

CHARLES UNIVERSITY IN PRAGUE
FACULTY OF PHYSICAL EDUCATION AND SPORT
Department of physiotherapy

**Physiotherapy treatment of patient with chronic lumbar
intervertebral disk herniation with radiculopathy**

Bachelor Thesis

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Abstract

Thesis title: Physiotherapy treatment of a patient with diagnosis of lumbar intervertebral disk herniation with radiculopathy.

Název práce: Fyzioterapie pacienta s diagnózou herniace bederní meziobratlové ploténky s radikulopatií.

Work placement: Ustředni Vojenská Nemocnice , Prague, 1200/1, 16200, Praha 6.

Summary: The objective of this thesis is to illustrate a case study of a conservative treated patient with intervertebral disc herniation of the L5 segment, in chronic stage. In my thesis I attempt to reveal the nature of this pathology, analyze the medical interventions and demonstrate the physiotherapeutic approaches, rehabilitation plan and all the conducted procedures.

This thesis is divided in two parts. The first comprises the theoretical part which includes the anatomy, kinesiology, physiology and biomechanics of the lumbar spine as well the diagnostic and therapeutic procedures and approaches.

The second contains a health chart which depicts the medical history of my patient and a detailed report that clarifies the clinical practices applied.

Key words: Disk herniation, intervertebral disk, chronic state, physiotherapy, rehabilitation, lumbar spine conservative treatment, deep core, functional training

Declarations

I declare that this bachelor's thesis was handled and fulfilled by myself, under the supervision and instructions of Mgr. Kateřina Holubová. All information and clinical procedures which are presented in this thesis was based on used bibliography and knowledge gained during my academic studies. My thesis is a demonstration of my original clinical work that was performed under the supervision of Mgr. Markéta Ptáčková Cert. MDT. At the Ustředni Vojenská Nemocnice military hospital in Prague.

Prague, March 2014

Dimitrios Millas

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Special thanks to my supervisor Mgr. Kateřina Holubová for being an exceptional professional and teacher, able to guide me meticulously during my thesis and all those years as a student.

Dedications

I dedicate my thesis to my parents who always been the backbone in my life choices and supported me during this exhausting journey, my girlfriend which willingly shared this weight with me those 3 years in distance, to all students abroad who missed their family as i did and to all of those who stood beside me all this time and gave me courage to fight my inner demons...

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1. PREFACE

The objective of this thesis is to analyze in depth and demonstrate the physiotherapeutic approach in a patient with intervertebral disk herniation of the 5th lumbar segment at the chronic phase.

My thesis is divided into two parts, the general part and the special part (case study). The general part intends to deliver to the reader the fundamental theoretical knowledge of intervertebral disk herniation pathology. The sections of the general part include: anatomy, kinesiology, biomechanics, description of the mechanical stability mechanisms, epidemiology, assessment procedures, surgical approach, conservative approach and physiotherapeutic approach. The special part is the most important part of my research and it includes: the examination, treatment, evaluation of effectiveness of the therapeutic procedure and its results as also bibliography, list of figures, tables, abbreviation inventory and the personal application to ethics board review. The physiotherapeutic procedure performed using knowledge acquired from my studies, information found in academic literature and guidance by my supervisors.

The whole procedure took place at the ambulance department at the Ústřední vojenská nemocnice (ÚVN) military hospital, as part of my clinical practice.

2. GENERAL PART

2.1 Anatomy and role of the vertebral column

The vertebral column is an assemblage of linked individual bones called vertebrae. It is divided into 5 functionally separated parts; the cervical, thoracic, lumbar, sacrum and the coccyx. There are approximately 33 vertebrae that are divided as 7 cervical, 12 thoracic, 5 lumbar, 5 triangular ossified sacral and 4 fused elemental vertebrae consisting the coccyx [17, 18].

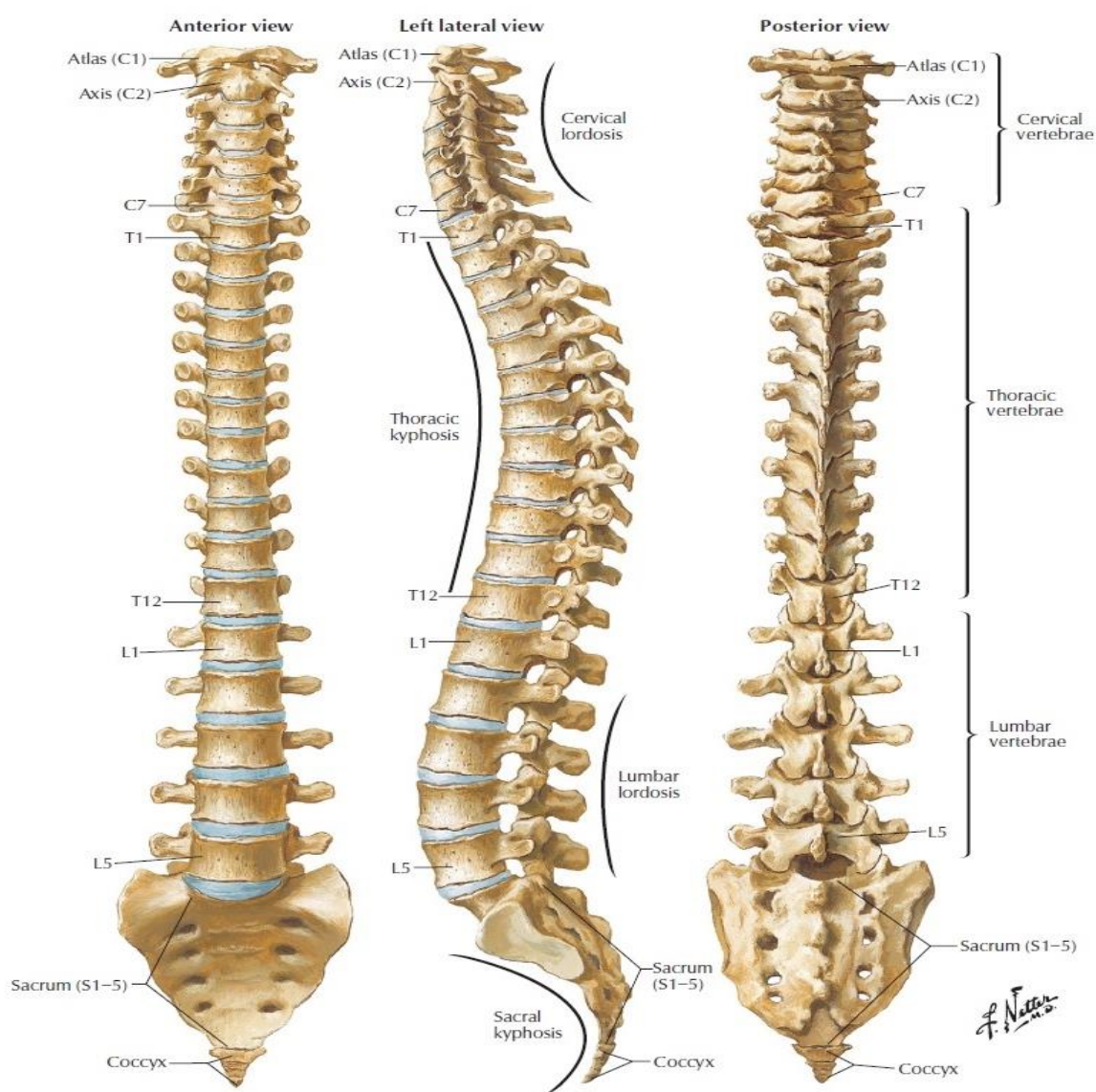


Figure 1: The spinal column in anterior, lateral and posterior view [17].

Each spinal sector vertebrae differs and shares characteristic among others. A typical vertebra has a ventral body, a dorsal arch extended by processes, a vertebral foramen engaged by the spinal cord, meninges and their vessels. There are 7 processes projecting per vertebral arch. Those consist of two transverse processes, a spinous process, and bilateral superior and inferior articular processes. On these articular processes there is a smooth hyaline cartilage-base joint, where the superior articular process of a vertebra articulates with the inferior articular process of the vertebra above it, to form the zygapophysial joint or facet [17, 18].

2.1.1 Anatomy of ligaments of the vertebral column

The ligaments of the vertebral column include the interspinous, intertransverse, supraspinous, ligament flava and the anterior and posterior longitudinal ligaments. The role of interspinous ligaments is to connect the ends of consecutive spinous processes in the time that intertransverse ligaments attaching to the transverse processes of the bordering vertebra. The longitudinal ligaments extend anteriorly from C1 and posteriorly from C2 vertebrae down to the sacrum and attaching to the intervertebral disc and neighbor vertebrae [17, 18].

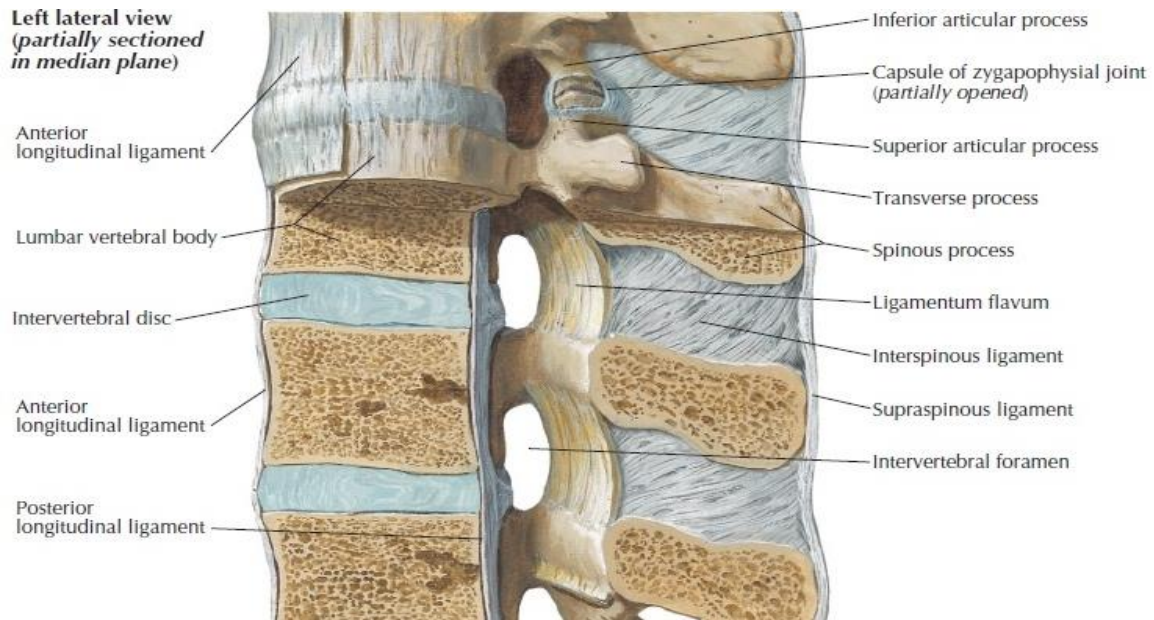


Figure 2: Lateral view, median sectioned composition of ligaments of vertebral column [17].

2.1.2 Anatomy and function of intervertebral disc

The intervertebral disc consists of an outer layer of collagen lamellae which compose annulus fibrosus. Annulus fibers surrounds the inner nucleus pulposus and is responsible for distribute the applied pressure within the disc. Nucleus pulposus contain loose fibers suspended in a mucoid gel that act as cushioning and shock absorbing material for the vertebrae. The disk's elastic properties are diminishing by age and the nucleus pulposus becomes more fibrous, thinner and less hydrated. The thickness of the disc varies according to their localization as the cervicothoracic disks are the thinnest and lumbar the thickest. Furthermore, cervical and lumbar intervertebral disks are thicker on their anterior portion, granting and enhancing the lordotic curvature of the spine segment. Intervertebral discs are adhered to the vertebral end-plates and contained by the ring apophysis and all of them are hooked anterior and posterior by the anterior and posterior longitudinal ligaments. In addition intervertebral disks found in thoracic spine have supplementary fixation by intra articular ligaments [16, 17, 18].

2.1.3 Joints of the lumbar spine

When any two consecutive lumbar vertebrae are articulated, they form three joints. The first is formed between the two vertebral bodies and the other two are formed by the articulation of the superior articular process of one vertebra with the inferior articular processes of the vertebra above (Figure 3). The joints between the articular processes are known as zygapophysial or facet joints that act as a "bridge" between two vertebrae. The space located between two vertebrae called intervertebral joint and its role is to aid the spine to move. The vertebral body and the vertebral arch are the contact points that forming the intervertebral joint [16].

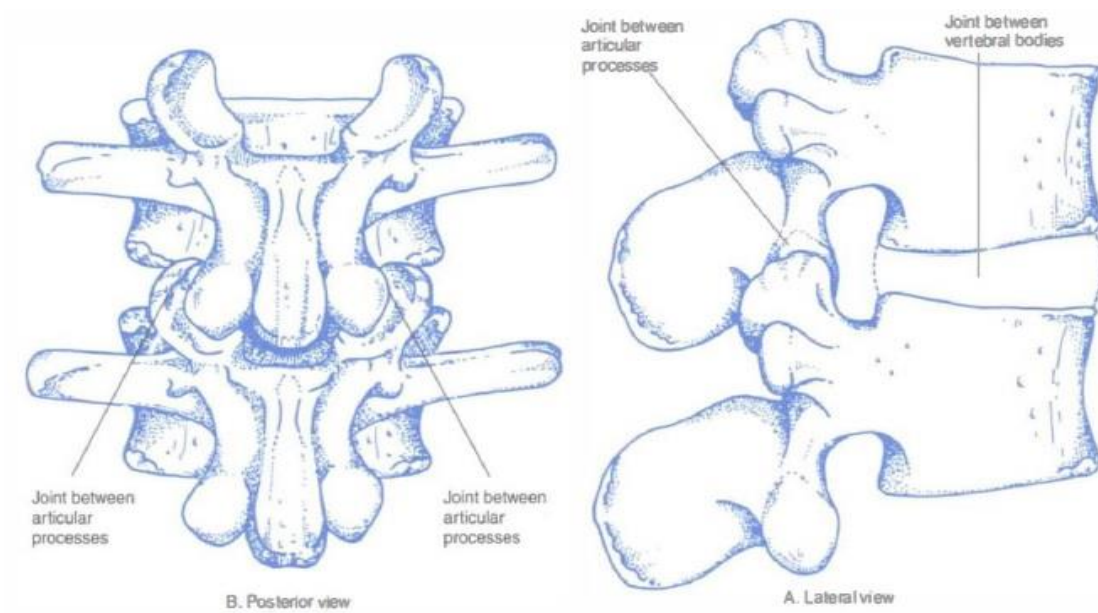


Figure 3: The joints between two lumbar vertebrae in posterior and lateral view [16].

2.2 Spinal nerves and segmental innervation

Spinal nerves are united ventral and dorsal spinal roots, attached in series to the sides of the spinal cord. There are 31 pairs of spinal nerves: 8 cervical (C1-C8), 12 thoracic (T1-T12), 5 lumbar (L1-L5), 5 sacral (S1-S5), 1 coccygeal (Co1). The peripheral nerves emerge through the intervertebral foramina. All ventral rami excluding T2-T12 are organized into nerve plexuses as the branching each other laterally to the vertebral column. Those plexuses are dividing into cervical (C1-C5), brachial (C5-T1), lumbar (L1-L4) and sacral (L5-S3) according to their localization. Every spinal segment is functionally connected to a distinct area of skin (dermatome, Figure 4), muscle (myotome), skeleton (sclerotome), and internal organs (enterotome) [18].

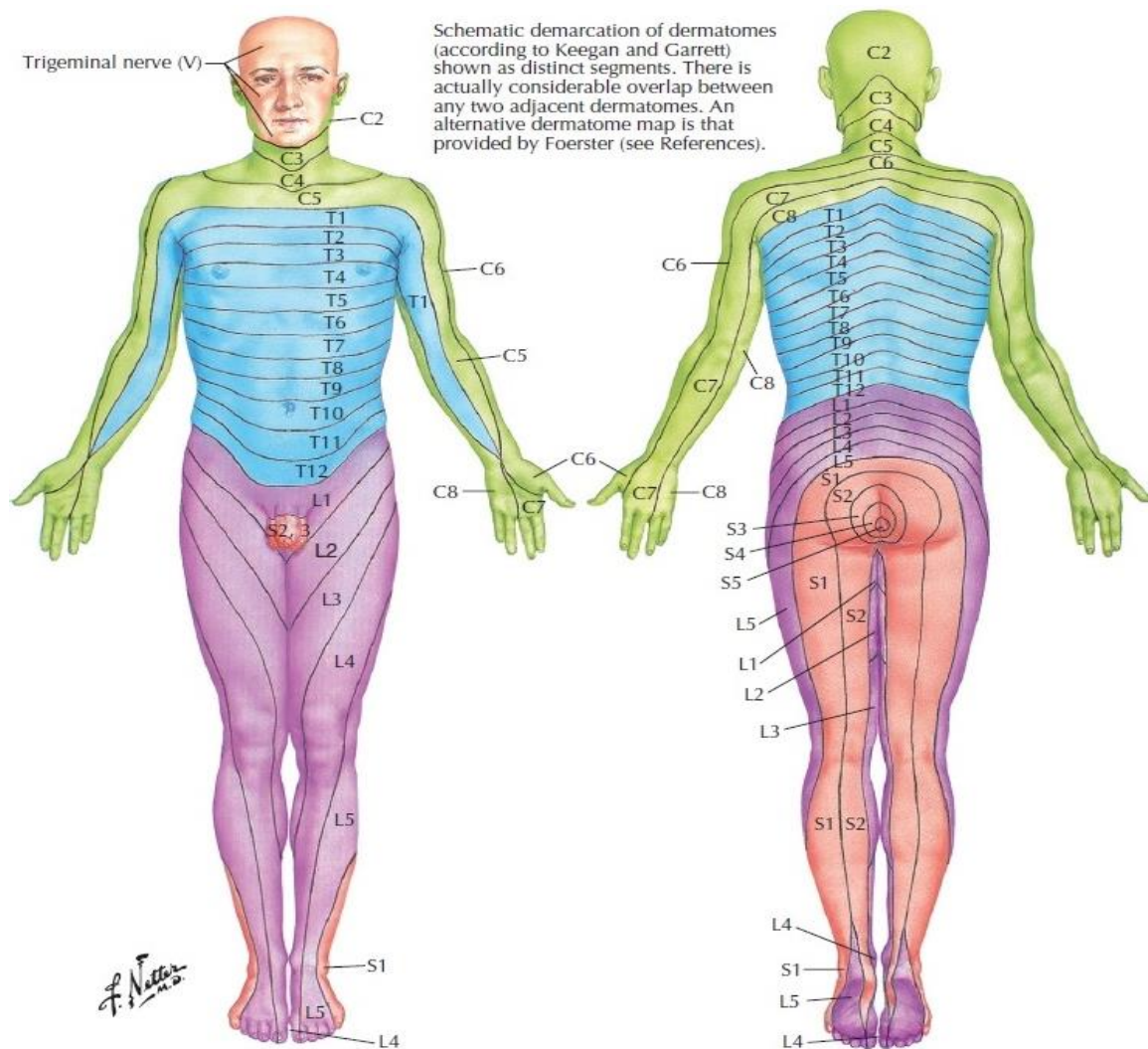


Figure 4: Schematic figure of dermatomes shown as distinct segments [17].

2.3 Kinesiology of the lumbar spine

2.3.1 The spine

The spine is curved in the sagittal and frontal planes. In the sagittal plane, it is curved twice in an S-shape that consists of forward convexity- cervical and lumbar lordosis, and convexity backward-thoracic kyphosis. The S-shaped curvature increases spinal flexibility and allows for springing movements during landing and gait. The development of spinal curvatures can be associated to the pull of the cervical and trunk muscles, the weight of the internal organs and the differences in the height between the anterior and posterior edges of the intervertebral disks. In the sagittal plane, spinal curvatures play a significant role in postural functions. From a functional perspective, symmetry is the most important aspect, implicating that maintenance of an erect posture demands minimal muscle activity. Postural balance with minimal muscle activity depends on the quality of control mechanisms and on the regional and global anatomical parameters [4, 11].

The human lumbar spine consists of 5 vertebrae with the ability to move independently into all directions. Within those 5 lumbar vertebrae are 10 facet joints (5 pairs) which carry about the 20%-25% of the axial load when the disc is intact and healthy but this can change and reach up to 70% with a degenerated disk. The facet joints also provide 40% of the torsional and shear strength. In most bibliographic sources the physiological ROM is defined 40°-60° for flexion, 20°-35° extension, 15°-20° of lateral flexion and 3°-18° of rotation. Normally, on a healthy person lumbosacral angle in the standing position is 140°, the normal lumbar lordotic curve is about 50°, the normal sacral angle is 30°, and the

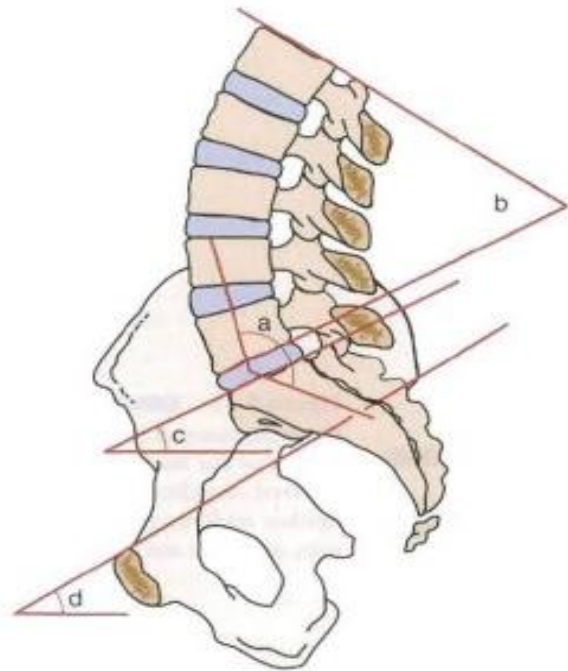


Figure 5: Physiological angles of spine and sacrum [11].

normal pelvic angle is 30°. In this position, the pelvis would be said to be in neutral (neutral pelvis). The pelvis is the key to proper back posture. For the pelvis to "sit" properly on the femora, the abdominal, hip flexor, hip extensor, and back extensor muscles must be strong, supple, and balanced [4,11].

2.3.2 Musculature related to lumbar spine

The musculature of the back is arranged in a series of layers, of which only the deeper are true, intrinsic, back muscles. True back muscles are characterized by their position and by their innervation by branches of the posterior (dorsal) rami of the spinal nerves. The true back muscles below the neck lie deep to the posterior layer of the thoracolumbar fascia. In the lumbar region, where the layers of the thoracolumbar fascia are well defined, they occupy the compartment between its posterior and middle layers. Lying superficial to the true, intrinsic muscles, there are the extrinsic muscles. The most superficial of these run between the upper limb and the axial skeleton, and consist of trapezius, latissimus dorsi, levator scapulae and the rhomboid muscles. Beneath this layer lie the serratus posterior group, superior and inferior, which are variably developed but usually thin muscles whose function may be respiratory or possibly proprioceptive. All the extrinsic muscles are innervated by ventral rami. The intrinsic muscles are also arranged in layers. The more superficial layers contain the splenius muscles in the neck and upper thorax, and the erector spinae group in the trunk as a whole. The deeper layers include the spinotransverse group, which is itself layered into semispinalis, multifidus and the rotatores, and the suboccipital muscles. Deepest of all, lie the interspinal and intertransverse muscles. The latter group constitutes a mixture of dorsal and ventral spinal muscles. The lumbar intertransversarii mediales, thoracic intertransversarii and medial parts of cervical posterior intertransversarii are innervated by dorsal rami, but the others are supplied by ventral rami [16, 17, 18, 22].

Although muscles will move the spinal column, the majority of muscular activity is involved in providing stability to maintain posture and to provide a firm platform for limb function. Thus the importance of emphasizing on deep stabilizing muscles in a modern rehabilitation program [4, 6, 7, 18].

Instability is an often encountering issue in intervertebral disk herniation so special significance must be given on muscles forming the deep stabilization system. These muscles include the diaphragm, the transversus abdominis, internal obliques abdominis, lumbar multifidei, longissimus and iliocostalis posterior and iliopsoas and quadratus lumborum [4, 7].

2.3.3 Extensors of the lumbar spine

Erector spinae is a large musculotendinous mass which differs in size and composition at different vertebral levels (Figure 6). It consists of fascicles that assume systematic attachments to homologous parts of the skull, the cervical, thoracic, and lumbar vertebrae, the sacrum, and the ilium. Individual muscles are defined by the attachments of their fascicles and the regions that they span. Erector spinae is separated to iliocostalis, longissimus and spinalis muscle [6, 16, 18].

The thoracic and lumbar components of erector spinae are powerful extensors of the vertebral column. Acting concentrically and bilaterally they can extend the thoracic and lumbar spines whereas acting unilaterally they can laterally flex the trunk. However, more commonly, erector spinae act eccentrically. From the upright posture, the trunk can flex forwards under the influence of gravity. This movement is initiated by flexor muscles, such as rectus abdominis, in order to bring the center of gravity of the trunk forward. Thereafter, erector spinae control the descent of the thorax under gravity. When the trunk is fully flexed, many parts of erector spinae cease to contract and become electromyographically silent. In this position, flexion is limited by passive tension in the back muscles, and tension in the thoracolumbar fascia, the posterior spinal ligaments, and the intervertebral discs. Similarly, lateral flexion under gravity is controlled by the contralateral erector spinae, with input from the abdominal oblique muscles [6, 16, 18, 22].

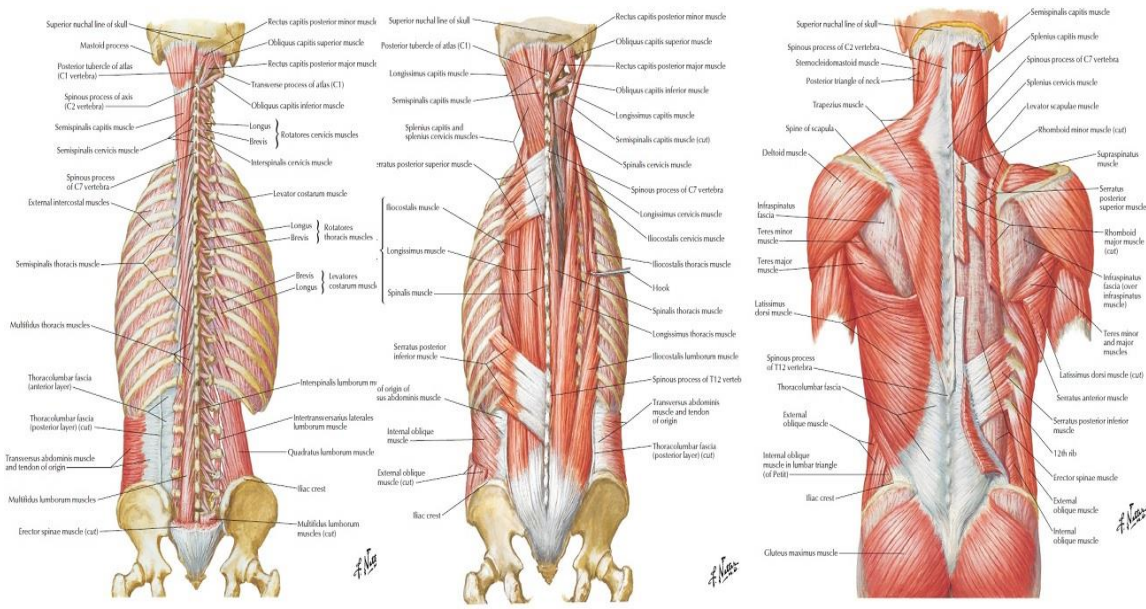


Figure 6: Muscles of back, arranged in layers [17].

Another extensor group of the back is called spinotransverse group which consists of muscles where the fascicles span between a spinous process and the transverse elements of vertebrae at various levels below. Those muscles are rotatores, multifidus and semispinalis. All the spinotransverse muscles are extensors. They extend the vertebrae from which they arise, or the head in the case of semispinalis capitis. The predominantly longitudinal orientation of their fascicles precludes any substantive action as rotators [6, 16, 18, 22].

In deepest layer of the lumbar spine are the interspinales and intertransversarii muscles. The functions of interspinales and intertransversarii have not been established. They are very small muscles, and are unlikely to be able to generate enough force to be prime movers of the vertebrae. However, they are richly endowed with muscle spindles: the density approaches that found in the lumbricales of the hand and in the extraocular muscles. It therefore seems reasonable to assume that the short muscles of the back may serve a proprioceptive function in controlling the position of the vertebral column and its movements [6, 16, 18, 22].

2.3.4 Flexors of the lumbar spine

The flexors of the lumbar spine are formed the iliiothoracic and femorospinal muscle groups. The iliiothoracic group belongs to the extrinsic muscles and includes: Rectus abdominis, pyramidalis, external oblique, internal oblique and transversus abdominis that constitute the anterolateral muscles of the abdomen. They act together to execute several functions, some of which involve the generation and control of IAP within body cavities [6, 16, 18, 22].

The active contraction of those muscles plays an important role in conserving the tone of the abdominal wall when the IAP is increased. The compression of the abdominal cavity required to increase the internal pressure is brought about mainly by the contraction of the diaphragm. Both pelvis and lower thoracic cage provide an incompressible structure to part of the abdominal wall. During the increase of positive IAP, the abdominal wall acts to hold the position of the wall fixed, rather than increasing pressure directly. The oblique muscles are also important by acting through the anterior aponeurosis and the rectus sheath, providing the majority of this tension, even though transversus abdominis and rectus abdominis also contribute. The lateral abdominal muscles, external oblique, internal oblique and transversus abdominis, have important role in those functions, by causing tension onto the linea alba and rectus sheath. Rectus abdominis a muscle of major importance as it cause anterior flexion of the trunk. When the pelvic girdle is fixed, flexion of the thorax and pectoral girdle occurs. With a fixed thoracic cage, contraction of rectus abdominis causes the pelvis to lift and tilt and eventually positioned closer to the horizontal plane. Lateral flexion and rotation of the trunk against resistance is provided by unilateral contraction of the oblique muscles [1, 2, 4, 5, 7, 16, 18, 22, 28].

The femorospinal muscle group belongs to the intrinsic muscles and consists by: psoas major, psoas minor and iliacus. Their function is flexion of hip and trunk [16, 18].

2.3.5 Lateral flexors of lumbar spine

As true lateral flexion isn't described as a motion it can be defined as the composition of side bending and rotational movement. Muscles that are responsible for lateral flexion are quadratus lumborum, transversus abdominis, and oblique abdominal muscles [18].

2.3.6 Rotators of lumbar spine

Rotation of the lumbar spine is defined by a multi-regional diagonal motion caused by a unilateral muscle contraction. Almost all extensors of lumbar spine are able to cause an oblique direction contraction producing a rotation movement. As mentioned above all the spinotransverse muscles can act as rotators due to the longitudinal orientation of their fascicles [16, 18].

2.3.7 Diaphragm

The diaphragm (Figure 7) is a curved musculofibrous sheet that separates the thoracic from the abdominal cavity. Its mainly convex upper surface faces the thorax, and its concave inferior surface is directed towards the abdomen. The diaphragm is the major muscle of inspiration, responsible for approximately two-thirds of quiet breathing in healthy humans. Diaphragm is a very important muscle for my topic because of both of its respiratory, postural and stabilizing functions [4, 5, 6, 7, 8, 18].

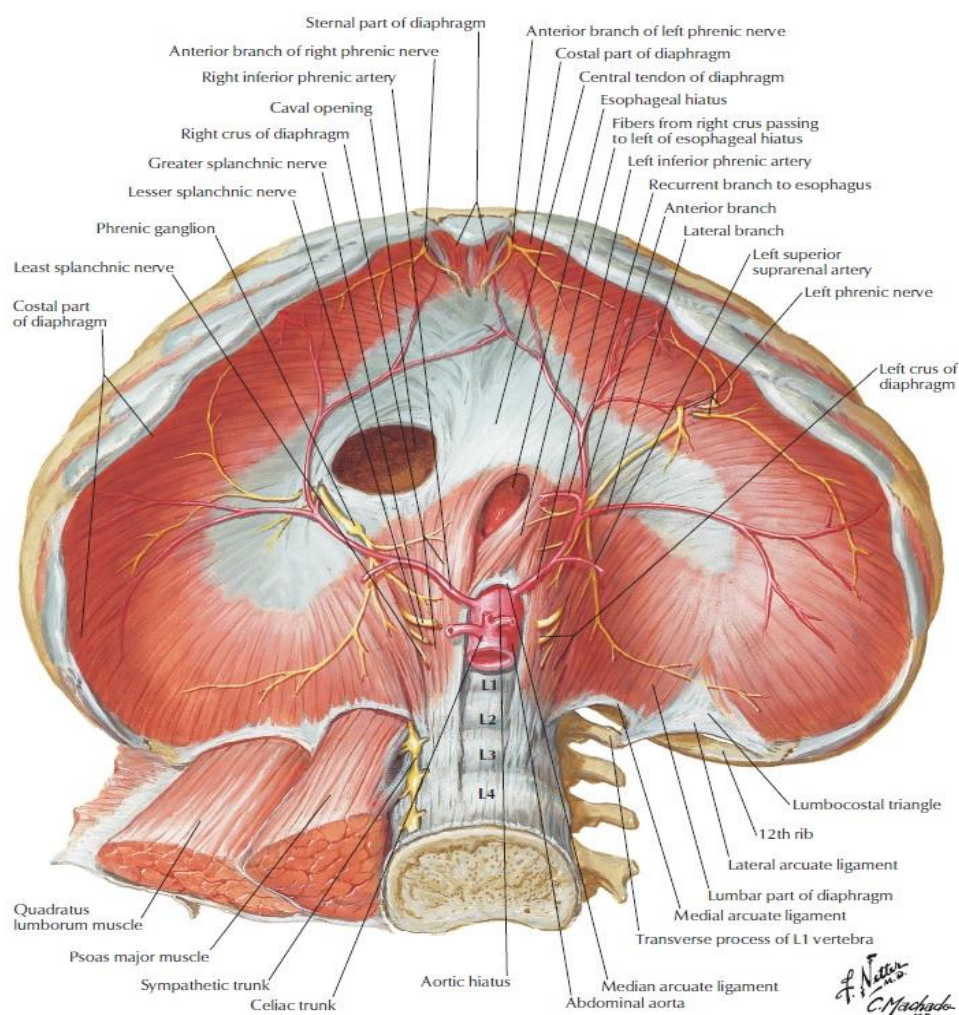


Figure 7: Diaphragm Inferior view [17].

2.3.8 Pelvic floor muscles

The muscles arising within the pelvis form two groups. Piriformis and obturator internus, although forming part of the walls of the pelvis, are considered as primarily muscles of the lower limb. Levator ani and coccygeus form the pelvic diaphragm and delineate the lower limit of the true pelvis. The pelvic floor is the lower component consisting the deep stabilization system. Coccygeus act as a lateral compressor of the various visceral canals which cross the pelvic floor. Levator ani contracts with abdominal muscles and the abdominothoracic diaphragm to raise intra-abdominal pressure and must relax appropriately to permit expulsion of urine and particularly faeces. Levator ani also forms much of the basin-shaped muscular pelvic diaphragm, which supports the pelvic viscera [4, 5, 7, 18].

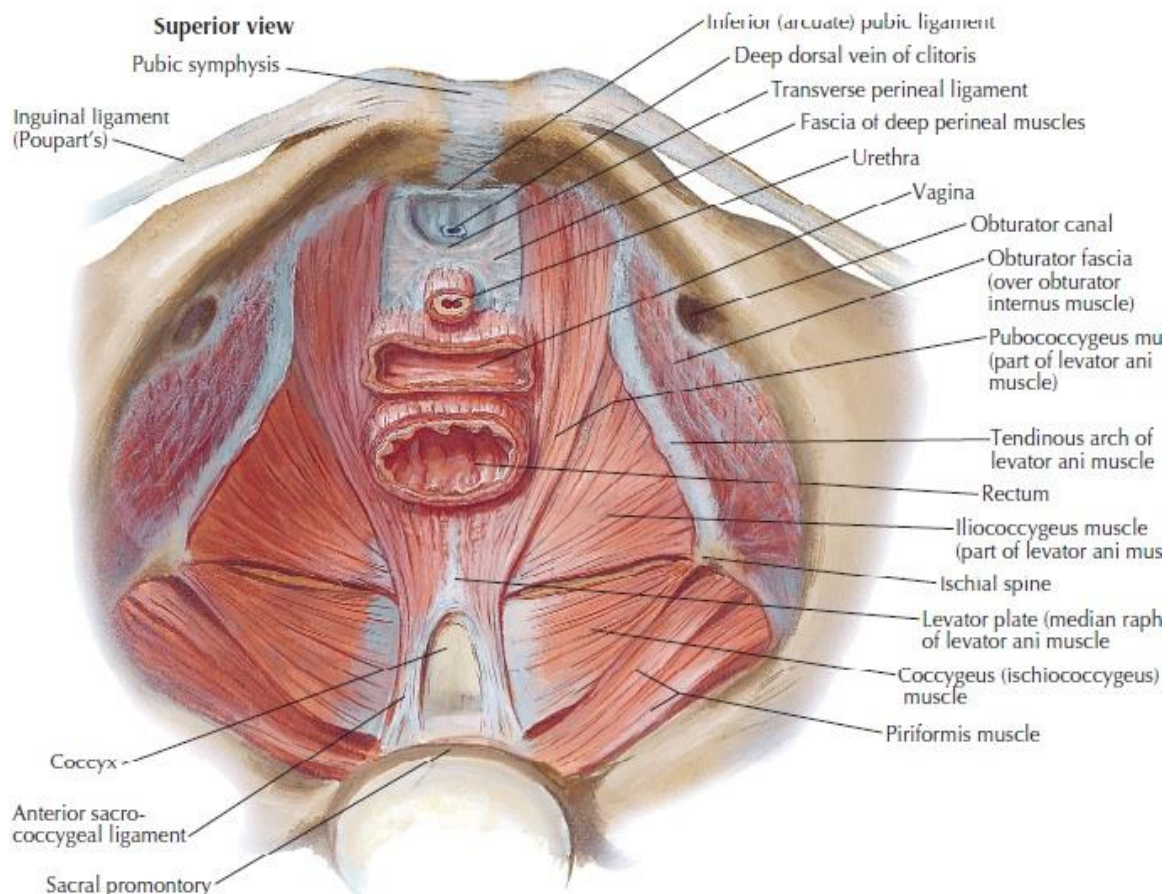


Figure 8: Female pelvic floor-diaphragm, superior view [17].

2.3.9 Lower crossed syndrome

Janda and Jull described a lumbar or pelvic crossed syndrome to show the effect of muscle imbalance on the ability of a patient to hold and maintain a neutral pelvis. The hypothesis was that there is a combination of weak, long muscles and short, strong muscles, which resulted in an imbalance pattern leading to low back pain. The concept of their treatment was based on treating muscle imbalances and thus relieving back pain. The weak, long inhibited muscles were the abdominals and gluteus maximus, whereas the strong tight (shortened) muscles were the hip flexors (primarily iliopsoas) and the back extensors. The imbalance pattern promotes increased lumbar lordosis because of the forward pelvic tilt and hip flexion contracture and hyperactivity of the hip flexors compensating for the weak abdominals. The weak gluteals result in increased activity in the hamstrings and erector spinae as compensation to assist hip extension. Also, the hamstrings show tightness as they attempt to pull the pelvis backward to compensate for the anterior rotation caused by the tight hip flexors. Weakness of gluteus medius results in increased activity of the quadratus lumborum and tensor fasciae latae on the same side. This syndrome is often seen in conjunction with upper crossed syndrome on cervical spine [4, 8, 7, 11].

2.4 Biomechanics of lumbar spine and mechanism of disk herniation

The functional unit of the spine the ‘motion segment’, consists of two adjacent vertebrae and their intervening soft tissues. The anterior portion of the segment is composed of two superimposed intervertebral bodies, the intervertebral disc, and the longitudinal ligaments. The corresponding vertebral arches, the intervertebral joints formed by the facets, the transverse and spinous processes, and various ligaments make up the posterior portion. The arches and vertebral bodies form the vertebral canal, which protects the spinal cord. The vertebral bodies are designed to bear compressive loads. The vertebral bodies in the lumbar region are thicker and wider than those in the thoracic and cervical regions; their greater size allows them to sustain the larger loads to which the lumbar spine is subjected. The intervertebral disc, which bears and distributes loads and restrains excessive motion, is of great mechanical and functional importance.

The intervertebral disk, has no direct blood supply and relies on diffusion for its nutritional needs. Motion is important for the diffusion process. Sustained loading has showed to impair diffusion, with a prolonged recovery time needed for diffusion to return to unloaded conditions [10, 13, 19, 20].

Values of Intradiscal Pressure for Different Positions and Exercises as a Percentage Relative to Relaxed Standing in One Subject (Chosen Arbitrarily as 100%)	
Position/Maneuver	Percentage
Lying supine	20
Side-lying	24
Lying prone	22
Lying prone, extended back, supporting elbows	50
Laughing heartily, lying laterally	30
Sneezing, lying laterally	76
Peaks by turning around	140-160
Relaxed standing	100
Standing, performing Valsalva maneuver	184
Standing, bent forward	220
Sitting relaxed, without back rest	92
Sitting actively straightening the back	110
Sitting with maximum flexion	166
Sitting bent forward with thigh supporting the elbows	86
Sitting slouched into the chair	54
Standing up from the chair	220
Walking barefoot	106-130
Walking with tennis shoes	106-130
Jogging with hard street shoes	70-190
Jogging with tennis shoes	70-170
Climbing stairs, one at a time	100-140
Climbing stairs, two at a time	60-240
Walking down stairs, one at a time	76-120
Walking down stairs, two at a time	60-180
Lifting 20 kg, bent over with round back	460
Lifting 20 kg as taught in back school	340
Holding 20 kg close to the body	220
Holding 20 kg, 60 cm away from the chest	360
Pressure increase during the night rest (over a period of 7 hours)	20-48

Figure 9: Values of Intervertebral disk pressure from different positions [11].

Nucleus pulposus lies directly in the center of all discs except those in the lumbar segments, where it has a slightly posterior position. The annulus fibrosus composition allows it to withstand high bending and torsional loads. Alterations in the disc such as degenerative changes, a normal part of aging, and annular tears will allow for increased intersegmental motion, thereby altering the biomechanical loading of the motion segment. Degenerative disc changes result in increased loading on the facets and changes in the distribution of interdiscal loading.

During daily activities, the disc is loaded in a complex manner and is usually subjected to a combination of compression, bending, and torsion.

The most common disk herniations are in the posterior-lateral direction, and their mechanical cause is often flexion, with lateral flexion and rotation.

Flexion, extension, and lateral flexion of the spine produce mainly tensile and compressive stresses in the disc, whereas rotation produces mainly shear stress. In a disc loaded in compression, the pressure is approximately 1.5 times the externally applied load per unit area. Because the nuclear material is only slightly compressible, a compressive load makes the disc bulge laterally; circumferential tensile stress is sustained by the annular fibers. In the lumbar spine, the tensile stress in the posterior part of the annulus fibrosus has been estimated to be four to five times the applied axial compressive load [11, 16, 19]. The highest loads on the spine are generally produced by external loads, such as lifting a heavy object. Just how much load can be sustained by the spine before damage occurs continues to be investigated although studies showed that compressive load to vertebrae failure ranged from 5.000 to 8000 N. Still it was observed that fracture point was reached in vertebral body or end plate, before the intervertebral disc sustained damage [21].

2.4.1 Disk herniation and its mechanism of injury

Direct vertical pressure on the disc can cause the disc to push fluid into the vertebral body. If the pressure is great enough, defects may occur in the cartilaginous end plate, resulting in Schmorl's nodules, which are herniation of the nucleus pulposus into the vertebral body. This change results from fluid movement in and out of the disc during the day through the cartilaginous end plate. This fluid shift acts as a pressure safety valve to protect the disc. If there is an injury to the disc, four problems can result, all of which can cause symptoms.

There may be a protrusion of the disc, in which the disc bulges posteriorly without rupture of the annulus fibrosus. In the case of a disc prolapse, only the outermost fibers of the annulus fibrosus contain the nucleus. With a disc extrusion, the annulus fibrosus is punctured and discal material moving into the epidural space. The fourth problem is a sequestered disc, or a formation of disc fragments from the annulus fibrosus and nucleus pulposus outside the disc. These injuries can result in pressure on the spinal cord itself (upper lumbar spine) leading to a myelopathy, pressure on the cauda equina leading to cauda equina syndrome, or pressure on the nerve roots which is the most common and the topic of my research [9,10,11,22,23,24].

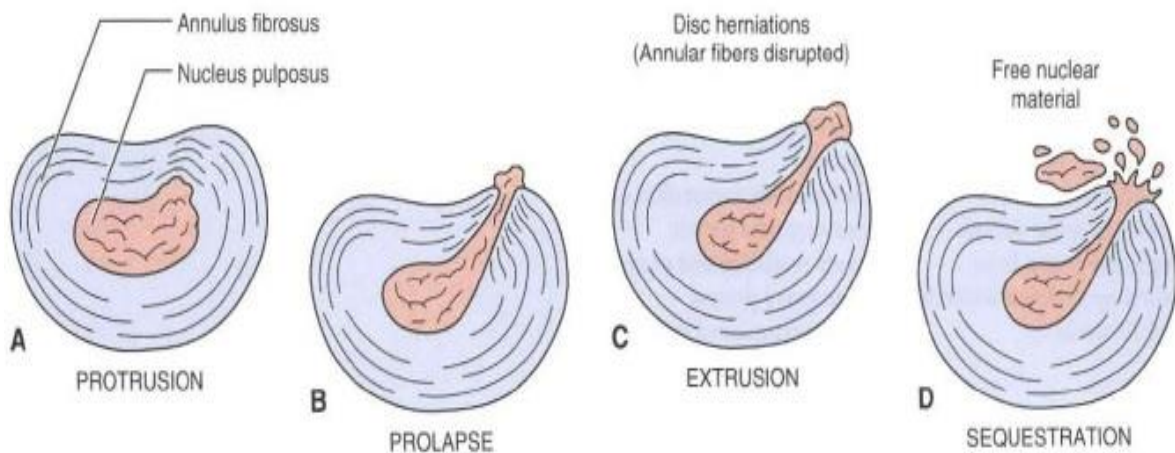


Figure 10: Types of disc herniation [11].

As described in the topics above a disk can be diagnosed as herniated when the nucleus pulposus moves freely through a ruptured annulus fibrosus. The most commonly affected segments are the lower lumbar at L4-L5 and L5-S1 due to the heavy compression loading that is applied there. Lumbar disc herniation is the most common spinal disk condition that provoking the symptoms of low back pain and very often with the coexistence of radicular pain. Most of medical literature explaining that presence of symptoms as radicular pain, paresthesia, dysesthesia and anesthesia depend on the way the hernia compressing the nerve root (Figure 11) [9,14].

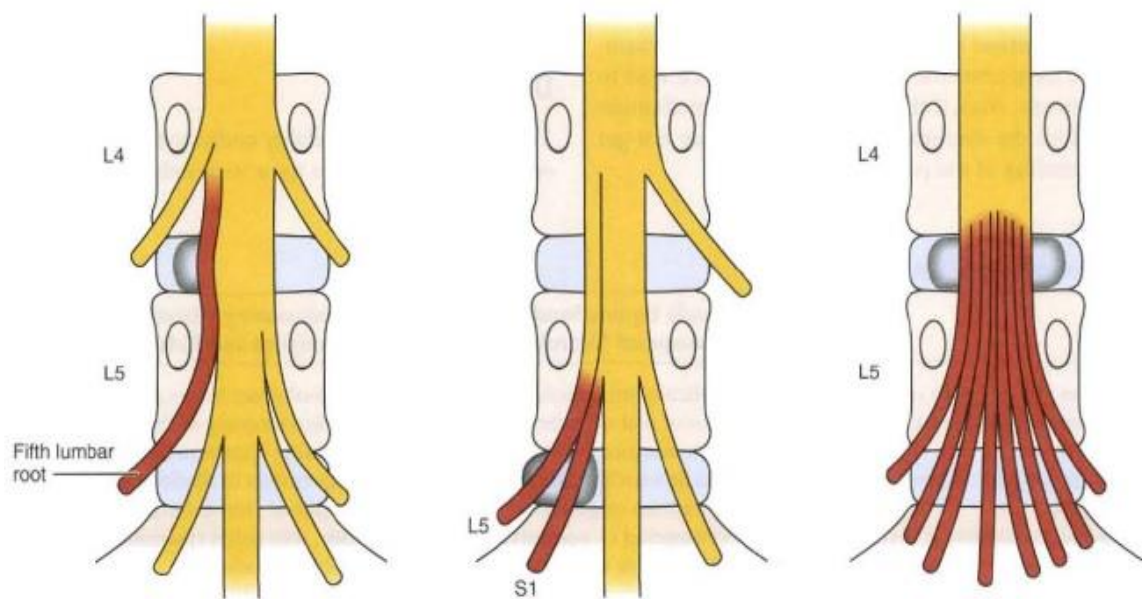


Figure 11: Possible effects of disk herniation [11].

2.5 Mechanical stability of the lumbar spine

Mechanical stability for the lumbar spine can be achieved through several means: IAP, co-contraction of the trunk muscles, external support, and surgery. In my topic it is very important to focus and analyse the properties of Intra-abdominal pressure (IAP) because of its functional significance in deep stabilization system. IAP is the pressure created within the abdominal cavity by a coordinated contraction of the diaphragm, the abdominals and pelvic floor muscles. IAP is one mechanism that may contribute to both unloading and stabilization of the lumbar spine as it serves as a “pressurized balloon” attempting to separate the diaphragm and pelvic floor. This action creates an elongation moment that

decreases the compression forces on the lumbar discs. This elongation produced by IAP has calculated reductions in elongation moment from 10% to 40% of the extensor load. Latest research found that transversus abdominis is the primary abdominal muscle responsible for IAP production. Transversus abdominis is horizontally oriented and it creates compression and increase in IAP without an accompanying flexor moment. It has been demonstrated by many authors that IAP contributes to the mechanical stability of the spine through a coactivation between the antagonistic trunk flexor and extensor muscles, in conjunction with the diaphragm and pelvic floor muscles, leading to increased spinal firmness. As the abdominal musculature contracts, IAP increases and converts the abdomen into a rigid cylinder that greatly increases stability as compared with the multisegmented spinal column. IAP increases during both static and dynamic conditions such as lifting and lowering, running and jumping, and unexpected trunk perturbations. Transversus abdominis muscle, together with the diaphragm and pelvic floor muscles, play an important role in stabilizing the spine in preparation for limb movement, regardless of the direction in which movement is anticipated and appear to occur independently, prior to activity of the primary limb mover or the other abdominal muscles [1,2,3,4,5,7,8,19,28].

2.6 Epidemiology of low back pain

Low back pain is an extremely common symptom that affects more than 40% of population. Studies have shown a lifetime prevalence as high as 84%. Most patients have short attacks of pain that are mild or moderate and do not limit activities, but these tend to recur over many years. Most episodes resolve with or without treatment. A small percentage of low back pain becomes chronic, however, and causes significant disability. Between 80% and 90% of the health care and social costs of back pain are for the 10% who develop chronic low back pain and disability. Just over 1% of adults in the United States are permanently disabled by back pain, and another 1% are temporarily disabled [10, 13, 22, 23].

2.7 History, physical examination and imaging diagnostics.

A complete history and physical examination is important in the evaluation of low back pain to determine the cause of the symptoms, rule out serious medical pathology, and determine whether further diagnostic evaluation is needed.

History and personal anamnesis of the patient must be the first part of assessment of a patient regarding its condition. Throughout a proper anamnesis we could be able to gather information as with any pain history, features of back pain that should be explored include location, character, severity, timing, including onset, duration, and frequency, alleviating and aggravating factors, and associated signs and symptoms. Each of these features can assist the clinician in obtaining a diagnosis and prognosis and determining the appropriate treatment. The causes of back pain are very usually difficult to determine. One of the main purposes of the history is to rule out rare but serious causes of back pain. Elements of historical information that suggest a serious underlying condition as the cause of the pain such as cancer, infection, long tract signs, and fracture are called red flags. When these are present, further workup is necessary. Besides determining a diagnosis, a purpose of the history is to explore the patient's perspective and illness experience. Certain psychosocial factors are valuable in determining prognosis. Factors such as poor job satisfaction, catastrophic thinking patterns about pain, the presence of depression, and excessive rest or downtime are much more common in patients in whom back pain becomes disabling [11,15,22,23].

The physical examination is the next part of examination that will finally provide the information that will lead us on a specific diagnosis. The physical examination includes observation, palpation, range of motion, gait, joint mobility, neurologic examination and orthopaedic special tests that include manual muscle testing, deep stabilization system evaluation and muscle length test which will be described below analytically [11, 15, 22, 23].

Observation should include a survey of the skin, muscle mass and bony structures, as well as observation of overall posture, and the position of the lumbar spine in particular. Gait should also be observed for clues regarding etiology and contributing factors.

The muscle tone assessment is a part of the physical examination that can provide information not only in matter of muscle tonicity but also important clues for dysfunctional movement pattern and neurological deficits caused by a peripheral lesion. Palpation should begin superficially and progress to deeper tissues. It should proceed systematically to determine what structures are tender to palpation.

ROM Amount and quality of can be measured by several methods including single or double inclinometers or by manner of dynamic postural evaluation. Dynamic evaluation is usually chosen because of its ease of performance as for it may reproduce pathological signs and underline the presence of lack or excessiveness of range of motion.

The neurologic examination of the lower limbs can rule out clinically significant nerve root impingement and other neurologic causes of leg pain. The physical examination should logically proceed to discover whether a particular root level is affected by combining the findings of weakness, sensory loss, diminished or absent reflexes, and special tests such as straight leg-raising sign. The accuracy of the neurologic examination in diagnosing herniated disk is moderate. The accuracy can be increased considerably, however, with combinations of findings. There are multiple nerve stretch tests available but the most common used is the Laseque test because of its high sensitivity and specificity [25]. Straight leg raise- Laseque test is a passive test, and each leg is tested individually with the normal leg being tested first. With the patient in the supine position, the hip medially rotated and adducted and the knee extended, the examiner flexes the hip until the patient complains of pain or tightness in the back or back of the leg. If the pain is primarily back pain, it is more likely a disc herniation from pressure on the anterior theca of the spinal cord or the pathology causing the pressure is more central. If pain is primarily in the leg, it is more likely that the pathology causing the pressure on neurological tissues is more lateral. Disc herniation or pathology causing pressure between the two extreme arcs is more likely to cause pain in both areas. The examiner finally drops the leg slowly to the initial position till the patient feels no pain or tightness. There are several tests that can be used to assess neurodynamics, neural tension and lesions. Those are Brudzinski-Kernig Test, Bragard's test, Sicard's test, Turyn's test, Slump test, Crossover sign, Valsalva maneuver,

Femoral Nerve traction test, Babinski test, Oppenheim test et cetera that can won't be described further in this paper [9, 11, 14, 22].

Orthopedic tests for strength and flexibility can investigate if back pain can be caused by deconditioning, poor endurance, and muscle imbalances. This makes it important to identify any inefficient or abnormal movement patterns of muscles that control the movement of the spine and the position of the pelvis. Because of their stabilizing effect on the spine, abdominal muscle strength and endurance is important. Besides determining the strength of the abdominals, strength testing of the back muscles and pelvic stabilizers, such as the hip abductors, can be useful. Assessing for areas of relative inflexibility is also important. Commonly performed tests are hip flexor flexibility, hamstring flexibility, other hip extensors' length, and gastrocnemius/ soleus length. Balance challenges, such as the ability to maintain single-footed stance, the ability to lunge or squat, and other functional tests are also helpful to determine a patient's baseline status.

Modern researches and literature mention that common cause of mechanical low back pain is segmental instability that responds specific to stabilization treatments. Therefore accurately identifying this group from other forms of low back pain could be important. These special tests include passive intervertebral motion testing and the prone instability test. Passive intervertebral motion testing is performed manual by applying anterior pressure over the spinous process to assess vertebral motion and whether pain is provoked. In prone instability testing examiner initially performs passive intervertebral motion at each level and notes provocation of pain then the patient lifts the legs and the painful levels are repeated. A positive test is assessed when the pain diminish when the legs are lifted off the table. The explanation lies to the extensors ability to stabilize the spine in such position [11, 15, 22, 23].

The final part of diagnostics is imaging evaluation. Imaging of the lumbar spine should be used in the evaluation of the low back pain if specific pathology needs to be confirmed after history and physical examination.

MRI is the preeminent imaging method for evaluating degenerative disk disease, disk herniation, and radiculopathy. The disadvantage of MRI is that, although it is a very sensitive test, it is not very specific in determining a definite source of pain. Because of the resolution of anatomic structures in MRI, it has essentially replaced computed tomography (CT) scanning as the imaging study of choice for low back pain and radiculopathy. CT scanning is still more useful than MRI, however, in evaluating bony lesions. CT scans are also useful in the postsurgical patient with excessive hardware that can obscure MRIs, and in patients with implants that preclude on MRI [11, 15].

2.8 Surgical approach for lumbar intervertebral disk herniation.

Intervertebral disk herniation can be treated conservatively or surgically. Surgery is indicated when there is presence of severe motor deficits resulting from a large extruded or migrated disk fragments, patient suffer from intractable pain and conservative treatment doesn't prove effective. There are several types of surgery procedures for intervertebral disk herniation. Lumbar discectomy and microdiscectomy which is a less invasive surgical approach are the most commonly performed surgeries with very high success rate. Another type of surgery is laminectomy that that is performed in patient with lumbar stenosis. The classical microsurgical approach in the treatment of herniated nucleus pulposus has been substituted over the years by endoscopical approach, in which it is possible to practice via endoscopy a laser thermo-discoplasty, and by percutaneous laser disc decompression and nucleotomy both with high success rate approximately 70% [30]. Nowadays minimal invasive procedures are the most widespread because of the reduced surgical incisions and postoperative morbidity. Microdiscectomy approach provides faster recovery period in comparison to standard discectomy [15, 23, 24, 29].

2.9 Conservative approach for lumbar intervertebral disk herniation.

The conservative approach consists of medication, rest and physiotherapy. Bed rest is the oldest and simplest of conservative treatments for lumbar disc herniation. Its effects are related to a decrease in intradiscal pressure, spine motion and lumbar lordosis as well as to relaxation of the paraspinal muscles. Bed rest may be particularly useful during the first few days after onset of lumbar radicular symptoms. The bed should be hard and the position to be preferred is that which most reduces lumbar radicular pain. This is usually the supine position with the hips and knees slightly flexed. The prone position should be avoided if, as usually occurs, it exacerbates lumbar radicular pain. Medical therapy is based on various types of medication: analgesics, anti-inflammatory drugs, muscle relaxants, sedatives and neurotrophic medications. Analgesics may be non-narcotic or narcotic. Non-narcotics, such as acetaminophen and ketorolac, have analgesic but not anti-inflammatory effects, since they inhibit prostaglandin production in the central nervous system, but not in the peripheral organs. Narcotic analgesics include codeine, meperidine and morphine. The advantage of pure analgesics is that they have little or no gastrointestinal side effects. One of the main disadvantages is the short duration of their action. These drugs may be particularly useful in patients with acute lumbar radicular pain complaining of gastrointestinal disturbances and who do not tolerate anti-inflammatory medications, to which, however, analgesics may be associated. Anti-inflammatory drugs include nonsteroidal agents and corticosteroids. Nonsteroidal anti-inflammatory drugs (NSAIDs) have both anti-inflammatory and analgesic effects. Corticosteroids have purely anti-inflammatory effects and have high effect in reducing radicular inflammatory changes and thus radiated pain. These drugs are indicated in patients with severe radicular pain of recent onset.

2.10 Physiotherapeutic approach for lumbar disk herniation.

According to many studies the first step considered the base of the treatment pyramid is education of the patient. Education should include explanation in terms that patient is able to understand. The patient must be educated about activities and lifestyle habits that could prove hazardous and could influence future prognosis negatively. Also it is important to provide sufficient information including the likely course of their back pain, how to manage the pain, how to optimize life activities and lifestyle to return to usual activity quickly and how to minimize the frequency and severity of recurrences. Providing this information in an amount and in a way that patients can understand helps build a therapist-patient relationship, built up a trustful environment and therefore reduce anxiety and speed up recovery time.

Exercise prescriptions for mechanical low back pain generally begin with the goal of improving alignment and posture. The correction of posture as an initial goal is important for several reasons. One is that exercises are more effective if they are done from a position of proper alignment that promotes optimal joint function and movement patterns. Virtually all patients will spend much more time in habitual postures such as sitting and standing than exercising. The reason lies that if these habitual postures can reduce abnormal tissues strains, there is a better chance of reducing pain and setting a good prognosis for faster regeneration [4, 5, 7, 22, 23, 24].

Extension exercises are commonly used for treating low back pain and in particular back pain accompanied by radicular leg pain. Extension based exercises are often done using the principles of the McKenzie method. Several studies justified that McKenzie exercises were ideal treatment for increasing flexibility of spine as decreasing pain [26, 27].

During extension exercise, the patient is lying in prone position and using his arm to lift his upper body from the table till the arms fully extended or patient reach the its pain threshold (Figure 12) [4,5,7,15,22,23].

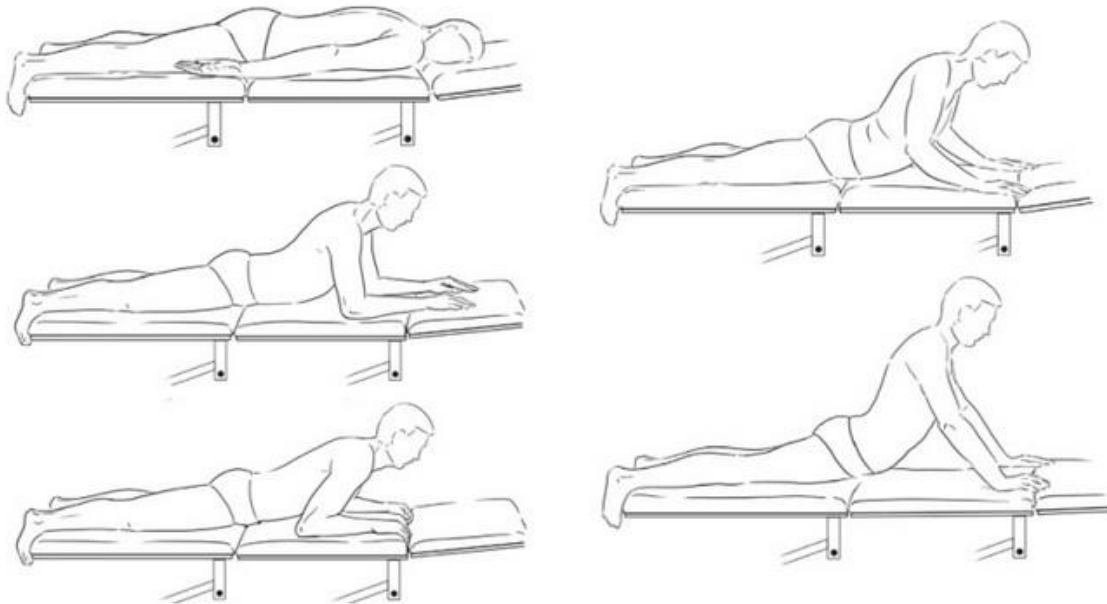


Figure 12: A sample of McKenzie exercise progression into extension [4].

Treatment of patients in the stabilization classifications is an important part of the therapy that must also begin with patient's education. Education should focus on abstaining from end-range movements of the lumbar spine to avoid positions that may overload the passive stabilizing structures of the spine. Lifting even light loads from a position of near end-range spinal flexion should be avoided because of the potentially damaging forces created in the ligaments and intervertebral disks of the spine by such movements. Stabilization training is ideal for patients with disk herniation because it helps maintaining trunk strength and overall endurance. Below some of those exercises will be thoroughly explained. Spinal exercises should not be done in the first hour after awakening due to increased hydrostatic pressures in the disk during that time [5].

The “cat and camel” (Figure 13) and the pelvic translation exercises are ways to achieve spinal segment and pelvic accessory motion prior to starting more aggressive exercises [1, 2, 3, 5, 12, 28].

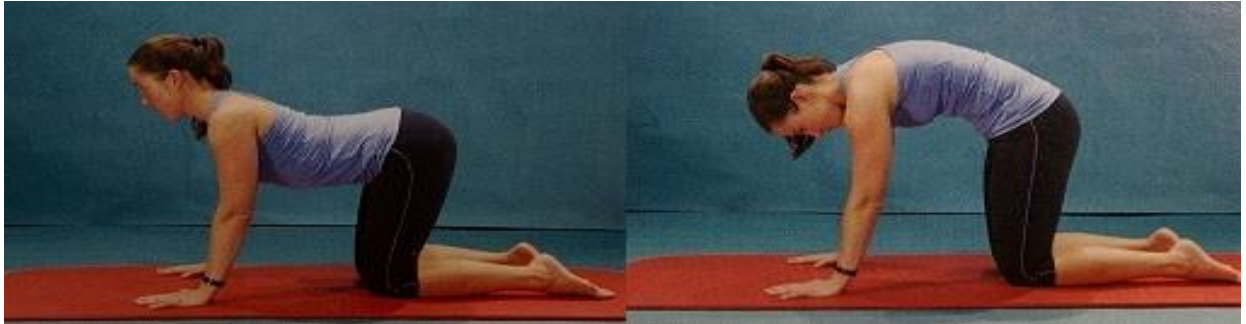


Figure 13: "Cat and Camel" exercise [5].

The plank exercise (Figure 14) is another essential exercise from the repertoire of core stability training. The front plank is performed by supporting the body’s weight between the forearms and toes. It primarily activates anterior and posterior core muscles. The lateral bridge, mainly activate the lateral core muscles. In this exercise the patient is positioned on the side supported by the elbow and hip. The free hand is hand is placed on the opposite shoulder fixating it in a caudal direction [5, 12, 28].

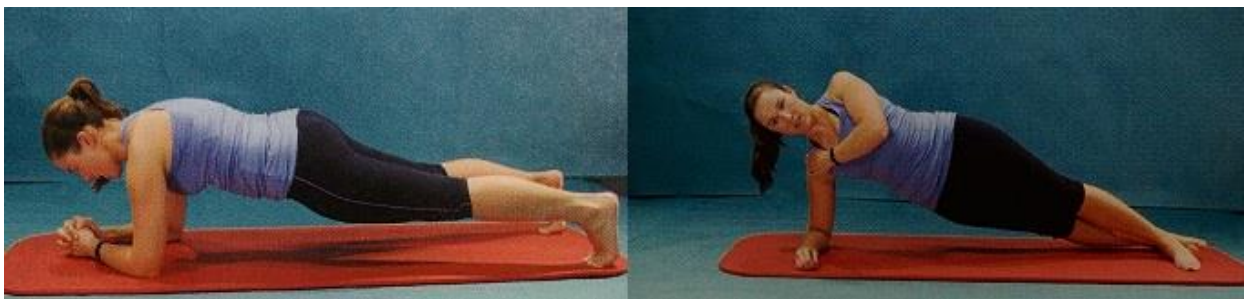


Figure 14: Plank and side Plank exercises [5].

Bridging is an essential exercise for improving functional strength and deep core stability. The patient lies on the back with the knees flexed and the feet on the floor. Then the patient activates gluteus maximus by bringing the buttocks together. Once the activation is mastered the patient begins bringing the torso off the floor. Imaging squeezing the gluteus maximus muscles prior to performing the back bridge will assist in grooving gluteal-dominant hip extension patterns. Once this exercise is mastered, squat performance will also improve due to co-activation of quadriceps throughout exercising.

Another exercise that is more demanding called bird dog (Figure 15). This exercise mainly trains the extensor muscles but at the same time abdominals are consciously activated to control and maintain the neutral spine posture. It is important to set and modify progression according to patient's unique needs and responses to exercise, along with insistence of correct form and confidence that patient experiences strength and endurance gains without injury. The starting position is on the hands and knees with the hands under the shoulders and the knees directly under the hips. For a beginner or a patient with a deconditioned back, this exercise involves simply lifting a hand or knee a few cm off the floor. After the patient will be able to raise a hand or knee without pain, it is appropriate to progress to raising the opposite hand and knee simultaneously. The exercise begins with the sweep at its innermost point and coming back out of the sweep. The patient then extends the active limbs back out into the bird dog position. Finally the raised hand and arm should co-contraction together with the shoulder focusing on the upper back so primarily key muscles are facilitated to a higher level of contraction. To develop the motor control challenge further, the patient shouldn't rest by placing the hand and knee to the floor after each holding repetition. Rather after extending to the bird dog position, the patient should "sweep" the floor with the hand and knee so that no weight is borne by either. This technique will allow muscles to reoxygenate with each "sweep" cycle [5,8,12].

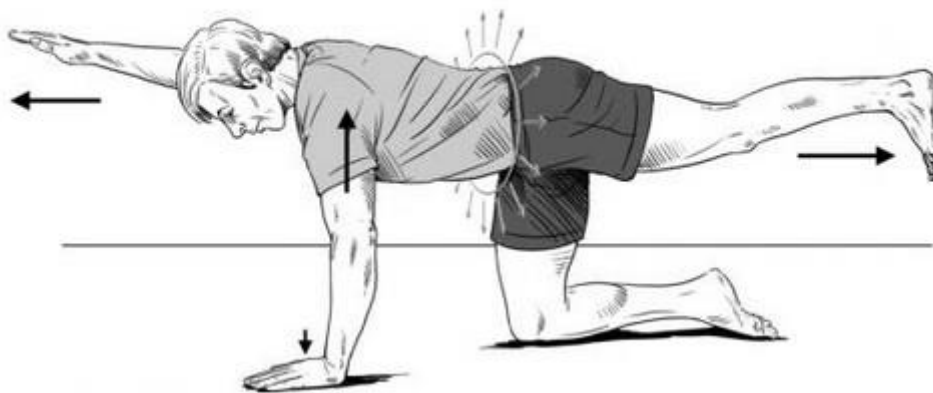


Figure 15: Bird-dog exercise [12].

While the patient's functional progression increasing, the basic ground exercises must progress to positions of function, from a stable ground environment to a progressively less stable surface and more complicated movement so muscle activity and strengthening will progress to a program of dynamic stabilization.

Another important part of the therapeutic procedure is the restoration of soft tissue and joint mobility when certain pathologies affect them. In matter of manual medicine it has been found in many bibliographic resources that manual traction techniques could be proved beneficial on both acute and chronic stage. The biggest advantage of manual traction is that the effect of therapy is immediate, so both patient and therapist can adjust the therapeutic plan according to daily control evaluation.

Final stage of the treatment is the re-education of movement pattern and improvement of motor control of specific tasks according to patient's daily living and habits. This part could contain locomotive skills as lunges, squats, lifting several objects and execute specific skills while maintaining correct posture and control the activity of deep stabilization system [8,15,28].

2.10.1 Physical Therapy

Important part of the conservative treatment is physical therapy. Several types of physical means have showed positive effects on patients with intervertebral disk herniation. Electrotherapy is one of the most common used physical means due to its effectiveness and ease of use. Continuous or galvanic currents can be used to perform iontophoresis, which consists in percutaneous administration of medications with a positive or negative polarity. Alternating low-frequency or medium-frequency currents can be also used including: diadynamic currents, interferential currents and transcutaneous electric nerve stimulation (TENS). All these current can be employed for analgetic electrotherapy. Low- frequency magnetic field therapy has proved advantageous as it does thermic effects and it is thus suitable for patient with acute lumboradicular pain. Ultrasound therapy is among the most commonly used forms of physical therapy in patients with low back and lumboradicular pain. Although as ultrasound is an alternative form of endogenous thermotherapy it isn't indicated in the acute phase of pain, since it may stimulate the local inflammatory processes. In the subacute or chronic phase, the treatment may be carried out to relieve low back pain symptoms. Regarding phototherapy infrared, ultraviolet and bier thermotherapy are forms of exogenous heat therapy that may be indicated in chronic patients with low back pain, as a pre-applicative mean for massage of the lumbosacral area. Cryotherapy is usually performed by means of cold packs, ice massage or several cryogenic apparatuses programmed for temperature and duration of treatment. Cryotherapy is often indicated on acute phases of disk herniation for decreasing pain and muscle spasm [4, 15, 23, 24, 29].

3. SPECIAL PART (CASE STUDY)

3.1 Methodology

The clinical work practice was done in Ustředni Vojenská Nemocnice in Prague. My practice started on Monday 12th of January 2015 and finished on Friday 23rd of January 2015. Each day of practice in the hospital lasted for 8 hours. The total amount of my practice was 80 hours.

My clinical work placement was supervised by Mgr. Markéta Ptáčková Cert. MDT. The sessions with my patient were 7. The treatment started on 14th of January 2015 and finished on my last day of practice 23rd of January 2015.

Treatment proceeded by approval of the Ethics Committee of the Faculty of Physical Education and Sport at Charles University in Prague.

3.2 Anamnesis

Name of the patient: P.B.

Year of birth: 1987

Sex: Female

Diagnosis: Disease of lumbar intervertebral disk with radiculopathy

Code: M511

Present State:

Weight: 58kg

Height: 164cm

BMI: 21

BP: 130/90mmHg

BPM: 110/min

Chief complaint: Stiffness of the lower back and muscle weakness

History of present problem: The patient started to have low back pain 1.5 year ago but due to important and intensive daily schedule she couldn't investigate more for the reason of the pain. After some months she visited the hospital for the first MRI in which she was diagnosed with extrusion of her intervertebral disk on L5-S1 posteriorly without radicular pain present. In the next 3 following days she revisited the hospital while she was experiencing sharp pain on her lower back that started irradiate on her knees which directly impaired her posture, walking and daily living activities. The second time she was treated with painkillers, infusions and cauda block epidural injection. While the effects weren't optimal she revisited the hospital in which another MRI was performed and diagnosed that extrusion has been also moved laterally towards the left side. After discussion with the doctor she decided to undergo microdisectomy surgery of the L5-S1 on 14.9.2014 which

was successful. She spent 2 months at rest after instruction of the doctor and finally she started the rehabilitation program which started on 26 November 2014 and lasted till 23 January 2015. She is planning to go for balneotherapy soon within February.

Pharmacological anamnesis:

Painkillers only at the acute stage after the operation

Abuses:

The patient is smoker, 20 per day and occasionally alcohol 1-2 per week

Allergies:

Chorine

Social anamnesis:

The patient is single, lives with a roommate in flat on first floor and uses stairs and occasionally elevator.

Gynecological anamnesis:

No problems specified

Occupational anamnesis:

Office job, spending many hours in sitting position

Surgical anamnesis:

None specified

Family anamnesis:

Patient's mother is suffering by Diabetes Mellitus type 1

Rest of patient's family members are healthy

Hobbies:

Reading, dancing and walking

Prior rehabilitation:

After a two month rest period after the doctor instruction the patient commenced the Rehabilitation in UVN military hospital in Prague, in which she underwent McKenzie exercises (that still performs) which helped her recover some of her mobility, flexibility and conditioning that was lost after the two month pause period. Currently she feels fine but she's not still in the most optimal condition thus her reestablishment of her rehabilitation.

Excerpt from patient's healthcare file:

The first MRI was performed on 17/11/2013. Degenerative changes of intervertebral disk were found in the lumbosacral area. The intervertebral disc of L5-S1 was herniated and compressing posteriorly without causing radicular pain on that point.

The second MRI took place on 09/08/2014 which diagnosed further degeneration of L5-S1 intervertebral disk which was herniated and compressing posterolateral towards the left side.



Picture 1: 1st Magnetic resonance imaging of the patient's lumbosacral region in sagittal plane.

Indication for rehabilitation:

McKenzie Exercises, soft tissue techniques, joint mobilization, activation of deep stabilization system, strengthening and conditioning

3.3 Initial kinesiologic examination**Examination Proposal**

Postural Examination

Dynamic Spine Evaluation

Gait Examination

Anthropometric Measurement

Balance and Perception Evaluation

Range of motion examination

Muscle Length Examination

Muscle Strength Examination

Palpation Examination

Joint Play Examination

Neurologic Examination

Examination of diaphragm function and deep stabilization

Movement Pattern Evaluation

3.3.1 Postural Examination:

Posterior View:

Slight varosity of ankles

Both calves have symmetrical trophy

Popliteal lines are symmetrical with slight varosity on both knee joints.

Gluteal muscles are aligned

Pelvis is physiological without elevation

Right scapula is slight depressed

Head is positioned in the midline

Lateral View:

Ankle, knee and hip are in good alignment

Shoulders and head are slightly protruded

Anterior View:

Slight varosity of ankles

Patellae are symmetrical with knees observed with slight varosity.

Umbilicus located in the midline

Thoracobrachial triangle is bigger on the left side

Shoulders are symmetrical and clavicles are aligned

Head is positioned in the midline

3.3.2 Dynamic Spine Evaluation:

While performing extension it was noticeable that the motion was mostly occurred in the thoraco-lumbar junction with sufficient range of motion and without appearance of pain.

Throughout the lateral flexion the distance to the left measured to 19cm and to the right 20cm with the spinal curvature almost symmetrical and without provoking pain.

During the forward flexion we could inspect that the lower lumbar vertebrae had restricted motion and during the maximal effort the distance to the floor was measured to 26cm. The patient didn't mention any pain during the procedure.

3.3.3 Gait Examination:

The patient performed gait with symmetrical step length and rhythm. The loading of the foot and the activity of toes was fair as stepping was executed with proper heel to toe walking pattern. Synkinesis was noticeable between upper and lower extremities providing a functional walking pattern. During gait, patient's trunk motion observed to be slightly rigid as it wasn't participating in the walking properly. The patient performed successfully backward gait as so toe and heel gait. Disturbances appeared during the squat gait that the patient needed more effort to provide it.

3.3.4 Anthropometric Measurement:

	Left Lower Extremity	Right Lower Extremity
Thigh circumference	43cm	44cm
Knee circumference	33cm	33cm
Calf circumference	31cm	32cm
Ankle circumference	22cm	22cm
Functional length	85cm	85cm
Anatomical length	80cm	80cm

Table 1: Anthropometric measurements

Scar was measured 4cm

3.3.5 Balance and perception tests:

Vele's test found grade I

Romberg test grade I and II found negative but grade III was positive

Tredelenburg test was found negative on both legs

Weight bearing scale: Left 27Kg, Right 29Kg

3.3.6 Range of Motion Evaluation:

Movement	Left Lower Extremity		Right Lower Extremity	
	Active	Passive	Active	Passive
Hip flexion (knee extended)	85°	90°	85°	90°
Hip flexion(knee flexed)	100°	110° *	100°	120°
Hip extension	10°	15°	10°	15°
Hip adduction	10°	10°	10°	10°
Hip abduction	35°	40°	35°	40°
Internal Rotation	25°	30°	20°	30°
External Rotation	40°	45°	40°	45°
Knee flexion	110°	120°	110°	120°
Knee extension	0°	0°	0°	0°

Table 2: ROM of lower extremities

*The patient was complained about pain on the lower back during maximal passive movement of the left hip joint.

3.3.7 Muscle length testing according to Janda:

Length test of hip flexors was performed on both legs and grade 0 (no shortness) was found.

3.3.8 Muscle strength testing according to Kendall:

Muscle	Right side	Left side
Rectus abdominis	4	
Quadratus lumborum	4+	4+
Iliopsoas	5	5
Gluteus maximus	4	4
Gluteus medius	4-	4-
Piriformis	4+	4
Quadriceps	4	4
Tensor fascia latae	4	4
Hamstrings	4	4
Gastrocnemius	5	5
Soleus	5	5
Tibialis Anterior	4+	4
Peroneus longus	4+	4+
Flexor hallucis longus	5	4+
Flexor hallucis brevis	5	4+
Extensor hallucis longus	4	4
Plantar interossei	5	5
Dorsal interossei	5	5

Table 3: Strength test evaluation

3.3.9 Palpation examination:

The scar was palpated initially which is located in the lower part of the back above the L5-S1 spines. Palpation shown that scar was healed, in good condition and elasticity without causing pain or restriction in any direction. The fascia of the lower back found to be restricted on both sides in cranial direction. During the subskin examination adhesion has been found that was causing inability to perform Kibler's fold successfully.

Muscle	Left side			Right side		
	Tonus	Pain	Trigger Point	Tonus	Pain	Trigger Point
Rectus Abdominis	Normal	No	No	Normal	No	No
Erector Spinae Thoracic	Normal	No	No	Normal	No	No
Erector Spinae Lumbar	Normal	No	No	Normal	No	No
Quadratus Lumborum	Hypertonic	No	No	Hypertonic	No	No
Gluteus Maximus	Hypotonic	No	No	Hypotonic	No	No
Gluteus Medius	Normal	No	No	Normal	No	No
Piriformis	Hypertonic	Slight Painful	No	Hypertonic	Slight Painful	No
Iliopsoas	Normal	Slight Painful	No	Normal	Slight Painful	No
Quadriceps	Normal	No	No	Normal	No	No
Hamstrings	Normal	No	No	Normal	No	No
Gastrocnemius	Normal	No	No	Normal	No	No
Soleus	Normal	No	No	Normal	No	No
Tibialis anterior	Normal	No	No	Normal	No	No
Peroneus Longus	Normal	No	No	Normal	No	No

Table 4: Palpation evaluation

3.3.10 Joint Play Examination:

Initially the sacroiliac joint was tested in which the Spine sign, Rosina's test, Overtake testing and Springing tests showed that the sacroiliac joint is unblocked. Then lumbar spine was examined by springing in retroflexion, anteflexion and side bending and it found to be restricted on flexion of the L4-L5 segments.

3.3.11 Neurological Examination:

Patellar (L2-L4) and Achilles tendon (S1) deep tendon reflexes were tested and both legs were scaled normal (2+). Also slight hypoesthesia of the little toe of the left lower extremity was found during the superficial sensation. Laseque test was performed on both legs with negative results.

3.3.12 Movement Pattern Evaluation according to Janda:

Hip extension evaluated and showed that in both sides the activation sequence was: Hamstrings, gluteus maximus, contralateral erector and finally ipsilateral erector spinae. The hip extension movement pattern was executed fine on both sides.

The Curl up movement pattern was finally performed. The initial activation was done by the abdominals although during the first degrees of motion the lower limbs lost contact with the bed indicating a positive test with the hip flexors dominant over abdominals.

3.3.13 Examination of diaphragm and deep stabilization function

according to Kolar:

As described by Kolar et al in the DNS concept, the function of the diaphragm had to be tested first through several positions during inspiration before proceeding to testing of deep stabilization system.

First the patient was instructed to get in sitting position where palpation of the lower ribs and the intercostal spaces from dorsal part was performed. It was found that during inhalation lateral expansion of the ribcage and widening of the intercostal spaces occurred that suggest proper function of the diaphragm.

When diaphragmatic function was tested in supine lying position, palpation showed that the patient was able to increase and maintain the intra-abdominal pressure (IAP) in the lower abdominal cavity during inhalation.

Intra-abdominal pressure (IAP) test in supine position followed which showed that, although the patient's lower chest was widening and could maintain intra-abdominal pressure during inspiration, the umbilicus was observed in upward movement that indicates hyperactivity of upper rectus abdominis.

Then intra-abdominal pressure (IAP) testing was performed in sitting position, which showed slight disturbance of activation which also observed by the cranial movement of umbilicus.

Finally deep stabilization activity was tested in sitting position in which diaphragm's properties, inhalation and generation of pressure in the abdominal cavity were evaluated in functional combination. The finding showed that the patient had difficulty to perform those two tasks combined.

3.3.14 Initial Examination Conclusion:

The patient examination found out restriction of movement during the dynamic evaluation of spine, mostly into flexion. The gait showed difficulties during squat that must be connected with the muscle weakness that was found on muscles around pelvis. In matter of ROM there were no big impairments. As it was expected though, muscle tone abnormalities around site of lesion were persisted. Fascia of the lower back was also found to be restricted in cranial direction. The lower lumbar segments found also restricted into the direction of flexion. Neurological examination showed hypoesthesia of the little toe of the left leg but without any other pathological findings in present. Finally examination of diaphragm and deep stabilization function showed disturbances of co-activation due to hyperactivity of upper rectus abdominis.

3.4 Short and Long rehabilitation plan

Short Rehabilitation Plan

Eliminate Pain

Release of soft tissue

Relaxation of hypertonic muscles

Strengthening of weakened muscles

Stretching exercises for maintaining mobility and improving flexibility of spine

Reeducation of posture and habitual patterns

Long Rehabilitation Plan

Maintain results achieved by short rehabilitation plan

Improve coordination and motor control of the patient

Improve functional strength according to patient's ADL activities and hobbies

Education of self-therapeutic techniques for home rehabilitation

3.4.1 Therapy Proposal

Spinal Exercises according to McKenzie

Postural Re-education according to McKenzie

Fascia release of the lumbar the lumbar part in cranial direction according to Lewit

Post isometric relaxation for quadratus lumborum and piriformis muscles according to Lewit

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit

Sensomotoric stimulation, introduction of small foot according to Janda

Core and deep stabilization system activation through breathing integration

Core stability training with instruction of closed kinetic chain exercises

Education of lifting activity according to Liebenson

Education of patient to self-therapy techniques

3.5 Therapy Progress

Note: As prescribed by the doctor, the patient is continuing the execution of McKenzie exercises as my supervisor instructed him.

Session 1: 14/1/2014

Subjective Report: The patient's main complaint is stiffness in the lower back but without the appearance pain or irritation.

Objective Report- Assessment: Restriction in the fascia of the low back was found in cranial direction. Kibbler's fold wasn't executable. Quadratus lumborum and piriformis found hypertonic on both sides.

Goal of today's therapy: Improve fascia mobility, relaxation of hypertonic muscles and introduce patient to new exercise units.

Therapy Proposal:

Spinal Exercises according to McKenzie

Postural Re-education according to McKenzie

Fascia release of the lumbar part on both sides in cranial direction according to Lewit

Post isometric relaxation for quadratus lumborum and piriformis muscles on both sides according to Lewit

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit

Education of patient to self-therapy techniques

Core and deep stabilization system activation through breathing integration

Core stability training with instruction of closed kinetic chain exercises

Therapeutic procedure:

Shifting and stretching the dorsal fascia cranial from prone lying position according to Lewit.

PIR for quadratus lumborum and piriformis according to Lewit.

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit.

Education for self-induced PIR for quadratus lumborum, piriformis and self-mobilization of the lumbar spine into flexion and extension according to McKenzie.

Activation of transversus abdominis through breathing and education of optimal breathing pattern according to Lewit.

Cat and camel exercise according to Brukner and Khan.

Bridging exercise according to Fredericson and Moore.

Modified kneeling front plank exercise according to Liebenson.

Education of patient about correct sitting posture according to McKenzie.

Subjective results: The patient mentioned fair improvements in her feeling and remarkable decrease of tension in her lower back. She mentioned slight stiffness of the lower back during extension but without appearance of pain.

Objective results: The mobility of the dorsal fascia improved but there is still progression to go. Big improvement of the muscle tone occurred mostly on quadrati lumborum that became eutonic. The patient's strength isn't yet optimal but the exercises were executed with fine technique and that is a marking a positive prognosis for future status.

Session 2: 15/1/2014

Subjective Report: Stiffness of the lower back mostly after extension motion. No pain was mentioned.

Objective Report- Assessment: Restriction of dorsal fascia in cranial direction was persisted. Quadratus lumborum and piriformis were evaluated on both side and only piriformis found hypertonic.

Goal of today's therapy: Improve fascia mobility, relaxation of hypertonic muscles and focus on improving the quality of execution of the exercises.

Therapy Proposal:

Spinal Exercises according to McKenzie

Fascia release of the lumbar part on both sides in cranial direction according to Lewit

Post isometric relaxation for piriformis muscles according to Lewit

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit

Core and deep stabilization system activation through breathing integration

Core stability training with closed kinetic chain exercises

Therapeutic procedure:

Shifting and stretching the dorsal fascia cranial from prone lying position according to Lewit.

PIR for piriformis according to Lewit.

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit.

Activation of transversus abdominis through breathing according to Lewit.

Cat and camel exercise according to Brukner and Khan.

Bridging exercise according to Fredericson and Moore.

Modified kneeling front plank exercise according to Liebenson.

Introduction to novice side plank exercise according to Liebenson.

Self-mobilization of the lumbar spine into flexion and extension according to McKenzie.

Subjective results: After the session there wasn't complaint of tension or stiffness during executing extension of lumbar spine. My patient is very satisfied with the variety of exercises and the results that she feels to her body.

Objective results: After the therapy the dorsal fascia was increased further in matter of mobility. Kibler's fold was easier executable which provides good feedback on effectiveness of therapy.

Session 3: 16/1/2014

Subjective Report: The patient informed us about stiffness of her lower back occasionally during the day that is decreased with exercises. She also mentioned some trembling of her abdominals during the bridging exercise.

Objective Report- Assessment: Restriction of dorsal fascia in cranial direction was still persisted but the Kibler's fold could be executed. Piriformis was still hypertonic but the patient was feeling a better feeling during palpation.

Goal of today's therapy: Improve fascia mobility, relaxation of hypertonic muscles, focus on improving the quality of execution of the exercises and provide progression elements for improving motor control during exercising.

Therapy Proposal:

Spinal Exercises according to McKenzie

Fascia release of the lumbar part on both sides in cranial direction according to Lewit

Post isometric relaxation for piriformis muscles according to Lewit

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit

Core and deep stabilization system activation through breathing integration

Core stability training with closed kinetic chain exercises

Therapeutic procedure:

Shifting and stretching the dorsal fascia cranial from prone lying position according to Lewit.

PIR for piriformis according to Lewit.

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit.

Activation of transversus abdominis through breathing according to Lewit.

Cat and camel exercise according to Brukner and Khan.

Modified Bridging exercise according to Fredericson and Moore with ankles balancing on TOGU.

Modified kneeling front plank exercise according to Liebenson.

Introduction to novice side plank exercise according to Liebenson.

Self-mobilization of the lumbar spine into flexion and extension according to McKenzie.

Subjective results: The patient feel pleasant during exercises, no tension or irritation was mentioned.

Objective results: Fascia gained further mobility after therapy, piriformis showed remarkable gains in matter of palpation and it feels almost eutonic. Patient's deep stabilization is improving technically and functionally during the sessions. The TOGU modification was initially confusing for the patient but she managed to compensate the difficulty before the treatment session was over.

Session 4: 19/1/2014

Subjective Report: Patient mentioned that she feels great. She repeated lot of exercises during weekend and the execution difficulty was easier to compensate.

Objective Report- Assessment: The dorsal fascia found slight restricted during control and piriformis remained eutonic.

Goal of today's therapy: Improve fascia mobility, relaxation of hypertonic muscles, improve technical components of exercises, improve coordination and condition of deep core muscles, introduction to sensomotrics.

Therapy Proposal:

Spinal Exercises according to McKenzie

Fascia release of the lumbar part on both sides in cranial direction according to Lewit

Post isometric relaxation for piriformis muscles according to Lewit

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit

Sensomotoric stimulation, introduction of small foot according to Janda

Core and deep stabilization system activation through breathing integration

Core stability training with closed kinetic chain exercises

Therapeutic procedure:

Shifting and stretching the dorsal fascia cranial from prone lying position according to Lewit.

PIR for piriformis muscles according to Lewit.

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit.

Activation of transversus abdominis through breathing according to Lewit.

Cat and camel exercise according to Brukner and Khan.

Modified Bridging exercise according to Fredericson and Moore with ankles balancing on TOGU.

Modified kneeling front plank exercise according to Liebenson.

Modified novice side plank exercise according to Liebenson.

Sensomotoric training, introduction to "small foot" and integration to static balance and stepping exercises according to Janda.

Self-mobilization of the lumbar spine into flexion and extension according to McKenzie.

Subjective results: The patient was really delighted with the introduction and the possibilities of the new exercises and fulfilled them successfully.

Objective results: Fascia mobility was decent after the stretching and subskin was also more moveable decreasing the adhesions that persisting. Intra-abdominal pressure control is still improving throughout exercising from different positions. Sensomotoric training seems to have already influenced the postural perception of the patient and captured her interest.

Session 5: 21/1/2014

Subjective Report: The patient reported her body control and perception has improved a lot since she started exercising.

Objective Report- Assessment: The dorsal fascia found still in slight restricted during control evaluation. Overall clinical picture is satisfying with piriformis palpated and found eutonic.

Goal of today's therapy: Improve fascia mobility, improve technical components of exercises, improve coordination and condition of deep core muscles and reeducation of lifting activity.

Therapy Proposal:

Spinal Exercises according to McKenzie

Fascia release of the lumbar part on both sides in cranial direction according to Lewit

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit

Education of lifting activity according to Liebenson

Core and deep stabilization system activation through breathing integration

Core stability training with closed kinetic chain exercises

Therapeutic procedure:

Shifting and stretching the dorsal fascia cranial from prone lying position according to Lewit.

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit.

Cat and camel exercise according to Brukner and Khan.

Modified Bridging exercise according to Fredericson and Moore with ankles balancing on TOGU.

Modified kneeling front plank exercise according to Liebenson.

Modified novice side plank exercise according to Liebenson.

Modified Lunges combined with activation of deep core according to Brukner and Khan.

Supported 90⁰ squats on wall bars combined with activation of deep core according to Brukner and Khan.

Self-mobilization of the lumbar spine into flexion and extension according to McKenzie.

Reeducation of lifting activity with use of illustrative material according to Liebenson.

Subjective results: The patient was surprised with today's procedure, both by new exercises and preparation for reeducation of lifting activity.

Objective results: Fascia is almost released, patient's technique during exercises is ideal and she understands the procedure fully.

Session 6: 22/1/2014

Subjective Report: The patient reported moderate fatigue on her upper thighs after repeating the lunges and squats at home.

Objective Report- Assessment: Only slight restriction was found to persist on the dorsal fascia.

Goal of today's therapy: Improve fascia mobility, improve technical components of exercises, improve coordination and condition of deep core muscles, provide alternative progressions for patient's exercise plan and start evaluation of final kinesiologic examination*.

Therapy Proposal:

Spinal Exercises according to McKenzie

Fascia release of the lumbar part on both sides in cranial direction according to Lewit

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit

Core and deep stabilization system activation through breathing integration

Core stability training with closed kinetic chain exercises

Therapeutic procedure:

Shifting and stretching the dorsal fascia cranial from prone lying position according to Lewit.

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit.

Modified Bridging exercise according to Fredericson and Moore with ankles balancing on TOGU.

Modified kneeling front plank exercise according to Liebenson.

Modified novice side plank exercise according to Liebenson.

Lunge balancing on Airex Balance Beam with activation of deep core.

Modified 70⁰ Squats on Bosu with controlled activation of deep core.

Supported 90⁰ squats on wall bars combined with activation of deep core according to Brukner and Khan.

Self-mobilization of the lumbar spine into flexion and extension according to McKenzie.

Subjective results: The patient was worried with the new modifications that initially were difficult to execute properly but finally she could perform them with ease.

Objective results: Dorsal fascia was finally treated. Strength and balance of patient have improved.

Note*: Due to therapy time limit, half of final kinesiologic examinations were performed during this session.

Session 7: 23/1/2014

Subjective Report: The patient reported the she feels healthy and stronger before the therapy.

Objective Report- Assessment: No fatigue, irritation, pain or any other pathological findings were assessed.

Goal of today's therapy: Improve technical components of exercises, improve coordination and condition of deep core muscles, discussion with patient about recommendations and changes on her lifestyle, completion of final kinesiologic examination.

Therapy Proposal:

Spinal Exercises according to McKenzie

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit

Core and deep stabilization system activation through breathing integration

Core stability training with closed kinetic chain exercises

Therapeutic procedure:

Post isometric traction of the lumbar spine during exhalation and inhalation according to Lewit.

Modified Bridging exercise according to Fredericson and Moore with ankles balancing on TOGU.

Lunge balancing on Airex Balance Beam with activation of deep core.

Modified 70° Squats on Bosu with controlled activation of deep core.

Supported 90° squats on wall bars combined with activation of deep core according to Brukner and Khan.

Self-mobilization of the lumbar spine into flexion and extension according to McKenzie.

3.6 Final kinesiology examination

3.6.1 Postural Examination:

Posterior View:

Slight varus of ankles

Both calves have symmetrical trophicity

Popliteal lines are symmetrical with slight varus on both knee joints.

Gluteal muscles are aligned

Pelvis is physiological without elevation

Scapulae are aligned

Head is positioned in the midline

Lateral View:

Ankle, knee and hip are in good alignment

Shoulders and head are slightly protruded

Anterior View:

Slight varus of ankles

Patellae are symmetrical with knees observed with slight varus.

Umbilicus located in the midline

Thoracobrachial triangle is bigger on the left side

Shoulders are symmetrical and clavicles are aligned

Head is positioned in the midline

3.6.2 Dynamic Spine Evaluation:

While the patient performed extension it was clear that motion was provided mostly by thoraco-lumbar junction without limitation or triggering pain.

During latero-flexion the distances were measured 21cm on the left side and 22cm on right side with the spinal curvature symmetrical and without pain.

During forward flexion restricted motion of the lower lumbar vertebrae was persisted but the distance from the floor was improved to 18cm without provoking pain or irritation.

3.6.3 Gait Examination:

During gait analysis it was noticeable that patient had symmetrical step length and good rhythm. Important changes showed on the motion of the trunk that observed less stiffened and now shift slight latero-lateral and participating more during walking compared with the initial findings. The patient performed successfully backward gait as so toe and heel gait as also squat gait which initially was more difficult and challenging.

3.6.4 Anthropometric Measurement:

	Left Lower Extremity	Right Lower Extremity
Thigh circumference	43cm	44cm
Knee circumference	33cm	33cm
Calf circumference	31cm	32cm
Ankle circumference	22cm	22cm
Functional length	85cm	85cm
Anatomical length	80cm	80cm

Table 5: Final Anthropometric measurements

Scar was measured 4cm

3.6.5 Balance and perception tests:

Vele's test found grade I

Romberg test grade I, II, III found negative

Tredelenburg test was found negative on both legs

Weight bearing scale: Left 27Kg, Right 29Kg

3.6.6 Range of Motion Evaluation:

Movement	Left Lower Extremity		Right Lower Extremity	
	Active	Passive	Active	Passive
Hip flexion (knee extended)	85°	90°	85°	90°
Hip flexion(knee flexed)	100°	120° *	100°	120°
Hip extension	10°	15°	10°	15°
Hip adduction	10°	10°	10°	10°
Hip abduction	35°	40°	35°	40°
Internal Rotation	25°	30°	25°	30°
External Rotation	40°	45°	40°	45°
Knee flexion	110°	120°	110°	120°
Knee extension	0°	0°	0°	0°

Table 6: Final ROM evaluation of lower extremities

*No complain or pain was recorded during ROM evaluation

3.6.7 Muscle length testing according to Janda:

Length test of hip flexors was performed on both legs and grade 0 (no shortness) was found.

3.6.8 Muscle strength testing according to Kendall:

Muscle	Right side	Left side
Rectus abdominis	4+	
Quadratus lumborum	4+	4+
Iliopsoas	5	5
Gluteus maximus	4+	4+
Gluteus medius	4+	4+
Piriformis	4+	4+
Quadriceps	4+	4+
Tensor fascia latae	4+	4+
Hamstrings	4+	4+
Gastrocnemius	5	5
Soleus	5	5
Tibialis Anterior	5	5
Peroneus longus	5	5
Flexor hallucis longus	5	5
Flexor hallucis brevis	5	5
Extensor hallucis longus	5	5
Plantar interossei	5	5
Dorsal interossei	5	5

Table 7: Final Strength test evaluation

3.6.9 Palpation examination:

During the palpation the fascia of the lower back found to be moveable on both sides in all direction. The subskin mobility has also improved as Kibler’s fold is easier to perform on both sides.

Muscle	Left side			Right side		
	Tonus	Pain	Trigger Point	Tonus	Pain	Trigger Point
Rectus Abdominis	Normal	No	No	Normal	No	No
Erector Spinae Thoracic	Normal	No	No	Normal	No	No
Erector Spinae Lumbar	Normal	No	No	Normal	No	No
Quadratus Lumborum	Normal	No	No	Normal	No	No
Gluteus Maximus	Normal	No	No	Normal	No	No
Gluteus Medius	Normal	No	No	Normal	No	No
Piriformis	Normal	Slight Painful	No	Normal	Slight Painful	No
Iliopsoas	Normal	Slight Painful	No	Normal	Slight Painful	No
Quadriceps	Normal	No	No	Normal	No	No
Hamstrings	Normal	No	No	Normal	No	No
Gastrocnemius	Normal	No	No	Normal	No	No
Soleus	Normal	No	No	Normal	No	No
Tibialis anterior	Normal	No	No	Normal	No	No
Peroneus Longus	Normal	No	No	Normal	No	No

Table 8: Final Palpation Evaluation

3.6.10 Joint Play Examination:

During evaluation of joint play was performed all initial testing was repeated for both sacroiliac and lumbar spine and found that restriction to flexion was still persisted on segments L4-L5.

3.6.11 Neurological Examination:

Patellar (L2-L4) and Achilles tendon (S1) deep tendon reflexes were tested and both legs were scaled normal (2+). Slight hypoesthesia was still persisted but as reported by the patient the feeling was better than initial testing. Lasseque test was performed on both legs with negative results.

3.6.12 Movement Pattern Evaluation according to Janda:

The patient looked more relaxed during the whole testing procedure of movement pattern evaluation. It was noticeable that the patient was performing the pattern with more fluent movement and less effort during both tests but without ideal activation order of her muscles.

More important during the curl up pattern it was noteworthy that, patient was using her abdominals combined with deep core stability in order to provide the pattern and achieved to maintain contact of her lower limbs with the bed instead of activating hip flexors as documented on initially testing.

3.6.13 Examination of diaphragm and deep stabilization function according to Kolar:

Initial tests were finally reevaluated resulting to the conclusion that the patient is now aware of the function of diaphragm individually and the deep core as a stability system. Patient was able to maintain intra-abdominal pressure (IAP) throughout all testing positions with success, marking great improvement compared to initial evaluation.

3.7 Evaluation of the effects of therapy:

Lumbar intervertebral disk herniation is a condition that varies in each person. Evaluating retrospectively the therapy accession, one can say that the therapeutic approach successfully handled, individual and combinative the complexity of issues that bothered my patient. It is important to mention that the whole procedure was tolerated and no overloading and overexertion was provoked.

The examinations and therapeutic methods which guided me throughout the rehabilitation procedure focused mainly on concepts, methods and principles as described by Magee (2008), Kendall et al. (2005), Janda et al. (2007), Richardson et al. (2004), Brukner et al. (2012), Lewit (2010), Kolář et al. (2014), Liebenson et al. (2014) and McKenzie as instructed by supervisor Mgr. Markéta Ptáčková Cert. MDT.

Below i describe analytically the most important changes resulted by the therapeutic approach.

Dynamic Spine Evaluation			
Initial Kinesiologic Examination		Final Kinesiologic Examination	
Flexion	26 cm	Flexion	18 cm
Right lateral flexion	20 cm	Right lateral flexion	22 cm
Left lateral flexion	19 cm	Left lateral flexion	21 cm
Extension	Sufficient ROM, no pain	Extension	Sufficient ROM, no pain

Table 9: Comparison of initial and final findings in dynamic spine mobility

Astonishing results were granted after the stretching of dorsal fascia cranially. The patient reported immediate relief of the stiffness even from the first visit and gave me early feedback about the effectiveness of the specific procedure. Significant improvements found also in muscle tone quality with quadratus lumborum, gluteus maximus and piriformis to have changed to eutonic after application of therapy. Although it is important to mention that both piriformis muscles had to be treated repetitively in most therapeutic procedures in order to finally achieve normal tonicity. My suspicion insisted that changes in piriformis muscle tone sustained for long time and affected my patient in functional and postural

manners. I believe that fascia stretching and PIR techniques as described by Lewit [7] were truly valuable. I classified those procedures within the most essential because they promoted immediate relaxation and were very tolerable from my patient.

When joint mobility was re-evaluated it was noticeable that the restriction of lower lumbar region into flexion persisted but the motion was already increased compared with initial state of patient. McKenzie self-mobilization technique as described by my supervisor proved ideal for treating the lumbar restrictions and surely added a new chapter to my knowledge also. Post isometric traction according to Lewit [7] proved a really effective and beneficial technique for treating the feeling of stiffness and “unblocking” the lower spine.

Noticeable improvement found in patient’s mobility of spine into flexion. The patient reported improvement of quality of movement and decreased fatigue while performing her daily activities and exercise execution. I undoubtedly believe that McKenzie mobilization techniques contributed mostly among any other therapeutic procedure on improving dynamic mobility of the spine. The instructions were plain, simple and understandable for my patient as also the execution was well tolerable. The numbers may not be appearing ideal but my patient’s feedback was more than positive throughout the procedures which highly encouraged me and prompted me to insist on my therapeutic plan.

Gait Evaluation	
Initial Kinesiologic Examination	Final Kinesiologic Examination
Trunk motion rigid, without participation during gait. Squat gait performed with difficulty	Trunk motion increased observable slight shift latero-lateral during gait. Squat gait performed easier.

Table 10: Comparison of initial and final finding in gait evaluation

My patient didn’t appear any marked limitation in ROM of lower extremities and so on minor changes were found during final evaluation. Very small improvements found on passive flexion of left hip as also in active internal rotation on the right hip.

Muscle Strength Testing				
Muscle	Initial Right	Initial Left	Final Right	Final Left
Rectus abdominis	4		4+	
Gluteus maximus	4	4	4+	4+
Gluteus medius	4-	4-	4+	4+
Piriformis	4	4	4+	4+
Quadriceps	4	4	4+	4+
Tensor fascia latae	4	4	4+	4+
Hamstrings	4	4	4+	4+
Tibialis anterior	4+	4	5	5
Peroneus longus	4+	4+	5	5
Flexor hallucis longus	5	4+	5	5
Flexor hallucis brevis	5	4+	5	5
Extensor hallucis brevis	4	4	5	5

Table 11: Comparison of initial and final findings of manual muscle testing

Very satisfying image was formed after strength evaluation was made with changes found globally in patient's body bilaterally. Outstanding improvement has to be mentioned in matter of muscle strength and control considering the amount of time and number of available procedures with my patient. Deep core training handout rewarding results as my patient's body perception and control changed rapidly day by day. I can't distinguish any of the exercise units as the most efficient nor effective because each one contributed in the final result according to its goal. My patient though reported that the plank modification as described by Liebenson [8, 12] was from the one hand demanding but on the other very

effective. Sensomotoric training according to Janda [8] was a major station for improving perception of the patient and affecting the posture swiftly. Remarkable improvement in stability, strength and general performance of my patient resulted by the modifications of squats and lunges, integrated with deep core activation according to Brukner & Khan [5]. Examination of deep stabilization function according to Kolar [4] proved that the exercise units improved awareness and activity of diaphragm individually and the deep core as a stability system.

Another positive mark of the therapeutic procedure was the improvement of muscles strength analytically but also improvement functionally. Noteworthy changes found on the curl up movement pattern in which during initially evaluation, patient's feet lost contact with from them bed indicating hip flexors and during final evaluation patient provided the pattern with co-activation of deep core and achieved to maintain the contact of her feet.

I claim this part of therapy the most important. Strengthening according to the principles of Liebenson [8, 12], Richardson [28] and Brukner [5] et al. proven ideal for my patient. Their approach matched with the pathologic profile of my patient and showed great and rapid changes. That was the part that both I and my patient noticed the biggest improvements and understood the true effectiveness of the therapy. After the end of each therapy I could easily see how pleased my patient was by her improvements and progression. Since this part was the most time consuming I had the chance to test and improve my corresponding instruction skills in order to interactively correct my patient when it was necessary. Balance tests showed improvements with Romberg Test III found negative during the final control evaluation which is an undeniable sign that balance has already improved.

3.8 Prognosis:

The evaluation of therapy showed remarkable improvements which is setting a good prognosis for my patient.

Although it depends on my patient's choices, lifestyle and attitude if she will decrease the risks of reappearance of the problem, respecting the prognosis of my patient, i am expecting that improvements will occur day by day as my patient will grow stronger, more stable, better postural supported and she will not experience any back problem in the instant future.

4. CONCLUSION

The patient's smile at the end of each therapy reassured me that my choices and instructions as a physiotherapist were correct. My goals were achieved in a satisfactory level so I can say that the therapy was successful. I believe that the experiences earned during my practice will surely help me in my personal life but also in my professional career. The first days of practice in the UVN military hospital were anxious and difficult to compensate but my colleagues there helped me integrate. I understood that except of having the knowledge and skills to treat a patient, it is also important to be able to communicate and cooperate with your patient and colleagues.

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6. SUPPLEMENTS

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Supplement 4

Abbreviations

UVN= Ústřední vojenská nemocnice

ROM= Range of motion

IAP= Intra-abdominal pressure

CT= Computer tomography

MRI= Magnetic resonance imaging

NSAIDs= Nonsteroidal anti-inflammatory drugs

TENS= Transcutaneous electric nerve stimulation

DNS= Dynamic neuromuscular stabilization

PIR= Post isometric relaxation

MDT= mechanical diagnosis and therapy

Supplement 5

Informed consent form

INFORMOVANÝ SOUHLAS

V souladu se Zákonem o péči o zdraví lidu (§ 23 odst. 2 zákona č.20/1966 Sb.) a Úmluvou o lidských právech a biomedicíně č. 96/2001, Vás žádám o souhlas k vyšetření a následné terapii. Dále Vás žádám o souhlas k nahlížení do Vaší dokumentace osobou získávající způsobilost k výkonu zdravotnického povolání v rámci praktické výuky a s uveřejněním výsledků terapie v rámci bakalářské práce na FTVS UK. Osobní data v této studii nebudou uvedena.

Dnešního dne jsem byla odborným pracovníkem poučena o plánovaném vyšetření a následné terapii. Prohlašuji a svým dále uvedeným vlastnoručním podpisem potvrzuji, že odborný pracovník, který mi poskytl poučení, mi osobně vysvětlil vše, co je obsahem tohoto písemného informovaného souhlasu, a měla jsem možnost klást mu otázky, na které mi řádně odpověděl.

Prohlašuji, že jsem shora uvedenému poučení plně porozuměla a výslovně souhlasím s provedením vyšetření a následnou terapií.

Souhlasím s nahlížením níže jmenované osoby do mé dokumentace a s uveřejněním výsledků terapie v rámci studie.

Datum:.....

Osoba, která provedla poučení:.....

Podpis osoby, která provedla poučení:.....

Vlastnoruční podpis pacienta /tky:.....

Supplement 6

Ethics committee approval form



CHARLES UNIVERSITY IN PRAGUE
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Application for Ethics Board Review

Undergraduate research, involving human subjects

Project title: Case study of a patient with the diagnosis of lumbar intervertebral disk herniation with radiculopathy.

Nature of the research project: Bachelor's Thesis

Author (chief investigator): Dimitrios Millas

Supervisor (in case of student research): Mgr. Kateřina Holubová

Research project description: Case study of a patient with the diagnosis of lumbar intervertebral disk herniation with radiculopathy will be conducted under a professional's supervision at ústřední vojenská nemocnice. No invasive methods will be used.

Guaranteed safety to be judged by experts: No invasive methods will be used.

Ethical aspects of the research: Personal data obtained during the investigation will not be published.

Informed consent (attached)

Date: 23.1. 2015

Author's signature:

Faculty of Physical Education and Sport, Charles University in Prague ETHICS BOARD REVIEW

Ethics Board members: Prof. Ing. Václav Bunc, CSc.
Prof. PhDr. Pavel Šlepička, DrSc.
Doc. MUDr. Jan Heller, CSc.

The Ethics Board at the Faculty of Physical Education and Sport, Charles University, approved the research project.

Approval number: 012/2015

Date: 27.1. 2015

The Ethics Board at the Faculty of Physical Education and Sport, Charles University, reviewed the submitted research project and found no contradictions with valid principles, regulations and international guidelines for biomedical research involving human subjects.

The chief investigator of the project met the necessary requirements for receiving the Ethics Board approval.

UNIVERZITA KARLOVA v Praze
Official school stamp kulta tělesné výchovy a sportu
Josef Martího 31, 162 52, Praha 6

Signature, REB Chairman