Charles University

Faculty of Physical Education and Sports

A Case Study of Physiotherapy Treatment of Low Back Pain

Bachelor's thesis

Prague, April 2011

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Abstract

Title:

A Case Study of Physiotherapy treatment of Low Back Pain.

Thesis aim:

This thesis involves a case study regarding physiotherapy approach to low back pain localized in the area of the lumbo-sacral junction and the left hip joint. The theoretical part aims to explain the kinesiology and biomechanical pathologies of the lumbo-sacral joint and pelvic girdle functioning as a unit. While the practical part refers to the case study; the examinations used and the effectiveness of the therapy with the approaches used.

Methods:

The practical part is based on a 55 year old female, in a state of 2 year post fall on the left hip who now complains of low back and left hip joint pain. The study consisted of physiotherapeutic approaches for initial kinesiological examination, followed by 5 therapy sessions lasting an hour each, and a final kinesiological examination. All methods used were non-invasive.

Results:

Progress was very much markable in the course of 5 days of therapy. The patient's pain level at the left hip joint and low back pain (LBP) decreased. The therapies used have shown to be very successful concerning my patient's diagnosis.

Conclusion:

The patient felt the improvements and after 5 sessions, her goal's have been met, and that was to decrease the pain she felt at rest, during sleep. The patient is very motivated, therefore her prognosis is great.

Keywords:

Lumbo-sacral pain, hip joint pain, muscular imbalance, case study, physiotherapy

Declaration

I hereby declare that this work is entirely my own, individual work based on my knowledge gained from books, journals, reports and attending lectures and seminars at FTVS.

I also declare that no invasive methods were used during the practical treatment and that the patient was fully aware of the procedures at all times.

Prague, April 2011

Acknowledgment

Firstly, I would like to thank my family and foremost my parents for their confidence, ongoing motivation and support in the course of my studies and general living. I could not have done this without you. I would also like to express my gratitude to my friends; the ones close by and the ones across the world for their belief in me.

Special thanks to the Professors at FTVS that I have encountered in the past three years of my studies for sharing their knowledge and practice. I would also like to thank my supervisors of my summer clinical practices for pushing me into expanding my skills.

I would like to thank PhDr. Edwin Mahr PhD. for allowing me to realise my full potential during my bachelor's practice.

At last but not the very least, my deepest gratitude to Mgr. Agnieszka Kaczmarská PhD. who has guided me every step of the way with the entire process of the bachelor's thesis; your help is very much appreciated.

Thank you all.

Lousin Moumdjian

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1 General part

1.1 Low Back Pain; an introduction

Low back pain (LBP) is the most common symptom that leads individuals to seek the health care profession. Its etiologies are caused by different factors that contribute to a dysfunction; either functional or structural. Physiotherapy for LBP can be prescribed as a conservative treatment plan, or as complimentary treatment to pre-operative cases, or to rehabilitate post-operative cases.

The main goal of a physiotherapeutic management in regards to LBP is to pick-point the location and cause of the dysfunction that leads to the symptoms, and alter them. For this reason, a perspective understanding of the anatomy, kinesiology and functional alterations of kinesiology along with biomechanics of the human body is needed. In this section I will describe these areas in detail in the region of the lumbar spine and pelvic girdle.

1.2 An introduction to the Lumbar Spine and the Pelvic girdle

The lumbar spine functions as a complex interplay of musculo-skeletal and neurovascular structures creating a mobile, yet stable transition between the thorax and the pelvis. It repetitively sustains enormous loads throughout one's life time, while still providing the mobility necessary to allow a person to perform tasks associated with activities of daily living (ADL) (1).

In addition, it provides the fibro-osseous pathway for the inferior portion of the spinal cord, cauda equinda and lumbo-sacral spinal nerves travelling to and from the trunk and lower extremity (1).

Considering the magnitude and complexity of these functional demands, LBP is the most common site of dysfunction representing the most frequent musculo-skeletal problems with their enormous variability of its clinical manifestation. This in turn imposes a challenge in the diagnosis of LBP (1).

The pelvic girdle primarily functions to position the hip joint for effective limb movement (2). The bony pelvis, consisting of 2 innominate bones and the sacrum. This provides the transition from the upper trunk to the lower limbs (1).

1.3 Anatomy of the Lumbar Spine and Pelvic girdle

The vertical dimensions of the lumbar vertebral bodies are positioned anteriorly, forming a slight wedge-shaped that results in adjacent vertebrae forming a natural lordotic curve. The vertebral bodies become progressively larger from L1-L5 as a function of progressively increasing load demands from cranial to caudal (1).

Anatomical variations in the facet joint planes is common, for example, facet joint planes on one side of a vertebrae may be oriented more obliquely than the facet joint plane on the opposite side, leading to asymmetrical side bending or rotation (1).

Lumbo-Sacral (LS) junction

The L5 vertberae is atypical, because it's features reflect its rate in transmitting the weights of the head, upper limbs and trunk to the sacrum. It has massive transverse processes that are in contact with the entire lateral surface of the sacral pedicle and side of the sacral body. The contrast between the anterior and posterior heights of the vertebral bodies is also the greatest at L5. This along with the greater anterior than posterior heights of the fifth lumbar inter-vertebral disk (IVD), contributes to the angle formed at the lumbo-sacral junction (1).

The superior articular processes of L5 are typical, put the facets on the inferior articular processes are vertical and project anteriorly and slightly laterally to articulate with the superior articular processes of the bone of sacrum. This in turn places the lumbo-sacral facet joint cavities in a coronal plane. This change from sagittal to coronal plane contributes to lumbo-sacral integrity by resisting the shearing stress between L5, lowest IVD and the base of the Sacrum (1).

The Sacrum

The Sacrum is also known as vertebra magna. It is the most atypical vertebrae; it's shaped as an inverted triangle formed from the fusion of five sacral vertebral segments. The broad base of the Sacrum projects antero-superiorly to articulate with the L5 at the LS junction. Its blunted apex- projects antero-inferiorly to articulate with the first coccygeal segment at the sacro-coccygeal (SC) junction (see figure 2) (1). Muscles originating from here are the piriformis, multifidus, erector spinae and gluteus maximus. The sacrum has four sets of separate dorsal and ventral foramina for the passage of dorsal and ventral primary rami of spinal nerves S1-4 (1).

The Innominate Bone

We have two innominate bones, and each bone is formed from the union of three separate bones called ilium, ischium and pubic. These three unite at a central point - the acetabulum, from which they expand (1). The cartilage on the acetabulum is thickener in the periphery where it merges with a rim of fibrocartilage that contributes to the stability of the joint (2). Muscles originating from the ilium, ischium and pubis are described below. Table 1 shows a summary of the muscles originating from the innominate bones along with their functions (2).

Table 1: Summary of the muscle discussed above and their functions (2):

Muscle	**Function at the hip**
Rectus femoris	Flexion
Iliopsoas	Flexion
Sartorius	F, ABD and lateral rotation
Pectineus	F, ADD and lateral rotation
TFL	F, ABD and medial rotation
Gluteus maximus	E and lateral rotation
Gluteus medius	ABD and medial rotation
Gluteus minimus	ABD and medial rotation
Gracilis	ADD
Adductor magnus	ADD and lateral rotation
Adductor longus	ADD, lateral rotation and assists with F
ADD brevis	ADD and lateral rotation
Semitendinosus	E
Semimembranosus	E
Biceps femoris (long head)	E of thigh
The 6 external rotators (Gamellus inferior and superior, piriformis, obturator internus and externus, quadratus femoris)	External rotation of thigh

The Lumbar Plexus

The lumbar plexus is formed by the loops of communication between the anterior divisions of the first three and the greater part of the fourth lumbar nerves; the first lumbar often receives a branch from the last thoracic nerve. It is situated in the posterior part of the psoas major, in front of the transverse processes of the lumbar vertebræ (3). Its innervations are both motoric and sensory (see figures 1, 2 and 3).

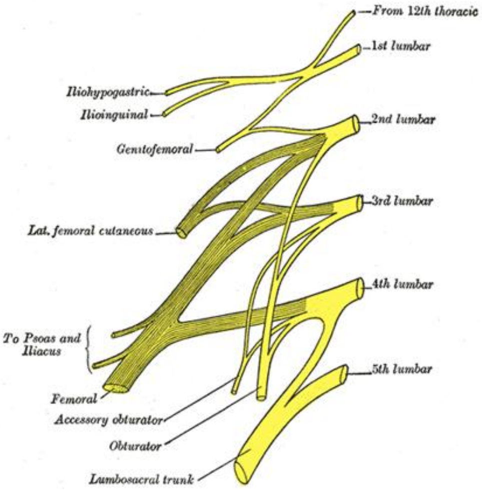

Figure 1: The Lumbar Plexus (3)

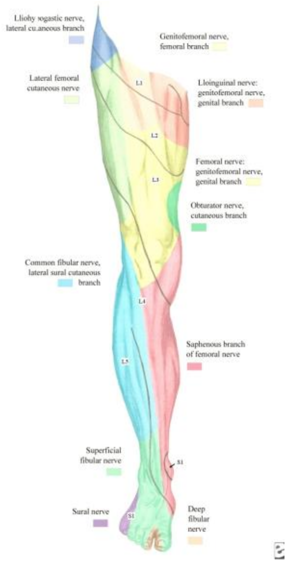

Figure 2: Dermatomal innervation by the Lumbar plexus on the anterior aspect of the leg (3)

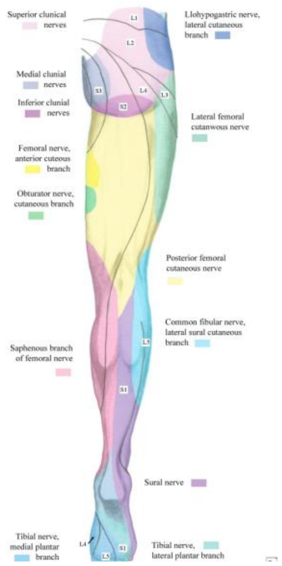

Figure 3: Dermatomal innervation by the Lumbar plexus on the posterior aspect of the leg (3)

The Sacral Plexus

The sacral plexus (see figure 4) is formed by the LS trunk, the anterior division of the first and portions of the anterior divisions of the second and third sacral nerves. The LS trunk comprises the whole of the anterior division of the fifth and a part of that of the fourth lumbar nerve; it appears at the medial margin of the psoas major and runs downward over the pelvic brim to join the first sacral nerve. The anterior division of the third sacral nerve divides into an upper and a lower branch, the former entering the sacral and the latter the pundendal plexus (4).

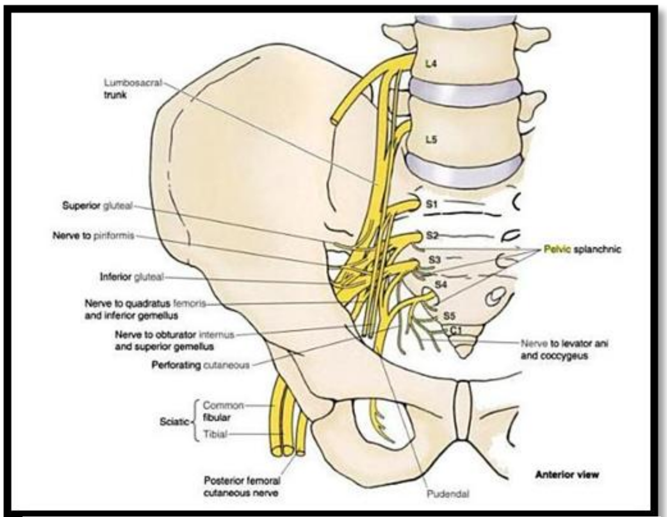

Figure 4: The sacral plexus (4)

The nerves forming the sacral plexus converge toward the lower part of the greater sciatic foramen, and unite to form a flattened band, from the anterior and posterior surfaces which several branches arise. The band itself is continued as the sciatic nerve, which splits on the back of the thigh into the tibial and common peroneal nerves. These 2 nerves sometimes arise separately from the plexus (4).

1.4 Kinesiology of the Lumbar Spine and Pelvic girdle

The osseous parts of the Lumbar spine compromise of 5 vertebrae's; L1-L5. However, sometimes the junction between the first and second sacral vertebrae fails to fuse, this is called Lumbarisation, and results in a sixth mobile lumbar vertebrae. In some cases the LS junction fuse together during growth and development, and in this case there is a Sacrolisation of the LS junction. Yet, it is important to note that neither of these cases appears to increase the risk of LBP (1).

Motions of the Lumbar spine (1)

Gross motion of the lumbar spine is based on cardinal planes, and following demonstrates the motions physiologically possible to execute in the lumbar spine in their certain planes: flexion in the sagittal plane, extension in the sagittal plane, lateral flexion in the frontal plane and rotation in the transverse plane.

The main structures that allow these motions are the muscles and ligaments attached to the lumbar spine. Firstly, I will describe the muscles from the anterior, posterior and lateral aspects and their functions, followed by the ligaments and the motion that they restrict.

Muscles of the Lumbar Spine (1,2)

The anterior aspect:

Rectus abdominis- functions to flex the trunk and depress the ribs. Unilateral tension development causes lateral flexion towards the tensed muscle.

Internal oblique abdominis- functions are flexing the trunk, ipsilateral trunk rotation, increase of intra-abdominal pressure, rib depression, spinal stabilisation and decrease of anterior tilting the pelvis. Unilateral tension development causes rotation of the spine towards the tensed muscle.

External oblique abdominis- functions are trunk flexion, contralateral trunk rotation, increase of intra-abdominal pressure, rib depression, spinal stabilisation. Unilateral tension development causes rotation of the spine opposite to the side of the tensed muscle.

Transverse abdominis: functions to increase intra-abdominal pressure and serves to stabilise the spine.

The posterior aspect:

Erector spinae; the following muscles collectively known as erector spinae: sacrospinalis, semispinalis, multifidi, rotators, interspinalis, intertransversarii, levator costarum, longissimus and iliocostalis. These group as major extensors and hyper extensors of the trunk when contracting bilaterally, and lateral flexors when contracting unilaterally. They also support anterior shear forces.

The lateral aspect:

Quadratus lumborum and psoas major. Bilaterally the quadratus lumborum extends the trunk and the psoas major flexes the trunk and unilaterally laterally flex the lumbar spine.

Ligaments around the Lumbar spine (1)

The ligaments (shown in figure 5) are intermeshed with fascia, tendinous attachments of muscles and outer portion of IVD and function to provide restraint of motion.

Classification:

- Extrasegmental; anterior longlitudenal, posterior longlitudenal and supraspinous.
- Segmented; ligamentum flavum, interspinous and intertransversus.
- Regional; iliolumbar.

The anterior longlitudenal ligament is a large, broad band that spans the anterior portion of the vertebral bodies and annulus fibrosus. It's strongly anchored to the anterior sacrum and strongly reinforced tissue against anterior displacement of the IVD. The posterior longlitudeal ligament spans the posterior aspect of the vertebral bodies. It had an hourglass shape, and covers the posterior portion of the IVD. The interspinous ligament is located between the spinous process, and the supraspinous ligament is covers the posterior tips of spinous process. The latter two provide posterior stability for the motion segment. While ligamentum flavum connect the laminae of adjacent vertebrae, all the way from the axis to the first segment of the sacrum.

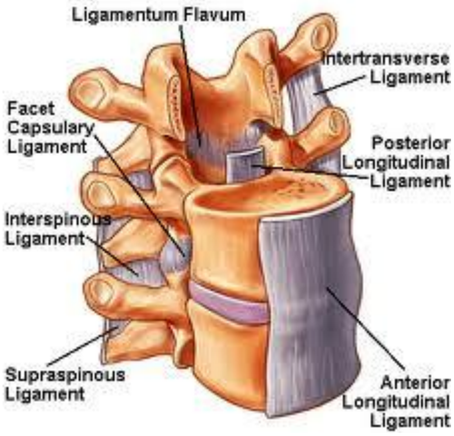

Figure 5: Ligaments found at the Lumbar spine (22)

All lumbar ligaments except for ligamentum flavum are inelastic and exhibit viscoelastic response or time dependant elongation to loading. By identifying the location of a ligament and direction of its fibres, we can hypothesise the motions that a given ligament resists. For example, ligaments posterior to the axis of rotation of a motion segment (posterior longlitudenal ligament, interspinous, ligamentum flavum and supraspinous ligament) restrain against flexion. While the anterior longlitudenal ligament restrains extension (1).

Ligamentum flavum is unique due to the fact that it 80% of its composition is elastic. It can be elongated to 40% of its resting length without causing tissue damage (1). Flavum lengthens when stretched during spinal flexion and shortens during spinal extension. It's in tension, even if the spine is in an anatomical position; this quality enhances spinal stability. The tension creates a slight constant compression in the IVD and this is referred to as prestress (2).

A summary of displacements opposed by Lumbar ligaments is shown in table 2 (1):

Table 2: Displacements opposed by Lumbar ligaments (1)

Ligament	Displacement resisted
Anterior longlitudenal	Vertical separation of anterior vertebral

	bodies. example lumbar extension, anterior bowing of L spine
Posterior longlitudenal	Separation of posterior vertebral bodies
Supraspinous	Separation of the spinous processes
Interspinous	Separation of posterior vertebral bodies. Ie lumbar F, posterior translation of the superior vertebral body.
Ligamentum flavum	Separation of the laminae
Intertransverse	Separation of transverse process
Iliolumbar	F, E, R and lateral bending

The Lumbo-Dorsal Fascia

Is a dense connective tissue with a well developed lattice of collagen fibres (2) causing the lumbar region great support during lumbar flexion and lifting activities. It's made of three layers; the anterior and middle layers arise from transverse processes of the lumbar vertebrae and joint together laterally, encompassing the quadratus lumborum while blending with the fascia of the transverse abdominis and internal oblique abdominal muscles. This creates a direct connection between the body of the spine and deep abdominal muscles; which is an important relationship for the dynamic stabilisation of the lumbar spine (1). The tendons of longissimus thoracis and iliocostalis lumborum also pass under the LDF to their sacral and iliac attachments. It appears that the LDF may provide a form of strapping for the low back musculature (2).

Curvature of the Lumbar spine (2)

The lumbar spine is lordotic. The degree of the lordosis present is influenced by factors such as heredity, pathological conditions, individual's mental state and forces that the spine is subjected to on a daily basis. However, the most common cause of an increased lordotic spine is caused by having weak abdominals and gluteal muscles, and the pelvis being in anteversion. This places a compressive stress on the posterior elements of the spine, subjecting the person to LBP. Further deviations can also be present in the lumbar spine in the form of lateral deviations to the left or right. This condition is known as scoliosis. More details on scoliosis can be found under the section 1.5.

Load bearing (1)

The increase surface area of the lumbar vertebrae compared to the vertebrae's of the rest of the spine reduces the amount of stress to which the vertebrae would be subjected to. The facet joints also assist in load bearing. These and the IVD joints provide 80% of the spine's ability to resist rotational torsion and shear. Their facet joint also sustain up to approximately 30% of compressive load on the spine, especially when the spine is in hyperextension.

Spinal Stability (1)

Activating a muscle increases stiffness of both the muscle and joints around it. Activating a group of muscle synergists and antagonists however in their optimal way becomes an issue. This is because if one muscle with inappropriate activation or force/stiffness can produce instability or at least unstable behaviour.

Abdominal muscle activity needed to create higher intra-abdominal pressure (IAP) increases spinal compressive load, yet, IAP through contraction of abdominals appears to stabilise the spine. One theory for this spinal stability is that the IAP produces an external moment that assists the erector spinae in supporting the spine. Another theory is that abdominal muscles with other trunk muscles serve to stiffen the spine causing an air splint to develop around the spine.

Stiffness is defined as a ratio between the force applied to an object and the object's resulting change in shape. Therefore, the question remains; how much stiffness is requires from muscles to stabilise the lumbar spine. Too much stiffness form muscles causes compressive forces, while extreme stiffness impends joint motion. Keeping in mind that after an injury, passive tissue stiffness is decreased and motor system is altered, resulting in an inadequate muscle activation sequence. In this case, sufficient stability is needed, that is the amount of muscular stiffness needed for stability. Large muscular forces are not required to stabilise the lumbar spine, but proper muscular co-ordination, activation sequence and endurance.

Motions of the Pelvis

Motion of the pelvis consists of movements of both:

1) Innominates as a unit in relation to the sacrum referred to as symmetrical motion
2) Antagonistic movements of each innominate bone with relation to the sacrum, referred to as asymmetrical motion

3) Rotation of the spine and both innominates as a unit around the femoral heads, referred to as Lumbo pelvic motion.

Sacral Inclination

The sacrum sits below the L5 with its base titled forward and its apex backwards. The sacral inclination therefore formed consists of the base of the sacrum being tilted forward off the horizontal by approximately 30 degrees (ranges are between 20 to 90 degrees) (1).

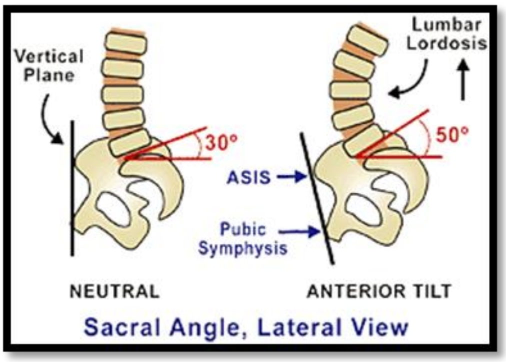

Figure 6: A physiological sacral angle from a lateral view is shown on the left, and an increase of the sacral angle from a lateral view is shown on the right, resulting to a lumbar lordosis and an anterior tilt of the pelvis (23)

The sacral inclination, the wedge-shaped L5 vertebral body and the IVD contribute to the LS angle, which is greater in males. The inclination and angle are intimately related to the lumbar lordosis (see figure 6). An increase of inclination and therefore the angle results in an increase of lumbar lordosis (1).

The Sacro-Iliac joint

The sacro-iliac (SI) joint makes up the iliac, sacral auricular surfaces and tuberosities; both the sacral and iliac cartilages are hyaline. That is the articular surface from a synovial joint, connected by an interosseous ligament which constitute to a fibrous form of a synarthrosis. After 30 years of age, the synovial part of the joint shows signs of degeneration.

From 40 to 80 years of age, the joint is characterised by stiffening of the capsule, severe loss of cartilage thickness, subchondral bone erosion, increase in surface irregularity, intra-articular fibrosis of joint surfaces and in some cases, total ankylosis. This advance is more rapid in males than females (1).

Ligaments around the pelvis

The Iliolumbar ligaments- connects the L5 to the Ilium and reinforces the junction laterally (2). This ligament is not present in newborns and develops by metaplasia of fibres of the quadratus lumborum and undergoes degeneration after 40 years of age. It's suggested that its development is due to the stress of the body assuming an upright position. The lower band of the iliolumbar ligament is in a coronal position, and thus controls Lateral flexion. The upper band of the iliolumbar ligaments is positioned obliquely backwards and exerts a posterior pull on the L5 to prevent anterior slipping of the vertebral body during weight bearing and controls flexion as well. The ligament as a whole however controls axial rotation (1).

Ventral and dorsal SI ligaments (VSIL, DSIL) attach to the margins of the SI joint, and interosseous sacroiliac ligament (ISIL) is found across the joint. During incremental loading of the sacrum, the DSIL becomes tense when the base of the sacrum moves backwards (counternutation) and slackens with movement in the opposite direction (nutation). The sacrotuberous and sacrospinous ligaments, pass from the sacrum to the ischium (1). While the iliofemoral and pubofemoral ligaments strengthen the hip joint capsule anteriorly with posterior re-enforcement from the ischiofemoral ligament. Tension from these ligaments act to twist the head of femur into the acetabulum during hip extension (2).

Lumbo-pelvic rhythm during bending forward

When you bend forward, a combined movement of the lumbar spine and the pelvis occurs. As you begin to bend forward, this movement starts from the head and upper trunk. The pelvis shifts backwards to keep the centre of gravity over the base of support, thus balancing the body. For approximately the first 45 degrees of forward flexion, the extensor muscles of the spine maintain the balance of the body. The posterior ligaments become taut and the facet of the intervertebral joints come together, which provides stability for the intervertebral joints, and the muscles relax (2).

When the movement has reached the point where all the vertebral segments are at full range, supported by the posterior ligaments and facets, the pelvis begins to rotate forward: an anterior pelvis tilt. The gluteals and hamstrings control this part of the movement. The pelvis will continue to rotate forward, until the muscles are at full length. The final range of motion (ROM) depends on the flexibility of the back extensors, the fasciae and the hip extensors. To return to an upright position, the hip extensor muscles rotate the pelvis posteriorly, after which the back extensors extend the spine, beginning at the lumbar region and working its way upward. Any interruption of this rhythm may result in LBP (2).

1.5 The Intervertebral Disk (IVD); anatomy, kinesiology, biomechanics and mechanisms of injury

IVD in healthy people account for one fourth of the height of the spine. When the trunk is erect, the differences in anterior and posterior thicknesses of the disks produce the lumbar, thoracic, and cervical curves of the spine (2). The IVD (see figure 8) and the big bony vertebrae's allow to sustain the most of the compressive load. Furthermore, the neural arch and the IVD sustain most of the torsional load-bearing acting on the LS region. In upright postures, the vertebral bodies of the lumbar spine assume 80-90% of the compressive load bearing, but they have a poor capacity to tolerate rotational stresses. This is compensated by the IVD and posterior body structures as well as muscular support(1).

The IVD is the central figure in spinal mechanics and pathology. It consists of outer fibrous covering named annulus fibrosus, and an inner gel-like region named nucleus pulposus (1).

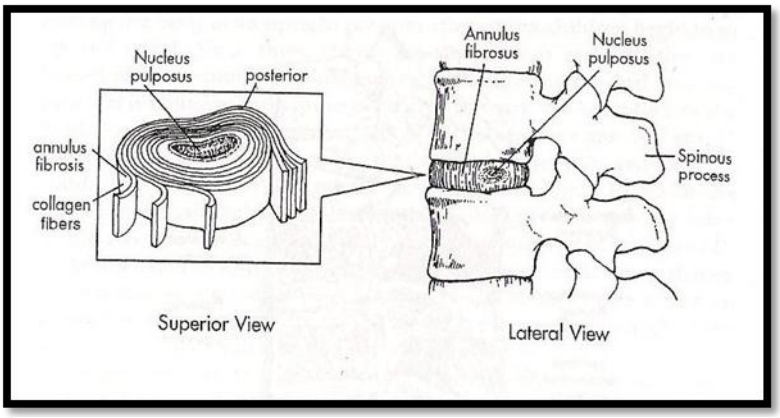

Figure 7: Superior and lateral view of the IVD (2)

<u>The Annulus Fibrosus</u>

Is made of rings of fibrocartilage forming the outer portion of the IVD. Obliquely oriented to one another (1), the collagen fibres of the annulus crisscross vertically at about 30 degree angles to each other, making the structure more sensitive to rotational strain than to compression, tension or shear (2), and so tolerating high magnitude of tensile loads. Strong attachments exist from here and outer portion of the vertebral bodies and end plates as well with the anterior longlitudenal ligament (1).

The IVD is slightly concave in its central posterior position to increase amount of the annulus fibrosus material posteriorly to resist the flexion loads common in daily activities. The posterior-lateral annulus is not well reinforced, and so is the common site for herniation. Furthermore, great number of mechanoreceptors and free nerve endings are found here; this gives the annulus fibrosus an important role in proprioception and pain production (1).

The Nucleus Pulposus

This accounts for the inner portion of the IVD. It is a mucopolysaccaride gel that is 70-90% water; the water concentration decreases with age. The disk maintains hydration by diffusion of tissue fluid mediated by mechanical forces and osmotic gradients. This is done by hydrostatic pressure; by external loads acting on the disk from muscle and ligamentous tension, and osmotic pressure; by molecular composition (1).

Hydrostatic pressure during compression load on the IVD (1)

External forces that approximate the vertebral bodies exert a compressive load on the IVD. The disk converts vertically applied forces to circumferentially applied tension by a phenomenon known as hoop stress. Pascal's law states that pressure applied to a liquid is distributed equally in all directions. As the compressive load is applied, pressure within the nucleus increases, but because water is incompressible, the nucleus exerts pressure against the surrounding annulus fibrosus, a process known as radial expansion. The annulus then resists this load through tension developed in the collagen fibres. The nucleus also exerts pressure against the superior and inferior vertebral end plates and so transmitting part of the load from one vertebra to the next.

Osmotic pressure during compression loads on the IVD

In ADL, compression is the most common form of loading on the spine. When a disk is loaded in compression, it simultaneously loses water and absorbs sodium and potassium until the internal electrolyte concentration is sufficient to prevent further water loss. When the chemical equilibrium is achieved, internal disk pressure is equal to the external pressure. Continuous loading over several hours results in further decrease in disk hydration (2).

Considering the numerous variations in person's posture from one moment to the next and so change in load in one's life span one can see that the disk is constantly changing its shape and fluid content. With sustained loading, fluid is lost from the disk and so loss of vertical dimension results (1). Therefore the spine undergoes a decrease in height up to 2cm over the course of the day. Approximately, 54% of this loss occurs during the first 30 minutes after getting up in the morning. Once the pressure on the disk is relieved, the disk quickly reabsorbs the water and disk volumes and heights are decreased (2). Nevertheless, elevated disk fluid volume early in the morning predisposes the disk to injury during lumbar flexion (1).

Bogduk and Twomay describe a second property of the disk as the ability to store energy during loading and to recoil elastically once the load is released, giving it the function shock- absorber (5).

The normal disk therefore functions hydrostatically with internal pressure increase in relation to externally applied forces. With dehydration or surgical excision of nucleus, the capacity of the IVD to tolerate compression load is altered and so may cause degenerative changes (1).

Mechanically, the annulus fibrosus acts as a coiled spring whose tension holds the vertebral bodies together against resistance of the nucleus pulposus, and the nucleus acts like a ball bearing composed of incompressible gel (figure 9) (2).

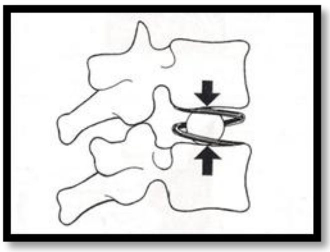

Figure 8: Mechanical presentation of the annulus fibrosus acting as a coiled spring while the nucleus pulposus acts like a ball bearing composed of umcompressible gel (2)

Compressive forces on the IVD during trunk movements

During flexion and extension, the vertebral bodies roll over the nucleus, while the facet joints guide the movement. Spinal flexion, extension and lateral flexion produce compressive stress on one side of the disk and tensile forces on the other (see figure 10) (2). Furthermore, the nucleus deforms in direction opposite to the motion during sagittal/frontal plane motion. So in lumbar extension, it displaces anteriorly. This theory is the base of Mckenzie lumbar extension exercises (1).

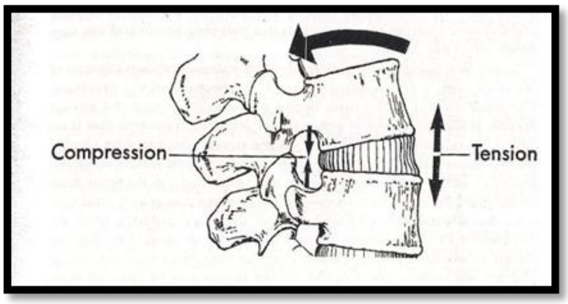

Figure 9: Spinal F, E, and LF produce a compressive stress on one side of the disk and tensile on the other (2).

Torsional stress on the IVD during rotation

Rotation of the spine places a torsional stress on IVD (see figure 11), and only a portion of the annulus fibrosus is able to resist the torsional stress. Fortunately for the lumbar spine, the arrangement of facet joints in the sagittal plane limits rotation and therefore protects it against these forces. However, these protective mechanisms of injury are decreased if a combination of rotation and flexion is applied to the lumbar spine (1).

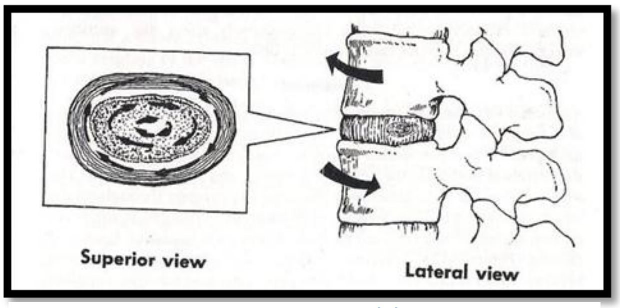

Figure 10: Torsional tress on the IVD (2)

Mechanisms of IVD injury

There are three mechanisms in which the IVD can be injured. Firstly, by direct injury to the pain-sensitive outer portion of the annulus fibrosus. Secondly, if a herniated disk is present- where the nucleus breaks through the boundaries created by the annulus fibrosus causing mechanical pressure and chemical irritation of the pain sensitive structures of the vertebral foramina. Thirdly, degenerative disks that loses vertical dimension and causes the vertebrae to approximate to one another leading to a reduction of stability of the segment. However, not all of these display symptoms (1).

1.6 Biomechanics of the Lumbar Spine and Pelvic girdle

Forces acting on the spine include body weight, tension in spinal ligaments, tension in surrounding muscles and intra-abdominal pressure and any applied external loads (2). In an upright position, the body weight, weight of any loads in the hands and tension of surrounding ligaments and muscle contribute to spinal compression. In this position the centre of mass (COM) is anterior to the spinal column, placing the spine under constant forward bending moment. Therefore, to maintain this position, the torque must be counteracted by tension in the back extensors (2).

As the trunk or arms are flexed, the increasing moment arms of these body segments contribute to increasing flexor torque and so increasing compensatory tension in back extensors. Due to spinal muscles having extremely small moment arms, with respect to the vertical joints they must generate large forces to counteract the torques produces about the spine by weights of the body segments and external loads. Therefore, the major forces acting on the spine is usually that derived from muscle activity (2).

During erect standing, the body weight also loads the spine in shear. The shear increases the tendency of the vertebrae to displace anteriorly with respect to adjacent inferior vertebrae. Due to the orientation of the fibres of spinal extensors, as the tension in these muscles increase, both compression and shear on vertebral joints and facet joints increase.

Shear is a dominant force in the spine during daily activities and activities requiring backwards lean on the trunk. Furthermore, excessive shear stress contributes to disk herniation (2).

Another factor affecting spinal loading is body movement speed, which in turn increases compression and shear forces of the spine and so increasing the tension of the paraspinal muscles. Compression of the lumbar spine increases in sitting, further in spinal flexion, and even furthers more in slouched sitting position (see figure 12) (2).

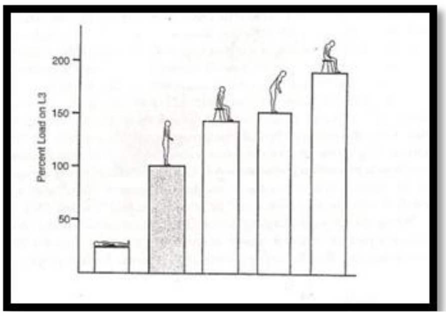

Figure 11: Compression forces on the lumbar spine in lying, standing, sitting, trunk flexion and slouched sitting (2)

Lifting objects with spinal flexion (1)

This causes the posterior ligaments to strain. Firstly, the dominant direction of the pars lumborum fibers of the longissimus thoracis and iliocostalis lumborum muscle causes these muscles to produce a shear force on the superior vertebrae. In contrast with spinal flexion, the interspinous ligament complex generate forces with the opposite oblique abdominis muscles and therefore imposes an anterior shear forces on the superior vertebrae.

Therefore, the posture or curvature of the spine is important in influencing the interplay between passive tissues and muscles that ultimately modulates the risk of different types of severe injury. Therefore using muscle to support the moment in a more neutral posture rather than in full flexion of trunk with ligamental support greatly decreases the shear load.

Loads on the Lumbar spine during a fall (1)

The lumbar spine can tolerate more compressive load (10kN) than shear loads (1000N). If cyclic loading is placed on the lumbar spine then an injury will occur. Injuries caused by falls is characterised by high velocity and high rate of strain applied to the tissue. Studies have showed that 20% of cadaveric spines posses ruptured lumbar interspinous ligaments in their middle and not their bony attachments. Therefore, ventral and dorsal portion of the ligament along with supraspinous ligament remains intact during a fall injury. Given the oblique fibre direction of the interspinous complex, a very likely scenario to damage this ligament would be slipping, falling and landing on one's behind. This causes driving the pelvis forward on the impact, and creating a posterior shearing of the lumbar joints when the spine is fully flexed.

Loads on the Lumbo-Sacral Junction

The compressive load is the primary function of the muscle force needed to support the junction. Any increase in the externally applied moment needs an increase in muscle force. Picking up large loads from the ground increases the external moment; as does lifting a small load while holding it far from the body-which in turn increases the moment arm of the load. Both need an increase in muscle force leading to large compressive forces at the LS junction (1).

The orientation of the LS junction also affects the magnitude of the compression and shear forces because the compressive force is approximately perpendicular to the bodies of L5 and S1, and the shear forces are parallel to the plane between the bodies of L5 and S1. Shear forces are more dangerous than compressive ones. Because the plane of LS junction usually is oriented at a larger angle from the horizontal than the rest of the lumbar spine, the LS junction is particularly susceptible to anterior shear forces (1).

As the angle between the plane of the vertebral bodies and transverse plane increases, the shear component of the weight of the head, arms, trunk (HAT weight) and any lifted weight also increases. Slouched sitting posture also appears to increase the anterior shear forces on the LS junction when the backrest pushes the HAT weight anteriorly as the sacrum rotates posteriorly (1).

Loads on LS joint while walking

Average peak compression forces at LS joint range from 1.7 to 2.52 times the body weight, and anterior shear forces range from 0.22 to 0.33 times the body weight during speed walking. The resultant forces on the LS facer joints, while smaller than the loads on the disk are approximately 1.5 times the body weight. This force on both the disk and facet joint peak during double limb support phases of the gait, when the pelvis is in anteversion. Therefore because anteversion is associated with increase in lumbar joint extension and trunk hyperextension, it appears that they increase the load on the LS joint. This theory explains why people feel LBP during walking (1).

Loads on the Sacro-Iliac joint

Generally, forces on the SI joint are less studied than the LS. Due to the fact that so many different structures affecting the joint have no attachments to the ilium or sacrum. Loads on the SI joint vary from 0.85 to 1.1 times the body weight in single leg stance. While forces on the SI joint four times the body weight were reported at the end of the single limb support during gait. SI joint sustain larger loads during ambulation due to the need for muscular activity and large muscle force stabilising the SI joint during its function. The extensor muscles that attach close to the SI joint appear to support the lower back and generate forces more than 6500 N. The joint appears to sustain large loads, which may contribute to SI joint dysfunction in some individuals (1).

1.7 Functional alterations of the kinesiology of the lumbar spine and the pelvic girdle

There are various conditions ranging from structural variations to functional alterations that may lead to symptoms of low back pain. In this section, firstly, I will talk about the disturbances in functional kinesiological and biomechanical alterations of the lumbo-sacral junction that would lead to back pain and/or pelvic dysfunction.

The functional alterations seen in the lumbar spine and the pelvic girdle

To discuss this, we have to note that those two segments has to be considered as one unit working together to sustain loads and transmit loads across the body. For this process, all body segments have to undergo some form of stability and be able to compensate unstable situations (6).

The term stability is a mechanical term, and it describes the conduct of a mass body residing on a fixed pad, under the influence of external mechanical forces. The upright position of the body is not stable and must be permanently established by the postural system and be slightly modulated by the breathing movements (6).

The influence of the pelvis on stabilisation

The pelvis constitutes the supporting base of the trunk and the vertebral column to the lower limbs. The pelvis transmits forces from the vertebral column over the L5 vertebra and then towards the lower limbs through two branches; one passing through the SI articulations to the iliac bones, and the other through the hip joints (6).

At the same time, reactive forces coming from the feet also split into two branches; one passing the iliac bone and moving towards the L5, and the other passing the pubic bone and moving towards the pubic symphesis. These two lines of forces form a ring in the pelvis. Therefore, the body weight loads the pelvis more if the lumbar spine is flat. Due to this mechanism of loading, any fault in the hip joint may be projected into the low back, and similarly, any faults in the low back may be projected into the hip joint. Any functional lesions in the hip joint may be found as a result of restriction of internal rotation of the femur into the acetabulum (cyriax articular pattern) (6).

This pattern will in turn cause shortness and hypertonicty of the external rotators of the hip joint, which will further cause the formation of myofascial trigger points in close proximaty to the lesion (in the adductor muscles and pelvic floor mucles). This may lead to further pelvic floor dysfunctions, such as blockages of the SI joint nutation movements, changing the position of the pelvis, and so affecting the sacral inclination and curvature of the lumbar spine. This will further cause more musculo-structural changes, such as lower crossed syndrome, most associated with shortnening of the hip flexors and hamstings, and weakness of abdominals and quadriceps, which will further alter the position of the pelvis and increase the lumbar lordosis (6).

Clinical representations

When standing at ease:

The promontory is lowered and the sacrum tends to rotate outwards in a nodding-nutation movement. In the same time, the reaction forces from the ground is transmitted to the hips, tilting the pelvic bones backwards into retroversion. If the nutation movements is blocked, then the pelvis cannot move into retroversion and this results in muscular imbalances and further blockages; these may lead to referred pain in the region of the low back (6).

Standing on one foot (stance phase of gait)

The standing limb is extended and the swinging limb is slightly flexed. The pelvis is tilted down on the side of the swinging limb and shearing forces load the symphesis. The destabilisation here has to be compensated by the activity of the gluteus medius on the standing leg. If the gluteus medius is week or inactive, then the pelvis cannot be stabilised. This in turn will cause further blockages and muscular imbalance; these may lead to referred pain in the region of the low back (6).

Lying down with extended hips

Flexor muscles cause the pelvis to be anteversion, and also push the tip of the sacrum anteriorly. The SI joint counter-nutates, enabling the articulation of the head of femur into the acetabulum. If the nutation movements is blocked, the movement of the femur in the acetabulum will be altered. This in turn may result in lesions of the hip joint which may again lead to secondary referred pain in the region of the low back (6).

Furthermore, unilateral blockage of the nutation of the SI joint causes distortion of the pelvis. The superior and posterior iliac spines should lay in the same height and be parallel. If the line tilts to one side or the other (caused by the unilateral blockage of the nutation movement of the SI joint) then this will cause the slackening of the gluteus maximus on the blocked side, lowering of the subgluteal line, and tilting of the intergluteal line to one side (6).

Therefore, we can conclude that the position of the pelvis plays an important role in postural functions along with locomotion. Any changes in the length or weakness of the muscles around the region of the pelvis will cause change in the pelvic position and in turn musculo-skeletal structural change in the above and below segments (6).

Summary of the muscles operating with the pelvic girdle is shown in table 3 (6) .

Table 3: Muscles operating with the pelvis (6)

Segments connecting the pelvis	**Muscles**
The thorax	Abdominals and quadratus lomborum
Lumbar spine	Iliopsoas
Pelvic floor	Levator ani and coccygeus
Lower extremity	Hip flexors: iliopsoas, rectus femoris and pectineus Hip extensors: gluteus maximus, biceps femoris, semimembranosus and semitendinosus Hip adductors: adductor longus, brevis, magnus and gracilis

	Hip abductors: gluteus medius and minimus, sartorius and TFL Hip ERs: piriformis, quadratus femoris, obturator internus and externus, gamellus inferior and superior

<u>The pelvic diaphragm</u>

The pelvic diaphragm forms the pelvic bottom and closes the pelvic outlet through a movable elastic muscular membrane working in partnership with the abdominal diaphragm participating on respiratory and postural movements. The pelvic floor muscles are formed by the levator ani and coccygeus (6).

Some of the most common dysfunctions in this region are:

<u>Pelvic muscle dysfunction-</u>

Impairment, either separate or in combination of nervous, muscular and fascial elements of the pelvic floor and pernineum. This include disorders of micturation, defecation and sexual functions as well as organ prolapse and pelvic discomfort (1).
Statistics say that 1 out of every 5 Americans (of every age) suffer from some type of pelvic floor dysfunction at some time in their life (7).

Conservative treatment is applied here, and this includes: external and internal soft tissue mobilisation, myofascial and trigger point release, visceral manipulation, connective tissue manipulation, deep tissue massage, biofeedback, electrical stimulation, transcutaneous electrical stimulation (TENS), hot and cold therapy and kegel exercises (7).

<u>Urinary incontinence-</u>

In 1988, the National Institute of Health defined urinary incontinence as the involuntary loss of urine so severe as to have social and/or hygienic consequences. This condition is more common in older woman (1). The main causes of urinary incontinence are from prostatectomy in males, changes in hormones and vaginal delivery in females. Furthermore, supraspinal neurological lesions, advanced age, functional impairment and drugs can cause urinary incontinence in both genders (1).

It occurs 10-30% in females, 1.5-5% in males aged 15-64 (1). Treatment for urinary incontinence depends on the type of incontinence, the severity the problem and the underlying cause (8).

Conservative therapy for UI: Firstly, behavioural training is trained, such as bladder training, scheduled toilet trips and fluid and diet management. Physiotherapy is also prescribed to strengthen the pelvic floor muscles (see the conservative therapy for the pelvic floor dysfunction above). Medication can also be helpful, and these include the groups of anticholinergics, tropical estrogens or imipramines. Medical devices can also be used to further control the disease, and these include urethral inserts and pessaries (8).

Surgical treatment: The most common procedures are: the insertion of an artificial urinary sphincter, sling procedures and bladder neck suspension (8).

The clinical relationship between the high tonicity of the pelvic floor muscles, low back pain and urinary incontinence(9)

In 1992 Bernstein noted that commonly demonstrated high tone if the pelvic muscles often lead to inadequate voluntary control of the urinary flow. Pelvic muscles are commonly tightened out of instinct under stress. A number of studies have pointed to an associated between LBP and pelvic symptoms, and particularly to urinary incontinence (UI).

Eliasson 2006 reported that UI was noted by 78% f 200 women with LBP. Smith 2006 further evaluated the case, and concluded that disorders of incontinence and respiration were strongly related to frequent back pain. This is explained by physiological limitations of co-ordination of postural, respiratory and continence functions of trunk muscles.

The breathing connection towards pelvic dysfunction(9)

Hodges (2007) has observed that there is a clear function between respiratory functions and pelvic floor functions and SI joint stability, especially in women. He noted that if pelvic floor muscles are in dysfunction, spinal support may be compromised, increasing external oblique abdominal activity, that alter the pelvic floor muscle activity, possibly leading to UI.

Pelvic problems involving low back pain, pelvic pain and pelvic floor dysfunction may involve failed load transfer through the musculo-skeletal components of the pelvic girdle, and/or failed load transfers through the organs of the pelvic girdle.

<u>Physiotherapeutic treatment of UI caused by pelvic floor dysfunction and LBP caused by pelvic floor dysfunction</u>(9)

This involves correction of the posture and pelvic position, mobilisation of any blocked segments, in particular at the SI joint and pelvis, stretching and decreasing the hypertonic muscles around the pelvic area (key muscles include: erector spinae, iliopsoas, hip adductors, hip ERs, pelvic floor muscles), strengthening of any weakened muscles around the pelvic area (key muscles include the gluteals, abdominals), removal of TrPt's (Theile massage or Kegel exercises are very effective), changing of breathing stereotype, neuromuscular re-education and instructions for an extensive home exercise programme.

Theile massage was proposed by Oyama in 2004, and is a form of transvaginal manual therapy of the pelvic floor musculature. Kegel exercises were founded by Dr. Arnold Kegel, and it consists of contracting and relaxing the pelvic floor by the use of pelvic toning devices.

<u>Breathing movements and its influence on the posture</u>(6)

Breathing changes the shape of the thorax and therefore the posture of the body. Inspiration leads to extension and thoracic inflation, while expiration leads to flexion and thoracic deflation. It also influences the neuronal excitability; inhalation facilitates muscles, while expiration inhibits them. Therefore, breathing is incorporated in most techniques that aids in the relaxation of hypertonic muscles and elongating shortened ones. It is also used in decreasing the loads that is sustained by the spine, and thus to help with low back pain.

For example, in sitting, the lumbar spine is overloaded further, especially if the thorax is bent forward. This contributes to the reduction of lumbar lordosis, increase in thoracic kyphosis and flattening of the cervical lordosis or causes the forward shifting of the head. The posterior longlitudenal ligaments are stretched and overloaded which in turn will cause an increase in nociception which may result in LBP. If however, the spine is kept upright, this alignment activates the deep stabilisation system and reduces the overloading in the spinal segments.

This is kept and supported by breathing movements. Expiration is accompanied by isometric activity of abdominals pushing the belly inwards and the diaphragm upwards to support the process of expiration itself. However, the isometric contraction of the abdominals should not near the pubic symphesis to the strenum, since this enables the synchronous contraction of the dorsal back muscles, that are typically shortened (6).

Valsalva meneuver is one way to prevent overloading in the lumbar spine. This involves holding the breath in inspiration, which reduces the axial pressure of lifting heavy burdens from the ground if the knees are extended. The meneuver decreases the forces developed in the muscles of the lumbar region, and also decreases the loading of the IVD of the Th12-L1 by 50% and L5-S1 by 30%. However, this meneuver should not be used with patients with cardiac problems or any diseases that are aggravated once the intra-abdominal pressure increase.

Loading of the feet(6)

The loads sustained by the feet are asymmetrical during standing. The physiological position of the foot towards the ground should be on 3 points (the tripod); the heel, metatarsal head of the big toe and the little toe. The longlitudenal arch is important in stability, and it reflects the position of the femur in the acetabulum. Decrease of the arch results in the IR of the head of femur in the acetablum, which in turn subjects the patients to the development of coxarthrosis.

The working pattern of postural muscles(6)

For keeping the posture, tonic muscles have to work in isometric mode using the co-activity of agonist and antagonist muscles. This however requires afferent signals to be working properly.

Mechanisms of the specific functional alterations(6)

Any alterations of the above mechanisms will in turn result in nociception and possibly LBP. In this section, 3 specific functional alterations of normal kinesiology and biomechanics is described.

Referred LBP secondary from the cervical spine(6)

It is supported that LBP is projected to the lumbar spine as referred pain as a result of sub-luxations in the region of the cervical spine. However, the influence of the nervous system should also be taken into account. The local muscular imbalance at the cervical spine may or may not cause nociceptive signals perceived as pain, but this imbalance influences the posture of the whole body and may cause secondary irritation in the lumbar region, and would be perceived as LBP.

In this case, it is important, to correct the muscular imbalance that may be presented by the form of upper crossed syndrome, in the form of stretching of hypertonic and/or shortened muscles using techniques such as PIR by Lewit, or PNF relaxation techniques by Kabat, mobilising blocked segments in the region of the cervical spine, applying soft tissue techniques by Lewit for facilitation of movement of the subcutaneous tissue, along with strengthening weak muscles using PNF strengthening techniques by Kabat or exercises. Followed by applying the same principles in the region of the low back.

Musculo-skeletal structural change and imbalance(6)

Here I will talk about the combination of muscular imbalance in the form of lower crossed syndrome, in the form of lowered crossed syndrome, which in turn may influence the position of the femur in the hip joint, which may be secondary to the inappropriate loading from the feet. Furthermore, how this may influence the tonicity of the pelvic floor muscles, breathing patterns, stabilisation system, body posture as a whole, and the possibility of the occurrence of pseudoradicular system.

Firstly, it is important to note how the position of the lumbar spine influences the position of the pelvis, and therefore how the position of the pelvis in turn influences the position of the lumbar spine.

If the pelvis is in retroversion, this decreases the lumbar lordosis and influences the whole body bearing. This may lead to flat lumbar spine, which decreases the sheltered shocking mechanism of the IVD and so overloading them; increasing the occurrence of diskopathy. If the pelvis is in anteversion, then this increases the lumbar lordosis, the increase of lumbar lordosis overloads the hip joint and escalates the incidence of coxarthrosis. If the pelvis in lateral tilt to one side, then this may cause compensatory scoliosis of the spine.

Therefore to solve a functional musculo-skeletal dysfunction, it is important to note what has changed in the body structure and how the body is compensating to these changes (6).

An example of a clinical representation of such as case(6)

This example is a compiled representation of towards a holistic approach, derived from the book referenced. If a patient presents with decreased longlitudenal arch (with flat feet), then the reaction forces from the ground will load the pelvis the lumbar spine more. Due to the faulty skeletal structure, the afferentation will be faulty, sending back improper efferent signals which will in turn cause hypertonicity of the tonic muscular system. The head of femur in the acetabulum will be positioned in IR, resulting in the shortening and hypertonicity of the ER's of the hip joint (the piriformis in particular).

Further, the SI joint may be blocked causing a pelvic tilt; this change in the pelvic position will result in muscular imbalance such as in the form of lower crossed syndrome. The hamstrings, hip flexors and erector spinae may shorted and become hypertonic (along with the adductors of the hip joint), while the abdominals and glutei muscles weaken. This may in turn increase the anteversion of the pelvis increasing the lumbar lordosis.

The sacral inclination of the LS junction may also increase, placing stress on the L5 vertebra, and subjecting it to conditions such as spondylolisthesis. This places a great stress on the structures around the lumbar spine and the sacrum. The posterior longlitudenal ligament may be stretched increasing the shear forces that the spine is subjected to; placing the L5-S1 IVD in the risk of diskopathy.

Returning to the pelvic area, the piriformis muscle may be very hypertonic and shortened, as to compress the sciatic nerve that runs beneath it. This will lead to pseudoradicular symptoms known as the piriformis syndrome, expressed by the patient to have similar symptoms to sciatica (both motoric and sensory).

Furthermore, the proprioception and exteroceptionmay be impaired due to improper afferentation due to the improper skeletal structural positions of the lower extremities. This impairs the muscle-firing sequence and co-ordination between muscular interplay. The pelvic floor muscles may also undergo hypertonicity, and lead to LBP and UI as described above.

Moving to the lumbar spine and the trunk, since abdominal muscles work alongside the abdominal diaphragm, then any weakness and/or hypertone of the abdominals may cause incorrect breathing patterns and alter the body stability. The normal stereotype of rib movements is also lost, resulting in blockages at the level of the ribs and surrounding segments.

Taking into account the fact that muscular chains and slings connect upper extremities to the lower extremities through the trunk, then there will be muscular imbalances transferred upwards, changing the whole musculo-skeletal constitution of the body. This will not only limit the pain to the low back, but also cause secondary referred pain to the head and neck or the upper trunk area (6).

As seen, when assessing the musculo-skeletal system, especially of LBP, it should be done through a holistic approach; the site of pain could be primary, secondary or even tertiary symptom.

Therapy plan for the above case(6)

Physiotherapeutic treatment plan for such a case is to reduce pain levels, restore muscular balance and co-ordination, release blockages, gain the structural integrity of the skeletal system, alter the faulty afferentation, correct breathing stereotype, and overall gain the proper stability and correct posture and alignment.

It is also true that in practice, there is no time to complete all of the above goals during certain numbers of therapy sessions. Therefore, it is essential that the patient understands the mechanisms of their dysfunction, and follows the advice and instructions of the physiotherapist.

The plan may consist of(6)

Stretching the shortened muscles and decrease the hypertonicity in the region of the pelvis and lumbar spine. Techniques could include PIR by Lewit, or PNF relaxation techniques such by Kabat. Mobilisation by Lewit of blocked joints; this should include local as well as distal segments extending all the way down to the metatarsals and up towards the thoracic spine and the ribs. Soft tissue techniques by Lewit to release the subskin and fascia as seen fit, and further to strengthen the weak muscles by the means of PNF strengthening techniques by Kabat, thera bands, or other exercises.

Centration of the hip joint should be achieved, and further, sensori-motoric training should be followed to increase the afferentation, correct any flat feet, increase the arches, and overall improve stability. Other modalities such as kinesiotaping to support the therapy session could be very helpful. Finally, gait remodification and postural education along with instructions of autotherapy should be included as well. Acupuncture needles are also helpful to decrease local pain, however, they are used as temporary pain relief rather than removal of the essence of the problem.

After the goals have been met on the lower trunk, then more focus should placed towards the upper trunk to correct any imbalances that have risen up using the same principles as above.

1.8 Common structural pathologies and epidemiology of the Lumbar Spine

Low back pain is the most common symptom when it comes to structural pathologies of the lumbar spine. This section describes 4 structural pathologies that are most commonly seen in the health care profession that leads to symptoms of low back pain.

I would like to point out that there are many various structural conditions concerning low back pain, and the four selected diagnoses are the most common and most often seen by the health care community, in particularly by physiotherapists.

Scoliosis

Scoliosis is defined as lateral bending of the spine (see figure 13). This can occur in the lumbar spine, thoracic spine, or even both. Sometimes deviations are found in 3 segments of the spine, this is called triple scoliosis (2).

There are two types:

Structural scoliosis which is an inflexible curvature that persists even with lateral flexion of the spine, and non-structural scoliosis; which is flexible and are corrected with lateral flexion of the trunk. Generally it is caused by congenital abnormalities or selected cancer that contribute to the development of a faulty structure. Non-structural scoliosis can also be secondary to leg length discrepancy or local inflammation. Smaller lateral deviations can also develop due to repetitive daily activities such as carrying bags or books on one side. However, 70-90% of case area known to be idiopathic, and are diagnosed between the ages 10-13 years, and are more common in females. This type is called juvenile idiopathic scoliosis (2).

Figure 12: Lumbar sinister scoliosis (24)

Spondylolysis

This is the site of bone fracture in weight lifting, American football, gymnastics, wrestling and tennis. The condition is also associated with cricket, swimming and soccer. Spondylolysis is defined as a defect in the pars inter-articularis of the spine (the structure between the superior and inferior articular processes). It represents a stress fracture, and is seen mostly in children and adolescents. During repeated sheer and compression accompanied with hyperextension as commonly seen in the sports listed above, the inferior articular facet is subjected to repeated loading and stress. This defect is most commonly observed at L5 segments of the Lumbar spine (10).

Spondylolisthesis

Spondylolisthesis occurs when bilateral spondylolysis is found, and is defined as the forward translation of one vertebra on another in the sagittal plane of the spine (11).

Disk herniation

Lumbar disc herniation occurs 15 times more often than cervical disc herniation, and it is one of the most common causes of lower back pain (12). It is defined as localized displacement of disc material beyond the normal margins of the intervertebral disc space. Disc material may include nucleus, cartilage, fragmented apophyseal bone, or fragmented annular tissue (13). The main cause of herniation is traumatic or stress-related; typically the involved disk shows signs of previous degeneration. The most common segments to undergo herniation is L4-L5, L5-S1, typically through the postero-lateral aspect of the disk (1).

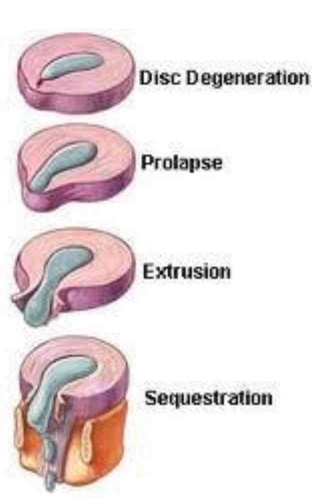

Figure 13: Lesions of the disk (25)

Although the disk is not innervated, sensory nerves supply the anterior and posterior longlitudenal ligaments, the vertebral bodies and articular cartilage of the facet joint. If the herniated disk presses on one or more of these structures, or on the spinal cord or spinal nerves (L5-S1), pain and numbness may occur. Complications here include sciatica (of the Sciatic nerve is compressed by the annulus pulposus, which refers to pain, weakness, numbness, or tingling in the leg (1). The disk does not only go through herniation, but other classifications as well, (see figure 14) these include: bulging disk, protruded disk, sequestrated disk and extruded disk (13).

1.9 Rehabilitation of the structural pathologies of the Lumbar spine

<u>Scoliosis</u>

<u>Conservative treatment</u>

Mild cases can be nonsymptomatic and self corrected while moderate cases require physiotherapy: The main goal of physiotherapy in such patient's is to decrease pain levels, and try to regain the structural integrity of the spine as much as possible by stretching and strengthening muscles of the back as fit.

Figure 14: Boston brace (26)

It is also important to gain the correct centration of key joints, especially of the shoulder and hip joints to be able to utilise the muscular chains and slings that go through them. Most importantly, breathing exercises and correction of the breathing stereotype is also essential, due to the changed position of the diaphragm and the weakness of supporting muscles of the trunk.

Severe cases such as severe deviation and localised rotation of the spine which is painful and deforming are treated with bracing and casting. This method relies on direct manipulation of the spinal curvature, and its primary goal is to arrest or prevent deformities. Bracing is indicated for juvenile idiopathic scoliotic curves of 35 to 45 degrees in skeletally immature patients. One type of very effective brace is the Boston brace (see figure 15) (14).

<u>Surgical treatment</u>

The technological advancement has lead to less invasive methods and more accurate placement of instrumentation. Surgical methods to correct scoliotic deformities include thoracoscopic and laporoscopic decompressions and releases to correct the deformity (14). The main aim of surgery is the restoration of the sagittal balance after an osteotomy of a segment and fusion of vertebrae's to one another. Trans-iliac bar and femoral ring allografts are used in conjunction with anterior lag screws at L5-S1 levels (14). Physiotherapy can compliment surgery, both in pre-operative cases to strengthen and stabilise the segments necessary in order to gain the positive effect of surgery, and in post-operative cases, to restore the muscular integrity, gain further stability, and educate the patient regarding his condition and general movement patterns (14)..

Spondylolysis

Conservative treatment

Treatment depends on the severity of symptoms, age of the patient and the level of sporting activity. Conservative options include avoidance of sporting activity, trunk stability, core strength training, analgesic medication or brace treatment (10). Physiotherapy treatment plan includes supporting the fractured site by strengthening of the abdominal and glutei muscles and correction of trunk stability and alignment, with correction of any faulty breathing stereotypes. Care must be given in the attempt of relaxing the hypertonic and short muscles of the back, which may exaggerate the patient's condition if relaxed, since they are holding the segment in place (15).

Surgical treatment

A small number of patient's need surgical intervention. The incidence of unmanageable LBP because of a pars defect in the young, competitive athlete is low. However, some young sportsman experience disabling symptoms that are unresponsive to conservative treatment and prevent the, in participation of their sports (10).

Spondylolisthesis

Conservative therapy

This may be appropriate depending on the degree of instability or severity of the neural compression. Treatment modalities include NSAID, limitation of activities up to and including short-term bed rest, bracing and casting, weight reduction and physiotherapy. Epidural injections may be beneficial to patients that exhibit radiculopathy or spinal claudication symptoms, but they have limited long-term benefit (11). Physiotherapeutic plan is similar to that of spondylolysis. Care must be given to not increase the lumbar lordosis further. Patient re-education in regards to correct body posture and alignment in ADL, carrying objects and lifting should be explained.

Surgical treatment

Surgery is indicated when non-operative therapy has failed. The major indications for surgery include severe radiculopathy, neurogenic claudication or incapacitating LBP. Current options concerning the surgical treatment an arthrodesis combined with a decompressive laminectomy (the decompression is that of the exiting nerve root) (11).

Disk herniation

Conservative therapy

There are several conservative treatment options that may relieve the symptoms associated with a herniated disc. These include: alternate bed rest with ambulation and NSAID to decrease inflammation and pain. Physiotherapy is also prescribed, and the main goal is to regain trunk stability, lengthen shortened muscles (especially the iliopsoas and hamstrings), strengthen weakened muscles (especially the abdominals and gluteals), and improve any neurological deficits (16). Furthermore breathing stereotypes should also be corrected, and patient education regarding correct body posture and alignment in ADL, carrying objects and lifting should be explained.

Chemonucleolysis; this involves the percutaneous injection of Chymopapain and later Chymodiactin to enzymatically dissolve the nucleus pulposus (17). However, this is no longer routinely practiced in the United States, although it is still performed in European Centres (18).

Surgical treatment

If non-operative management does not give any results, then surgical intervention is needed. The most recent advancement is the use of micro-endoscope and tubular retractor system to perform lumbar diskectomy and laminectomy, allowing surgeons to reliably decompress a symptomatic lumbar nerve root via a minimally invasive surgical (MIS) technique. MIS approaches have been more popular due to the reduction of iatrogenic trauma (18).

Contra-lateral approaches (see figure 16)

Certain pathologies, such as foraminal narrowing, far lateral disk herniation and facet joint cysts, contra-lateral approaches is used. In this approach, excellent visualisation of the cyst wall is provided, allowing a safe cyst resection and nerve root decompression without compromising the facet joint (18).

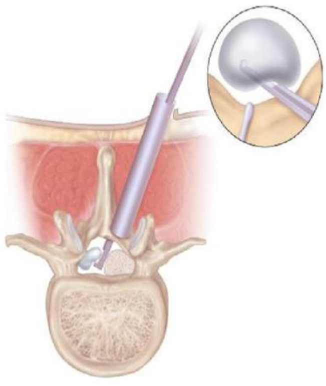

Figure 15: Schematic representation of the contralateral approach for facet cyst resection (18)

To conclude:

Low back pain is a very common symptom that may arise from a variety of functional or structural pathologies; some which are described in the above chapters. Understanding the kinesiology and biomechanics of the spine and the pelvic girdle and how they interplay to function as a unit gives the clinician a starting base on how to alter the pathologies, and in turn decrease low back pain.

2 Special part – case study

2.1 Methodology

I have completed my case study in Centrum Léčby Pohybového Aparátu Vysočany (CLPA) in Prague from the periods of 24/01/2011 to 07/02/2011. My patient presented with LBP; and the process of the case study was carried on by an initial kinesiological examination of the patient, followed by 5 therapy sessions and a final kinesiological examination.

The clinic mainly deals with acute and chronic overuse pain, post-traumatic pain and injuries, post-operative cases and most especially with group therapies for post-ACL reconstruction surgeries.

The clinic is equipped with complete therapy rooms, along with hydrotherapy, electrotherapy, magnetotherapy, ultra-sound and shock-wave units. A complete fitness gym is also found with a treadmill, bikes, sensor-motoric exercise tools and rehabilitative strengthening equipments, where each patient is supervised by a physiotherapist.

Therefore physiotherapists work together in different units; which is very time-efficient, each bringing their own specialty, which in return strengthens the effect of therapy. In the therapy rooms themselves, different techniques are used ranging from manual therapy to kinesiotaping, acupuncture and laser.

My study was supervised by PhDr Edwin Mahr, and my patient was fully informed about the process from the beginning, and the work has been approved by the Ethics Committee of the Faculty of Physical Education and Sport, Charles University, Prague, with the approval number 042/2011 (found in the supplements).

2.2 Anamnesis

Name: J.D; female.

Date of birth: 17/07/1955

Diagnosis: Low back pain; M54.5

Present state:

Height: 165cm

Weight: 67 kg

BMI: 24.6

55 year old female, complains of sharp low back pain localised in the region of the SL junction and a grinding pain on the left hip joint. She had a slip and fall accident 2 years ago; her left leg slipped whilst throwing a ball, causing her to lose her balance, having her other leg to slip as well, resulting in a fall on her left buttocks. After the accident, she suffered from incontinency. She consulted a neurologist who recommended her to do exercises to strengthen her abdominal muscles. She took yoga classes, and now she is in full control of her bladder.

The pain:

In the LS area: The pain began a couple of weeks after the accident and the intensity has not changed in the last 2 years, it is 5/10 in visual analogue scale (VAS) and the patient feels it all the time- both at rest and during movement. She cannot sleep a full night without the pain irritating her to wake up. Aggravating positions are extending back the trunk from a flexed position, in cold weather and when she coughs or sneezes if not contracting and holding her body still. Relieving positions are flexing the trunk to stretch the back, yoga, piriformis stretch and walking for a duration of 20 minutes.

The left hip pain: This pain began after the accident and she describes it as pinching and grinding pain (she feels two bones rubbing against each other) of the left hip only during movements such as hip abduction and rotations; on VAS it is 5/10 as well.
Relieving pain- is to avoid hip abduction and rotation. The patient's sleeping position is supine with pillows in between her thighs and legs, since lying on the left is too painful.

During severe fatigue and stress, she feels tingly sensation of the following pathway- on the posterior aspect of her left thigh, to the cranio-medial aspect of the thigh, down to the cranio-medial aspect of her shaft and to the big toe.

Other related symptoms that the patient feels:

- She suffers from headaches, and if she has a pillow on her neck so that her head is flexed for a duration of 15 minutes, then she feels a burning sensation travelling to her neck. She also feels tingling after working for a long time on her 4th and 5th fingers, but it is not regular (once or twice a month).

The patient's goal is to be able to sleep a whole night without waking up by the back pain, and to try not to feel it all day long.

Family history: Nill

Personal history:

- After the accident, she had lower extremity left leg discrepancy, so she used to wear orthesis in her shoes.

Social history:

She used to go to yoga classes regularly in the past 2 years, and swam for about a year (freestyle stroke). She is an active person, has two daughters, but lives alone with 3 dogs. She walks them 3 times a day, and she feels the walking is good exercise for her. She complains of the low back pain when she showers her dogs; her position is sitting on her knees and bending forward and having to extend her trunk when she needs to balance to hold the dogs still. Also during walking the dogs, she has to protrude her shoulders and increase her thoracic kyphosis to control them on the leash.

Activities of daily living (ADL); she cannot reach anything from high places, so she doesn't use high cupboards. Cleaning windows that require her to reach is difficult as well, so she uses cleaning services for it. She also can't do any activity that requires her to flex her trunk such as vacuuming the floors, again she uses cleaning services for that too. The patient also drives, and complains of the back pain when driving for a long period of time. She doesn't use a pillow for her back to support the lumbar region. She used to use an orthesis in her left shoe since she had a discrepancy about 5 years ago, she only used it for a year at work.

Work history:

She used to be a police officer, but now works as an English translator for the Czech police, therefore her work is both office work and field work. She again feels the pain when standing for long periods of time.

Pharmacology history:

She is currently on Vesicare 5mg, 1 pill daily, for the past 2 years.

Abuses: non-smoker, and social drinker

Allergies: allergic to pollen

Gynaecological: menopause for the last 5 years. But she had regular and normal cycles.

Previous rehabilitation

She has been to 13 electrotherapy sessions in the last 2 years.

Statement from the patient's medical documentation

CT of the Lumbo-Sacral spine on 16/03/2009.

Results: The skeleton in the investigation showed adequate structures and density with no lesions. Degenerative changes are found in the intervertebral disc of L4 / L5 and L5/S1, along with dorsal osteophytes in the intervertebral disc L5/S1.

Indication of rehabilitation

6 session of physiotherapy, indicated by the patient's neurologist to decrease pain and postural re-education to cope with activities of daily living.

2.3 Differential consideration

- Thoracic overload from blockages present at cervical and lumbar spines.
- Piriformis hypertone- compressing the sciatic nerve/ischial bundle, causing the neurological symptoms of lower extremity. As a protective mechanism, the pelvic underwent torsion so structural changes continued to process up to lumbar, thoracic and so cranially. Along with having weak gluteals and abdominal muscles, which will cause the lumbar spine to not be stabalised correctly, resulting in a thoracic overload and through more structural changes proceeding cranially, cause ulnar nerve compression (or compression of the brachial plexus).
- Flat feet- problems of muscle imbalance and skeletal changes proceeding cranially.
- Cervical dysfunction causing the pain to radiate to the lumbar spine.
- Instability of the spine, causing upper and lower syndromes, muscular imbalance, which causes further structural changes in the skeletal system- which causes compression of neural bundles which explains the positive neurological symptoms.
- The fall on buttocks, changing the position of the SI joint and pelvis, causing muscle imbalance of the lower extremity and the trunk, and so weakening the upper trunk muscles, and by the structural changes through the musculoskeletal system, causing neural compressions of bundles. This again explains the positive neurological symptoms.
- Pseudoradicular syndrome at L4 and L5 roots, causing the main neurological problems. Leading to a protective mechanism of muscle hypertonicity and shortness, which would in time cause skeletal changes of the pelvis and more blockages of the sacro-iliac joint, lumbar and thoracic spines. Furthermore, through these changes, more blockages will be caused cranially, altering all muscular imbalances, muscle shortnesses and hypertonicity of the upper trunk and extremity muscles, and may therefore cause compression of the brachial plexus, causing the symptoms that the patient feels.

2.4 Initial kinisiological examination

Done on 24/01/2011

1) **Postural examination by Kendall** (19)

Table 4: Results of postural examination by Kendall; posterior, side and anterior views during initial examination

Posterior view	**Side view (left and right)**	**Anterior view**
• Valgosity of ankles • Hypotrophy of left and right Gluteals • Left Gluteal line shifted down • Hypertrophy of left paravertebrals • Scapula alata on left side	• Flat lumbar • Thoracic kyphosis • Cervical kyphosis (especially on C7) • Shoulders protruded • Trunk rotation to right (slight) • Head forward	• Flat feet • Eversion of both feet, more on the left • Short base • lateral loading on both feet • Abdominal slackening.

2) **Gait examination by Kendall** (19)

- Short base, equal length of strides
- Take off at metatarsal ends of foot
- No extension of hip, compensated by excessive flexion of knees
- Head protrusion
- Very slight arm movements
- No trunk or pelvic movements (stiff posture)

<u>Modifications</u>

Table 5: Initial examination and results of gait modification

Tip toes (S1):	Possible to execute normally.
On heel (L5):	possible to execute, but pain in the left hip
Squats (L3/4):	possible to execute, but pain in the LS area
Backwards (Gluteals):	Possible to execute normally.
Sideways	Possible to execute normally.

(Adductors and Abductors):	

3) Pelvic examination

Coronal plane: ASIS on the right side is slightly higher that then left, but the PSIS of the left side is shifted posteriorly, and PSIS of the right side is shifted anteriorly, causing torsion of the pelvis anticlockwise.

Sagittal plane: pelvis in line.

4) Dynamic test of the spine

Flexion

- Thoracic kyphosis and overload (more on the right paravertebrals)
- Flat lumbar
- Anterior pelvis tilt when doing the movement
- Pain present when returning to neutral position
- Full range of motion

Extension

- Scapula alata (more on left side)
- Pain on posterior part of neck.
- Thoracic overloading- all the movement is carried on by lower thoracic segments.
- Normal range of motion

Lateral Flexion to the left

- Normal Range of motion
- Arms are in contact with the body
- Thoracic overloading- all the movement is carried on by lower thoracic segments.
- Rotational synkinesis of the pelvis is present

Lateral Flexion to the right

- Decreased Range of motion by 10cm compared to the left
- Arms are in contact with the body

- Thoracic overloading- all the movement is carried on by lower thoracic segments.

Rotation to left and right

- Movement substitution by trunk moving along the sagital plane
- During assisted rotation, the rotation is 20 degrees to both sides and the patient feels pain of 5/10 on VAS in the LS area

5) Altered movement patterns by Janda (15)

Extension

Right lower extremity extension: anterior tilt of the pelvic followed by activation of the gluteals, hamstrings and contralateral paravertebrals simultaneously, along with movement of the trunk anticlockwise, the range of motion was 5 degrees.
The patient was only able to correct the movement synkenises of the trunk by keeping it still on the bed, after being given instructions.

Left lower extremity extension: the same movement synkenises but not very exaggerated. The range of motion in extension was a few degrees more than the right.
The patient was not able to correct the movement synkenises after being given instructions.

Abduction

Right lower extremity: the pelvis moves forwards, and the leg is externally rotated

Left lower extremity: the pelvis moves forward, and the leg undergoes flexion and external rotation.
The patient was not able to correct the movement synkenises after being given instructions on both legs.
Result: Fixed overplay of TFL on the right side, and TFL and iliopsoas on the left side, with no proper spinal stability.

Curl-up

Anterior tilt of the pelvis, flexion of the knees and hip, very weak abdominals. The patient was not able to correct the movement synkenises after being given instructions.

6) Anthropometry

Table 6: Anthropometry; results of the lower extremity during initial examination

Lower extremity	**Left(cm)**	**Right(cm)**
Anatomical length	90	90
Functional length	86	87

7) Soft tissue examination by Lewit (20)

Kibler's fold: not possible to do on the lumbar and lower thoracic area.

Skin mobility and elasticity: slight restriction in the lumbar area in all directions.

Fascia: restriction of the sacral fascia in caudal direction.

8) Range of Motion examination by Kendall (19)

Table 7: Active and Passive ROM of the left and right hip and knees during initial examination

		Left (degrees)		**Right (degrees)**	
		Active	**Passive**	**Active**	**Passive**
Hip	S:	5-0-110	10-0-120	10-0-100	15-0-100
	F: (with extended knee)	30-0-20 (painful restrictions)	35-0-25 (soft restriction in ABD and painful ADD)	40-0-40	40-0-40
	F: (with flexed knee)	30-0-25 (end range was painful)	40-0-30 (soft restriction in ABD)	40-0-40	40-0-40
	R90:	45-0-10	45-0-10	35-0-15	35-0-15
Knee	S:	0-0-140	0-0-140	0-0-140	0-0-140

9) Neurological examination

Dermatomal examination of the lower extremity

Results: decreased sensitivity of the lateral aspect of the thigh, leg and foot of the left leg.

Deep sensation examination

Movement sense and position sense examination.

Results:

- Decreased proprioception of the left lower extremity.
- Intact proprioception of the right lower extremity.

Reflexes

Mono-reflexes of the patella and achillies:

Results: normal reflexes.

Provocative tests

Laseque's sign, reverse Laseque's sign and Bragard's sign.

Results: all signs were negative on both extremities.

Ulnar nerve stretch test

Negative on both extremities.

10) Muscle palpation, muscle shortness length testing by Kendall, and muscle strength testing by Kendall (19)

Table 8: Table representing the muscle tone, muscle length and muscle strength of left and right lower extremity during initial examination

Muscles Tested	**Left lower extremity**			**Right lower extremity**		
	Muscle tone	**Muscle shortness**	**Muscle strength**	**Muscle tone**	**Muscle shortness**	**Muscle strength**
Quadrates Lumborum	✓		4			4
Gluteus maximus	✓ ✓		2-	✓ ✓		2-
Gluteus medius + minimus	✓		2-			2-
Coccygeus						
Adductor longus	✓	✓	4		✓	4
Adductor brevis	✓		4			4
Adductor magnus			4			4

Gracilis	✓	✓	4	✓	✓	4
Hip lateral rotators (Gamellus superior+inferior, Obturator extern+internus, piriformis and quadratus femoris)	Difficult to palpate	✓	2-	Difficult to palpate	✓	2-
Piriformis	✓ ✓		2-	✓ ✓		2-
Iliopsoas	✓ ✓		3+	✓		4
Tensor faciae latae	✓	✓	3+			4
Sartorius			4			3+
Biceps femoris	✓		4	✓		3+
Semimembronosus+ Semitendronosus	✓		4			3+
Rectus femoris	✓		4			4
Vastus medialis	✓ ✓		4	✓		4+
Vastus lateralis +intermedius			4			4
Gastrocnemius + plantaris			4			4
Soleus			4			4
Peroneus longus+ brevis			4			4
Tibialis posterior			4			4

Tibialis anterior			4			4
Rectus abdominals			3+			3+
Transverse abdominals	✓		2-	✓		2-
External and Internal obliques			2-			2-

Table 9: Key for table 8

Key	
Hypertonic and shortned muscles	✓
Eutonic and muscles of normal length	
Hypotonic muscles	☆

Note:

- Pes anserinus was painful upon palpation on both extremities.
- The patient performed the movements during the strength test of 3 or lower with anterior tilting of the pelvic and substitution by using the other extremity to support the resistance.

11) Joint play by Lewit (20)

Table 10: Table showing results of joint play initial examination of selected joints of left and right lower extremities

		Left lower extremity	**Right lower extremity**
Head of fibula	***Dorsal direction***	Blocked, but not painful	Blocked but not painful
	Ventral direction	No blockages	No blockages
Talocrural joint in *dorsal direction*		No blockages	No blockages
Cuboid	***Plantar direction***	Blocked and painful	No blockages
	Ventral direction	Blocked and painful	No blockages

Navicular	***Plantar direction***	Blocked and painful	No blockages
	Ventral direction	Blocked and painful	No blockages
Lisfrank joint	***Plantar direction***	Blocked but not painful	No blockages
	ventral direction	No blockages	No blockages
Metatarsopharangeal joints (1st to 5th)- *shearing movement*		No blockages	No blockages
Metatarsophalangeal joint of the 1st toe in *rotation*		No blockages	No blockages
Proximal and distal phalanges (1st to 5th)	***Plantar direction***	No blockages	No blockages
	Ventral direction	No blockages	No blockages
	Lateral direction	No blockages	No blockages

Sacro-Iliac joint

Left side- it's blocked and stiff.

Right side- it's stiff but moveable.

Lumbar spine

Flexion- no blockages

Extension- Movement decreased slightly in individual lumbar segments.

Thoracic spine

Flexion- blocked in lower thoracic segments

Extension- blocked in lower thoracic segments

Lateral flexion to the left- no blockages

Lateral flexion to the right- blocked in lower thoracic segments

Rotation to the left- no blockages

Rotation to the right- blocked in lower thoracic segments

Ribs

Lower 3 ribs blocked more on the left, as well as the right.

12) Specialised tests

a) **Scale test:** 33kg on each leg

b) **Trendelenburg's**

Left side: less controlled, dropping of the pelvis and visible gluteal weakness.

Right side: more controlled.

The patient compensates by shifting the trunk backwards and in slight rotation anticlockwise when performing the test (on both right, but more on the left side).

c) **Patrick's sign:** positive on both extremities.

13) Breathing examination

The patient has paradoxal breathing pattern, but she can change it easily when she's instructed on the correct breathing pattern. The ribs don't expand in lateral directions, they only move in cranial direction.

14) Movement of the scapula

Patient standing up against a wall, and hands flexed to 90 degrees in front and push into the wall, observe the scapula.

Result:

- Moderate scapula alata on the left, weak Serratus anterior.
- Slight weakness of the Serratus anterior is also seen on the right.

Conclusion of examination:

55 year old female, post slip and fall accident, landing on her left buttocks, currently complaining of pain on a scale of 5/10 on VAS on the LS area at rest and movement, and pain of 5/10 on VAS on the left hip during abduction and external rotation of the hip.

The patient presents a slight pelvic torsion, in an anticlockwise direction, and a positive Trendelenburg's test on the left side, with visible weakness of the gluteals, and positive Patrik's sign (bilaterally).

Flexion and extension of lumbar and lower thoracic spine are restricted, with good lateral flexion and rotation components to the left, but restriction to the right. The left SI joint is also restricted. Thoracic overloading (movements carried on by lower thoracic segments) is very visible in all trunk movements.

The patient also presents in a shorter functional length of the left lower extremity by 1 cm, with the following muscles being hypertonic: iliopsoas (left), gluteals and piriformis (very hypertonic), biceps femoris and vastus medialis (both left) and severe pain upon palpation of the pes inserinus bilaterally.

Shortened muscles are the TFL, adductor longus and lateral rotators of the hip which limits the range of motion of the left hip in adduction, abduction and internal rotation to painful restrictions.

Neurological deficits include decreased sensitivity of the lateral aspect of the left lower extremity and decreased proprioception on the left leg as well. I believe this to be pseudoradicular symptoms.

The patient's head and neck problems are mainly the cause of poor musculo-skeletal development very visible on the patient's posture.

2.5 Further examination proposal

In my opinion, these further examinations are needed for the patient's secondary complaints of neck stiffness and headaches.

- Soft tissue examinations of head and neck by Lewit (20)
- Altered movement pattern by Janda of neck flexion (to find the imbalance between the deep neck flexors and extensors), shoulder abduction, and push-up.
- Palpation of muscles in the region of head and neck, upper trunk
- Scalene anterior, medius and posterior
- Sternocleidomastoid
- Platysma
- Suprahyoid and infrahyoid
- Serratus anterior
- Pectoralis major (sternal and clavicular parts)
- Rhomboids
- Levator scapula
- Trapezius upper, middle and lower fibres
- Infraspinatus
- Supraspinatus
- Teres minor
- Subscapularis
- Teres major
- Muscle length test by Kendall (19) of the following:
- Pectoralis minor
- Pectoralis major (sternal and clavicular parts)
- Trapezius upper fibres
- Resistive exercises to find muscle lesion of external, internal rotators and elevators of scapula
- Muscle strength tests by Kendall (19) for the following:
- Serratus anterior
- Pectoralis major (sternal and clavicular parts)
- Rhomboids
- Levator scapula
- Trapezius upper, middle and lower fibres

- Infraspinatus
- Supraspinatus
- Teres minor
- Subscapularis
- Teres major

- Neurological examination- dermatomal (on upper extremities and upper trunk up to T6 dermatome), deep sensation (proprio and exteroceptive).
  Monoreflexes of Biceps, Triceps and wrist Flexors, along with Thoracic outlet syndrome stretch tests.
- Joint play by Lewit (20) of the whole upper extremity, Sternoclavicular joint, Acromioclavicular joint, Clavicle, upper Ribs and the Cervical spine.

2.6 Main goal of therapy

Decrease the pain the patient feels at rest and during movement in the region of the LS of 5/10 on VAS, and the pain of 5/10 on VAS at the left Hip during movement. To allow the patient to sleep through the night without being awaken by pain, and possible be able to sleep on her sides. Furthermore, to decrease the neurological symptoms that the patient displays on the left lower extremity.

2.7 Rehabilitation plan

Short-term plan:

- Decrease hypertonicty of hypertonic muscles found.
- Increase muscle strength of abdominals and gluteals and therefore gain spinal stability.
- Correct the position of her posture.
- Relax and lengthen the shortened muscles.
- Decrease the neurological symptoms of the lower extremity.
- Remove blockages found on lower extremity joints, spinal segments and ribs.
- Breathing re-education, upper and lower breathing stereotypes, and proper lateral expansion of the diaghragm.
- Correct postural re-education in sitting, standing and performing daily activities and work.
- Educate the patient regarding the autotherapy exercises, and how the exercises

will help to change the musculo-skeletal structure of her body and therefore resolve her pain.

Long-term rehabilitation plan:

- Improve and maintain the points in the short-term rehabilitation plan.
- Correct her flat feet.
- Increase her proprioception through sensori-motoric training.
- After performing detailed further examinations of the upper trunk, and upper extremities; resolve the problems of:
- Blockages found on upper extremity joints, sternoclavicular joint and cervical spine.
- Correct muscle imbalances caused by a combination of muscle hypertonicity, muscle shortness or/and weakness.
- Neurological symptoms that would arise in the examinations.
- Education of correct posture in sitting, standing and when performing activities of daily living, driving and at work.
- Eventually the above will help to resolve the patient's headaches as well.

2.8 Therapy proposal

- Soft tissue technique on sacrum and dorsal fascia by Lewit (20)
- Post-isometric relaxation by Lewit (20) for the piriformis, gluteals, TFL, semimembranosus and semitendinosus, biceps femoris, rectus femoris, vastus medialis, adductor longus, gracilis and iliopsoas
- Strengthening of gluteals and abdominals through exercises
- Eccentric antagonistic contraction for the gluteals, piriformis, adductors and TFL.
- PNF by Kabat (21), hold-relax and/or rhythmic stabilisation for muscle relaxation; lower extremity first diagonal flexion and extension patterns, 2nd diagonal extension pattern.
- PNF by Kabat (21), hold-relax active movement technique and/or Rhythmic stabilisation for muscle strengthening; lower extremity, 2nd diagonal extension.
- PNF by Kabat (21), pelvic movements of anterior elevation and posterior depression, using hold-relax active movement technique.

- Tractions by Lewit (20) : PIR traction of the hip, PIR traction of the lumbar spine (along the sacral fascia), tractions of the lumbar spine
- Mobilisation by Lewit (20) of the head of fibula, navicular and cuboid, of the Sacro-Iliac joint, lumbar spine and thoracic spine and lower ribs in their restricted directions.
- Training of proper breathing stereotype (15)
- Sensori-motoric stimulation training (15)
- Centration of the left hip by Kolař
- Autotherapy for self-PIR, stretching, strengthening muscles, breathing exercises and sensori-motoric exercises.

2.9 Therapy proposal if further examination is done

- Soft tissue techniques by Lewit (20) on neck region
- Post-isometric relaxation by Lewit (20) for hypertonic muscles
- Strengthening of weak muscles
- Eccentric Antagonistic Contractions for hypertonic and weak muscles
- PNF by Kabat (21), hold-relax and/or rhythmic stabilisation for muscle relaxation.
- PNF by Kabat (21), hold-relax active movement technique and/or Rhythmic stabalisation for muscle strengthening
- PNF by Kabat (21), scapula movements, which ever diagonal that is needed.
- Tractions by Lewit (20)
- Mobilisation by Lewit (20)
- Centration of shoulder by Kolař
- Autotherapy as seen fit.

2.10 Therapy progress

Day to day therapy:

Date: 27/02/2011

Goal of today's therapy unit: Complete examination, the main therapy today was to stretch shortened muscles found in the examination and strengthen muscles, and mobilise blocked segments.

Therapy:

- Soft tissue techniques of the sacral fascia in caudal direction by Lewit.
- Post-isometric relaxation by Lewit on the left piriformis, gluteus maximus, biceps femoris, adductor longus and gracilis, along with the ilipsoas.
- Mobilisation by Lewit of the left head of fibula in dorsal direction, navicular and cuboid in both dorsal and ventral directions, Lisfrank joint in plantar direction.
- Mobilisation of the spine by Lewit- lumbar spine in lateral flexion and flexion, thoracic spine both anticlockwise and clockwise mobilisation of individual segments in prone position and sitting.
- Mobilisation of the SI joint by Lewit on the left side.
- Traction by post-isometric relaxation of the left hip by Lewit.
- Traction mobilisation of the lumbar spine by Lewit. (patient supine, knees in maximum flexion and hip in about 100 degree flexion, and movement by the lower extremity to the left and right in semi-circular motion)

Results:

- Mobilisation did relieve pain on the left cuboid and navicular bones.
- The patient felt relieved after the spinal mobilisations
- The position for the iliopsoas PIR was very painful for the patient to keep, therefore, change of position is necessary for next session.
- The TFL, piriformis and gluteals are very hypertonic, and PIR will take along while to work, therefore change of therapy to PNF using relaxation technique is needed.

Self-therapy:

Exercises:

- For control of pelvic movements- patient in supine position, and slowly performing anteversion and retroversion of the pelvic. *1 set 10 reps, twice daily.*
- Stretching of the hamstrings against a ball, and piriformis stretch sitting on a chair, placing one leg over the other and pushing the knee of the top leg towards her in a diagonal direction. *Twice daily, 3 times each stretch, holding the stretch for about 15 seconds.*
- For the gluteals- the patient in prone position, and simply contracting the gluteals without anterior tilt of the pelvis. *2set, 10 reps, twice daily*.
- For the abdominals- the patient in supine position, controlling the pelvis in retroversion, with the knees and hips flexed to 90 degrees and the feet flat on a physioball. The patient contracts the abdominals to extend the hip and knee and push the ball forward with the feet. *1set, 10 reps, twice daily.*
- Thoracic breathing- the patient on all fours, with a straight spine, and abducts one arm at a time with the head rotation to the direction of the arm being abducted. The patient breathes in during the arm abduction and breathes out when the arm is brought back to starting position. *1set, 10 reps on each side, twice daily*.
- Breathing exercises- patient supine, knees flexed so that the feet are flat on the ground. The arms at supporting the patient's head (beach position). Deep breathing, trying to bring out the abdominal wall during breathing in, and the abdominal wall back down during breathing out. *1 set, 10 reps, twice daily.*

Day to day therapy:

Date: 31/01/2011

Goal of today's therapy unit: relaxation of the piriformis and gluteals. Regaining range of motion in abduction and adduction of the hip.

Subjective information: No change in the patients pain levels. However, she feels the breathing exercises helped to comfort her back pain slightly.

Therapy:

- Soft tissue techniques on the sacral fascia in caudal direction by Lewit.
- Mobilisation by Lewit of the left head of fibula in dorsal direction, navicular and cuboid in both dorsal and ventral directions, Lisfrank joint in plantar direction.
- Mobilisation of the spine by Lewit- lumbar spine in lateral flexion and flexion, thoracic spine both anticlockwise and clockwise mobilisation of individual segments in prone position and sitting.
- Mobilisation of the SI joint by Lewit on the left side.
- Propioceptive neuromuscular facilitation by Kabat, using the technique hold-relax; on the left lower extremity 1^{st} diagonal flexion and extension, and 2^{nd} diagonal extension pattern.
- Centration of the left hip by Kolař
- Traction mobilisation of the lumbar spine by Lewit.

Results:

During PNF the patient struggled due to stretching pain, especially on the 2^{nd} diagonal extension pattern at the end position, however, after the therapy, the grinding pain on the left hip and the sharp pain on the SL area was slightly decreased as well.

Self-therapy:

As previous.

<u>Day to day therapy:</u>

Date: 2/02/2011

Goal of today's therapy unit: continue relaxing the piriformis, gluteals, TFL and adductors to fix the pelvic torsion. Strengthen the gluteals and abdominals to gain spinal stability. Try to educate the patient on sensori-motoric exercises for home therapy.

Subjective information: The patient was very positive about today's therapy, she thought that the therapy two days ago decreased the intensity of the LS pain during the night.

Therapy:

- Soft tissue techniques by the sacral fascia in caudal direction by Lewit.
- Propioceptive Neuromuscular facilitation by Kabat, using the technique hold-relax; on both left and right lower extremity 1st diagonal flexion and extension, and 2nd diagonal extension pattern.
- Mobilisation of the spine by Lewit- lumbar spine in lateral flexion and flexion, thoracic spine both anticlockwise and clockwise mobilisation of individual segments in prone position and sitting.
- Mobilisation of the SI joint by Lewit on the left side.
- Manipulation of the ribs on the left side by Lewit.

Results:

The patient is very positive today, the adductors are more relaxed, the range of motion of the left hip has increased by 5 degrees and the barrier at the end of motion is no longer present.

Self-therapy:

As before, but now for the gluteal contraction exercises, she would contract her gluteals, and slowly raise her leg (one at a time) for about a centimetre, trying to keep the pelvic from anteriorly tilting. 1 set, 10 reps, twice daily.
The patient has more control over the movement now.

<u>Exercises for the external oblique abdominals</u>-

Patient supine, arms along the body, pull the rib cage down to the symphonies and try to hold the position while breathing in normally. One leg at a time, bring flex the knee and put the feet flat on the ground while keeping the rib cage down. *Repeat, 1 set, 10 reps, twice daily*.

<u>Change piriformis stretch-</u>

Patient spine, bend both knees, hold one knee and bring it close to the chest, try to put the foot of the other leg on the knee held close to the chest. Note: the patient is able to perform this stretch, and it is not too painful anymore.

<u>Sensori-motorics and advices</u>-

- Use a spiky ball to facilitate the lower extremity. Use hot and cold towels 1 minute each on the left side of the lower extremity, 15 minutes a day.
- Forming of the short foot in a seated position, then trying to push the knee down and hold the position of the short foot. (10 minutes a day)
- Walk bare feet in the house as much as possible, and try to roll a spiky ball or a bottle of water under the foot while seated.
- Trying to abduct and adduct the toes while she's watching TV or doing paperwork at home.
- Correct gait re-education.

Day to day therapy:

Date: 3/02/2011

Goal of today's therapy unit: gain full range of motion of the left hip in abduction and adduction, correct muscular imbalance of the lower trunk.

Subjective information: The patient slept through the night without being awakened by pain. She feels that the left hip joint pain has decreased to about 1/10 on VAS, and she feels that intensity of the LS pain is decreased to 3/10 on VAS, and that it isn't as sharp anymore.

Therapy:

- Soft tissue techniques of the sacral fascia in caudal direction by Lewit.
- Propioceptive neuromuscular facilitation by Kabat, using the technique hold-relax; on both left and right lower extremity 1st diagonal flexion and extension, and 2nd diagonal extension pattern.
- Mobilisation of the spine by Lewit- lumbar spine in lateral flexion and flexion, thoracic spine both anticlockwise and clockwise mobilisation of individual segments in prone position and sitting.
- Mobalisation of the SI joint by Lewit on the left side.
- Manipulation of the ribs on the left side by Lewit.

Results:

Again, the patient feels very positive about today's therapy, the range of motion at the left hip joint is 45 degrees, and there is no longer a hard barrier.
She can now easily do the PNF therapy, especially of the 2nd diagonal extension pattern; she no longer feels pain at the end position of this particular pattern.

Self-therapy:

As above.

Adding an extra breathing exercise, since the patient feels it helps a lot with the SL pain. The patient in sitting position, her arms on the lateral aspect of her lower ribs, while breathing out, she pushes her cage inwards, and in breathing in, she relieves the resistance. On the third inspiration, she will quickly release her hands from her body, allowing for an expansion of the ribcage in lateral direction.

Day to day therapy:

Date: 4/02/2011

Goal of today's therapy unit: Last therapy session, correct the muscular imbalance, and give patient an exercise sheet with the exercises listed above and an advice sheet as well.

Subjective information: the patient is very happy with the results of therapy, she slept on her right side last night and didn't experience any pain through the night. She also describes the pain on the LS area that it is not completely gone, but the intensity has decreased, so that she is not bothered by it very much.

Therapy:

- Soft tissue techniques of the sacral fascia in caudal direction by Lewit.
- Propioceptive Neuromuscular facilitation by Kabat, using the technique hold-relax; on both left and right lower extremity 1st diagonal flexion and extension, and 2nd diagonal extension pattern.
- Mobilisation of the spine by Lewit- lumbar spine in lateral flexion and flexion, thoracic spine both anticlockwise and clockwise mobilisation of individual segments in prone position and sitting.
- Mobilisation of the SI joint by Lewit on the left side.
- Mobilisation by Lewit of the left head of fibula in dorsal direction, navicular and cuboid in both dorsal and ventral directions, Lisfrank joint in plantar direction.
- Manipulation of the ribs on the left side by Lewit.

Results:

Very positive result- so far the pain on the left hip is 1/10 on VAS, and the pain on the LS area is 3 sometimes 2/10. Her left hip abduction and adduction is within normal range of motion with no painful restrictions. Mobilisation helped to release the painful blockages found at the joints, specially the spine.

The patient's is able to control her pelvic movements now, and does all exercise precisely and carefully. She can also control her breathing pattern, and realises when she is using the paradoxal breathing and changes it when concentrating. The patient can also take the position for iliopsoas PIR by Lewit easily now with no pain.

Most importantly, the patient can sleep through the night without being awakened by pain, and she can now sleep on the right side as well, which was not possible before.

Self-therapy:

All exercises I have shown the patient to date. Also to follow the advices in the advice sheet I gave her (a copy is found in the supplements).

I have also showed and given the patient exercises for the head and neck (with pictures so she can do them correctly), these include:

- Self PIR for the sternocleidomastoid, levator scapulae, trapezius upper fibres and scalene anterior.
- Pushing the chin back and holding it and releasing while keeping the correct posture of the head and neck to try to increase the activity of the deep neck flexors.

2.11 Final kinesiological examination

Done on the 7/02/2011

1) Postural examination by Kendall (19)

Table 11: Results of postural examination by Kendall; posterior, side and anterior views during final examination

Posterior view	Side view (left and right)	Anterior view
• Valgosity of ankles • Hypotrophy of left and right gluteals • Left gluteal line shifted down • Decrease of hypertrophy of left paravertebrals • Scapula alata on left side	• Slight lumbar normal lordotic curviture • Decrease of thoracic kyphosis • Cervical kyphosis (especially on C7) • Shoulders protruded • Trunk rotation to right (slight) • Head forward	• Flat feet • Eversion of both feet, more on the left side • Short base • Lateral loading on both feet

2) Gait examination by Kendall (19)

- Short base, equal length of strides
- Take off at metatarsal ends of foot
- Starting to use extension of the hip, and less flexion of knees
- Head protrusion
- more arm movements
- Improvement of pelvic movement synkinesis

Modifications

Table 12: Final examination and results of gait modification

Tip toes (S1):	Possible to execute normally.
On heel (L5):	Possible to execute, without pain.
Squats (L3/4):	Possible to execute, without pain.

Backwards (gluteals):	Possible to execute normally.
Sideways (adductors and abductors):	Possible to execute normally without pain.

3) Pelvic examination

Coronal plane: The ASIS and the PSIS of the left side is higher than the right, therefore the patient displays a pelvic tilt to the right.

Sagittal plane: pelvis in line

Results: The patient's torsion to the right anti-clockwise is treated, however, now, the patient displays a pelvic tilt to the right.

4) Dynamic test of the spine

Flexion

- The lumbar spine is less flat, the loading is spread through the upper and lower thoracic spines now
- The range of motion is normal
- The patient feels the pain at the LS junction is decreased to 3/10 on VAS when she extends her back.
- Patient controls the anteversion to about 40 degrees of trunk flexion.

Extension

- Scapula alata on the left side more pronounces
- Loading is spread across the upper and lower parts of the thoracic spine.
- Normal range of motion

Lateral Flexion to the left

- Normal Range of motion
- Arms are in contact with the body
- Loading is spread across the upper and lower parts of the thoracic spine.

Lateral Flexion to the right

- Decreased range of motion by 10cm compared to the left
- Arms are in contact with the body

- Loading is spread across the upper and lower parts of the thoracic spine

Rotation to left and right

- Movement substitution by trunk is more controlled and less in the sagittal plane compared to the initial kinesiological examination.
- During assisted rotation, the rotation is 30 degrees to both sides and the patient feels pain of 3/10 on VAS in the cranio-medial sacral area

5) **Altered movement pattern by Janda** (15)

Extension

Right lower extremity extension: anterior tilt of the pelvic is controlled followed by activation of the gluteals, hamstrings and co-activation of the paravertebrals. The range of motion was 10 degrees.

Left lower extremity extension: the same movement synkenises but not very exaggerated. The range of motion in extension was a few degrees more than the right.

Abduction

Right lower extremity: the pelvis movement was more controlled and the leg moved in the coronal plane.

Left lower extremity: the pelvis movement was more controlled and the leg moved in the coronal plane.
Result: when the patient is concentrating on the movement, she is able to fix her movement pattern.

Curl-up

Anterior tilt of the pelvis is controlled, flexion of the knees and hip still present but is not excessive, abdominal strength is starting to be observed.

6) **Anthropometry**

Table 13: Final examination of anthropometric measurements of the left and right lower extremity

Lower extremity	**Left(cm)**	**Right(cm)**
Anatomical length	90	90
Functional length	86	87

7) Soft tissue examination by Lewit (20)

Kibler's fold: The skin is easier to try to gain a fold, but still not able to

Skin mobility and elasticity: The restriction in the lumbar area in all direction is less, especially in caudal direction.

Fascia: increase in movement of the sacral fascia in caudal direction.

8) Range of Motion examination by Kendall (20)

Table 14: Final examination of active and passive ROM on the left and right hip and knee

		Left (degrees)		Right (degrees)	
		Active	Passive	Active	Passive
Hip	S:	10-0-110	15-0-120	10-0-120	15-0-120
	F: (with extended knee)	45-0-30	45-0-30	45-0-30	45-0-30
	F: (with flexed knee-adduction done in sitting)	45-0-35	45-0-30	45-0-40	45-0-40
	R90:	45-0-10	45-0-10	35-0-15	35-0-15
Knee	S:	0-0-140	0-0-140	0-0-140	0-0-140

Results: most improved parameters are bilateral hip flexion, abduction and adduction which are within the normal ranges of motion.

9) Neurological examination

Dermatomal examination of the lower extremity

Results: decreased sensitivity of the lateral aspect of the thigh and shaft and foot of the left leg, however, the patient feels that the difference comparing the two legs is better than it was a week ago.

Deep sensation examination

Movement sense and position sense examination.

Results:

- Decreased proprioception of the left lower extremity.
- Intact proprioception of the right lower extremity.

Reflexes

Mono-reflexes of the patella and achillies:

Results: normal reflexes.

Provocative tests

Laseque's sign, reverse Laseque's sign and Bragard's sign.

Results: all signs were negative on both extremities.

Ulnar nerve stretch test

Positive on the right upper extremity.

10) Muscle palpation, muscle length test by Kendall (19) and muscle strength test by Kendall

Table 15: Final examination of muscle tone, muscle length and muscle length of left and right lower extremity

Muscles Tested	Left lower extremity			Right lower extremity		
	Muscle tone	Muscle shortness	Muscle strength	Muscle tone	Muscle shortness	Muscle strength
Quadrates Lumborum			4			4
Gluteus maximus	✓ but decreased		3+	✓ but decreased		3+
Gluteus medius + minimus			2+			2+
Coccygeus						
Adductor longus			4			4
Adductor brevis			4			4
Adductor magnus			4			4
Gracilis	✓		4	✓		4

Hip lateral rotators (Gamellus superior+inferior, Obturator extern+internus, piriformis and quadratus femoris)	Difficult to palpate	✓	2+	Difficult to palpate	✓	2+
Piriformis	✓ but decreased		2+	✓ but decreased		2+
Iliopsoas	✓ but decreased		3+			4
Tensor faciae latae	✓ but decreased		3+			4
Sartorius			4			3+
Biceps femoris			4	✓ but decreased		3+
Semimembronosus+ Semitendronosus			4			3+
Rectus femoris	✓		4			4
Vastus medialis	✓ But decreased		4	✓ but decreased		4+
Vastus lateralis +intermedius			4			4
Gastrocnemius + plantaris			4			4
Soleus			4			4

Peroneus longus+ brevis			4			4
Tibialis posterior			4			4
Tibialis anterior			4			4
Rectus abdominals			3+			3+
Transverse abdominals	✓ But decreased		3+	✓ but decreased		3+
External and Internal obliques			3+			3+

Table 16: A key for table 15

Key	
Hypertonic and shortned muscles	✓
Eutonic and muscles of normal length	
Hypotonic muscles	☆

Results:

Generally the hypertonicity has decreased in the muscles above, specially on the left gluteals, piriformis and TFL. Muscle shortnesses has also been resolved, except for the left lateral rotators of the hip joint, which corresponds to the decrease of internal rotation of the left hip.

11) Joint play by Lewit (20)

Table 17: Final examination of joint play of selected joints of left and right lower extremity

		Left lower extremity	**Right lower extremity**
Head of fibula	***Dorsal direction***	Blocked, but not painful	No blockages
	Ventral direction	No blockages	No blockages
Talocrural joint in *dorsal direction*		No blockages	No blockages

Cuboid	***Plantar direction***	No blockages	No blockages
	Ventral direction	No blockages	No blockages
Navicular	***Plantar direction***	No blockages	No blockages
	Ventral direction	No blockages	No blockages
Lisfrank joint	***Plantar direction***	No blockages	No blockages
	ventral direction	No blockages	No blockages
Metatarsopharangeal joints (1^{st} to 5^{th})- *shearing movement*		No blockages	No blockages
Metatarsophalangeal joint of the 1^{st} toe in *rotation*		No blockages	No blockages
Proximal and distal phalanges (1^{st} to 5^{th})	***Plantar direction***	No blockages	No blockages
	Ventral direction	No blockages	No blockages
	Lateral direction	No blockages	No blockages

Sacro-Iliac joint

<u>Left side-</u> no longer blocked

<u>Right side</u>- no longer blocked

Lumbar spine

<u>Flexion-</u> no blockages

<u>Extension</u>- regain of movement in individual segments

Thoracic spine

Flexion- no longer blocked in lower thoracic segments

Extension- no longer blocked in lower thoracic segments

Lateral flexion to the left- no blockages

Lateral flexion to the right- no longer blocked in lower thoracic segments

Rotation to the left- no blockages

Rotation to the right- no longer blocked in lower thoracic segments

Ribs

The ribs nicely expand during inspiration and approximate during expiration (bilaterally, although the left side is expands and approximates more).

12) Specialised tests

a) **Scale test**; 32kg on each leg

b) **Trendelemburg's**

Left side: pelvis slightly rotated anticlockwise, however, better gluteal control is observed, and well balanced.

Right side: Better control, however, compensation of the trunk by moving backwards.

Overall result: better stabilisation of the pelvis and proper gluteal activation is observed.

c) **Patrick's sign**

Positive on both lower extremities, however, the distance of the knee to the bed is closer than it was in initial kinesiological examination.

13) Breathing examination

The patient's can control her paradoxal breathing pattern when concentrating. The ribs are starting to expand in lateral directions as well.

14) Movement of the scapula

Patient standing up against a wall, and hands flexed to 90 degrees in front and push into the wall, observe the scapula.

Result:

- Moderate scapula alata on the left, weak serratus anterior is still present, similarly on the right side.

Conclusion of final kinesiological examination:

Overall, the patient's posture has improved, especially the flat lumbar curvature is now slightly lordotic, and the paravertebral hypotrophy has decreased as well. The sacral fascia has also been stretched and is no longer restricted.

The most improved ROM parameters are abduction at the hip by 15 degrees on the left and 10 degrees on the right, along with adduction of the hip by 10 degrees on the left and 5 degrees on the right.

As for the muscles, a decrease of hypertonicty is observed on both lower extremities, however, a higher decrease of tone was on the left side on the following muscles: quadratus lumborum, gluteus maximus, adductors, piriformis, iliopsoas and TFL. A visible increase of muscle strength is seen in bilateral abdominals and gluteus maximus; and the Trendelemburg's test shows an improvement in gluteal activation and proper pelvic stabilisation of both left and right sides, yet more on the left side.

Futhermore, the blockages located in the SI joint, lumbar and thoracic spines, ribs, head of fibula, navicular and cuboid has been resolved. The patient's sensation of the left lower extremity is increased when comparing with the other extremity. Lastly, the breathing stereotype has improved, and the ribs are undergoing the physiological lateral expansion as well.

3 Effect of therapy

I have achieved most of my patient's goals during my therapy sessions, that is to decrease her left hip pain from 5/10 to 1/10 on VAS, and the pain on the LS junction from 5/10 to 3/10 on VAS. The patient is able to sleep through the night without been awakened by pain, and can also sleep on the right side.

The hypertonic muscles have decreased in tone, especially the piriformis and gluteals, and the most improvements were with the abductors and adductors where the range of motion has been restored within the normal ranges, with no painful restrictions. Along with the abdominals and gluteals starting to stabilise the lumbar spine and pelvis correctly.

A noticeable change of the skeletal structure of the pelvis and spinal curvatures is visible, especially in a decrease of the thoracic kyphosis, and an increase in the load transfer on the whole thoracic segment and lumbar spine, which in turn relaxed the hypertrophic paravertebral muscles.

As for the neurological symptoms the patient displayed upon initial examination, she now has gained an increase of sensitivity of the left lower extremity, and slight improvement on the proprioception as well.

Overall, I believe that the therapies chosen have resulted to a positive effect in the short time of 5 days, and most importantly, the patient's main goals have been addressed.

4 Patient Prognosis

As a 55 year old female with degenerative changes in her L4/L5 spine, some nociceptive pain is expected to occur during her lifetime. However, as far as my evaluation of the patient, I believe her musculo-skeletal structure is very strong for her age. She is also very motivated and commonly exercises by her own will.

Along with the fact that the patient is very positive about her improvements, I believe that she will not stop the rehabilitative exercises, and will willingly follow the stretching, strengthening exercises, sensori-motoric training, and maintaining a correct posture, body carriage and movements during activities of daily living and work.

From this point of view, I believe the patient to have a very good prognosis relating to her low back and pain, along with the slow change of her posture and so the musculo-skeletal structure (which was very much visible within the short span of 5 day therapy).

The patient is also being prescribed physiotherapy sessions three times a year, 6 sessions at a time by her neurologist. For further improvements, it could be helpful to concentrate on the patient's upper trunk and correct the musculo-skeletal and neurological problems that arise from there in order to obtain the optimal therapeutic effect that can be reached.

5 Summary of the thesis

This thesis consists of a case study of physiotherapy treatment of a 55 year old female, with the diagnosis of low back pain due to 2 year post slip and fall injury, with the pain localised in the area of the LS junction and left hip joint.

The general part of the thesis explains the anatomy, kinesiology, functional alterations of the kinesiology, biomechanics and some pathologies and their rehabilitation and treatment found in the region of the lumbar spine and the pelvic girdle; which is specific to this case study. The main aim of this section is to provide these in detail in order to understand the mechanisms of movement and injury, therefore to find possible logical therapeutic methods for the rehabilitation of my patient.

The specialised part was the case study itself, and consisted of the patient's anamnesis, differential consideration, initial kinesiological examinations, further examination proposals, therapy proposals, short-term and long-term rehabilitation plans, detailed description of 5 therapy sessions and a final kinesiological examination.

The intial examination showed the patient's pain level was at 5/10 on VAS on the area of LS junction and left hip area. The main problems presented was the hypertonicity of the TFL, piriformis, gluteals and adductors bilaterally but more on the left side, bilateral weakness of the gluteals and abdominals, along with decreased ROM in both ABD and ADD of both hip joints. Furthermore, blockages being present in the ribs, thoracic and lumbar spines, SI joint and joints of the lower extremity (bilaterally). Decrease in proprioception and dermatomal sensitivity was also visible on the left lower extremity.

During the 5 therapy sessions, the main techniques used where soft tissue techniques, mobalisation and PIR by Lewit, PNF relaxation and strengthening techniques by Kabat, sensori-motor exercises, breathing exercises and autotherapy exercises for stretching and strengthening specific muscles.

Following therapy, the improvements were visible, while the pain level decreased to 3/10 and 1/10 on VAS on the LS junction and left hip joint respectively. Furthermore, the hypertonic muscles relaxed and the weak muscles improved in strength (of the muscles mentioned above). The ROM in ABD and ADD of the left hip joint improved by 15 and 10 decreased respectively, joint blockages also cleared, and a visible increase in dermatomal sensitivity was observed on the left lower extremity.

Overall, the patient is very motivated to continue with the exercises, and is taking a keen interest in altering her faulty posture during ADL and work, therefore her prognosis is great. Further physiotherapy sessions would be helpful in order to correct any musculo-skeletal dysfunctions present in the region of the upper trunk.

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7 Supplements

7.1 List of tables

7.2 List of figures

7.3 List of abbreviations

ABD- Abduction

ADD- Adduction

ADL- Activities of daily living

ASIS- Anterior superior iliac spine

AIIS- Anterior inferior iliac spine

BMI- Body mass index

CLPA- Centrum Léčby Pohybového Aparátu Vysočany (clinic)

COM- Centre of mass

Cm- centimeters

DSIL- Dorsal sacro-iliac ligament

ER- External rotation

E- Extension

F- Flexion

FTVS- Fakulta Telesne Vychovy a Sportu

IR- Internal rotation

IAP- Intra-abdominal pressure

ISIL- Interoesseous sacro-iliac ligament

IVD- Intra-vertebral disk

Kg- Kilograms

LBP- Low back pain

LDF- Lumbo-dorsal fascia

LS- Lumbo-sacral

NSAID- Non-steroidal anti-inflammatory drugs

PIR- Post-isometric relexation

PLL- Posterior longlitudenal ligament

PNF- Proprioceptive neuromuscular facilitation

PIIS- Posterior inferior iliac spine

PSIS- Posterior superior iliac spine

ROM- Range of motion

SC- Sacro-coccygeal

SI- Sacro-iliac

TFL- Tensor fascia latae

TENS- Transcutaneous electrical nerve stimulation

TLSO- Thoracic-lumbar-sacral othrosis

TrPt- Trigger point

UI- Urinary incontinence

VSIL- Ventral sacro-iliac ligament

VAS- Visual analogue scale

7.4 The advice sheet

Advice sheet handed to the patient:

1) Stretch as much as possible
2) Strengthen your buttocks and abdominal muscles every 3 days
3) Keep yourself comfortable- use a pillow for your back; if driving for a long time, use a pillow for your back
4) Try to think about posture as much as possible

- Head, neck and shoulder
- Try not to tilt your pelvis backwards
- Keep a straight spine

5) If you want to pick something from the floor, do it by bending you knees and using your arms (try not to lift anything heavy during the mornings)

6) Getting out of bed- turn to your most comfortable side, put your legs out first, push yourself to sit using your hands by extending your elbows
7) Groceries- carry bags on both hands. Try to let them be of equal weight

Extra important things:

a) Facilitate your left leg and hands where you feel numbness by brushing it with a spiky ball
b) Use a hot/warm towel then a cold towel on the places where you feel tingly sensation (for about 2 minutes each, for 14 minutes)
c) Put the spiky ball under your foot and roll it, let it copy the shape of your foot (you can do the same with an empty plastic bottle)
d) Put your foot flat on the ground when you're seated. Press down on the 3 points that we talked about. Then very slowly slide your heel backwards just by 1 cm (without lifting it off the ground)
e) If you feel neck pain; stretch (the patient has pictures of self-PIR for the upper trapezius, sternocleidomastoid, levator scapulae and scalene anterior, and she has been instructed on how to perform them)
f) If you suffer from great headaches or pain, place a hot pack on your shoulders, and try stretching

7.5 Ethic's board approval and patient's consent form

See next two pages.