice to distinguish from perineural fibrosis associated with presurgery. ⁽⁶²⁾

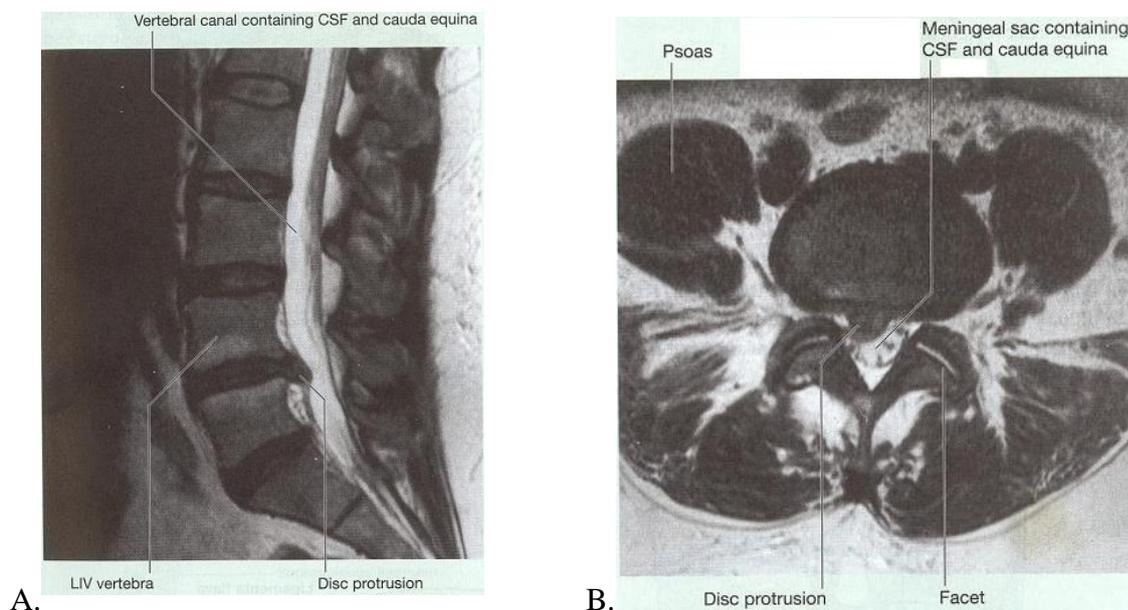


Figure 23: Disc protrusion – T2 weighted magnetic resonance images of the lumbar region of the vertebral column A. Sagittal plane. B. Axial Plane.

A **myelogram** can define the size and location of disc herniation. An **electromyogram** can determine the exact nerve root involved. A nerve conduction velocity test may also be performed.

Lumbar myelography (liquid dye is injected into the spinal column and appears white against bone on an x-ray film. A myelogram can show pressure on the spinal cord or nerves from herniated discs, bone spurs or tumors.), in the past was the usual method for establishing a diagnosis, but it is usually not necessary today. ⁽¹⁷⁾

Discography is an invasive diagnostic procedure designed to determine whether a disc is intrinsically painful. Discography involves the injection of contrast material or saline into the nucleus pulposus of the inter-vertebral disc. Postdiscography computed tomography can be used to highlight the features of internal disc disruption, which is the most common known cause of discogenic pain in patients with chronic spinal problems. It has been shown by this method that spinal pain caused by internal disc disruption is present in more than 39% of patients with chronic low back pain. However discography is not recommended as part of the diagnostic process for patients of acute lower back pain neither with suspected disc herniation. ⁽⁶²⁾

In spinal disorders, **electromyography** (EMG) is the method of choice for the identification of damage within the peripheral motor nerve fibers (highest sensitivity). However, the delay between the time of the actual damage and the first signs of denervation (acute denervation potentials occur after a mean of 21 days) must be considered. Also the activation pattern (complete or reduced interference) assessed during voluntary activation (here the patient needs to cooperate and perform a voluntary activation) can be applied as soon as the very first few days after a lesion to disclose a pathological innervation.

The performance of EMG in several muscles allows the specific localization of the nerve damage (somatotopic localization of a lesion) to be indicated and for the differentiation of acute, subacute and chronic axonal damage (denervation). The EMG has a high specificity and will rarely be abnormal in asymptomatic individuals but is usually not performed until at least 3 weeks after the symptoms begin. CT myelography is also considered an important tool for identifying herniated disc. ⁽⁵⁾

3.5. Therapy Procedures for disc herniation

3.5. 1 Conservative therapy procedures

The treatment of lumbar disc herniation is generally approached in stages. **Oral anti-inflammatory medications, activity modification, and physical therapy** are the **first line** of treatment. The **second line** of treatment involves **epidural steroid injections**. If these measures are not effective in relieving pain or restoring neurologic function, **surgery** can be considered.

However, it is generally accepted that a period of **nonoperative treatment** should be instituted for at least **6 to 8 weeks** and preferably **12 weeks** prior to considering surgical treatment. In approximately 80 percent of patients with lumbar disc herniations, the symptoms related to the herniation will resolve within 3 months. ⁽²¹⁾

Physical therapy can help to ease the painful muscles, which struggle to cope with the spine problem, and PT can also help to prevent abnormal stresses on the spine. **Epidural steroid injections** can reduce the inflammation in the area and are often helpful, but the pain tends to recur if the underlying problem is severe. For acute problems, the only remaining treatments have been to surgically remove part of the disc, or to surgically fuse the vertebrae to remove pressure on the disc. ⁽²³⁾

Acute sciatica may be so severe that the patient cannot be mobilized. In this first period, the most important goal is to reduce pain and gradually increase the physical activity. It is also very important to reassure the distressed patient that the course is usually benign. However, **bed rest** should not be prolonged for more than 3 days. **Anti-inflammatory** drugs aim to tackle the inflammatory component. **Physiotherapy** in the acute phases focuses on a pain reducing positioning.

After the acute phase; **therapeutic exercises** which will strengthen the back muscles and improve health status of the patients, represent a cornerstone of conservative treatment. Exercise that improves trunk strength and balance and does not exacerbate leg pain appears to be preferable. However, the clinical course is quite different in patients with severe sciatica and sensorimotor deficits. ⁽⁵⁾

Current knowledge indicates that the commonest causes are to be found in the **deep stabilizer system** (in conjunction with faulty breathing), the feet, faulty movement patterns, active scars, movement restrictions, and TrPs in the key region as well as the fascia. No less important are general measures: these include avoiding situations that routinely trigger recurrences, and protecting the lumbar region against chill after perspiring. ⁽³⁵⁾

No rehabilitation program can be fully effective if patients undo the beneficial responses of therapy with inappropriate activities of daily living. ⁽⁶²⁾

3.5.1.1. Conservative approaches

Brugger introduced the concept of central motor regulation as the main cause of impaired function of the musculoskeletal system. Overuse of faulty use of motor control is considered the most common factor for triggering factors. The ultimate aim of this concept is to achieve improvement in movement on automatic basis. In sitting for vertebral correction includes adapting the chair height and correcting the the sitting posture. In standing is mostly corrected of the feet and graceful erect posture.

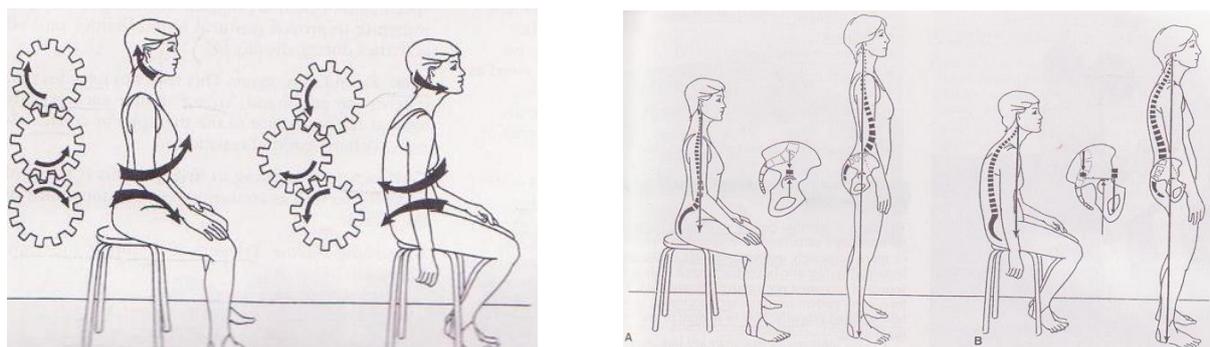


Figure 24: Cogwheel wheel model (Brugger2000): The concept of global movements and interplay between body segments. ⁽⁶²⁾ Sitting and standing (A) Ideal, (B) faulty from Brugger (2000) ⁽⁶²⁾

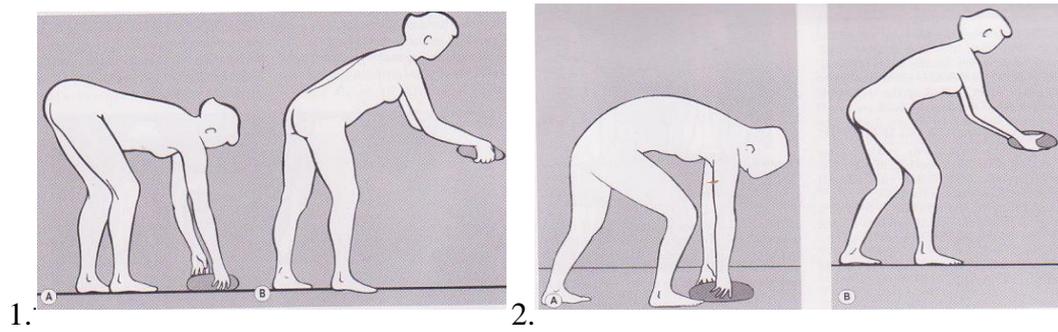


Figure 25: 1. (A) Stooching and (B) lifting an object, performed incorrect, long lever great stress on the lumbosacral junction. 2. (A) Stooching and (B) lifting an object correctly with coordination activity by the muscles of the the gluteal region, abdomen and back in lifting ⁽³⁵⁾

3.5.1.2. Therapeutic picture excises for ADL and core stability

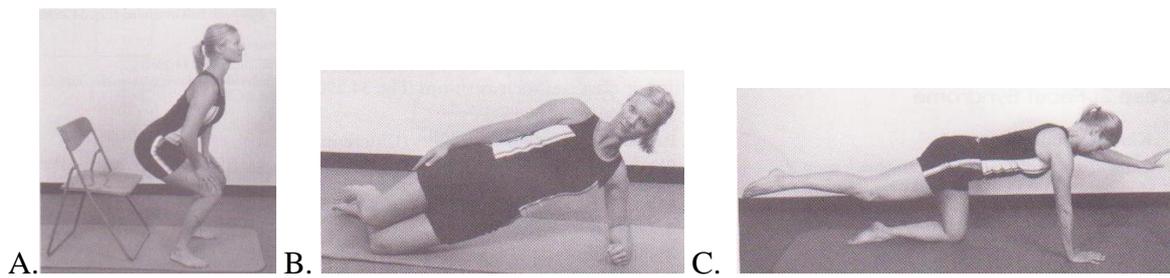
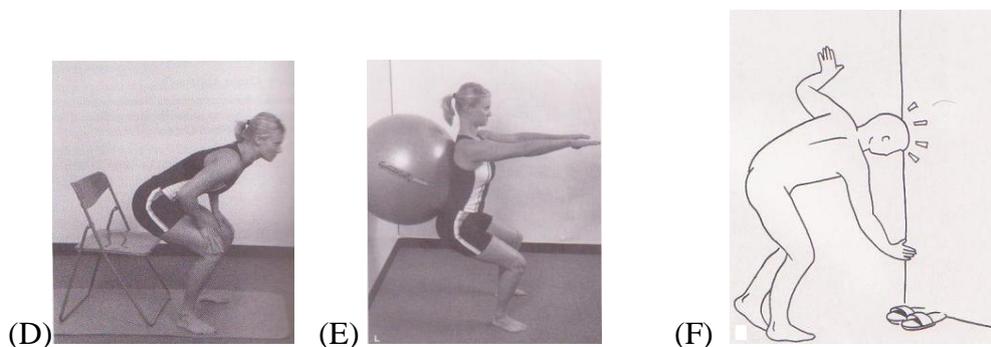


Figure 26: Core exercises: (A) hip hinge, (B) Side bridge, (C) quadraped arm and leg reach (D) squat with trunk flexion, and (E) Ball squat (F) end range of disc ADLs ⁽⁶²⁾



3.5.1.3. Mckenzie approach

Centralization is the movement of the pain to a more central location and centralization of pain that occurs as a patient exercises is a good sign. If the pain moves to the mid-line of the spine and away from areas where it is usually felt, this is the correct exercise program for the patient. Centralization of the pain is the most important guide for determining correct exercise of a problem.

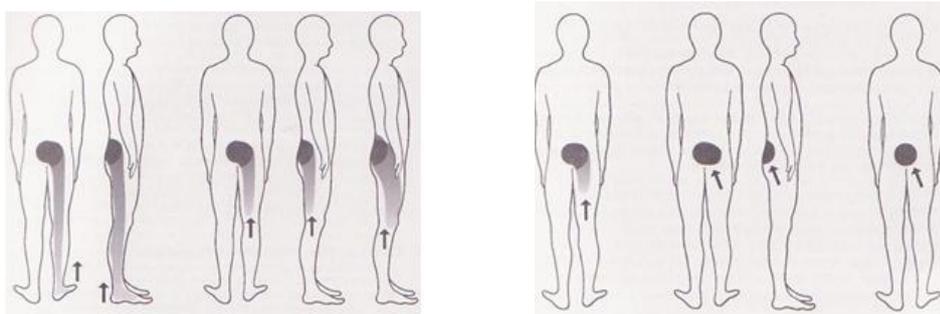


Figure 27: progressive centralization of pain indicates suitability of exercise program. ⁽⁴²⁾

The **exercise** that brings about a change of location or reduction in pain will, in most cases, be extension of the back and is the most effective first-aid procedure in treatment of acute low back pain. In these cases, extension becomes the mechanically determined directional preference, which is the movement in the direction that stops, reduces, or centralises pain.

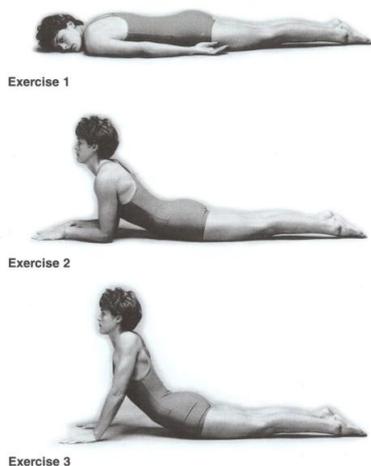


Figure 28: McKenzie prone extension exercises 1. Lying down, 2. Lying down in extension and 3. Extension in lying. ⁽⁴²⁾

3.5.1.4. Manual traction therapy

Taking in account of antalgic posture may be attempted in the acute stage. In other words, if the antalgic posture is in kyphosis, then traction is performed with the patient supine of the practitioner's knee, but if the antalgic posture is in lordosis, then traction is well tolerated it may procure immediate relief. Counterstrain to exaggerate the antalgic posture is also highly effective. This might be termed 'manipulative first aid'.

If these techniques fail to bring immediate relief, epidural anesthesia and bed rest in the antalgic posture should be considered, as should analgesic medication. However, bed rest should be kept as brief as possible because energetic ('aggressive') therapy in acute stage is the most important step in preventing chronicity.

Traction may also be helpful in the chronic stage, provided that the patient finds it agreeable and improvement is detected afterward. In every instance it is important to proceed in a manner that is consistent with the clinical findings, and this approach presupposes a fresh examination at every follow-up visit. In this process, chain reaction patterns should be sought in order to shed light on the pathogenesis. ⁽³⁵⁾

- **Mechanics of traction therapy**

Traction that increases the separation of the vertebral body decreases the central pressure in the disc space and encourages the disc nucleus to return to a central position. The mechanical tension of the annulus fibrosus and ligaments surrounding the disc also tend to force the nuclear material and cartilage fragments toward the center.

Movement of these materials relieves pain and symptoms if they are compressing nervous or vascular structures. Decreasing the compressive forces also allows for better fluid interchange within the disc and spinal canal. The reduction in disc herniation is unstable and tends to return when compressive forces return. The positive effect of traction in this instance may be destroyed by allowing the patient to sit after treatment. Minimizing compressive forces after treatment may be equally as important to the treatment's success as the traction. The sitting posture increases the disc pressure, causing the nucleus to follow the path of least resistance and the disc herniation to return. ⁽⁵⁵⁾

3.5.1.5. Injection procedures

Pain pathogenesis in cases with nerve root compromise is caused not only by a mechanical compression but also by a chemical irritation due to proinflammatory cytokines. The rationale for nerve root blocks is therefore to tackle the inflammatory component of the nerve root compromise.

The peri-radicular foraminal nerve root block is always performed under image intensifier control, allowing for a direct application of the antiinflammatory agent to the target nerve root. The objective of a therapeutic selective nerve root block is not to cure the patient by interfering with pathogenetic factors that are responsible for sciatica but rather to provide **temporary relief** from peak pain during the time required for spontaneous resolution of radiculopathy.⁽²¹⁾

Epidural injections include a variety of injection techniques such as caudal (sacral), interlaminar lumbar and cervicothoracic. In contrast to the **selective nerve root blocks**, epidural steroid injections have the drawback that the pharmacological agent has to diffuse to the site of inflammation and there is no guarantee that it does so. In cases with multilevel involvement or non-specific leg pain the epidural route has some advantages compared to selective nerve root blocks.

The preferred level is **one level above** the target level. Others favor the level which corresponds to the segment of origin of the patient's symptoms. One or two percent anesthetic agent is injected to anesthetize the needle track. Using an interlaminar approach, a 22- or 25-gauge spinal needle is advanced between the spinous processes of the target level. Aiming at the upper edge of the lower lamina, the needle is inserted into the posterior epidural space with or without fluoroscopic control depending on one's personal experience with this technique. The location is confirmed using a small amount of contrast material.⁽⁵⁾

Injection of the enzyme chymopapain into the herniated disc produces a loss of water and proteoglycans from the disc, thereby reducing both the disc's size and the pressure in the nerve root.⁽²¹⁾

3.5.2. Non- conservative therapy approaches

3.5.2.1 Surgical indications for disc herniation or spinal stenosis

The symptomatic lumbar disc herniation has been estimated to be 1-2% and only 1.6% of people have sciatica/radiculopathy lasting more than two weeks. ⁽⁵⁸⁾ Surgery for sciatica is estimated to be necessary in between 1.3% and 3.1% of the population. In contrast, spinal stenosis does not have such good prognosis. Approximately 15% of patients improve, 15% worsen, whereas the remainder remain fairly stable. ⁽⁶²⁾

According to the Rand Corporation ⁽⁶²⁾

- Appropriate:
 - Pain in lower limb, imaging positive for disc hernia or spinal stenosis, major or minor neurological findings, restricted activity for **more than 6 weeks**.
- Equivocal:
 - Pain in lower limb, imaging positive for disc hernia or spinal stenosis, **major neurological findings**, restricted activity for less than 4 weeks.
 - Pain in lower limb, imaging equivocal for disc hernia or spinal stenosis, minor neurological findings, restricted activity for more than 6 weeks.
- Inappropriate:
 - Pain in lower limb, imaging positive for disc hernia or spinal stenosis, minor neurological findings, restricted activity for less than 4 weeks.
- Minor neuro findings (2 or more items)
 - Assymmetric ankle reflex
 - Dermatomal sensory deficit
 - Positive ipsilateral SLR (straight leg raise) test
 - Sciatica
- Major neurologic findings
 - Progressive unilateral leg weakness, or
 - Positive contralateral SLR test. ⁽⁶²⁾

3.5.2.2 Minimal invasive procedures

Contained discs, which are completely covered by outer annular fibers or posterior longitudinal ligament, are not in direct contact with epidural tissue. By contrast, non-contained discs are in direct contact with epidural tissue. This differentiation is of importance for minimally invasive surgical procedures such as chemonucleolysis or percutaneous disc decompression. ⁽⁵⁾

- **Percutaneous discectomy**

An advanced form of percutaneous discectomy developed to date uses a plasma technology to remove tissue from the center of the disc. During the procedure, an instrument is introduced through a needle and placed into the center of the disc where a series of channels are created to remove tissue from the nucleus. Tissue removal from the nucleus acts to decompress the disc and relieve the pressure exerted by the disc on the nearby nerve root. As pressure is relieved, pain is reduced, consistent with the clinical results of earlier percutaneous discectomy procedures. There is little tissue trauma and recovery times may be improved in many patients.

- **Intradiscal Electrothermoplasty (IDET)**

This procedure involves the insertion of a needle into the affected disc with the guidance of an x-ray machine. A wire is then threaded down through the needle and into the disc until it lies along the inner wall of the annulus. The wire is then heated which destroys the small nerve fibers that have grown into the cracks and have invaded the degenerating disc.

The heat also partially melts the annulus, which triggers the body to generate new reinforcing proteins in the fibers of the annulus. A study of fifty-three patients with discogenic back pain was published in the October issue of the journal, *Spine*. Depending on the stringency of criteria used, the success rate of IDET may be as low as 23% or as high as 60%.

- **Radiofrequency Discal Nucleoplasty (Coblation Nucleoplasty)**

Nucleoplasty is similar to the IDET procedure, a needle is inserted into the disc. Instead of a heating wire, a special radiofrequency probe is inserted through the needle into the disc. This probe generates a highly focused plasma field with enough energy to break up the molecular bonds of the gel in the nucleus, essentially vaporizing some of the nucleus. The result is that 10-20% of the nucleus is removed which decompresses the disc and reduces the pressure both on the disc and the surrounding nerve roots.

This technique may be more beneficial for sciatica type of pain than the IDET, since nucleoplasty can actually reduce the disc bulge, which is pressing on a nerve root. The high-energy plasma field is actually generated at relatively low temperatures, so danger to surrounding tissues is minimized. These new techniques are exciting. They offer the possibility of treating discogenic low back pain and sciatica with much less trauma and risk than surgery, but we must remember that these are still unproven technologies.⁽²³⁾

3.5.2.3. Lumbar spinal surgery procedures

Lumbar spinal surgery is much more commonly performed in the United States than it is in other countries. The most common lumbar spinal surgery in America is surgical treatment of lumbar disc herniation, and it is performed far more frequently than it is in most European countries.

In most afflictions of the lumbar spine, surgical treatment should be seen as the **final phase** of treatment when all other forms of treatment have not been effective in relieving pain or restoring normal neurologic or physiologic function.⁽²¹⁾

Laminotomy and Microdiscectomy

The standard technique for lumbar disc excision is a laminotomy through a technique that is currently known as **microdiscectomy**. This involves a limited exposure of the hemilamina on the right or left side, depending on the location of the disc.

A small amount of hemilamina on the cephalad and caudal sides of the ligamentum flavum is removed along with the ligamentum flavum. A small portion of the medial aspect of the facet joint is also removed. The underlying nerve root is identified and retracted toward the midline with a small retractor, and the underlying disc material is removed.

The technique may involve division of the lumbodorsal fascia at the tips of the spinous processes and lateral retraction of the unilateral paraspinal muscle or it may involve splitting the muscle overlying the lamina area, with less muscular retraction. Magnification is not required in order for this technique to be a microdiscectomy.

Some surgeons prefer to use loupes. Others prefer to use an actual operating microscope, and still others may use no magnification at all. But some type of accessory light such as a headlight is often used to illuminate the small area of exposure. The advantages of this procedure involve minimal disruption of the important stabilizing structures. Specifically, the interspinous and supraspinous ligaments are left intact. The facet joint and its capsule are largely undisturbed.



Figure 29: 1. Lamina to be removed, 2. superior lamina removal of the ⁽¹⁵⁾

There is essentially no destabilizing effect from removal of small portions of the lamina and unilateral ligamentum flavum, which is often left partially intact in the midline. This technique may be performed at one level or at more than one level, depending on the needs of the individual patient. This procedure generally lasts for approximately 1 hour for a unilateral discectomy. Patients may be discharged on the same day or the day following surgery.

Laminectomy technically refers to removal of an entire lamina. It involves bilateral exposure of the hemilamina, generally by splitting the lumbodorsal fascia in the midline and then performing subperiosteal dissection to expose the entire lamina.

In a true complete laminectomy, the entire lamina, along with the spinous process and the ligamentum flavum caudal and cephalad to the lamina, is removed. This allows access to the entire spinal canal at a given laminar level, as well as to four nerve roots, two cephalad and two caudal.

The facet joints are generally preserved, but when this technique is used-and it is often used in spinal stenosis-the facets are undercut. This procedure involves removal of inferior osteophytes underneath the facet by reaching from within the spinal canal rather than removing the entire facet, which causes significant destabilization of the motion segment.

Complete laminectomy produces a destabilizing effect. However, this procedure is generally performed in older individuals with degenerative disc settling and degenerative facet joints and these areas are generally stable due to the degenerative changes. It is not necessary to perform a fusion whenever a complete laminectomy is performed.

In spinal stenosis it is common to perform laminectomy at multiple levels, as symptomatic spinal stenosis is often a multilevel disease. When a complete laminectomy is performed to decompress a spondylolisthesis, it is often referred to as a **Gill procedure**.⁽²¹⁾

4. Methodology

This thesis completed a systematic review of the relevant literature on the efficacy of conservative treatment of Lumbar Disc Herniation (LDH). In order to evaluate and in order to make the thesis more reliable, the author selected mostly research studies that used the most recent reliable experimental designs and systematic reviews.

The main criteria in this systematic review for trials analyzed were that all patients would have sciatica radiculopathy symptoms due to disc herniation. The assessment was to evaluate patients with certain duration of symptoms due its good overlaps over time. The research was made to describe and evaluate all important information assessing the disc pain and the rehabilitation of it.

Literature Search, Study Selection and Data

Extraction

We search a broad range of database to identify published and unpublished studies with information about disc herniation with main concern of treatments benefits and differntations. We selected and extracted rescent articles that we felt relevant or intresting as well as choosing what we were aware of being potentially important.

Each database was searched from its starting date on September 2009. The databases searched were:

- MEDLINE
- Pre MEDLINE
- EMBASE
- The Spine Journal
- Europran Spine Journal
- British Medical Journal

- Cochrane Database of Systematic Reviews
- The New England Journal of Medicine
- American academy of orthopaedic surgeons
- Journal of the american medical association
- Journal of chiropractic medicine

To identify the patient groups, interventions, and outcomes that should be included in the review, we read background material from diverse sources including textbooks, reports, and proceedings with Doctors, and Web sites. The quality of all trials in the review was assessed using a list of items indicating components of internal validity.

All reviews were to assess all different documentations on disc herniation in the lumbar region and the most treatments known for it. Evaluating results of each treatment effect and to compare from different conclusions from the different trials mentioned.

Measures of outcomes for pain and disability will be analyzed in detail to understand better the process of the effect of each treatment and to distinguish them to reach a conclusion of when and which treatment is appropriate for the patients with symptomatic disc herniation.

Most outcomes were measured with a baseline and duration of meeting of examinations. These were mostly: Visual analogue scale (VAS), Oswestry Disability Index (OID), Roland morris disability index and other outcomes were included by sciatica severity measured by the Sciatica Bothersomeness Index, satisfaction with symptom self-reported improvement and employment status.

All reviews and articles were in English language.

In the Appendix the the level of evidence are shown.

5. Conservative versus non conservative treatments trials for disc herniations

5.1. Non conservative treatments

5.1.1. Surgery versus non operative treatment for disc herniation

The spine patient outcomes research trial (S.P.O.R.T.) assessed a four year outcome of surgery versus non operative care in 13 spine clinics in 11 states in the U.S.A. **1244 participants** with lumbar intervertebral disc herniation were enrolled out of 1991 eligible for enrollment. The patients had the chance to choose if they would follow a randomized or a cohort observation trial. The assessment was made for an observational cohort of 743 participants and a randomized trial of 501 participants which evaluation was at 6 weeks, 3 months, 6 months and 1 and 2 years. ⁽⁷⁵⁾

In the **randomized clinical trial Weinstein et al.** patients were enrolled from March 2000 until November 2004 whom **501 patients** being surgical candidates with mean age of 42 years and 42% being females. A total of 472 participants completed at least 1 follow-up visit and were included in the analysis. There was limitation in compliance of assigned treatment: 50% of patient's assigned to surgery received surgery within 3 month of enrollment, while 30% of those assigned to nonoperative treatment received surgery in the same period.

In the non operative treatments: most patients received education/counselling (93%) and anti-inflammatory medication (61%) (no steroidal anti-inflammatory drugs, cyclooxygenase 2 inhibitors or oral steroids, 46% received opiates, more than 50% received injections (e.g. epidural steroids) and 29% were prescribed activity restrictions. 44% received active physical therapy during the trial but 67% had received it before the trial.

In the surgical treatments was **standard open discectomy**, it took a median time of 75minutes had median bloody loss of 49.5ml, with only 2% requiring transfusion. The most common complication was dural tear (4%). There were no post-operative complications in 95%. Reoperation occurred in 4% in 1 year of initial surgery of which 5% were from recurrent herniation at the same level.

Greater improvements in the Sciatica Bothersomeness Index were in the surgery group at all designated follow-up times: 3 months (treatment effect, -2.1; 95% CI, -3.4 to -0.9), 1 year (treatment effect, -1.6; 95% CI, -2.9 to -0.4), and 2 years (treatment effect, -1.6; 95% CI, -2.9 to -0.3), with results of the global hypothesis test being statistically significant ($P=.003$). Patient satisfaction with symptoms and treatment showed small effects in favor of surgery while employment status showed small effects in favor of nonoperative care, but none of these changes was statistically significant. Self-rated progress showed a small statistically significant advantage for surgery ($P=.04$).⁽⁷⁷⁾

As-treated analyses based on treatment received were performed with adjustments for the time of surgery and factors affecting treatment crossover and missing data. These yielded far different results than the intent-to-treat analysis, with strong, statistically significant advantages seen for surgery at all follow-up times through 2 years. For example, at 1 year the estimated treatment effects for the SF-36 bodily pain and physical function scales, the ODI, and the sciatica measures were 15.0 (95% CI, 10.9 to 19.2), 17.5 (95% CI, 13.6 to 21.5), -15.0 (95% CI, -18.3 to -11.7), and -3.2 (95% CI, -4.3 to -2.1), respectively.⁽⁷⁷⁾

In the **observational cohort Weinstein et al.** enrolled **743 patients** in which initially 521 patients chose surgery and 222 chose non operative care. In 91% surgery was received in the first 6 weeks of enrolment, a remaining 4% of patients received surgery in 6 months and the remaining 4% didn't receive any surgery and stayed with non operative care. From the non operative cohort 2% underwent surgery in the first 6 weeks while another 16% in the following 6 months and 22% had surgery in a 2 year period. Overall 528 patients received surgery and 191 patients received conservative treatment.

The mean age was 41.4 years old, being mostly men of Caucasian race which had full time or part time jobs. 98% of them had dermatome radiation pain; most herniations were at the level of L5-S1 which were posterolateral extrusions confirmed by an imaging technique.⁽⁷⁴⁾

In the non operative treatment of the observational cohort 92% of the patients received education and counseling; 58% received non-steroidal anti-inflammatory drugs; 35% received narcotic analgesic agents; 43% underwent physical therapy and 38% had epidural injections. The average time of the surgery was 70 minutes with a blood loss of 50ml on average and only 2 patients required transfusions. There were some surgical complications,

2% for Dural tear. There were also re-operations in 7% of the cases by the first year and 9% at 2 years with more than half being recurrent herniations at the same level.

Of the 743 patients enrolled in the observational cohort, 528 patients received surgery and 191 received usual nonoperative care. At 3 months, patients who chose surgery had greater improvement in the primary outcome measures of bodily pain (mean change: surgery, 40.9 vs nonoperative care, 26.0; treatment effect, 14.8; 95% CI, 10.8-18.9), physical function (mean change: surgery, 40.7 vs nonoperative care, 25.3; treatment effect, 15.4; 95% CI, 11.6-19.2), and O.D. I (mean change: surgery, -36.1 vs nonoperative care, -20.9; treatment effect, -15.2; 95% CI, -18.5 to -11.8).

These differences narrowed somewhat at 2 years: bodily pain (mean change: surgery, 42.6 vs nonoperative care, 32.4; treatment effect, 10.2; 95% CI, 5.9-14.5), physical function (mean change: surgery, 43.9 vs nonoperative care 31.9; treatment effect, 12.0; 95% CI; 7.9-16.1), and O.D.I (mean change: surgery -37.6 vs nonoperative care -24.2; treatment effect, -13.4; 95% CI, -17.0 to -9.7).

There was substantial improvement over time in both conservative and non-conservative groups of patients, but greater results were in those patients who underwent surgery. The benefit of surgery was noticeable at the first 6 weeks and was maintained for at least 2 years. With the primary outcome of 3 months, surgery was the most effective method in contrast with the non operative treatment. There was a **greater improvement with surgery** than conservative treatment, but after the second year the difference in effectiveness was slightly decreased.⁽⁷⁴⁾

Pearson et al. combining the S.P.O.R.T randomized and observational trial mentioned above; was made to evaluate if treatment, location and the morphology of disc herniation mattered. From the 1191 patients; **775 had surgery and 416 had non-operative** treatment in 2 years time.

In this analysis for **location** it demonstrated that 131 (11%) had central herniations and patients were younger and at baseline the pain was more severe than those patients with lateral herniation but benefited similarly with surgery. In the herniation **morphology** the analysis demonstrated that 322 (27%) had disc protrusions and from the questionnaires

mentioned above they had less severe symptoms. The extrusion/sequestration were more likely to undergo surgery than the protrusion group (64% vs. 56%, respectively, $P=0.009$).⁽⁴⁸⁾

Lurie et al. by combining both S.P.O.R.T randomized and observation cohort evaluated the outcomes of lumbar discectomy varying by **herniation level**. In both treatment groups with confirmed imaging methods for herniation levels the following patients were 646 L5-S1, 456 L4-L5, 68 L3-L4 and 20 L2-L3. The level of herniation varied with age as patient with upper level herniations were older, the level L4-L5 were intermediate in age and the L5-S1 group was the youngest.⁽⁴⁰⁾

The severity of leg-symptoms was lower at baseline for patients with upper herniations. In 72% (465) of 646 patients with L5-S1 herniation and 57% (262) of 456 with L4-L5 herniations had a positive ipsilateral straight leg-raising test, while 43% (38) of 88 patients with upper level herniations had a positive femoral stretch test. Asymmetric reflexes were less likely for upper herniation and L4-L5, while motor weakness were less likely found in L5-S1.

Foraminal herniations were most likely found in upper levels (24%), in L4-L5 (3%) and in L5-S1 (2%); far lateral herniations were found (25%) in upper levels, a 7% in L4-L5 and (6%) in L5-S1 and most were **posterolateral herniation** which represented in upper level (44%), in L4-L5 (76%) and in L5-S1 83%). The upper level herniation group was more likely to have a sequestered fragment.

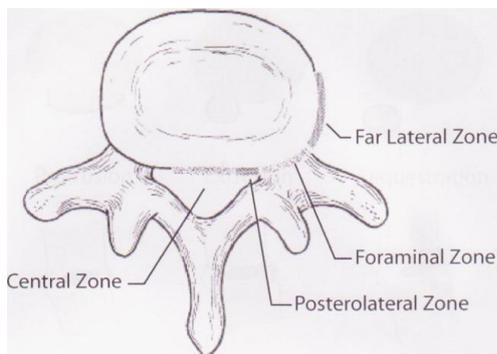


Figure 30: schematic display herniation location zones.⁽⁷⁵⁾

From the data of the research trial it shows a greater difference in improvement between operative and non-operative treatment for upper level herniation (L2-L3 and L3-L4) than for

herniations at the levels L4-L5 and L5-S1. Patients with upper level herniation had less improvement with non-operative treatment and slightly better operative outcomes than those with lower level herniations.

The difference between the upper level herniation and L5-S1 herniation was at range of 10 to 15 points on the SF-36 bodily pain and physical functioning scale and the O.D.I giving the relationship between level and outcome of surgery that the upper level herniation was greater than the L4-L5 results, which were greater than the L5-S1 results. ⁽³⁹⁾

Back pain improved in intervertebral disc herniation (IDH) patients treated either by surgery or non-operative care but the magnitude of improvement was greater in surgery. The surgery treatment effect was diminished during time but the difference between the two treatment groups was still significant at the two years landmark. Leg pain relief was also greater in surgery and it was noticed that leg pain relief was greater than back pain relief in both treatment groups. However work status didn't show significant benefit for surgery. ⁽⁷⁶⁾

There were a number of **limitations** in this study as of patient's **crossingover** treatment groups. Specifying the morphology of one herniation for concluding a more reliable study but would have a lesser amount of patients. The non operative had greater result than other studies compared to this study but it was specified in "usual care" which gave it a more generalization. Only 43% of the non operative patient's went to a physical therapist which show's that if a **more intensive program** was given, it may had been **more effective** for some patients. ⁽⁴⁰⁾

Nevertheless the combination as-treated analysis at 4 years concluded that the patients who had surgery achieved a greater improvement than no-operatively treated patients in all primary and secondary outcomes except work status. ⁽⁷⁵⁾

In an even longer trial **Atlas et al.** conducted a 10-year outcome of patients with sciatica resulting from a lumbar disc herniation treated surgically or nonsurgically. Patients were recruited from the practices of orthopedic surgeons, neurosurgeons, and occupational medicine physicians throughout **Maine**. ⁽²⁾

Clinical data were obtained at baseline from a physician questionnaire. Primary analyses were based on initial treatments received, either surgical or nonsurgical. Secondary analyses examined actual treatments received by 10 years. Outcomes included patient reporting

symptoms of leg and back pain, functional status, satisfaction, and work and disability compensation status.

From 507 initially enrolled patients for 10-year outcomes, available were 400 of 477 (84%) surviving patients; 217 of 255 (85%) were treated surgically, and 183 of 222 (82%) were treated nonsurgically. Patients undergoing surgery had worse baseline symptoms and functional status than those initially treated nonsurgically. By 10 years, 25% of surgical patients had undergone at least one additional lumbar spine operation, and 25% of nonsurgical patients had at least one lumbar spine operation.

In the 10-year follow-up, 69% of the patients were initially treated surgically reported improvement in their predominant symptom (back or leg pain) versus 61% of those initially treated nonsurgically ($P = 0.2$). A larger proportion of surgical patients reported that their low back and leg pain were much better or completely gone (56% vs. 40%, $P = 0.006$) and were more satisfied with their current status (71% vs. 56%, $P = 0.002$).

There were treatment group differences persisted after adjusting other determined outcomes in multivariate models. Change in the modified Roland back-specific functional status scale in favored of surgical treatment, and the relative benefit persisted over the follow-up period. Despite these differences, work and disability status at 10 years were comparable among those treated surgically or nonsurgically.

Surgically treated patients with a herniated lumbar disc had a more complete relief of leg pain with improved function and satisfaction compared with nonsurgically treated patients over 10 years. However, improvements in patient's predominant symptoms and work disabilities outcomes were similar regardless of treatment received.

Although, improvement in the patient's predominant symptom and work and disability outcomes were similar regardless of treatment received. A patient must require in an individualized treatment plan which requires to each patient and their physicians to integrate clinical findings with patient preferences based on their symptoms and goals. ⁽²⁾

In another randomized controlled trial in research **Peul et al** provided a **prolonged conservative care vs early surgery** in patients with sciatica due to lumbar disc herniation which had 3 articles providing information: 1) Efficiency after 1 year of trial 2) cost utility analysis for 1 year outcome and 3) efficiency after 2 years of trial.

The enrollment of patients was from November 2002 until February 2005 at a Dutch hospital. There were 599 patients with indication for surgical treatment from their practitioner. After initial consultation with neurologist 395 patients met the criteria and were verified by MRI. At by the second visit 283 patients whom continued to have sciatica due to lumbar disc herniation were randomized into 2 treatment strategies. Before randomization patients were again evaluated and if any recoveries of symptoms were found were excluded.

Early surgery was scheduled within 2 weeks from assignment. The symptomatic disc herniation was removed by a minimal unilateral transflaval approach with magnification with general or local anesthesia of the patient. Surgery was performed to decompress the nerve root and reduce the risk of recurrent disc herniation by performing an annular fenestration, curettage, and to remove of loose degenerated disc material from disc space using a rongeur, without attempting a subtotal discectomy. Duration of staying in hospital depended on patient's mobility. At home patients were supervised for rehabilitation by physiotherapist using a standard exercise protocol and were advised to resume their regular jobs.⁽⁵¹⁾

Prolonged conservative treatment was provided by general practitioners; patients were informed about their diagnoses and the natural course of the disease; for successful recovery expectations and intensity of pain. The main aim of treatments was resuming daily activities. Pain medications were prescribed if necessary and for patients who had limited movement were assigned to a physiotherapist.

Functional disability intensity of leg pain, and global perceived recovery were the primary outcomes and were assessed at 2,4,8,12,26,38 and 52 weeks. Secondary outcomes were repeated neurologic examination, functional and economic observation assessments which monitored scheduled at 8,12,52 weeks.

From the 283 patients having sciatica pain due to disc herniation divided randomly and assigned of 143 patients to undergo early surgery, 125 (89%) underwent **microdiscectomy** after a mean of 2.2 weeks. Of 142 patients designated for conservative treatment, 55 (39%) were treated surgically after a mean of 18.7 weeks. There was no significant overall difference in disability scores during the first year ($P=0.13$). Relief of leg pain was faster for the patients assigned to early surgery ($P<0.001$). Patients assigned to early surgery also reported a faster rate of perceived recovery. In both groups, however the probability of perceived recovery after 1 year of follow-up was 95%.

Patients were assigned for early surgical treatment, 16 (11%) recovered before surgery was performed without receiving conservative treatment. For the remaining 125 patients early surgery the median, was 1.9 weeks after randomization. 142 patients were assigned to prolonged conservative treatment but 55 underwent surgery during the first year, an average of 14.6 weeks. Another 7 underwent surgery in the second year because of persistent pain, resulting in **62 surgically** treated patients (**44%**) from the conservative group. ⁽⁵²⁾

In both groups which underwent surgery there was recurrent sciatica in 6% during the 2 year follow-up representing 3% of the total conservative, and 5% of the early surgery group. After the first 12 weeks of randomization, there was a faster recovery and relief of pain. Surgery complications occurred in 1.6% of the patients, involving two dural tears and one wound haematoma but no interventions was needed.

In this randomized trial we conclude that: when patients had sciatica for 6-12 weeks, an **early surgery provided faster recovery** than prolonged care. However after a year the results are similar with having the absence of outcome differences remaining the same in 2 years time. Knowing that early surgery has an earlier effect compared with prolonged conservative care it can be said that surgery shouldn't be discouraged because higher economic costs. The timing of surgery can not be determined from this trial and further research is needed. ⁽⁵⁰⁾ However since the treatment effects of early surgery are gone after six months, information concerning early surgery vs. prolonged conservative treatment should be provided to the patient and the patient should choose based on the information provided. ^(52, 51)

Conservative vs. non conservative trials evaluation

Webers study is a landmark in history on prospective studies for lumbar disc herniation treatments approach. Two hundred eighty patients with herniated lumbar discs, verified by radiculography, were divided into three groups. ⁽⁴⁰⁾

The mainly first group was consisted of 126 patients with uncertain indication for surgical treatment, who had their therapy decided by randomization which permitted comparison between the results of surgical and conservative treatment. Another group comprised of 67

patients had symptoms and signs that beyond doubt, required surgical therapy. The third group of 87 patients was treated conservatively because there was no indication for operative intervention.

In the follow-up examinations the first group were performed after one, four, and ten years. The controlled trial showed a statistically significant better result in the surgically treated group at the one-year follow-up examination. After four years the operated patients still showed better results, but the difference was no longer statistically significant. Only minor changes took place during the last six years of observation.⁽⁷¹⁾

Without any valid measures outcomes the 4 year result of Weber's study was similar with comparison of SPORT's with "good" results of 70% and 79.2% in surgery groups and 51% and 51.7% in the non-operative groups respectively.

Maine study reported larger adjusted treatment effect differences at 5 years between patients who had surgery within 3 months versus those that had not when compared with SPORT trial 4 year data; -7.1 vs. -3.3 9 (sciatica bothersomness), -2.0 vs.-0.9 (leg pain past week) and -1.2 vs.-.8 (low back pain past week). However SPORT had greater improvements in the non-operative group with the sciatica bothersomness mean change from baseline were -8.2 at 4 years vs. Maine trial -4.6 at 5 years.⁽⁷⁹⁾

In a general view of the above trials a significant efficiency in all clinical outcomes in favor of surgery against non-operative. There was some significant decrease over years in the following outcomes between these procedures but surgery maintained greater results. For early surgery it showed that after having sciatica for 6-12 weeks earlier pain relief in contrast of conservative treatment was evaluated. But these results were not so significant in 6 months and the difference between the two groups was decreased. Needed to be mentioned is the "usual care" given in conservative treatments advising in general instructions and treatments and not in specific treatments for better rehabilitation results. However good results in non-operative were also acknowledged in the trials. In all the trials a same limitation of criss-cross of patients between the groups due to randomization of treatment approaches produce a dysbalance of the initial group's enrollment.

5.1.2. Minimal Invasive procedures research

Percutaneous endoscopic lumbar discectomy

A prospective study of 116 consecutive patients undergoing single-level percutaneous endoscopic lumbar discectomy (PELD) was conducted by **Lee et.al.** According to preoperative MRI findings, disc migration was classified into **four zones** based on the direction and distance from the disc space: **zone 1** (far up) from the inferior margin of the upper pedicle to 3 mm below of the inferior margin of upper pedicle, **zone 2** (near up) from 3mm below of the inferior margin of upper pedicle to the inferior margin of the upper vertebral body, **zone 3** (near down) from the superior margin of lower vertebral body to the center of lower pedicle, **zone 4** (far down) from the center to the inferior margin of lower pedicle.

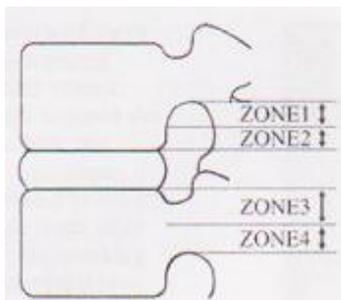


Figure 31: 4 anatomic zones and levels of disc herniation

Two surgical approaches were used according to this classification. Near-migrated discs were treated with “half-and-half” technique, which involved positioning a beveled working sheath across the disc space to the epidural space. Far-migrated discs were treated with “epidurosopic” technique which involved introducing the endoscope into the epidural space completely.

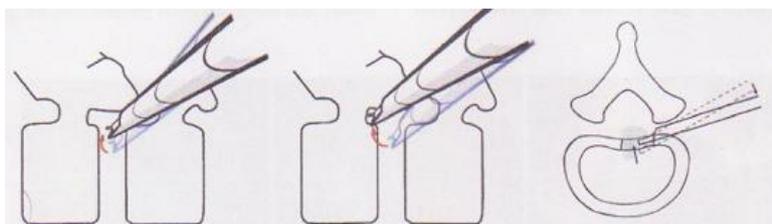


Figure 32: “Half-and-half” technique, “epidurosopic” technique and annulus removed

There were 73 males and 43 females, with a mean age of 35.5 (range 18-65) years. The mean follow-up period was 14.5 (range 9-20) months. The L4-5 disc was the most commonly herniated level (65 cases, 56.0%) followed by L5-S1 (47 cases, 40.5%), L3-4 (3 cases, 2.6%), and L2-3 (1case, 0.9%). Herniations were localized at zones 1- in 4 (3.5%), 5(4.3%), 73(62.9%), and 34(29.3%) cases, respectively.

According to modified Macnab criteria, satisfactory (excellent or good) results were distributed as follows: 91.6% (98/107) in the down-migrated discs; 88.9% (8/9) in the up-migrated discs; 97.4% (76/78) in the near-migrated discs; and 78.9 (30/38) in the far-migrated discs. The difference between near-migrated group (97.4%) and far-migrated group (78.9%) was statistically significant ($P=0.002$) while the difference between down-migrated group (91.6%) and up-migrated group (88.9%) was not statistically significant ($P=0.569$).

Two techniques of PELD can be used according classification: of disc migration into four zones. The results suggest that open microdiscectomy may give superior results in far-migrated discs. The results of this study will contribute to the establishment of surgical guidelines for PELD in the treatment of migrated disc herniation. A prolonged follow up is necessary to determine the validity of these initial results. ⁽³³⁾

Comparison of microscopic techniques

Franke et.al in a prospective randomized controlled clinical trial compared two operative techniques **standard microscopic technique** and **microscopic assisted percutaneous nucleotomy** (MAPN) technique. A two-center design was chosen with the developing (index) center and a less MAPN experienced (transfer) center. ⁽¹⁶⁾

All procedures in either center were performed by the same senior surgeon (R.G.-P. or J.F.) or at least assisted by that senior surgeon in order to get more valid results excluding the surgeon factor as far as possible. The pre-study surgical training of lumbar disc surgeries of both senior surgeons exceeded **300 cases**. There was pre-study experience for MAPN technique with 150 cases (R.G.-P.) and with 20 cases (J.F.).

Unlike the microsurgical technique the X-ray converter remains in the lateral view within the operation area. The level localization with a spinal needle was done on the opposite side. The pinpoint was directed at the open interlaminar window. The skin incision of 15 mm at the side of the pathology was performed in height of the needle entry point approximately 2 cm paramedian.

Both the thoracolumbar fascia and the paraspinal muscles were dilated till the working channel could be brought in. in the context of this study we utilized work channels with an outside diameter of 14 mm. All work steps were performed under direct vision via microscope in the fundamental technique.

Between September 2002 and May 2004, 100 patients were included to the study. A microsurgical procedure underwent 48 and 52 patients a MAPN procedure. At the index center 25 patients were randomized to both groups, whereas at the center 27 patients were randomized to the MAPN group and 23 to the MC group.

The average age of the complete group was 44 years (min 21, max 72, SD 11.7). There were 40 women and 60 men with an equal distribution between groups. The pathologic segment was L5/S1 in 42%, L4/5 in 51%, L3/4 in 6% and L2/3 in 1%. Preoperatively, 82 patients showed neurological deficits, 33 only sensory disturbances, and 49 motor and sensory deficits. According to the inclusion criteria they diagnosed 45% free sequestra, 42% subligamentous sequestra and 13% subligamentous herniation.⁽¹⁶⁾

There was a huge clinical improvement for all patients regardless of center or method by a repeated measures ANOVA on the sum VAS for all time points ($F=165$, $P<0.0001$), moreover, there was a significant center-method interaction ($F=4.9$, $P=0.006$).

These results suggest that the clinical outcome of both surgical methods was indistinguishable at the transfer center, whereas MAPN patients at the index center showed a slightly faster recovery when compared to MC patients. This was mainly due to the fact that there was a more pronounced reduction in the VAS scale for back pain. This phenomenon reached statistical significance at discharge ($P<0.001$), 8 weeks ($P=0.002$) and 6-month ($P=0.003$) follow up. For the 12-month follow up this difference could not be found ($P=0.467$). No difference was found for the VAS scale for leg pain at any of the time points.

In two cases a deterioration of the neurological situation occurred immediately postoperatively (<48 h), however, it recovered later uneventfully. In **83% of** the patient a primary observed **motor deficit** resolved completely within the follow up period. **Sensory deficits** completely resolved in **68%** of the patients, **improved in 18%**, and remained **unchanged in 14%**. For the neurological situation there was no obvious difference was found for the transfer center.

The mean hospital stay at the index center was significantly shorter for the MAPN group with 3.8 days compared to the MC group with 4.9 days. All patients, who were preoperatively in an employment relation, resumed their occupation within 14 weeks, 77% within 8 weeks. The average postoperative inability to work was 7 weeks.

Altogether, seven patients had to have a reoperation (7%). Five patients developed after a symptom free (ranging from 3 to 11 months) a genuine relapse (same level, same side). These five patients (four from the MC group, one from the MAPN group) underwent a reoperation using the same technique performed previously. At the remaining two patients (one with MAPN and one patient from the MC group) a segmental instability within the follow-up period got apparent due to progressive disc degeneration. Eleven months after the original intervention one total disc arthroplasty was implantes, whereas the other patient underwent a PLF (posterior lumbar fusion) procedure. No further complications did occur.

Within the study period no real clinical advantages of the less traumatized posterior muscles could be found. Thus, the hypothesis that with a lesser traumatized back muscle leads to a quiker recovery and to less chronic pain could not be confirmed.⁽¹⁶⁾

Percutaneous Laser Disc Decompression

In a review of Percutaneous Laser Disc Decompression (PLDD) Schenk B. et.al evaluated **sixteen clinical trials** included, representing a total of **1579 patient**. The basic technique of PLDD is the same for all trials. The procedure is conducted under local anesthesia of the skin and underlying muscles.

After assessment of the correct disc level by using a fluoroscopy, a hollow needle was inserted 10 cm from the midline, pointing toward the center of the disc. When the needle was

in place, its correct position was verified by using biplanar fluoroscopy, sometimes in combination with CT imaging. A laser fiber (0.4 mm) is inserted through the needle into the center of the nucleus pulposus. Laser energy is then delivered into the nucleus pulposus to vaporize its content and reduce intradiscal pressure.

The **criteria for selection** of patients for treatment of PLDD which is based on the concept of the intervertebral disc being a **closed hydraulic system, only contained herniations** can be expected to respond to reduction of intradiscal pressure.

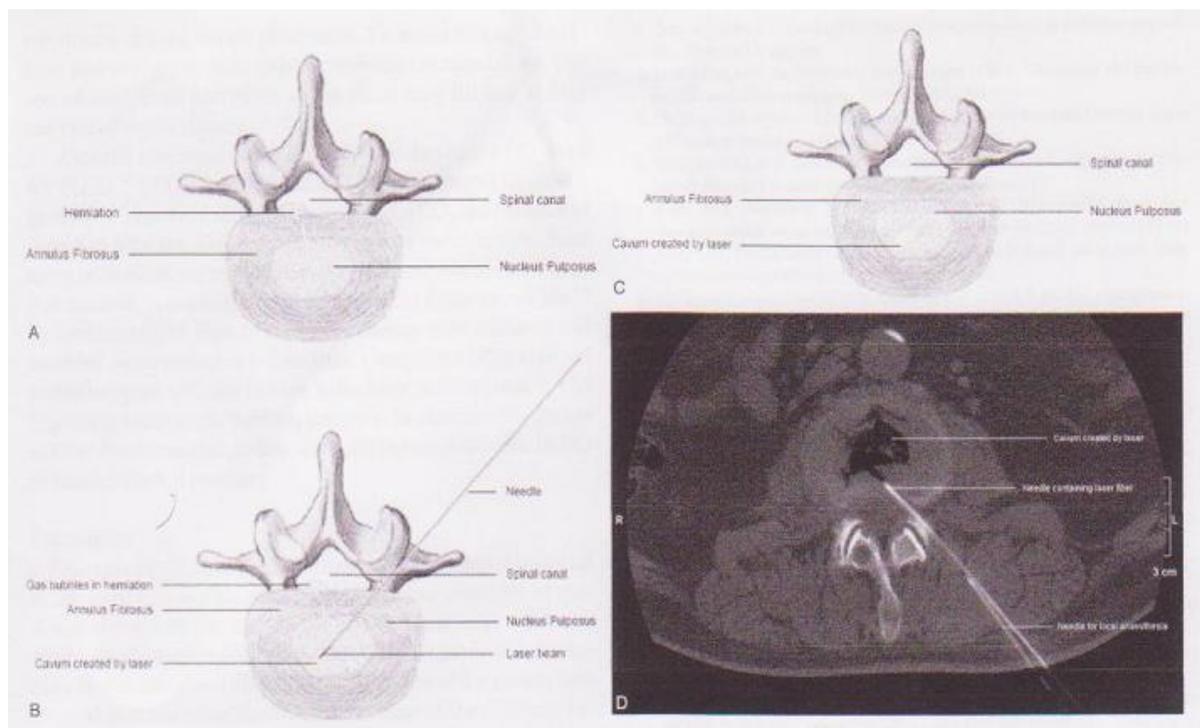


Figure 33: A Herniated disc before PLDD, B. Application of laser energy into the NP, C. Herniated disc after PLDD, D. CT image after PLDD, showing gas-containing in NP.

Success rates in the larger studies varied from 75% (95% confidence interval [CI], 69% - 81%) to 87% (95% CI, 80% - 94%). The definition of successful outcome varied strongly between the different studies, depending on the outcome measures used. The duration of follow-up ranged from 3 to 84 months. There was insufficient improvement of symptoms or recurrent herniations, 4.4% to 25% whom patients received additional surgical treatment. In most cases of surgery the presence of free fragments in the spinal canal was revealed.

No randomized, controlled trials were available. Almost all trials were case series, with a relatively **low strength of evidence**. Furthermore, the sample size in most trials was relatively small, resulting in broad 95% CIs that made interpretation of success rates difficult. Generalization of the results into general practice remains difficult, because of the different inclusion and exclusion criteria, laser types, and outcome measures used and the large variation in duration of follow-up.⁽⁶²⁾

In the largest study to date **Tassi** reviewed the outcomes from 500 patients with discogenic pain and herniated discs treated with microdiscectomy (1997-2001 by 6 surgeons) and 500 patients treated with percutaneous laser disc decompression (2002-2005 by a single surgeon). Patients with sequestered disc were excluded. This retrospective review found that the hospital stay (six vs. two days), overall recovery time (60 vs.35) and repeat procedure rate (7% vs. 3%) were lower in the laser group. The percentages of patients with overall good/excellent outcomes were found to be similar in the two groups (85.7% vs. 83.8%) at a two year assessment.⁽⁶³⁾

Despite the fact that PLDD has been around for almost 20 years, **scientific proof** of its **efficacy** still remains **relatively poor**, though the potential medical and economic benefits of PLDD are too high to justify discarding it as experimental or ineffective on the sole basis of insufficient scientific proof.⁽⁶³⁾

A standard Cochrane review method to analyze of all randomized controlled trials which were published up to January 1, 2007 was used and identified forty randomized controlled trials (RCTs) and 2 quasi-RCTs.

Many of the early trials were of some form of chemonucleolysis, whereas the majority of the later studies either compared different techniques of discectomy or the use of some form of membrane to reduce epidural scarring.

Four trials directly compared discectomy with conservative management, and these gave suggestive rather than conclusive results. However, other trials showed that discectomy produces better clinical outcomes than chemonucleolysis, and that in turn is better than placebo.

Microdiscectomy gives broadly comparable results to standard discectomy. Recent trials of an interposition gel covering the dura (5 trials) and of fat (4 trials) show that they can reduce scar formation, however there is limited evidence about the effect on clinical outcomes.

There is insufficient evidence on other percutaneous discectomy techniques to draw firm conclusions. Three small RCTs of laser discectomy did not provide conclusive evidence on its efficacy. There were no published RCTs of coblation therapy or transforaminal endoscopic discectomy.

Surgical discectomy for carefully selected patients with sciatica due to lumbar disc prolapse provides faster relief from the acute attack than conservative management, although any positive or negative effects on the lifetime natural history of the underlying disc disease are still unclear. The evidence for other minimally invasive techniques remains unclear except for chemonucleolysis using chymopapain, which is no longer widely available. ⁽⁴⁶⁾

5.2. Conservative treatments: Medications

5.2.1 Oral Medications

Medications are common used for pain associated with lumbar disc herniations which include nonsteroidal anti-inflammatory drugs, corticosteroids, muscle relaxants, and opioid pain medications. (Rhee et.al) ^(57,58)

Nonsteroidal anti-inflammatory drugs have been shown to be helpful for the management of acute low-back pain (Tulder et al), but a meta-analysis of the literature demonstrated that they had no benefit in the treatment of radiculopathy compared with controls (odds ratio = 0.99) (Vroomen et al.).

Corticosteroids are administered orally or by injection. While oral steroids are commonly prescribed in clinical practice, we found only one study on their use for the treatment of lumbosacral radicular pain (Haimovic). In this study, dexamethasone was not superior to a placebo for either early or longterm relief of lumbosacral radicular pain, but it helped patients who had presented with a positive result on the straight-leg-raise test. ^(57,58)

Non-steroidal anti-inflammatory drugs vs. Placebo in sciatica caused by disc herniation

One systematic review of medical treatments for sciatica caused by disc herniation (search date 1998, 3 RCTs, 321 people) (Vroomen et al). The RCTs compared non-steroidal anti-inflammatory drugs (NSAIDs) (piroxicam 40 mg daily for 2 days or 20 mg daily for 12 days; indometacin [indomethacin] 75–100 mg 3 times daily; phenylbutazone 1200 mg daily for 3 days or 600 mg daily for 2 days) versus placebo.

The review found **no significant difference** between NSAIDs and placebo in global improvement at 5–30 days (pooled AR for improvement in pain 80/172 [46.5%] v 57/149 [38.3%]; OR for global improvement 0.99, 95% CI 0.6 to 1.7.

The systematic review did not report the adverse effects of NSAIDs. NSAIDs may cause gastrointestinal complications.

The absolute numbers in the RCTs relate to the outcomes of improvement in pain (3 RCTs) and return to work (1 RCT). However, the meta-analysis used the outcome measure of global improvement. The relationship between these measures is unclear. ⁽⁷⁸⁾

5.2.2. Injection

Valat et.al to determine the efficacy of **epidural corticosteroid injections** for sciatica provided the study which was a multicenter, **randomized double blind, controlled clinical trial**, conducted in five rheumatology departments of university hospitals in France from October 1997 to January 2000. Randomization took place after written informed consent and baseline information which were obtained from the study participants.

Inpatients referred for sciatica were eligible if they had a first or recurrent episode of sciatica lasting for more than 15 and less than 180 days. With pain intensity which had to be >30 mm on visual analogue scale (VAS).

The patients received three epidural injections (at two day intervals) of either 2 ml prednisolone acetate (50mg) or 2 ml isotonic saline by a lumbar interlaminar approach using loss of resistance technique, without fluoroscopic guidance.

Lumbar exercises and other spinal injections were not authorized during the study. Non-steroidal anti-inflammatory drugs (NSAIDs) were authorized only 20 days after the first injection. **Non-opioid analgesics, bed rest, mild lumbar tractions, and lumbar belts** were authorized. The doctors making the assessments were not the same doctors as those giving the injections. So the patient and the assessing doctor were both **unaware** of the treatment received.

The patients were re-evaluated five days after inclusion (after the last injection, before leaving the hospital) and as outpatients 20 and 35 days after the first injection. Each patient was examined by the same doctor throughout the trial. At each visit, information on the use of analgesics and NSAIDs was recorded.

Between October 1997 and December 1999, 85 patients were enrolled in the study, 43 patients in the steroid group (SG), and 42 in the control group (CG). The baseline characteristics were similar in the two groups. The large majority of the injections (89.5%) were performed at the L4-5 level, 7% at the L3-4 level and 3.5% at the level L5-S1 level.

On an intention to treat analysis at day 20 the groups did not differ significantly with respect to the primary outcome: 15/42 (36%) patients in the CG and 22/43 (51%) in the SG ($p=0.15$) were considered as success (difference 15.5%; 95% confidence interval (CI) for the

difference -5.4 to 36.3). At the end of the study (day 35), 20/42 (48%) patients in the CG and 21/43 (49%) in the SG ($p=0.91$) were considered as success (difference 1.2%; 95% CI for the difference -20.0 to 22.5).

Among the 48 failures, 14 patients (six in the CG and eight in the SG) required NSAIDs, three required surgery (2 in the CG and 1 in the SG) another two required chemonucleolysis (one each group) and five (two in the CG and three in the SG) other routes of corticosteroids administration. On analysis according to protocol, at day 20 in the 74 remaining patients, 12/35 (34%) in the CG and 22/39 (56%) in the SG ($p=0.057$) were considered at success (difference 22.1%; 95% CI for the difference 0.0 to 44.2).

In conclusion we cannot exclude an efficacy of isotonic saline administered epidurally for sciatic, but epidural corticosteroid injections did not provide any additional improvement.⁽⁴⁷⁾

One systematic review of medical treatments for sciatica caused by disc herniation (search date 1998, 4 RCTs of epidural steroids, 265 people) and one subsequent RCT.¹⁴ The review compared four different doses of epidural steroid injections (8 mL methylprednisolone 80 mg, 2 mL methylprednisolone 80 mg, 10 mL methylprednisolone 80 mg, and 2 mL methylprednisolone acetate 80 mg) versus placebo (saline or lidocaine [lignocaine] 2 mL) after follow up periods of 2, 21, and 30 days.¹³ The review found limited evidence that epidural steroids increased participant perceived global improvement (which was not defined) compared with placebo.

The results were of **borderline significance** (73/160 [45.6%] with steroid v 56/172 [32.5%] with placebo; OR 2.2, 95% CI 1.0 to 4.7). The subsequent RCT (36 people with disc herniation confirmed by magnetic resonance imaging) compared epidural steroids (3 injections of methylprednisolone 100 mg in 10 mL bupivacaine 0.25% during the first 14 days of hospitalisation) plus conservative non-operative treatment versus conservative treatment alone.

Conservative treatment involved initial bed rest and analgesia followed by graded rehabilitation (hydrotherapy, electroanalgesia, postural exercise classes) followed by physiotherapy. It found no significant difference in mean pain scores at 6 weeks and 6 months measured on a visual analogue scale (at 6 months, 32.9 [range 0–85] with steroids v 39.2 [range 0–100] with conservative treatment). There were no significant differences in

mean mobility scores (Hannover Functional Ability Questionnaire: 61.8 [range 25–88] with steroids v 57.2 [range 13–100]), in the number of people who had back surgery (2/17 [12%] with steroids v 4/19 [21%]; RR 0.56, 95% CI 0.09 to 2.17), or in people returning to work within 6 months (15/17 [88%] with steroids v 14/19 [74%]; RR 1.19, 95% CI 0.75 to 1.33).

No serious adverse effects were reported in the RCTs included in the systematic review, although 26 people complained of transient headache or transient increase in sciatic pain. The subsequent RCT did not report adverse effects of epidural injections.⁽⁷⁸⁾

- Caudal epidural vs transforaminal epidural steroid injections

In a retrospective case control during the period between June 2002 and July 2004; 132 patients were diagnosed for primary lumbar radiculopathy of L4, L5, or S1 and were randomized into 2 groups to evaluate the efficacy of 2 different approaches of epidural steroid injection.

Conservative care consisted of activity modifications, physical therapy and epidural steroid injections. Physical therapy included **extension-based exercise** program and light, **isometric core strengthening**. **Medications** were also used, and included non-steroidal anti-inflammatory agents, muscle relaxants, and in some cases, narcotics.

These patients were subject to two different types of epidural steroid injections as part of their treatment plan. Treatment groups were allocated according with randomly assigned appointments to the clinics of either of the two senior authors.

In each of these clinics, a different preference of epidural injection technique was maintained. All procedures were performed by the same group of interventional muscular-skeletal radiologists, with a standardized technique.

The caudal epidural steroid injections (ESI) were performed under fluoroscopic guidance with a 22g needle, and either 2cc of Depo-Medrol (40mg/ml) or 3cc Celestone (6mg/ml) were injected. The trans-foraminal epidural steroid injections (TESI) were also performed under fluoroscopic guidance for the L4 and L5 nerve roots, and under CT-guidance for the S1 nerve roots. A 20/25 coaxial system was utilized, and 1.5–2cc 1:1 solution of Marcaine 0.25% with Depo-Medrol (40mg/ml) or Celestone (6mg/ml) were injected.

Patients who consented to participate in the study included 39 of 58 patients (67.2%) treated with caudal ESI and 54 of 74 (72.9%) treated with TESI. Of the 93 patients, 16 were lost to follow up. Of these, 20% of the chymopapain group, and 47% of the saline group requested surgery during the observation period of 2 years. **Karppinen** ⁽²⁹⁾ found that periradicular infiltrations of Methylprednisolone + Bupivacaine had only short-term clinically meaningful benefits over periradicular infiltrations with normal saline solution.

The effectiveness of TESI is comparable to that of ESI (approximately 60%) for treatment of primary lumbar radiculopathy. The increased complexity of TESI is not justified for primary cases, and may have a more specific role in a recurrent disease or for diagnostic purposes. ⁽⁵⁵⁾

Between March 1, 2001 and August 25, 2002, a total of 263 patients were referred to the Department of Diagnostic Radiology for image-guided percutaneous steroid injections. 91 of 263 patients (50 males and 41 females, age range: 13-78 yrs) were treated with transforaminal ESI for lumbosacral disc herniations.

Twenty-three of 91 patients whose imaging studies were CT/one side MRI (n = 13) or whose clinical follow-ups after the injections were missed (n = 10) were excluded in this analysis. A total **68 patients** were included in this study with an average follow-up period of 3.6 months.

All procedures were performed in a sterile manner, and fluoroscopic guidance was used for the injections. The patients were placed prone on a fluoroscopy table and the C-arm was rotated to an ipsilateral oblique angle with respect to the suspected nerve root (L4, 5 or S1). Lidocaine (1%) was used for the cutaneous and needle tract local anesthesia. The MR findings were assessed for the type, hydration, location and size (volume) of the herniated disc, the grade of nerve root compression and the associated findings of spinal stenosis. The type of herniated disc was classified as protrusion, extrusion and sequestration.

The final analysis included 68 patients with an average follow-up period of 3.6 months (range: 7 days-24 months). Transforaminal ESIs were given at the following levels and all the procedures were done at a single level: L4 in two patients, L5 in 36 patients and S1 in 30 patients. Forty one of 68 patients (60.3%) had successful outcomes (the responders), and twenty seven patients showed unsatisfactory results (the non-responders). The pre-injection symptom duration of the responders ranged from 3 days to 2.5 years, and that of the non-responders was from 6 days to 2 years. There were no serious side effects of the injections.

There was no significant difference between the responders and non-responders in terms of injection level, age, gender or the pre-injection symptom duration ($p > 0.05$). Seven of 41 responders and three of 27 non-responders underwent repeat injections. MR analysis showed no significant difference between the responders and non-responders in terms of the type, hydration and size of the herniated disc, or an association with spinal stenosis ($p > 0.05$). This study has its limitation but nevertheless MRI could play an important role in predicting the clinical outcome of non-surgical transforaminal ESI treatment.

Several outcome studies of ESI treatment for lumbar herniated discs have evaluated the clinical differences between responders and non-responders. **Lutz et al.** have reported that patients with pre-injection symptom durations of less than 36 weeks were most likely to respond to treatment. **Viton et al.** have found that the decrease in pain was greater for the patients less than 50 years of age than for the older patients after transforaminal ESI for lumbar radiculopathy. ⁽²⁹⁾

5.3. Non-medical Conservative treatments

5.3.1. Natural History

Takata et al. made an investigation for morphological changes of 42 patients (28 men and 14 women) with a mean age of 42 years (range 16–64 years) who presented with unilateral leg pain and low back pain that was definitely diagnosed as being caused by LDH.

All patients were treated conservatively (bed rest, oral non-steroidal, anti-inflammatory drugs, pelvic traction and caudal epidural block) and followed up by serial MRI. The symptomatic disc level was L2-L3 in 8 cases, L3-L4 in 6 cases, L4-L5 in 15 cases and L5-S1 in 13 cases. All patients underwent MRI examinations every three months for a period of 3-24 months (mean 10.3months). Images were obtained using a 1.5 tesla superconducting MR scanner.

LDH was classified into three types: protrusion (n=7), extrusion (n=17) and sequestration (n=18), using T2-weighted sagittal MR images. The size of the herniated mass was determined from the ratio of the anterior-posterior diameter of the spinal canal to the maximum diameter of the mass on T2-weighted axial images.

All patients were re-examined and their MRI findings were re-evaluated by the same physician during follow-up. The clinical outcome was evaluated using the JOA (Japanese Orthopaedic Association) score for LDH 9 and recovery rate. Radicular leg pain was rated as follows: Excellent - no pain (recovery rate 100%), Good - slight pain but bearable during daily activity (recovery rate 80%), Poor - sometimes unable to perform daily activities due to pain (recovery rate < 50%).⁽⁶⁶⁾

The time taken for spontaneous involution of the herniated mass by >50% (classified as effective regression) was 3 months in 8 cases, 6 months in 15 cases, 9 months in 12 cases and 12 months in two cases. No marked reduction of the herniated mass was recognized in 5 patients in the final MRI study of up to 24 months.

Two patients with protruded LDH showed spontaneous involution of the herniated mass by >50% 12 months after the onset of symptoms. The other 5 patients with this type of LDH showed no morphologic changes at the time of the final MRI study.

Among patients with extruded LDH, there was a decrease of the herniated mass by >50% in 7 patients 6 months after the onset. In another 10 patients with this type of LDH, the majority showed a significant reduction of size after 9 months. Among patients with sequestered type, 10 showed over 50% involution of their herniated mass after 3 months, and 6 others after 6 months. Among these 16 patients, 8 showed complete disappearance of their hernia. Two patients showed a significant reduction of hernia size 12 months after the onset of symptoms.

The recovery of symptoms, especially radicular leg pain, preceded the involution of the herniated mass on MRI. In the patients with sequestered LDH, severe radicular leg pain was the initial symptom and the pain improved 1–5 weeks after the onset, leaving sensory changes or a motor deficit, while a permanent severe motor deficit (MMT \leq 3) was observed in six cases.

In the patients with extruded LDH, radicular leg pain was not so severe compared to the patients with sequestration and leg pain lessened 4–8 weeks after the onset. Patients with the protruded LDH usually complained of leg pain on walking and improved after 3–14 weeks. Four patients with this type of hernia showed no MRI changes and had no decrease of their leg pain.

In conclusion of this investigation were that 37 out of 42 patients (88 %) showed effective (>50%) reduction of the herniated mass on MRI 3–12 months after the onset of symptoms. Sequestered hernia and transligamentous extrusions seem to be more easily and rapidly absorbed. MRI changes and improvement of symptoms are well correlated with MRI changes, but a time lag is observed. The basic treatment of LDH should be conservative according to the results of this study; however surgery may be necessary for large central protruding hernias and patients who show severe motor deficits. ⁽⁶⁶⁾

5.3.2. Bed rest

When comparing **bed rest** to no treatment for patients with acute LRS they found no difference (1 HQ trial: moderate evidence) regarding overall improvement at short-term follow-up and no difference (1 HQ trial: moderate evidence) regarding pain and disability at short and intermediate follow-up.

In one low quality study comparing manipulation to other conservative care for patient with LRS they found no difference (1LQ trial: moderate evidence) regarding overall improvement pain and return to work at short-term follow-up.⁽³⁷⁾

5.3.3. Physical therapy

- Physical therapy and General Practitioner vs General practitioner alone

Luijsterburg et al. conducted a randomized clinical trial in primary care with a 12- months follow-up period in two groups: The intervention group received physical therapy added to the general practitioners' care and the control group with general practitioners' care only. To assess the effectiveness of PT additional to general practitioners' care compared to general practitioners' care alone, in patients with acute sciatica.⁽³⁸⁾

About 135 patients with acute sciatica were treated by the GP according to their clinical guideline. GPs gave information and advice about LRS and, if necessary, prescribed (pain) medication. Physical therapy treatment consisted of exercise therapy as well as giving information and advice about LRS. Passive modalities such as massage and manipulation techniques or applications such as ultrasound therapy or electrotherapy were **not allowed**.

The treatment protocol was developed in a consensus meeting with participating physical therapists. They acted as coaches and guided the patient in order to stimulate return to activity (type/ content of exercises was left to the expertise of the participating physical therapists), despite the pain experience.

Both GP and PT interventions (only in a one to one setting; group settings were not allowed) were restricted to a maximum of nine treatments/consultations in the first 6 weeks after randomization. At 3, 6 and 12 weeks after baseline there was no significant difference between the two groups on the primary outcome: GPE. However, at these follow-up moments the intervention group showed a higher proportion of 'improved' patients. At 52 weeks after baseline there was difference between the groups on the GPE measurement, in favor of the intervention group. About 53 patients (79%) in the intervention group versus 38 patients (56%) in the control group reported to be improved (RR, 1.4 95% CI: 1.1; 1.8).

There were no significant differences between the groups in the most of secondary outcomes at 3, 6, 12 and 52 weeks after baseline. At 12 and 52 weeks follow-up the mean improvement on leg pain was clinically relevant in both groups; respectively, 3.9 and 4.4 points for the intervention group and 3.7 and 3.7 points for the control group. The mean improvement on disability (RDQ) was also clinically relevant at 12 and 52 weeks follow-up in both groups; respectively, 7.7 and 10.0 points for the intervention group and, respectively, 8.5 and 9.1 points for the control group. The results in this study indicated that PT added to GP care had better results than a GP alone however it was a more expensive procedure. ⁽³⁸⁾

Two low quality studies compared physical therapy to other conservative treatments. In these studies they found no difference in overall improvement pain and return to work between groups. When comparing physical therapy to other conservative care for patients with LRS they found no difference (2LQ trials: moderate evidence) regarding overall improvement, pain and return to work at short-term.

In one low quality study they found a difference in improvement at 1-year follow-up, in favor of surgery. In the same study they found no difference in improvement at 4 and 10-years follow-up between the two groups.

They concluded that there was limited evidence that surgery is more effective for patients with LRS regarding overall improvement than physical therapy at 1-year follow-up. At 4 and 10-years follow-up they found no difference regarding overall improvement between surgery and physical therapy.

In one low quality study they found no differences in overall improvement, pain, and disability at short-term follow-up between groups. In one high quality study they found no differences in pain, disability at short and intermediate follow-up between groups. ⁽³⁸⁾

5.3.4. Traction

Luijsterburg et al. systematic review found in four studies compared traction to inactive/sham traction. One low quality study did not report any data. In one high quality and one low quality studies they found no difference in pain between traction and inactive/sham traction at short-term. Also, in one low quality study they found no difference in improvement between groups at short-term.

When comparing traction and inactive/sham traction for patients with LRS they found no difference regarding pain and disability at short-term follow-up.

In five studies compared traction to another conservative treatment. All five studies were considered of low quality. In one study they found a difference between traction and other conservative care in overall improvement, in favor of traction.

However, in three studies they found no difference in overall improvement between groups. In one study they found no difference in pain between traction and other treatments, but in another study they found difference in pain, in favor of traction. In one study they found no difference to return to work between groups. When comparing traction to other conservative treatments for patients with LRS they found **conflicting evidence regarding improvement** of pain at **short-term** follow-up. They found no difference regarding return to work at short-term follow-up.

In one high quality study they found no difference in pain and disability at short and intermediate follow-up between groups. When comparing physical therapy to inactive treatment for patients with acute LRS they found no difference (1 HQ trial: moderate evidence) regarding pain and disability at short and intermediate follow-up. ⁽³⁷⁾

- Traction and physical therapy

Twenty six patients (14 F, 12 M), diagnosed with lumbar disc herniation with clinical and magnetic resonance imaging were conducted in this clinical study (Kamanli et al.). Physical examination of the lumbar spine, severity of pain sleeping status, patient and physician global assesment with VAS, and functional disability questionnaires (Rolands, ODI) were assesed at baseline and 4 – 6 weeks after treatment. MRI was carried out before and 4066 weeks after treatment. ⁽²⁷⁾

Fifteen sessions (per day during 3 weeks) of physical therapy were applied. That included hot pack, ultrasound, electrotherapy (TENS) and lumbar traction. The intermittent lumbar traction treatment (10 seconds pulling and 10 second relaxing) was performed in supine position with pulling force of one third of patients weight of a total of 15 sessions and in each

session lasted 10 minutes. Pulling weight was increased by 5 kg in every session in a way that was tolerated for the patient.

All of the patient's completed the therapy sessions and there were no complications. All patients benefited from treatment. There were significant improvements ($p < 0.001$) in pain, sleeping disturbance, patient and physician global assessment and pain when coughing or sneezing and significantly increased lumbar movements between baseline and follow-up periods.

The results showed that the clinical parameters of patients improved primarily. Regression of herniation in 5 of 26 patients and increase of herniation of 3 of 26 patients were observed. Improvement of clinical parameters from the 2 increased herniations and the other patient represented no difference.

The results show that physical therapy programs including conventional lumbar traction are **quite beneficial** on lumbar disc herniation without emergent operative indications. Also clinical improvements were noticed to occur prior to radiological improvement. In conclusion clinical parameters should be considered in primary evaluation of treatment results of patients with lumbar disc herniation. ⁽²⁷⁾

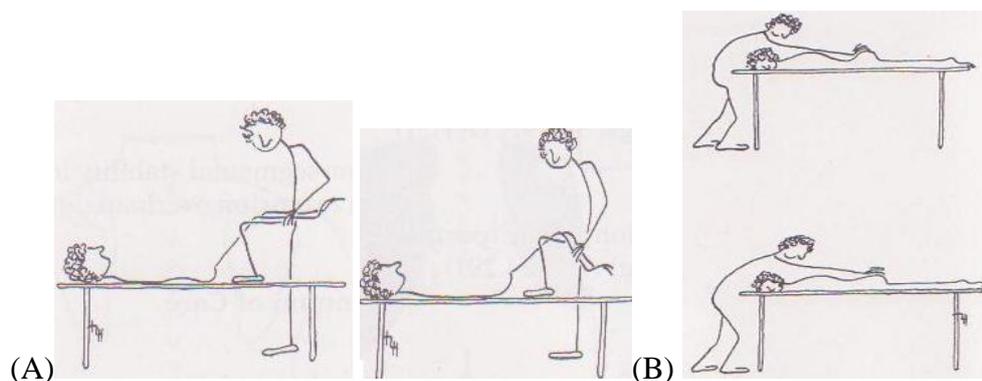


Figure 34: (A) supine rhythmic traction of the lumbar spine, (B) manual traction of the pelvis ⁽³⁶⁾

5.3.5. Mckenzie therapy centralisation method

- Mechanical Diagnosis and Therapy (Mckenzie)

For disc herniation, 104 patients examined and 60 of them recruited underwent a standardized Mechanical diagnosis and therapy (MDT) evaluation to expose 2 groups: central (CG)'n and non-central'n group (NCG). All patients were treated in the same way and were followed for one year. If patients did not have improvement surgery was considered.

Outcomes included back and leg pain, disability, Nottingham Health Profile, and surgical outcome. 25 patients were classified in the CG, 35 were NCG and other baseline characteristics were similar between groups.

At 1, 2 and 3 months the CG had significant better outcomes than the NCG. At 2 months the CG had more improvements in leg pain ($P < 0.007$) disability ($P < 0.001$) and Nottingham Health Profile ($P < 0.001$). After 1 year, disability was less in CG ($P < 0.029$). 3 CG patients underwent surgery vs 16 NCG ($P < 0.01$). The odds ratio for surgery in NCG WAS 6.2.

Conclusion of the examination of patient with sciatica and suspected disc herniation who have a centralization response will have significantly better outcomes. Patients who do not have centralization will be 6 times more likely to undergo surgery. ⁽⁶⁵⁾

A trial providing diagnostics to patients with LBP and varying degrees of leg pain and altered sensation referred for lumbar discography due to pain sufficiently severe to warrant invasive testing, failure of conservative care, and 1 or more MRI studies w/o compelling surgical findings. Underwent MDT assessment and classified as centralizers, peripheralizers, or not effect on pain.

Routine lumbar discography and CT imaging followed. Outcomes of the two types of assessment were compared. 50% centralized, 25% peripheralized only, and 25% reported no effect on their leg pain with the MDT evaluation. 57% had positive discograms of which 81% did not leak. 43% were negative. 74% of centralizers, 69% of peripheralizers and only 12% of no effect patients had positive discograms. 91% of centralizers had intact annuli but only 54% of peripheralizers.

Despite the chronicity of the patients, **50% still demonstrated a reversibility** of their pathology, which was shown in 74% of cases to be disc. The ability to distinguish between a positive and negative discogram based on MDT findings was highly significant ($P < 0.001$).
(10, 11)

In North Jutland Country Denmark (500,000 population), in 1997, two non-surgical spine clinics established focused on MDT care and educational program for general doctors for pts with 1 to 3 months' of sciatica, with or without low back pain. Data on rates of lumbar disc surgery were obtained from the National Registry of Patients over the next four years.

The annual rate of lumbar disc operations for pts in N. Jutland Country decreased from 60-80 per 100,000 before 1997 to 40 per 100,000 in 2001 ($P = 0.00$), and the rate elective, first-time disc surgeries decreased by approximately two thirds ($P = 0.00$). The rate of lumbar disc operations in the rest of Denmark remained unchanged during the same period.

The implementation of these non-surgical spine clinics coincided closely with a significant reduction in the rate of lumbar disc surgery. The observed reduction seems most likely to be causally associated with educational activities and improved patient care provided by the clinics.⁽¹¹⁾

- Extension exercises

After examining 67 patients with low back pain (LBP) radiating to the calf or foot with at least one significant sign of nerve root irritation and at least 6 weeks of failed non-operative therapy. All patients underwent an initial trial of extension exercises. Those who had no symptom worsening were prescribed an extension exercise program for several days while still hospitalized. The 52% of patient (34 of them) shown no worsening during extension test.

All 34 performed extension exercise program. 100% regained their full lumbar extension range and eliminated symptoms within 2-5 days. The other 32 underwent laminectomy and discectomy. Pre-operatively, there was no difference between the groups with regard to age, gender, pain below knee, or any of the neurological signs or SLR. 56% of the surgical patients had a free fragment, 19% had swollen or displaced nerve root, and 19% had a bulging disc. Finally, some of these patients responded so dramatically to extension therapy that the use of extension exercises as a therapeutic modality was recommended.⁽³¹⁾

5.3.6. Chiropractic approach in general radiculopathy

In a retrospective review concerning the clinical outcomes of patients with **cervical and lumbar radiculopathy** treated with a nonsurgical, **chiropractic treatment** protocol in combination with other interventions.

Chiropractic manipulation was performed on all patients. Joint dysfunction was determined by palpation demonstrating abnormal resistance to springing of the joint, reactivity of the underlying musculature, and/or the patient's report of pain. In selected cases, radiographic biomechanical analysis was performed to determine deviations from neutral to position to patient of **manipulation, centration and stabilization** procedures that center the cervical and lumbar spine in the frontal and sagittal plane.

In cases of lumbar spine radiculopathy, distraction manipulation (DM), a low-velocity technique, and a secondary high-velocity low-amplitude (HVLA) manipulation technique were used. The maneuvers were always delivered in a direction that did not cause peripheralization of the pain. Distraction manipulation was performed on a flexion-distraction table with the patient prone using a stomach pillow to position the patient in lumbar semiflexion. Distraction manipulation motions included flexion, extension, and lateral flexion in the direction of spinal centration (centering) only. There was no rotation performed, with extension motion limited from semiflexion to neutral. In the HVLA technique, the lumbar spine deviation from neutral (translation or lateral flexion) was performed using a drop table in the side-lying position so that there would be no introduction of rotation to the HVLA technique. ⁽⁸⁾

How does manipulation work?

- Increases joint motion induced by manipulation allows the inflammation from disc material to subside more easily, and/or:
- Manipulation may provide input to functional reflexes, modifying pain; and/or
- Manipulation reduces related and overlying pain from facet joints. ⁽⁶⁵⁾

Neuromobilization was used as a manual- and exercise –oriented method that is theorized to mobilize nerve roots that are suspected to be the source of nerve root pain. All patients were given the same series of stabilization exercises for home performance. The spine stabilization procedures used were progressive, meaning beginning procedures were performed before intermediate and advanced procedures. Each patient demonstrated the assigned procedure correctly before they left the office. Each patient on subsequent visits was required to demonstrate satisfactory “pain-free” performance of beginning procedures before they allowed advancing to the intermediate and advance procedures.

Of the 162 consecutive patient reviewed, 99 were female and 63 were male. Upper extremity symptoms were seen in 61 cases and **lower extremity in 108 cases**, with 7 of these cases demonstrating both. Of 162 total cases, 85.8% resolved their significant subjective radicular complaints; and the patients were discharged from active treatment. The treatment trial was 9 (mean) treatment sessions, ranging from 1 to 23 visits and lasting between the first treatment date and the first symptom improvement was 4.2 (mean) days, with a range (standard deviation) of 0.78 to 7.7 day(s). The initial numerical pain rating scale score (median) was 5.8 with a final score of 2.1 (median). The pain change between initial and final score was 4.2 (median).

Of 162 total cases, acute and chronic presentations were represented. Sixty-seven (41.36%) were classified as “acute”, meaning their symptom duration was less than 3 months. Ninety-five (58.64%) were classified as “chronic”, meaning their symptom duration was greater than 3 months. **Ninety-one percent** of acute presentations resolved with a treatment trial (mean) of 6.2 sessions, ranging from 1 to 20 visits. **Eighty-one percent** of chronic presentations resolved with a treatment trial of 8.6 (mean) sessions, ranging from 1 to 23 visits.

There were 10 unresolved cases referred for medication management as a result of the nonsurgical treatment not resolving the radicular complaints. Six cases experienced minimal to moderate improvement before referral. The treatment trial ranged from 3 to 25 visits. Three unresolved cases were referred for and underwent surgery. Of the 162 total cases, these represent 1.85%. All 3 cases showed no symptom improvement before referral. The treatment trial ranged from 2 to 7 visits, lasting between 9 and 17 days. The MRI on each of these cases demonstrated a significant disc extrusion.

Incidentally noted, with lumbar radiculopathy cases, there was a consistent increase in active lumbar flexion (standing tension angle), passive hip flexion (sciatic tension angle), and passive hip extension (femoral tension angle) in cases that resolved. Similarly there was a common finding of the straight leg raise. Braggard, slump, and femoral nerve stretch tests when positive progressing to negative testing in cases that resolved. Comparative palpatory tenderness, sacroiliac and sciatic notch regions commonly decreased or resolved in cases where the radicular complaints resolved.

Most of the cases that resolved their radiculopathy complaint completed up to 50% of the stabilization procedures. It was noted that very seldom did it require completion of all the stabilization procedures listed above.

There are several important limitations to this study. It is not a randomized controlled trial; thus, interpretation of the result must be made with worth of caution. The natural history of radiculopathy is generally thought to be favorable; however, data on untreated patients with this disorder are lacking.

The current study supports the notion that chiropractic management and nonsurgical measures are a viable alternative to surgery in patients with radiculopathy. Randomized controlled trials are needed for to further assess of this nonsurgical approach compared with untreated controls and surgical treatments. ⁽⁸⁾

Two systematic reviews and one subsequent RCT were found. The first systematic review (search date 1998), which did not perform meta-analysis, identified two RCTs of spinal manipulation for sciatica caused by disc herniation. The second systematic review (search date not stated) identified no RCTs.¹⁵ The first RCT (207 people) included in the review compared spinal manipulation (every day if necessary) versus placebo (infrared heat 3 times weekly). It found that spinal manipulation increased overall self perceived improvement at 2 weeks compared with placebo (98/123 [80%] v 56/84 [67%]; RR 1.19, 95% CI 1.01 to 1.32; NNT 8, 95% CI 5 to 109). ⁽²⁴⁾

The second included RCT (322 people) compared four interventions: spinal manipulation, manual traction, exercise, and corsets, in a factorial design. It found no significant difference among treatments in overall self-perceived improvement after 28 days (quantified results not available). The subsequent RCT (112 people with symptomatic herniated lumbar disc)

compared pulling and turning manipulation versus traction. It found that significantly more people were “improved” (absence of lumbar pain, improvement in lumbar functional movement) or “cured” (absence of lumbar pain, straight leg raising of >70°, ability to return to work) with spinal manipulation compared with traction (54/62 [87.1%] with manipulation v 33/50 [66%] with traction; RR 1.32, 95% CI 1.06 to 1.65; NNT 5, 95% CI 4 to 16; timescale not stated).

The first systematic review did not report adverse effects. The second systematic review identified one review of 135 case reports of serious complications after spinal manipulation published between 1950 and 1980. The case review attributed these complications to cervical manipulation, misdiagnosis, presence of coagulation dyscrasias, presence of herniated nucleus pulposus, or improper techniques. The subsequent RCT found that two out of 60 people receiving traction had syncope; no adverse effects were reported in people receiving manipulation.

In another systematic review (search to date 2001, 5 prospective observational studies). The largest study included in the review (4712 treatments in 1058 people undergoing both cervical and lumbar spinal manipulations) found that the most common reaction was local discomfort (53%), followed by headache (12%); tiredness (11%); radiating discomfort (10%); dizziness (5%); nausea (4%); hot skin (2%); and other complaints (2%).

The incidence of serious adverse effects is reported as rare, and is estimated from published case series and reports to occur in one in 1–2 million treatments. The most common of these serious effects were cerebrovascular accidents (the total number of people undergoing manipulations was not reported and the rate of this adverse effect cannot be estimated). However, it is difficult to assess whether such events are directly related to treatment.

In the third review, which examined risks, the percentages include both cervical and lumbar spinal manipulations, which may overestimate the effect of lumbar spinal manipulations. The authors of the review advise caution in interpreting these results, as they are speculative and based on assumptions about the numbers of manipulations performed and unreported cases. More reliable data are needed on the incidence of specific risks. ⁽²⁴⁾

5.3.7. Stabilization theory with case treatment

Dynamic neuromuscular strategy leads to optimal joint position which allows the most effective mechanical advantage. The centered joint has the greatest interosseous contact to transfer the optimal load across the joint and along the kinetic chain. Allows the maximal muscle pull and protect the passive structures.

The ideal path of instantaneous center (axis) of rotation during the movement ensures balance function for muscular activity at any moment of time during the movement. Muscular synergy always depends on body posture as a whole and not that of a particular segment.

In faulty stabilizing function may cause changes in skeleton in adulthood with morphological consequences of chronic poor stabilization are often called “Degenerative changes”.

Insufficient deep stabilization is frequently occurred by internal forces developed by our own muscles are more important (dangerous) than external forces (loading). Internal forces are decisive in what way external forces apply on our system (spine, joints). We can change MRI findings by changing quality and distribution of internal forces.

By means of regular proper stabilization exercise at time it is possible to change even the structure. Changing the function may change the structure. Comparing MRI pictures of patients and radicular pain syndrome. ⁽³⁰⁾



Before the treatment



after 2 years of treatment

Figure 35: MRI changes of structural abnormality by changing function ⁽³⁰⁾

The structural change may result from rehabilitation, but may also be spontaneous. However function is the most important, providing stabilization giving pain resolution. Surgery removes a disc protrusion but structural pathology frequently results from spinal instability, it is necessary to improve (restore) spinal stabilization and influence primary cause of structural damage. Important is to emphasis on finding out the cause of proble and not the source. ⁽³⁰⁾

5.4. Post-surgery of disc herniation

- **Exercise programme after surgery**

In this open, prospective and controlled study they examined 42 patients who **had undergone microdiscectomy** between January and September 1998 in the Neurosurgery Clinics of Sisli Etfal and Taksim Education and Research Hospitals. Lumbar disc herniation was diagnosed using a clinical radiological (MRI) examination in the neurosurgery clinics.

The most common level of disc herniation was between L4 and L5 (45.24%, 19 patients). During the initial examination of the patients there were no differences between the 3 groups in terms of pain, functional capacity, depression, fingertip-floor distance LS, MLS, LE, LF, rotation and PILE (neck) scores. Prior exercise PILE (back) and body strength scores in the first group were worse than those in the groups. ⁽⁷⁹⁾

The examination of the patients in the first group at completion of the **exercise programme** showed significant improvement had occurred in all parameters. The examination of the control group patients, after the 8-week period, showed improvement in the functional capacity, fingertip-floor distance, modified lumbar Schober and in left rotation while in the other parameters there were no significant differences.

At the end of the follow-up period the physical and neurological progress of the patient was satisfactory. Abolished deep tendon reflexes did not recover. Among 10 patients with paravertebral muscular spasm, it had disappeared in 1. Among 8 patients with sensory deficit, 3 became asymptomatic. Four of the 8 patients with motor deficits showed healing in motor loss.

In the second group only one patient with paravertebral muscular spasm and another patient with sensory deficit improved, while the others remained the same. The patients' progress was satisfactory. In the third group none of the patients with paravertebral spasm. Sensory or motor deficit improved. In addition, at the second group the number of patients with sensory deficit and paravertebral spam increased.

It is known that approximately **25% of patients** who have been operated on for lumbar herniation have post-operative **complaints**. It is also, known that in operated and non-operated patients there is lumbar, abdominal and dorsal **muscle weakness**. **Kahanowits et al.** have reported that the **trunk muscles' strength** is **decreased** about **30% after discectomy operation**. Hence both operated and non-operated low back patients need to follow an exercise programme for the relief their painful backs. ⁽⁷⁹⁾

In this prospective study, they examined 75 patients who had undergone discectomy between March 2002 and August 2002 at the Wooridul Spine Hospital, Seoul, Korea. The inclusion criteria were: 1) unilateral radiating leg pain with or without back pain not responding to conservative treatment methods and having a good radiological correlation; 2) first-time lumbar spine operation; 3) single-level disc herniation; and 4) absence of associated systemic diseases such as cardiac ailments or orthopedic contraindications for subsequent exercise program. Patients were randomized into two groups, a control group and an exercise group.

The CT scan measurements were taken by an independent observer using a software PiView program. At the end of the sixth postoperative week, all patients underwent measurement of the isometric strength of the **extensor muscles of the lumbar spine** using the MedX (Ocala, FL) system. This marked the baseline measurement. The measurements were obtained at various angles of lumbar flexion from 0 to 72 degrees. The maximal voluntary effort applied was calculated and was quantified by the machine as the torque generated.

After the sixth postoperative week, the control group continued with the home-based basic lumbar conditioning exercises. The exercise group started with the intensive schedule with a defined set of exercises for extensor muscle strengthening for the next 12 weeks. It was a supervised and graded program that also included aerobic and limb-strengthening exercises. The exercises included both dynamic and isometric exercises for the lumbar extensors. This exercise program used the MedX system, which by restricting the hip and pelvic motion using restraints, isolates the lumbar extensor muscles. Also, progressive resistance exercises can be given by increasing the weight.

At the end of the 12-week program (eighteenth postoperative week), all patients, including the control group, again underwent CT scanning of the lumbar spine for cross-sectional area measurements of the longissimus and the multifidus, in addition to the strength of the erector spinae being calculated by the MedX system. The VAS for pain and the ODI also were noted.

The patients were then followed up to assess their return to work. At the end of 1 year, all patients were evaluated for pain by VAS.

Hakkinen et al. evaluated trunk muscle strength, pain, flexibility, and disability in patients who had been operated for lumbar disc herniation 2 months after surgery. Although the leg pain and back pain decreased by approximately 80%, 30% of the patients perceived moderate to severe disability measured by ODI score. It was also noted that decreased muscle strength and mobility, especially with older patients and with considerable postoperative pain, caused significant functional disability. The recovery of **multifidus muscle** is not spontaneous after resolution of painful symptoms, and this inhibition can be reversed only by **specific training exercises**. This then can prevent the subsequent incidence of low back pain and thus also **prevent recurrences**.⁽¹⁸⁾

Ostelo et al. in a Cochrane systematic review⁽⁷²⁾ for rehabilitation after surgery conducted fourteen studies, of which seven had a low risk of bias. Most programs were only assessed in one study. Statistical pooling was only completed for three comparisons in which exercises were started **four to six weeks post-surgery**: exercise programs versus no treatment, high versus low intensity exercise programs, and supervised versus home exercises.

There was low quality evidence (three RCTS, N = 156) that exercises are more effective than no treatment for pain at short-term followup (WMD -11.13; 95% CI -18.44 to -3.82) and moderate evidence (two RCTS, N = 136) that they are more effective for functional status on short-term follow-up (WMD -6.50; 95% CI -9.26 to -3.74). None of the studies reported that exercises increased the reoperation rate.

There was low quality evidence (two RCTS, N = 103) that **high intensity** are slightly more effective than **low intensity** exercise programs for pain in the short term (WMD -10.67; 95% CI -17.04 to -4.30) and moderate evidence (two RCTS, N = 103) that they are more effective for functional status in the short term (SMD -0.77; 95% CI -1.17 to -0.36).

There was low quality evidence (three RCTS, N = 95) that there were no significant differences between **supervised and home exercises** for short-term pain relief (SMD -1.12; 95% CI -2.77 to 0.53) or functional status (three RCTS, N = 88; SMD -1.18; 95% CI -2.63 to 0.26).

Only one RCT with a high risk of bias (N = 212) (Alaranta 1986) compared a **multidisciplinary rehabilitation** program that consisted of sessions with a physical therapist, psychiatrist, occupational therapist, psychologist, social worker and an intensive back school with usual care. There was low quality evidence that at one year follow-up, there were no statistically significant differences between groups for global perceived effect, sick leave or re-operativerates (3.7% in both groups).

One RCT with a low risk of bias (N = 105) compared a **behavioural** graded activity program with standard physiotherapy (Ostelo 2003). There was low quality evidence (one RCT only) that in the short term there was a clinically relevant and **statistically significant difference** of 19% in global perceived recovery in favour of the **physiotherapy program**, but there were **no differences** on the long term. There was also low quality evidence that there were no differences (short-term or long-term) in pain (VAS), functional status (RDQ) or return-to-work. This trial also included a cost effectiveness analysis that suggested that the behavioural program was associated with higher costs during the one-year follow-up.

Exercise programs starting in four to six weeks post-surgery seem to lead to a faster decrease in pain and disability than no treatment. In high intensity exercise programs led to a faster decrease in pain and disability than low intensity programs. There was no significant difference between supervised and home exercises for pain relief, disability, or global perceived effect. There is no evidence that active programs increase the re-operation rate after first-time lumbar surgery. ⁽⁷²⁾

- **Lumbar status associated with surgery**

In a prospective study of 80 people Lundin et al. evaluated the condition of a stiff back spine to be associated with outcome in surgery. The degree of lumbar lordosis and reduces lumbar mobility are regarded as important clinical finding in patient with low back pain and in lumbar disc herniation.

The main aim of this study was to investigate whether there were any correlation between lumbar lordosis and flexion associated with good prognosis for microdiscectomy. The second aim was to determine the pattern of post operative improvement in pain, perceived disability,

and flexion/lordosis for 2 years surgery. Pain (VAS) and disability and lordosis (Debrunner's kyfometrer) were the methods for measuring the outcomes.

From the 79 enrolled patients provided flexion with mean range of 24°. Patients with higher values than the median were categorized as having hyperflexion (n=39) and patients with lower values in hypoflexion (n=40) while for hyperlordosis 41 patients and with hypolordosis 38. Patients with hypoflexion were represented by 16 patients with hyperlordosis and 24 patients with hypolordosis. In hyperflexion patients were represented by 25 patients with hyperlordosis and hypolordosis 14. This showed a low but significant of which patients with hyperlordosis was more with hyperflexion and patients with hypolordosis were more with hypoflexion.

Patients with hyperlordosis before the surgery had shown more pain and disability after surgery procedure than patients with. Preoperatively patients with hyperlordosis had more severe pain (51%) compared to patients with hypolordosis (34%). Similarly the patients with hypoflexion had more severe pain (50%) than hyperflexion

Neither the preoperative degree of flexion ($p=0.8$) nor lordosis ($p=0.5$) was statistically significant associated with severe pain preoperatively. There was a tendency for patients with hypolordosis preoperatively to have less severe pain postoperatively than patients with hyperlordosis (OR 0.42, 95% CI: 0.16-1.1; $p=0.07$).

There were differences from 2 week onward until the 6-week time point. Patients with hyperflexion preoperatively had somewhat more pain postoperatively than patient's hypoflexion, but the difference was far from statistical significant. (OR 1.1, CL: 0.45-2.9; $p=0.8$) The statistical interaction between flexion and lordosis was significant ($p=0.004$) meaning that difference in postoperative pain between hyper and hypolordosis depended on the patient degree of flexion. With stratification of the analyses of flexion at patients with hypoflexion preoperatively, patients with hypolordosis (OR 0.06, CI:-0.27; $p=0.003$) but when looking at hyperflexion patients preoperatively no association was found.

In conclusion patients with a stiff and flat back have good prognosis after lumbar disc surgery, and in most cases the pain will reach 2-year level during the 2-6 weeks, while the physical restoration measured by lumbar flexion and lordosis and the perceived disability, will continue to improve over the first 6 months after surgery. ⁽³⁹⁾

5.5. Reoperation of disc herniations

A total of 40 recurrent disc herniation cases performed between 2004 and 2007 were selected for this study. **Criteria for inclusion** in the study were (a) previous operation due to lumbar disc herniation (b) recurrent disc herniation on the operated side and (c) lack of a response to medical treatment at six weeks. Cases with different spinal pathology, spondylolisthesis, traumatic vertebral fracture, scoliosis, infection and serious systemic disease were excluded from the study.

All patients were taken into the operating room under general anaesthesia in the prone position. Prophylactic antibiotics were given to all patients before the operation. All operations were performed using operational microscopy and standard surgical technique. The level of operation was determined via intraoperative fluoroscopy. When the interlaminar level with recurrent disc herniation was approached from the medial aspect, existing laminotomy was widened with the help of a high-speed drill and the facet joints' medial portions were removed.

After identifying the correct nerve root, free disc fragments under the nerve root and passageway were removed. Decompression was finished by performing the required for laminotomy. After carrying out the microdecompression procedure, they also executed posterior dynamic transpedicular stabilisation from the same incision, with the help of lateral intraoperative fluoroscopy by Wiltse approach via inside lateral paravertebral muscle. The dynamic pedicle hinged screws used in this cases were Cosmic (Ulrich GmbH & Co. KG, Ulm, Germany). Dynamic pedicle screws were used in combination with rigid rods.

The mean follow-up period for all 40 patients was 41 months (range: 24-63 months). The VAS and Oswestry scores showed significant improvements at 3, 12 and 24 months postoperatively as compared to preoperative scores ($p < 0.01$). Variation in Oswestry measurements was found to be highly significant ($p < 0.01$) during the follow-up period. Post-hoc Bonferroni test evaluations revealed highly significant decreases in post-operative 3rd-, 12th- and 24th-month measurements ($p < 0.01$). Variation in VAS scores during the follow-up period was also found to be highly significant ($p < 0.01$). According to post-hoc Wilcoxon signed-rank test, decreases in the 3rd, 12th and 24th post-operative months were highly significant ($p < 0.01$).⁽³⁴⁾

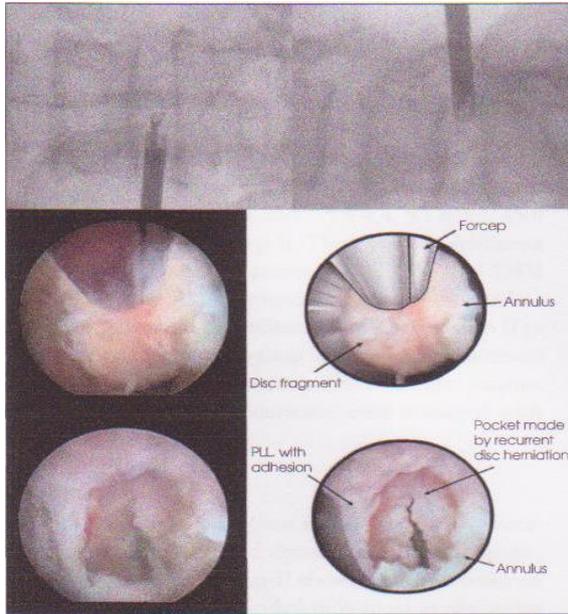


Figure 36: Upper: Intraoperative fluoroscopic images taken after insertion of endoscopic cannula. Middle: Recurrent disc herniation was removed with forceps under endoscopic view. Lower: Endoscopic view taken successful removal of recurrent disc herniation. ⁽³⁴⁾

Variation in Lumbar Lordosis (LL) measurements taken during pre-operative, early post-operative, and post-operative months 3, 12, and 24 were not statistically significant ($p > 0.05$). Changes in segmental lordosis angle (α) measurements taken during pre-operative, early post-operative, and post-operative months 3, 12, and 24 were not statistically significant ($p > 0.05$). Changes in intervertebral space (IVS) measurements in pre-operative, early post-operative and post-operative months 3, 12, and 24 were also not statistically significant ($p > 0.05$).

They observed complications in two patients. Foreign body reaction was observed in the first patient. The patient was reoperated upon and the dynamic stabilisation system was removed. In the other patient low back pain and sciatica due to PDTs continued. Therefore, the dynamic system was removed and fusion with rigid stabilisation was performed.

Recurrent disc herniation accounts for the most common problematic situations after lumbar disc surgery. Recurrent disc herniations are radiologically visualised lumbar disc herniations, which are non-responsive to medical treatments other than surgery. The rate of reoperation

due to recurrent disc herniation after lumbar disc surgery is approximately 5-15%. Segmental instability is diagnosed in 20% of patients with lumbar disc herniation.

Instability after lumbar disc surgery is secondary segmental instability, described as 'status-post discectomy' by Frymoyer. In fact this situation is not an overt instability; as described by Benzel, it is a chronic instability. Studies have shown that when performed on segmental degeneration cases, discectomy may cause segmental instability and accounts for 38% of unsatisfactory results.

Segmental fusion operations are performed frequently as treatment for recurrent disc herniation. Nevertheless, fusion also carries various risks such as adjacent segment degeneration, bone graft donor place pain, and pseudoarthrosis.⁽⁶⁹⁾

Two – hundred and ten patients had surgery for lumbar disc herniation in Jyvaskyla Central Hospital in the year 1999 (1/1000 inhabitant of the area). Of this number 173 patients (82%) volunteered for a follow up study, filled a preoperative questionnaire and were referred of 2 and 12 month post operative check up visits in the hospital's outpatient clinic. Twelve month recovery has been reported earlier. After that they were mailed a 5 year questionnaire retrospectively to obtain their current health information. Of the 173 patients, 7 were excluded due to previous back surgery. The final study group followed up for five years consisted of 166 virgin lumbar disc herniation patients. The age of the patients varied from 16 to 74 years. The indication for the initial surgery was extensive or unbearable pain radiating down to the lower extremity or muscle weakness. In some cases also, loss of the patellar or Achilles reflex, regional sensory loss, and positive straight leg raising test (SLR<60) were present.

Main results of the original 166 patients the cumulative rate of reoperations for lumbar disc herniation over the 5 year period was 10.2% (17 patients, 95% CL 6.0 to 15.1). Of those, twelve patients (7.4%, 95% CI 3.7 to 11.3) had desire at the same side and level as the primary herniation and five (3.1%, 95% CI 0.6 to 6.2) had herniation at a site other than that of their primary prolapsed. In addition to re operated lumbar disc herniation 6 patients also underwent other back surgery during the follow up (2 had decompressive surgery and 4 had spinal fusion). Three out of twelve residives occurred within one year and the overall

occurrence of residue lumbar disc herniations was evenly distributed over the 5 years. All primary and re operations were done in the same hospital.

In the present study, the cumulative rate of operations for lumbar disc herniation was 10% at 5 year follow up. Atlas et al. 2005 reported outcomes of patients with lumbar disc herniation treated surgically of none surgically. At 10 year follow up out of 217 surgically treated patients 25% had undergone at least one additional lumbar spine operation.

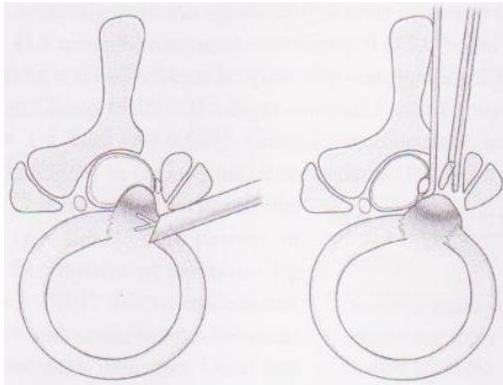


Figure 37: Schematic drawing showing percutaneous endoscopic lumbar discectomy (left) and repeated open lumbar microdiscectomy (right) for recurrent disc herniation. ⁽³⁴⁾

Osterman et al. 2003 reported an increasing cumulative risk for lumbar re operations over time as at the one year follow up 25%. A Swedish 10 year follow up showed that 10% out of 27.576 patients under went multiple operations for disc herniation. A large Finnish study with 25.366 patients and with an average follow up time of 4 years reported that 12% of the patients had at least one re-operation in the lumbar area. In the study 76% of the first re-operations were repeated extirpations of disc herniations, 21% decompression operations and 3% spinal fusion operations.

Four percent of the patients had decompressive surgery or spinal fusion percent after the first lumbar disc herniation. However the accurate comparison of the risk for re operations between studies is not possible due to differences in samples, follow up times and statistical methods. ⁽²²⁾

6. Results

In this review we sought to analyze the symptomatic lumbar disc herniation and to compare overall benefits of conservative and non conservative treatments. Relationships effecting lumbar disc herniation will be also be mentioned.

Conservative versus non-conservative treatments for lumbar disc herniation

The most recent clinical trials available were SPORTs having one randomized and one observation cohort comparing conservative and surgery treatment for a symptomatic lumbar disc herniation with duration at least 6 week of pain.

Overall, 1,244 SPORT participants with lumbar intervertebral disc herniation were enrolled (501 in the randomized cohort, and 743 in the observational cohort). In both cohorts combined, 805 patients received surgery at some point during the first 4 years; 439 (35%) remained non-operative. Over the 4 years, 1,192 (96%) of the original enrollees completed at least 1 follow-up visit and were included in the analysis (randomized cohort: 94% and observational cohort 97%).⁽⁷⁵⁾

The treatment effects significantly **favor** surgery in both cohorts. In the combined analysis, treatment effects were statistically significant in favor of surgery for all primary and secondary outcome measures (with the exception of work status) at each time point.

The treatment effects for the secondary measures of sciatica bothersomeness, satisfaction, and self-rated improvement narrowed between 3 months and 2 years but remained significant at all periods. **Work status** was **significantly worse in the surgery group at 3 months** due to surgery patients recovering from surgery; work status thereafter showed a small but non-significant benefit for surgery. At 4 years, the adjusted percentage of patients working was 84.4% surgical vs. 78.4% non-operative, treatment effect 6.0 (95% CI -0.9, 12.9).

The results of SPORT are similar to the Maine Lumbar Spine Study (MLSS) and the Weber landmark study. The MLSS reported somewhat larger adjusted treatment effect differences at 5 years between patients who had received surgery within 3 months versus those that had not when compared to the SPORT 4-year data: -7.1 vs. - 3.3 (sciatica bothersomeness), -2.0

vs. -0.9 (leg pain in the past week) and -1.2 vs. -0.8 (low back pain in the past week). The differences are mainly related to **greater improvements in the non-operative group in SPORT** vs. MLSS; that is, the sciatica bothersomeness non-operative mean change from baseline for SPORT was -8.2 at 4 years vs. MLSS -4.6 at 5 years. While there are no validated outcome measures that can be directly compared between SPORT and the Weber study, their 4 year results of 70% more patients in the surgical group and 51% in the conservative treatment group with “Good” results is similar to SPORT’s 79.2% self-rated major improvement in the surgery group and 51.7% in the non-operative group at 4 years. ⁽⁷⁵⁾

In a general overview of the trials comparing conservative and non-conservative treatments a significant efficiency in all clinical outcomes were favor of surgery against non-operative. There were some **significant decrease after 6 monthss** in the following outcomes between these procedures but **surgery maintained greater results**.

Peul et al. trial for early surgery showed that after having sciatica there was earlier pain relief for surgery in contrast of conservative treatment. But these results were not significant in **6 months** and the difference between the two groups **was decreased**. ⁽⁵⁰⁾ In all trials there was also good results overtime for conservative especially in SPORTS in the “usual care” mentioned. With having **only a 43% of physical therapy** intervention and those we can conclude that if there better interventions to conservative patients there may have been better results.

In all the trials the same limitation of crossover of patients were found between the groups due to randomization of treatment approaches produced a dysbalance of the initial group’s enrollment.

Minimal invasive procedures and their efficiency for lumbar disc herniation

Microdiscectomy gives broadly comparable results to standard discectomy and show that they can reduce scar formation, however there is limited evidence about the effect on clinical outcomes. ⁽⁴⁶⁾ There is insufficient evidence on other percutaneous discectomy techniques to draw firm conclusions. The evidence for other minimally invasive techniques remains unclear except for chemonucleolysis using chymopapain, which is no longer widely available.

By comparing two operative techniques standard microscopic technique and microscopic assisted percutaneous nucleotomy (MAPN) technique the clinical outcomes of both surgical

methods were indistinguishable at the transfer center, whereas MAPN patients at the index center showed a slightly faster recovery when compared to MC patients.

In 83% of the patient a primary observed motor deficit resolved completely within the follow up period. Sensory deficits completely resolved in 68% of the patients, improved in 18%, and remained unchanged in 14%. For the neurological situation there was no obvious difference found for the transfer center.

Within this study period no real clinical advantages of the less traumatized posterior muscles could be found. Thus, the hypothesis that with a lesser traumatized back muscle leads to a quicker recovery and to less chronic pain could not be confirmed.⁽⁵³⁾

Tassi reviewed outcomes from 500 patients with discogenic pain and herniated discs treated with microdiscectomy (1997-2001 by 6 surgeons) and 500 patients treated with percutaneous laser disc decompression (2002-2005 by a single surgeon). Patients with sequestered disc were excluded. This retrospective review found that the hospital stay (six vs. two days), overall recovery time (60 vs.35) and repeat procedure rate (7% vs. 3%) were lower in the laser group. The percentages of patients with overall good/excellent outcomes were found to be similar in the two groups (85.7% vs. 83.8%) at a two year assessment.⁽⁵¹⁾

PLDD has been around for almost 20 years, scientific proof of its efficacy still remains relatively poor also the criteria for selection of patients for treatment of PLDD which is based on the concept of the intervertebral disc being a closed hydraulic system, and only contained herniations can be expected to respond to reduction of intradiscal pressure.

Conservative treatments and the efficiency for lumbar disc herniation

Luijsterburg et al randomized to evaluate physical therapist efficiency compared a general practitioner with a physical therapist and the only treatment by a general practitioner. About 53 patients (79%) in the intervention group versus 38 patients (56%) in the control group reported to be improved in the primary care within a 12- month's follow-up period. More significant results is needed with longer time evaluation. In other reviews on systematic reviews no differences were found in overall improvement, pain, and disability at short-term.

Conflicting evidence regarding improvement of pain at short-term follow-up was found.

Physical therapy programs included conventional lumbar traction and had quite beneficial on lumbar disc herniation without emergent operative indications with clinical improvements noticed to occur prior to radiological improvement. In conclusion clinical parameters should be considered in primary evaluation of treatment results of patients with lumbar disc herniation. ⁽⁷⁶⁾

McKenzie method is a knowable evaluation and treatment procedure with give us the status of the patients pain in different positions. There was information found that surgery was decreased when McKenzie approach was available in Denmark and that it had good acute outcomes when extension exercises were tolerable for patients. However clinical significant results were not available to conclude further.

From a review analyzed with the results there is belief that **chiropractic management** and nonsurgical measures (manipulation, stabilization and neuromobilization) are a viable alternative to surgery in patients with radiculopathy. Of the 162 consecutive patient reviewed, 99 were female and 63 were male. Upper extremity symptoms were seen in 61 cases and lower extremity in 108 cases, with 7 of these cases demonstrating both. ⁽⁸⁾

Ninety-five (58.64%) were classified as “chronic”, meaning their symptom duration was greater than 3 months. Ninety-one percent of acute presentations resolved with a treatment trial (mean) of 6.2 sessions, ranging from 1 to 20 visits. Eighty-one percent of chronic presentations resolved with a treatment trial of 8.6 (mean) sessions, ranging from 1 to 23 visits.

There were several important limitations to this study and randomized controlled trials are needed for further assess of this nonsurgical approach compared with untreated controls and surgical treatments.

For stabilization there was no significant finding but there is an effect by providing it. An interesting case mentioned of a structural change of a disc herniation by providing efficient functional stabilization approach. This goes hand in hand with the stabilization theory in the general part by describing how important is functional stereotypes performed and with abdominal breathing (stability) providing increase abdominal pressure which gives lower compression on the lumbar spine and simultaneously lesser on the intervertebral discs.

Does morphological, location and natural history play a role in lumbar disc herniation?

In a combination of SPORTS data Pearson et al. evaluating morphology and lumbar spinal level herniations showed that a greater difference in improvement between operative and non-operative treatment for upper level herniation (L2-L3 and L3-L4) than for herniations at the levels L4-L5 and L5-S1. Patients with upper level herniation had less improvement with non-operative treatment and slightly better operative outcomes than those with lower level herniations resulting outcome of surgery that the upper level herniation was greater than the L4-L5 results, which were greater than the L5-S1 results. ⁽⁴⁹⁾

Foraminal herniations were most likely found in upper levels (24%), in L4-L5 (3%) and in L5-S1 (2%); far lateral herniations were found (25%) in upper levels, a 7% in L4-L5 and (6%) in L5-S1 and most were posterolateral herniation which represented in upper level (44%), in L4-L5 (76%) and in L5-S1 83%). The upper level herniation group was more likely to have a sequestered fragment. The extrusion/sequestration was more likely to undergo surgery than the protrusion group and in the severity of leg-symptoms was lower at baseline for patients with upper herniations.

Takata et al. investigation for **morphological changes** of 42 patients (28 men and 14 women) with a mean age of 42 years (range 16–64 years) who presented with unilateral leg pain and low back pain that was definitely diagnosed as being caused by LDH.

In conclusion of this investigation were that 37 out of 42 patients (88 %) showed effective (>50%) reduction of the herniated mass on MRI 3-12 months after the onset of symptoms. Sequestered hernia and transligamentous extrusions seem to be more easily and rapidly absorbed. MRI changes and improvement of symptoms are well correlated with MRI changes, but a time lag is observed. ⁽⁶⁶⁾

The basic treatment of LDH should be conservative according to the results of this study; however surgery may be necessary for large central protruding hernias and patients who show severe motor deficits. There is a need of more randomized experiments for conservative treatments with chronicity within at least 2 years for better statistical significant results. ⁽⁶⁶⁾

Post surgery results, reoperation, training and posture influence

The rate of reoperation due to recurrent disc herniation after lumbar disc surgery is approximately 5-15%. Segmental instability is diagnosed in 20% of patients with lumbar disc herniation.

Hakkinen et al. evaluated trunk muscle strength, pain, flexibility, and disability in patients who had been operated for lumbar disc herniation 2 months after surgery. Although the leg pain and back pain decreased by approximately 80%, 30% of the patients perceived moderate to severe disability measurements. It was also noted that decreased muscle strength and mobility, especially with older patients and with considerable postoperative pain, caused significant functional disability. The recovery of multifidus muscle is not spontaneous after resolution of painful symptoms, and this inhibition can be reversed only by specific training exercises. This then can prevent the subsequent incidence of low back pain and thus also prevent recurrences. ⁽¹⁸⁾

Ostelo et al. in a Cochrane systematic review concluded that: exercise programs starting in four to six weeks post-surgery seem to lead to a faster decrease in pain and disability than no treatment. In high intensity exercise programs led to a faster decrease in pain and disability than low intensity programs. There was no significant difference between supervised and home exercises for pain relief, disability, or global perceived effect. There is no evidence that active programs increase the re-operation rate after first-time lumbar surgery. ⁽⁷²⁾

In a prospective study of 79 people Lundin et al. ⁽³⁹⁾ evaluated the condition of stiff back spine to be associated with outcome in surgery and found that patients with a stiff and flat back had good prognosis after lumbar disc surgery, and in most cases the pain was reach a 2-year level during the 2-6 weeks, while the physical restoration measured by lumbar flexion and lordosis and the perceived disability, will continue to improve over the first 6 months after surgery.

In conclusion specific training influence the post surgery results by strengthening the weakend muscles and limiting a relapse for the disc herniation. Nevertheless there is a great amount of relapses and reoperations that give us information that a better examination is need to determine which patients are for surgery. In the study for back status associating with surgery it showed a good prognosis but there is also a need of evaluating clinical outcomes.

7. Discussion

In this review for lumbar disc herniation provoking radiculopathy research on conservative and non conservative was performed to compare and evaluate their efficiency. The results of the most recent trials were comparing directly treatments were found and described as the question in this review was the

Weber's landmark study was similar with comparison of the most recent available SPORT's with "good" results of 70% and 79.2% in surgery groups and 51% and 51.7% in the non-operative groups respectively. ⁽⁴⁰⁾

Limitations of the trials were found similarity in the randomized trials from the crossover of patients with the SPORTs groups with the other recent randomized trial recent for disc herniation; Peuls et al. shared nearly the same amount of crossover 38% in 6 months and 39% in 5 months had crossed into surgery respectively.

The estimated improvements 1 year after surgery in these two studies were similar (Peul vs. SPORT): SF-36 BP 59.3 vs. 43.7; SF-36 PF 50.3 vs. 44.4; and Sciatica Bothersomeness -11.5 vs. -11.2. In addition, the differences at 1 year between randomized groups in the intent-to-treat analyses were also quite similar: SF-36 BP 2.7 vs. 3.6; SF-36 PF 2.2 vs. 2.0; and Sciatica Bothersomeness -0.4 vs. -1.9.

These results further validate the SPORT randomized cohort results but again highlight is needed to also consider the as-treated analysis in this study population to estimate the true effect of surgery and to avoid bias towards no significant results. ⁽⁴⁰⁾

From other trials there was low evidence on treatments efficiency but some results were obtained and analyzed. Franke et al. ⁽⁴⁶⁾ in a prospective randomized controlled clinical trial compared two operative techniques standard microscopic technique and microscopic assisted percutaneous nucleotomy (MAPN) technique. The microsurgical procedure underwent 48 and 52 patients a MAPN procedure. In 83% of the patient a primary observed motor deficit resolved completely within the follow up period. Sensory deficits completely resolved in 68% of the patients, improved in 18%, and remained unchanged in 14%.

Within the study period no real clinical advantages of the less traumatized posterior muscles could be found. Thus, the hypothesis that with a lesser traumatized back muscle leads to a quicker recovery and to less chronic pain could not be confirmed.⁽⁷⁴⁾

After these trials the review focused on conservative treatments in trials and reviews there was also low evidence for conclusions but information were obtained and evaluated. Luijsterburg et al. showed greater improvement when using a physical therapist with a general practitioner rather than only treatment by a general practitioner. About 53 patients (79%) in the intervention group versus 38 patients (56%) in the control group reported to be improved (RR, 1.4 95% CI: 1.1; 1.8).⁽⁷⁶⁾

In a chiropractic approach 162 total cases, of acute and chronic presentation had general radiculopathy which this is the limitation of the trial. Nevertheless the results were so that needed to be mentioned. Ninety-one percent of acute presentations resolved with a treatment trial (mean) of 6.2 sessions, ranging from 1 to 20 visits. Eighty-one percent of chronic presentations resolved with a treatment trial of 8.6 (mean) sessions, ranging from 1 to 23 visits.⁽⁸⁾

Evaluating with McKenzie method using the extension exercise showed that after examining 67 patients with low back pain (LBP) radiating to the calf or foot with at least one significant sign of nerve root irritation and at least 6 weeks of failed non-operative therapy. The 52% of patient (34 of them) shown no worsening during extension test. All 34 performed extension exercise program with 100% regaining their full lumbar extension range and eliminating their symptoms within 2-5 days.⁽³¹⁾

For postoperative patients Ostelo et al. in a Cochrane systematic concluded that exercise programs starting in four to six weeks post-surgery seem to lead to a faster decrease in pain and disability than no treatment. In high intensity exercise programs led to a faster decrease in pain and disability than low intensity programs. There was no significant difference between supervised and home exercises for pain relief, disability, or global perceived effect. There is no evidence that active programs increase the re-operation rate after first-time lumbar surgery.⁽⁴⁶⁾

This review gave positive results that with function and exercises there was improvement for patients with lumbar disc herniation however this results were with low evidence to obtain significant results.

The outcome of the trials are low in evidence and not significant valued however the interesting of the review of lumbar disc herniation was also describing the mechanical overview of the lumbar spine and by trying to understand what influence has body posture and stabilization function for disc herniation and especially in the lumbar region.

Experiments of stabilization of the lumbar spine were described in the general part showing the importance of stability for any lumbar problem of the abdominal breathing in stability. Abdominal breathing provides stability in the trunk by just providing resistance on an extremity with abdominal breathing has quicker return to initial state rather than chest breathing. ⁽⁷¹⁾

Internal positive pressure creates functional strength and contributes to stability. Positive pressure is regulated by intrabdominal pressure (IAP) which is generated and maintained by trunk and abdominal muscles. ⁽⁶³⁾

Does morphology of a disc herniation change?

When the diaphragm flattens during inspiration it acts against the resistance of the abdominal wall. Synergistic action of the diaphragm, with the abdominal, and the pelvic floor controls the intr-abdominal pressure (IAP) to provide anterior stabilization of the Lumbosacral spine. By means of regular proper stabilization exercises at time it is possible to change even the structure by comparing a 2 year difference MRI pictures of patients with radicular pain syndrome. ⁽⁶³⁾

Takata et al. investigated **morphological changes** of 42 patients (28 men and 14 women) with a mean age of 42 years (range 16–64 years) who presented with unilateral leg pain and low back pain and was definitely diagnosed as being caused by LDH.

In conclusion of this investigation were that 37 out of 42 patients (88 %) showed effective (>50%) reduction of the herniated mass on MRI between 3-12 months after the onset of symptoms. Sequestered hernia and transligamentous extrusions seem to be more easily and

rapidly absorbed. MRI changes and improvement of symptoms are well correlated with MRI changes, but a time lag was observed. ⁽⁶⁶⁾

Low evidence significance but interesting information showing that disc herniation benefits by time and can change its morphology by only usual care. If we can progress this information with functional stability mentioned and McKenzie evaluation and treatment with other conservative care such as traction, mobilization and reflex changes may provide in a long run beneficial effects on a lumbar disc herniation.

According to the results of this study the basic treatment of LDH should be conservative; however surgery may be necessary for large central protruding hernias and patients who show severe motor deficits. ⁽⁶⁶⁾

There is a need of more randomized experiments for conservative treatments with specific and combining treatments with chronicity at least 2 years for better statistical significant results.

8. Conclusion

This thesis completed a systematic review of the relevant literature on the efficacy of conservative treatment of symptomatic lumbar disc herniation (LDH). Thirty clinical trials and four systematic reviews were found and evaluated according to their results with conclusions:

A significant improvement in surgery in evaluation in the first six months which follows in a slight decrease in the first 2 years comparing with conservative approach.

Microdiscectomy effectiveness is comparable with standard discectomy but without any chronic significant findings. A stiff and flat back has a good prognosis for patients undertaking lumbar disc surgery. Conservative treatments can improve patient but there were no statistically significant however good results were shown in evaluation and exercise by McKenzie also physical therapy had some good results with exercises, and traction but with greater result in chiropractic approach. Conservative is needed after surgery for better and longer timing results. By MRI findings there was conclusion that only with natural history and conservative approach a disc herniation can relapse.

Future recommendation

In enrolling patients after having at least duration of 4 weeks sciatica due to disc herniation is needed. Providing a randomized of 3 groups: a control group (usual care), a conservative treatment group with specific treatments and not usual methods, a surgery group. With low amount of enrollment no more than 100 patients in each group for a better significant result data. Conservative treatments group will provide combination of treatments in deep stabilization training, traction, mobilization, soft tissue basically in a manual therapy approach. This with combining MRI every 3 months for 2 years of trial will be the best combination of a randomization to evaluate the treatment for lumbar disc herniation in favour for the physiotherapist.

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Appendix

Levels of Evidence for Primary Research Question¹

Types of Studies				
	Therapeutic Studies Investigating the results of treatment	Prognostic Studies Investigating the effects of a patient characteristic on the outcome of disease	Diagnostic Studies Investigating a diagnostic test	Economic and Decision Analyses Developing an economic or decision model
	<p>High quality randomized trial with statistically significant difference or no statistically significant difference but narrow confidence intervals</p> <p>Systematic review² of Level I randomized controlled trials (RCTs) (and study results were homogenous³)</p>	<p>High quality prospective study⁴ (all patients were enrolled at the same point in their disease with $\geq 80\%$ follow-up of enrolled patients)</p> <p>Systematic review² of Level I studies</p>	<p>Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)</p> <p>Systematic review² of Level I studies</p>	<p>Sensible costs and alternatives; values obtained from many studies; with multiway sensitivity analyses</p> <p>Systematic review² of Level I studies</p>
	<p>Lesser quality RCT (e.g., $<80\%$ follow-up, no blinding, or improper randomization)</p> <p>Prospective⁴ comparative study⁵</p> <p>Systematic review² of Level II studies or Level I studies with inconsistent results</p>	<p>Retrospective study⁶</p> <p>Untreated controls from an RCT</p> <p>Lesser quality prospective study (e.g., patients enrolled at different points in their disease or $\leq 80\%$ follow-up)</p> <p>Systematic review² of Level II studies</p>	<p>Development of diagnostic criteria on consecutive patients (with universally applied reference "gold" standard)</p> <p>Systematic review² of Level II studies</p>	<p>Sensible costs and alternatives; values obtained from limited studies; with multiway sensitivity analyses</p> <p>Systematic review² of Level II studies</p>
	<p>Case control study⁷</p> <p>Retrospective⁶</p>	<p>Case control study⁷</p>	<p>Study of nonconsecutive patients; without consistently</p>	<p>Analyses based on limited alternatives</p>

Types of Studies				
	Therapeutic Studies Investigating the results of treatment	Prognostic Studies Investigating the effects of a patient characteristic on the outcome of disease	Diagnostic Studies Investigating a diagnostic test	Economic and Decision Analyses Developing an economic or decision model
	comparative study ⁵ Systematic review ² of Level III studies		applied reference "gold" standard Systematic review ² of Level III studies	and costs; and poor estimates Systematic review ² of Level III studies
	Case series ⁸	Case series	Case-control study Poor reference standard	Analyses with no sensitivity analyses
	Expert opinion	Expert opinion	Expert opinion	Expert opinion

1 A complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.

2 A combination of results from two or more prior studies.

3 Studies provided consistent results.

4 Study was started before the first patient enrolled.

5 Patients treated one way (e.g., cemented hip arthroplasty) compared with a group of patients treated in another way (e.g., uncemented hip arthroplasty) at the same institution.

6 The study was started after the first patient enrolled.

7 Patients identified for the study based on their outcome, called "cases"; e.g., failed total hip arthroplasty, are compared to those who did not have outcome, called "controls"; e.g., successful total hip arthroplasty.

8 Patients treated one way with no comparison group of patients treated in another way.