Charles University

Faculty of physical education and sports

Case study for of physiotherapy treatment of a patient with sacral, lumbar and lower thoracic Lumbago

Bachelor thesis
April 2014, Prague

Author: Lars Næss.
Supervisor: Mgr. Lenka Satrapova.

Abstract.

Title:

English: Case study: Physiotherapy treatment of a patient with lumbar, sacral and lower thoracic lumbago.

Czech: Kazuistika fyzioterapautické péce o pacienta s lumbàlním, sakralním a dolním hrudním lumbagem.

Thesis aim:

Through one practical- and one theoretical part, I will discuss the rehabilitation of lumbago. I emphasize the practical part, where I worked with a middle-aged nurse who has struggled with lumbago for a long while. Here I want to describe examination, therapy and conclusion on her state with lumbago. In the theoretical part, I want to describe what I think is the most important aspects of lumbago in anatomy, kinesiology, biomechanics and epidemiology.

Methods:

In the special part, we mostly used dynamic neuromuscular stabilization (acc. Kolar), but also PIR, soft tissue techniques, ADL training, joint play (acc. Lewit) and breathing exercises. I had 6 sessions with the patient. In the general part, I used books, notes, PowerPoint-presentations and Google books to search for material.

Result:

Objectively, the patient had better movement in the whole spine after the treatment, and a much better breathing pattern. We also taught her how to move when dealing with patients.

Subjectively, the patient felt much better after the week of treatment. The pain decreased, and the antalgic posture was gone.

I collected theoretical information from books, articles, from the Mgr. Sedlicka at Monada and from lectures at FTVS. This theoretical base helped me to provide the best possible practical knowledge on how to treat the patient.

Conclusion:

From the initial examination to the final, the patient showed a big difference, as expected. She reached a level she can function fine without more treatment. Her prognosis is good, and she learned several exercises she finds very useful when in pain. Low back pain is quite common I physiotherapy, as most people will experience it through a lifetime. We had a good basic knowledge of what to look for and how to treat the symptoms, so in the special part, I think we had a nice base. In the general part, the difficult part was to narrow everything down, but still include the essentials. I could have written almost indefinitely, because the low back/sacrum is such a vast and important area in motor function and daily life routines.

Keywords:

Lumbago, physiotherapy, lumbar spine.

Declaration:

I hereby declare that this is entirely my own work, based on knowledge from articles, journals, books and what we have learned attending FTVS.

We did not use any invasive methods during the practical approach, and the patient was made fully aware of the procedure we did at all times.

Prague, March 2014

Acknowledgement

Firstly, I would like to thank my family, girlfriend and friends both in Prague and in Norway for all the support I have gotten during my three years attending FTVS. Their support has been absolutely crucial for my studies here, and I am forever thankful for it. I would also like to thank my classmates, who have made sure everyone ha enjoyed their time here.

My supervisor at Monada, Mgr. Veronika Sedlicka has been very kind to me, and showed patience, knowledge and skill in my bachelor practice. I would not have had a nice time without her and her valuable advices. Her way of speaking to patients is something I will never forget.

Last but not least, I would like to thank my faculty supervisor, Mgr. Lenka Satrapova Phd. Her attitude and commitment towards me in writing this thesis has overwhelmed me, and I owe her huge gratitude. She has answered every question, no matter when or how relevant, and this professionalism has been very important to me through this process.

THANK YOU!

Lars Næss

Prague, April 2013

Table of content

1. Introduction:

In this thesis, I will try to give a complete picture of the diagnosis lumbago. Through a theoretical part and a case study where I was a part of the six therapy sessions we had with the patient. Lumbar and sacral lumbago is unspecified pain at the level of the low back or sacrum. There are two main causes for lumbago; the first is a sudden occurrence after a false movement or an effort with too much loading, resulting in sharp pain. The second is a result of poor posture and muscle stability, which leads to overstrain, weakness, shortness or wrong movement patterns. In the first case, there are mostly young people who overload their low back and pelvis, while the second is more normal for elderly. It is very important to rule out more complicated problems, like disc herniation, nerve compression or fracture. This should be tested in the kinesiologic examination, but could be seen on an X-ray or MRI scans. Lumbago is thought to be the second most common health problem in America, only surpassed by flu/cold. This makes it a huge health problem for the state, employers and employees or in a family situation.

The thesis has two parts, a general and a specific. In the general part, I will try to show lumbago from all perspectives, from anatomy, kinesiology, and biomechanics of the spine to frequency in society, epidemiology and different therapeutic approaches. The general is supposed to be an overview of the lumbar spine and lumbago, before discussing it in detail in the special part.

The specific part is the most important part of this thesis, and it is here I examined a patient with lumbago, before together with my two supervisors, we decided on the therapy implementation. During this period, I had to put everything I have learned to the test to try to give the patient the best possible treatment. In the special part is both initial and final examination of the patient, together with therapy progress, description of the therapy applied, prognosis and therapy evaluation.

At the end of the thesis, I list the literature used, tables, figures and explanation of abbreviations in addition to the signed ethics board review for.

2. Theoretical part

2.1 Anatomy and kinesiology

2.1.1 Anatomy

The spine is a complex piece of biological engineering, and is an adaptation to our nature and environment. The mechanics and structure of the spine is imperative to our everyday function. Due to our erect position and our continual aging, the spine ages and loses the functions so critical to our life as any other organ. However, the spine in particular can cause several painful conditions as it ages and/or suffers mechanical changes.

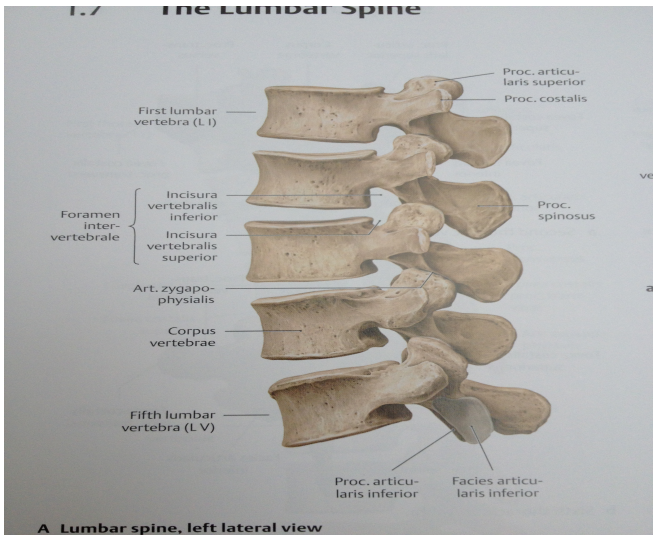

Figure 1 Lumbar vertebrae

The human spine consists of 24 moveable and 5 fused vertebrae; seven cervical vertebrae, twelve thoracic vertebrae, five lumbar vertebrae and five sacral vertebrae fused together in the adult to form the sacrum. The lowermost three to five vertebrae fuse late in the adult life to form the coccyx.

Between each moveable vertebra (except C0-C1 and C1-C2), we have intervertebral discs located anteriorly in the spinal column. Seven processes arise from the posterior portion of the typical vertebra.

The spinous process is a midline structure that is directed posteriorly and to a variable degree inferiorly. The transverse processes are a pair of lateral projections. The other four are articular, and each vertebra has a superior pair and an inferior pair. The function will be discussed in detail in the biomechanics part. (1)

2.1.2Ligaments of the low back

The joints are reinforced by many, strong ligaments that pass between vertebral bodies and connect components of the vertebral arches. These ligaments are divided in two groups:

1. Vertebral body ligaments:
   - Lig. longitudinale anterius
   - Lig. longitudinale posterius
2. Vertebral arch ligaments:
   - Lig. flava
   - Lig. interspinalia
   - Lig. supraspinale
   - Lig. nuchae
   - Lig. intertransversaria

   (1)

2.1.3 Nerve supply to lumbar back

We have 5 pairs of lumbar nerves, the first between L1-L2. The last is L5-S1. These are divided into anterior and posterior divisions.

Cauda eqiuna:

At the base of the spinal column, near the first lumbar vertebra, is a collection of nerves called the cauda equina. Just above, the spinal chord ends and it continues on as this collection of spinal nerves through the vertebral canal. The cauda equina has approximately 10 fiber pairs at its base. These consist of three to five lumbar fiber pairs, five sacral fiber pairs, and one coccygeal nerve. The primary function of the cauda equina is to send and receive messages between the lower limbs and the pelvic organs

(the bladder, the rectum, and the internal genital organs). The important sciatic nerve emerges from cauda eqiuna. (2)

These are the nerves running from cauda equina, the lumbosacral plexus:

As we from the functions, nerve irritation in the low back can cause huge problems for the daily living and can be very painful.

Table 1 Innervation routes

Nerve	**Function**
Femoral	Sensory to skin over anterior and medial thigh, knee, leg, dorsum of foot to base of 1. Metatarsal. Motor to m. iliacus, m. Pectineus, m. Sartorius, quadriceps femoris
Genitofemoral	Sensory to skin over scrotum, upper anterior thigh area. Motor to the cremaster
Iliohypogastric	Sensory to skin over hypogastric and lateral gluteal areas
Iliolingual	Sensory to skin over genitals and upper medial thigh area
Inferior gluteal	Motor to m. gluteus maximus
Lateral femoral cutaneous	Sensory to skin over lateral thigh
Muscular branches	Motor to m. Psoas maj/min, m. quadratus femoris, m. gemellus inferior and superior, m. piriformis, m. obturator internus
Obturator	Motor to m. adductor longus, brevis and magnus, m. obturator externus, m. gracilis,
Posterior femoral cutaneous	Sensory to skin over inferior buttock, posterior thigh, popliteal space, perineum, external genitalia
Pudendal	Sensory to skin over genitalia, anus, scrotum, penis, clitoris. Motor to m. levator ani, M.coccygeus, m. sphincter ani externus, m. transversus perinei superficialis and profundus.
Sciatic	Sensory to skin over posterolateral aspect of leg and lateral foot and heel, over upper third of lateral aspect of leg, over anterolateral aspect of leg and dorsum of foot and toes. Motor to hamstrings, m.

	adductor magnus, m. gastrocnemius, m. plantaris, m. soleus, m. Popliteus, m. Tibialis ant/post, Flexor/extensor digitorum longus and brevis, m. Peroneus longus, brevis and tertius, Abd/Add hallucis, m. quadratus plantae, m. Flexor hallucis brevis, m. extensor hallucis longus, m. abductor digiti quinti brevis, all interossei and 1 to 4 lumbricales.
Superior gluteal	Motor to m. gluteus medius and minimus, m. tensor fascia latae.

(2)

2.1.4 Muscles involved in posture:

The muscles move our body. We divide the muscles into phasic and tonic. Phasic muscles are fast and designed for a quick response from the brain. Tonic muscles are slower, and design to keep us upright against gravity. In an inactive lifestyle, or as a result of poor posture, the tonic muscles are usually the ones with strains.

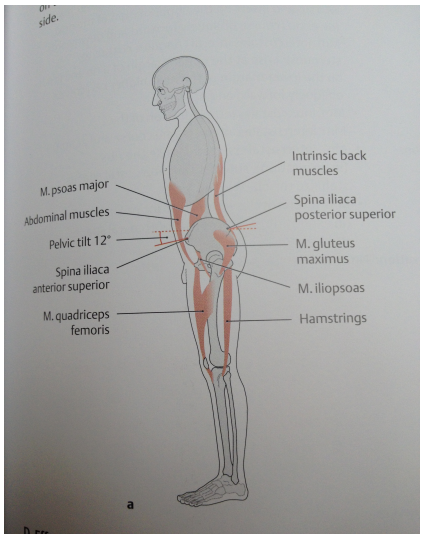

Figure 2 Normal active posture

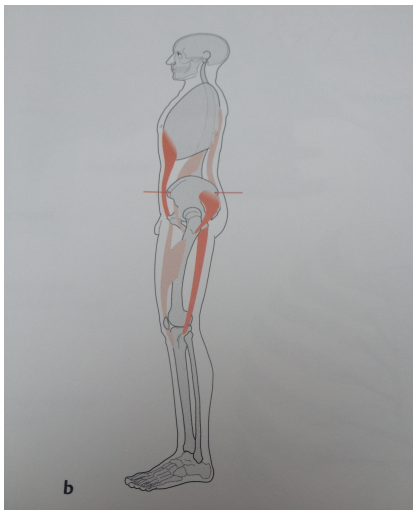

Figure 3 Active rigid posture

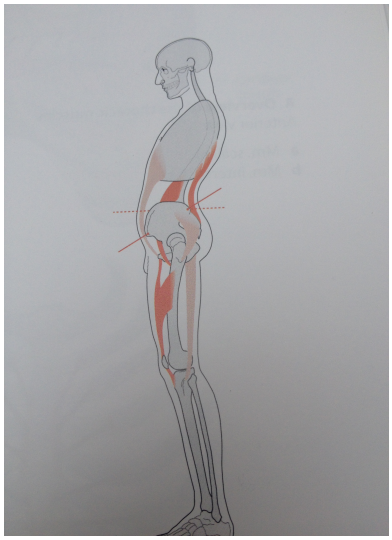

Figure 4 Passive slumped posture

2.1.5 Trunk wall muscles in the strict sense

Intrinsic back muscles (erector spinae)

Lateral tract of the m. erector spinae

- Sacrospinal system (m. iliocostalis, m. longissimus)
- Spinotransverse system (m. splenius)
- Intertransverse system (mm. intertransversii, mm. levatores costarum)

Medial tract of the m. erector spinae

- Spinal system (mm. interspinales, m. spinalis)
- Transversospinal system (mm. rotatores breves and longi, m. multifidus, m. semispinalis)

Paravertebral neck muscles

- m. longus capitis
- m. longus colli
- m. rectus capitis superior and inferior

Muscles of the thoracic cage (chest wall muscles)

- mm. intercostales
- m. transversus thoracis
- mm. subcostales
- mm. scaleni (topographically belongs to deep neck flexors, but functionally linked to thoracic breathing)

Muscles of the abdominal wall

Oblique abdominal muscles:

- m. obliquus abdominis externus and internus
- m. transversus abdominis

Anterior abdominal muscles:

- m. rectus abdominis
- m. pyramidalis

Posterior abdominal muscles:

- m. quadratus lumborum
- m. psoas major (functionally works in the hip, but pulls the lumbar spine forwards (Panek, 2013))

2.1.6 Trunk wall muscles in a broader sense

Pelvic floor muscles

Diaphragma pelvis:

- m. levator ani (m. puborectalis, m. pubococcygeus, m. iliococcygeus, m. coccygeus)

Diaphragma urogenitale:

- m. transversus preinei profundus
- m. sphincter urethrae

Diaphragma:

- Pars costalis
- Pars lumbalis

- Pars sternalis

(1)

2.1.7 Secondary trunk muscles important for posture

Spinocostal muscles:

- m. serratus posterior superior
- m. serratus posterior inferior

Spinohumeral muscles between the trunk and shoulder:

- m. rhomboideus major and minor
- m. levator scapulae
- m. serratus anterior
- m. subclavius
- m. pectoralis minor
- m. trapezius

Spinohumeral muscles between trunk and arms:

- m. latissimus dorsi

Thoracohumeral muscles:

- m. pectoralis major

(1)

All these muscles need to be in good cooperation for the body to be in good alignment, and maximize functionality. A huge amount of lumbago patient, or indeed the rest of the population does not have the adequate muscle balance, and this leads to strain, overstretch, shortening and inactivation of muscles. In the next section, I will show the cooperation of muscles of the trunk in different movements from a kinesiologic view.

2.2 Kinesiology

The coordination of muscle groups in the trunk is vital for fluent, painless movement. The muscles have different tasks according to movement. Like m. rectus femoris, that is the prime mover in trunk flexion, but is the antagonist in extension, and

is a neutralizer in lateral flexion. In these tables the different tasks of the muscles in movement are discussed:
(8)

Table 2 Trunk flexion kinesiology

Movement	**Trunk flexion**
Prime movers	m. Rectus abdominis
Synergists	m. External and internal oblique, Psoas
Antagonists	Erector spinae (m. iliocostalis, m. longissimus, m. spinalis), m. latissimus dorsi
Neutralizers	m. external and internal oblique, when bilaterally contracted neutralize rotation
Stabilizers	Intrinsic stabilization system (m. transverse abdominis, m. diaphragm, pelvic floor)
Fixators	All musculature of the hip, especially gluteals

Table 3 Trunk extension kinesiology

Movement	**Trunk extension**
Prime movers	Erector spinae, m. latissimus dorsi
Synergists	Intrinsic musculature of the spine
Antagonists	m. rectus abdominis, m. external and internal oblique, m. Psoas major
Neutralizers	Bilateral contraction of erector spinae and quadratus lumborum
Stabilizers	Intrinsic stabilization system
Fixators	All musculature of the hip, especially gluteals

Table 4 trunk lateral flexion kinesiology

Movement	**Trunk lateral flexion**
Agonist	m. quadratus lumborum
Synergists	Ipsilateral m. external and internal oblique, ipsilateral erector spinae, ipsilateral m. latissimus dorsi.

Antagonists	Contralateral; m. quadratus lumborum, m. external and internal oblique, m. latissimus dorsi, erector spinae
Neutralizers	Erector spinae neutralizes flexion force created by obliques, intrinsic stabilization system creates posterior force on lumbar spine to neutralize lumbar extension, m. rectus abdominis and m. Psoas prevent anterior pelvic tilt
Stabilizers	m. rectus abdominis, m. Psoas, intrinsic stabilization subsystem
Fixators	All musculature of the hip, especially gluteals

Table 5 Trunk rotation kinesiology

Movement	**Trunk rotation**
Prime movers	Contralateral m. external oblique and ipsilateral m. internal oblique
Synergists	Ipsilateral m. latissimus dorsi, contralateral m. psoas
Antagonists	Opposing m. external and internal oblique
Neutralizers	Erector spinae neutralize the flexion force created by the obliques, m. quadratus lumborum neutralizes lateral flexion force created by obliques, m. rectus abdominis prevent anterior pelvic tilt created by m. latissimus dorsi
Stabilizers	Intrinsic stabilization subsystem
Fixators	All musculature of the hip, especially gluteals

Table 6 Trunk flexion and rotation kinesiology

Movement	**Trunk flexion and rotation**
Prime movers	m. rectus abdominis, contralateral m. external oblique, ipsilateral m. internal oblique
Synergists	Ipsilateral m. latissimus dorsi, contralateral m. Psoas
Antagonists	Opposing m. external and internal obliques, erector spinae
Neutralizers	m. quadratus lumborum neutralizes the force created by obliques
Stabilizers	Intrinsic stabilization subsystem

Fixators	All musculature of the hip, especially gluteals

(13)

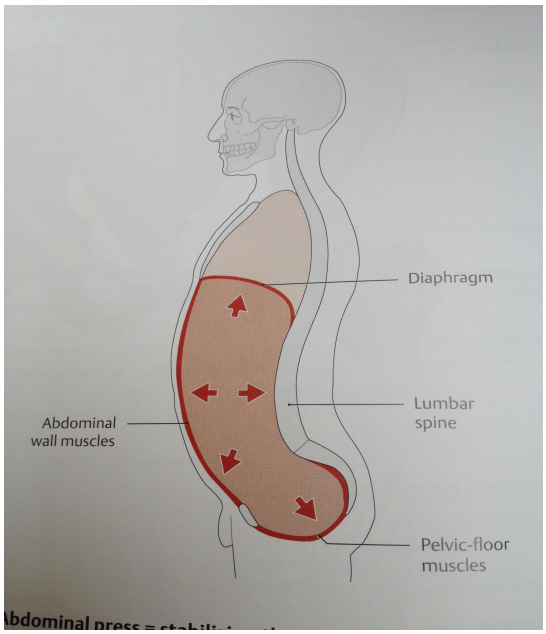

Figure 5 Simplified function of abdominal wall muscles

2.2.1 The lumbar curvature:

The curve of the lumbar spine, and indeed the rest of the spine, depend on the position of the pelvis:

- The **backward tilt** of the pelvis decrease the lumbar lordosis and influence the whole body bearing. The flattening of spinal curve decreases the occurrence of discopathy.
- **Forward tilt** of the pelvis increases lumbar lordosis. This position overloads the hip joint and escalates coxarthrosis.
- **Sideward tilt** causes a compensatory scoliosis of the spine.

2.2.2 Range of motion in lumbar spine:

The ROM varies greatly both with each subject, but also factors like aging, gender, previous sports etc.

Table 7 ROM in lumbar spine

Movement	**ROM**
Flexion	40 deg

Extension	30 deg
Lateroflexion	20-30 deg

(8)

2.3 Biomechanics of the lumbar vertebral column and sacrum

Mechanical loading is good for the back. The bones, muscles, ligaments and discs of the spine are all capable of adapting to physical exercise by becoming stronger, and this makes them less vulnerable to injury. The old myths about the harmful effects of physical exercise are gradually being discredited, as is the use of bed rest as a treatment for back pain. We now emphasise the importance exercise in maintaining the health of the musculoskeletal system. The new "enemies" of a healthy spine are; genetic inheritance, unhealthy lifestyle, the human personality and poor posture. Usually, all these factors, plus more, combine rather than one factor bringing low back pain.

Design:

In mechanical terms, the lumbar vertebral column is a device that

- Provides axial rigidity to the abdominal portion of the trunk
- Separates the thorax from the pelvis
- Provides movement in all planes
- Enables certain movements between the thorax and pelvis
- Is an origin for parts of the abdominal muscles
- Offers points of attachment for m. Lattisimus Dorsi
- Movement vs. stability

Disorders of the lumbar spine may present impairment of one or more of these functions.

(5)

2.3.1 Biomechnical properties

2.3.2 Rigidity

Axial rigidity is the main feature that separates vertebrates from soft body molluscs. Also called stiffness, or resistance to bending or collapse. This is essential for walking upright against gravitation. In order to do this and provide movement, the lumbar vertebrae has intervertebral discs, ligaments, muscles and fascia surrounding them.

2.3.3 Separation

The essential component of the vertebrae is its vertebral body. This is a block of bone, rectangular in profile (side view), with flat superior and inferior surfaces and semi-columnar in top view, with curved anterior and lateral surfaces, but with a flat posterior surface. Because of the height of each vertebra body, the lumbar vertebral column is endowed with length, and thereby separates the thorax from the pelvis. This is crucial to make space in which the thorax can move relative to the pelvis. Larger space equals more movement.

2.3.4 Compression

Under the weight of the thorax, and of any load carried in the upper limbs, will exert a compression load on the lumbar spine. These loads are amplified by the contraction of the back muscles that control the position of the upright lumbar spine. Consequently, the lumbar spine is designed to withstand heavy force. Each lumbar vertebra consists of an outer shell of cortical bone (like a box). Although very strong, this shell is not strong enough to sustain the axial loads that normally fall on the lumbar spine. This is why narrow struts of bone called Trabeculae reinforce the vertebral bodies internally, both horizontally and vertically. The vertical Trabeculae act like columns that transmit compression loads from the upper surface of the vertebral body to its lower surface. The horizontal Trabeculae helps the vertical by preventing them from buckling sideways under large compression loads. The lumbar spine is also curved, to better deal with loads, in what we call lumbar lordosis.

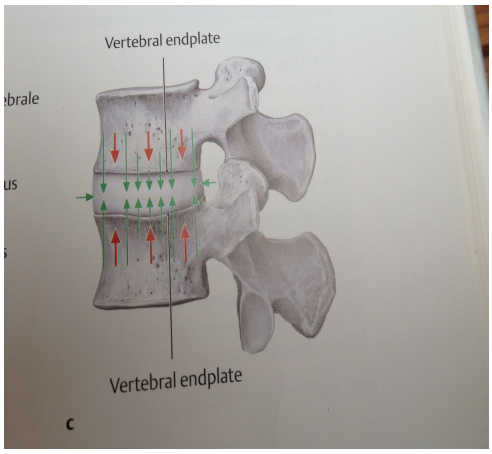

Figure 6 pressure applied

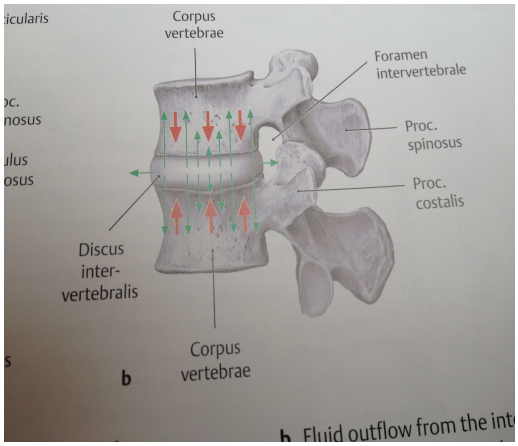

Figure 7 pressure released

2.3.5 Mobility

In order to be mobile, the lumbar spine requires joints. The principal joints are between the vertebral bodies. They occur between the inferior surface of one vertebra and the superior surface of the next. Each is a secondary cartilaginous joint, in which an intervertebral disc separates the bodies. The structure of the joints allows movement in all planes, and the total mobility of the lumbar spine is the sum of mobility of its five joints.

(5)

2.3.6 Intervertebral discs

The intervertebral discs are designed to separate lumbar vertebrae, this produces a potential space between them where to bodies can move in relation to one another. To do this, each disc needs height, but in order to allow movement, the tissue of the disc must be very flexible. It also needs to be and stiff and strong in order to sustain the compression loads between the vertebral bodies. The essential component is the annulus fibrosus. This consists of 10-20 sheets of collagen (lamellae), tightly packed together in a circumferential fashion around the periphery of the disc. When packed together, the lamellae are stiff, and can sustain huge compression loads.

Being collagenous, the annulus fibrosus is sufficiently flexible that it can deform and thereby enable bending movements between the vertebras. However, here lies the liability of the annulus fibrosus. If it buckles and loses its stiffness, and is less able to sustain compression loads. To counter this, the annulus fibrosus requires a second component of the vertebral discs- nucleus pulposus. The nucleus pulposus is a hydrated gel located in the center of each disc. When compressed, the semi-fluid mass expands in a radial fashion. Radial expansion is resisted by the surrounding annulus fibrosus, but on the other hand, the expansion braces the annulus fibrosus from the inside. This preventes it from buckling inwards and losing its stiffness. By this cooperation, the stiffness of the disc is maintained against compression loads, but both tissues are sufficiently compliant that they allow some degree of movement between the vertebral bodies.

The third component comprises the superior and inferior vertebral end plates. These are plates of cartilage that cover the superior and inferior aspect of the discs, and they bind the disc to their respective vertebral body.

In addition to enabling bending movements between vertebral bodies, the intervertebral disc allows twisting movements and sliding movements of small amplitude. These are resisted by tension developed in the collagen fibres of the annulus fibrosus and their amplitude is a function of the elasticity and tensile stiffness of the annulus.
(12)

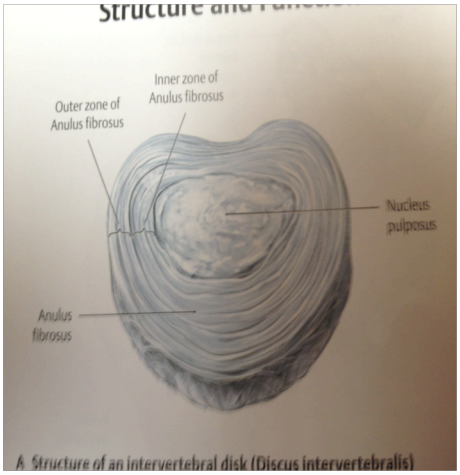

Figure 8 Intervertebral Disc

2.3.7 Disc height

Each lumbar intervertebral disc is about 10mm in height. Collectively, the five lumbar intervertebral discs contribute 5cm to the length of the lumbar spine. During activities of the daily living in an upright position, water is squeezed out of the lumbar discs and they lose height. After rest in lying position, this height is restored as water is re-absorbed. The height is restored after fex. a nights sleep. Contrary to other organs and functions, disc height is preserved with age. However, disc narrowing can occur in certain disorders of the disc. Any disorders that disrupt or degrade the proteoglycans of the nucleus polposus will impair their water-binding capacity and compromise the ability of the disc to maintain its height. In more frequent pathophysiology, poor posture can influence the discs, and applies more strain than normal, making a person more likely to suffer from for example disc herniation.

2.3.8 Movement

The vertebra bodies and discs form a column that provides rigidity and length, as well as permitting movement. They strongly resist compression, and easily bear the loads of the trunk and upper extremities. Flexion is achieved by each intervertebral disc compressed slightly anteriorly, and is resisted by developing tension in the posterior annulus fibrosus. Extension and lateral flexion are achieved by corresponding events in the opposite direction and in the coronal (frontal) plane. Rotation of the lumbar spine is

achieved by each disc allowing a small degree of twist, and is also resisted by building tension.

However, these structures alone are relatively unstable and susceptible to injury. In order to maintain stability and afford control of movements, the essential lumbar vertebral column requires additional elements. These are the posterior elements of the lumbar vertebrae.

2.3.9 Posterior elements

Are designed to control the position of the vertebra bodies. Forces may be exerted directly by muscles acting, or indirectly by loads on the thorax trying to bend or twist the lumbar spine. In the upper end of its posterior surface, each lumbar vertebra is endowed by with a pair of stout pillars of bone called pedicles. These support and transmit forces from them to the vertebra bodies, and vice versa. From both pedicles, a plate of bone (lamina) projects towards the midline. At the midline, the laminae fuse. Here they form the neutral arch, which together with the posterior surface of the vertebra body encloses a space and channel, called vertebral foramen. At the junction of its two laminae in the midline, each lumbar vertebra bears a spinous process that projects dorsally in the shape of an axe. Projecting laterally from the junction of the pedicle with its lamina on each side is a long rectangular, flattened bar of bone called the transverse process. On its posterior surface, near its root each transverse process bears a thick, but narrow spike of bone called the accessory process. These processes are sites of attachment for muscles that control the lumbar vertebral column, and endow these muscles with lever-arms. From its superior, lateral corner, the lamina has an extension of bone called the superior articular process. On its medial surface, the superior articular process presents an articular facet that is covered by articular cartilage. On its dorsal surface, each superior articular process has a small bump, the mammillary process, which is a site for muscle attachments. From its inferior, lateral corner, the lamina gives rise to an inferior articular process that bears an articular facet on its lateral surface. The superior articular processes of one vertebra receive the inferior articular processes of the vertebra above to form zygapophysial joints. These joints allow certain movements, but limits or prevent others. When the vertebral foramina are vertically aligned, there is a canal of nerves and arteries/veins, called the vertebral canal. Foremost, the canal transmits the lower end of the spinal cord and the

roots of lumbar, sacral and coccygeal nerves. The resting shape of the intact lumbar column is lordosis (concave posteriorly).
(5)

2.3.10 Ligaments

Many of the structures called ligaments are in fact not true ligaments, but can serve as it due to its strength and rigidity. They either do not connect two bones, or they are too fragile to serve as ligaments. Topographically though, the ligaments of the lumbar spine can be classified into four groups:

1. Those ligaments that interconnect the vertebral bodies.
2. Those ligaments that interconnect the posterior elememts.
3. The iliolumbar ligament.
4. False ligaments.

(14)

The most definite ligament is ligamentum flavum. It consists of elastin that connect the lower end of the internal surface of one lamina to the upper end of the external surface of the lamina below. This is a very extensible ligament that stretches when the lumbar vertebral column bends forwards. It consists of elastin in order that upon resumption of the neutral posture of the lumbar spine after flexion, the fibres of the ligament can recoil and shorten, without buckling. A collagen-ligament could resist flexion as well as ligamentum flavium, but it would not be able to shorten. The result would be buckling inwards towards the neural elements within the vertebral canal, with risk of compression. The advantage of an elastic ligamentum flavium is that it ensures that the neural elements always face a smooth, flat surface. We also have thin sheets of collagen fibres connecting both the transverse processes to each other, and the spinous processes. These structures are too insubstantial to function as ligaments, but they separate the ventral muscle compartment from the dorsal. They can also function as tendinous fibres of erector spinae muscles. In addition to the ligaments of the posterior elements, ligaments that connect the vertebral bodies reinforce the lumbar vertebral column.
The strongest ligament attached to the lumbar vertebral column is the iliolumbar ligament. Its fibres arise from the lateral angle of the transverse process of the fifth

lumbar vertebra, and pass backwards and laterally to the ilium. They anchor L5 on the pelvic girdle to prevent it from sliding forwards and rotating.
(5)

2.3.11 Zygapophysial joints

The zygapophysial joints provide an important locking mechanism between consecutive lumbar vertebrae. They block axial rotation and forward sliding of the lumbar vertebrae. By doing this, they protect the intervertebral discs from excessive torsion and dislocation of the vertebral bodies under the weight in forwards flexion. For example in rotation, the posterior elements of the moving vertebra swing laterally in a direction opposite of the rotation. To block this rotation, zygapophysial joints are arranged to block lateral displacement of the posterior elements. If the upper vertebra rotates to the left, its right inferior articular process will ram into the apposing superior articular process. This locking mechanism limits axial rotation at each vertebral joint and protects the intervertebral disc from torsion.
(14)

2.3.12 Sacrum

The sacrum is a solid bone that supports the lumbar vertebral column. It is also an important part of the pelvic girdle, which serves to transmit forces between the spine and lower limbs. It is triangular in shape, with a broad end tapering to a blunt point inferiorly. In profile the sacrum is curved with a smooth, concave anterior surface and a rough convex posterior surface. The whole bone is designed to articulate and connect the trunk with the pelvis. Consisting of five vertebrae fused together, each represents a rudimentary vertebra. A narrow block of bone has replaced the intervertebral disc, as they are no longer needed without intervertebral movement. The “remains” of the transverse processes are also fused to form a single mass of bone. More medially, foramina are formed. These foramina anteriorly on sacrum transmit the anterior rami of the sacral spinal nerves, which is very important for the lower extremities. Posteriorly, the sacral segments act closer to the posterior elements of the lumbar vertebra. In the midline, we find the spinous processes. At their side, the laminae are fused between consecutive segments. This is lacking from the fifth sacral segment, leaving a hole

called the sacral hiatus. The hiatus constitutes the inferior opening of sacral canal that passes through sacrum, continuing the lumbar vertebral canal. The fifth sacral segment presents a pair of articular processes that articulate with the coccyx. They flank the sacral hiatus like horns, and for this reason, they are called sacral cornua. The superior end of sacrum has a central surface that resembles the superior surface of a lumbar vertebra, and it receives the L5-S1 disc. In an upright position, the sacrum inclines forwards, with an angle of about 50 degrees.

This compromises the base for the lumbar vertebral column, because it invites the lumbar column to slide forwards and downwards across the sloping superior surface of sacrum.

We have three designs working against this tendency. First, the L5-S1 intervertebral disc is wedge-shaped to lessen the angle between sacrum and lumbar spine. Secondly, the superior articular processes of the sacrum face backwards at 45-90 degree angle in the sagittal plane. The result is that the inferior articular processes of L5 hook onto the sacrum, preventing the lumbar vertebral column sliding forwards. Last, iliolumbar ligaments secure the transverse processes of L5 to ilium. These large ligaments prevent forward displacement of L5 in relation the sacrum and pelvis. The lateral surface of the sacrum presents a large, articular surface with rough ligamentous area behind it. Here, the sacrum locks onto the pelvic ring through the sacroiliac joint. (14)

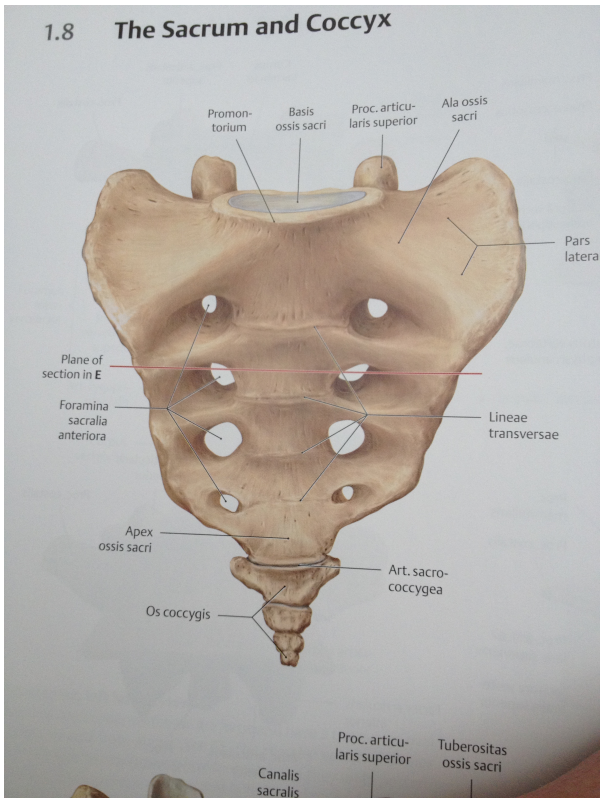

Figure 9 Sacrum and coccyx anterior view

2.3.13 The sacroiliac joint

The SI joint is a synovial joint between sacrum and ilium. Articular surfaces makes sure that the bones are secured properly.

Unlike the typical joints in the limbs/spine, the SI joint is designed not to allow range of motion, but restrict it. Range of motion in this joint should be around 2 degrees. There are no muscles that act to produce active movements of this joint. The SI joint is designed to act as a stress-relieving joint in the pelvic girdle. When walking, the pelvic girdle is subjected to twisting forces (we can compare to twisting a ring towards an eight-figure). The forces are so great that, if there had been a single bone, it would have cracked. This phenomenon can be seen in elderly in whom the SI joint has fused as a result of aging or disease. By having the SI joint, the pelvic girdle avoids cracking. Because of this, strong ligaments that absorb the stress applied to the pelvic girdle during gait surround the SI joint. The strongest is called interosseous sacroiliac ligament. This ligament is short but thick. Tension within the ligaments on both sides keeps ilium pressed against the sacrum. Injuries that tear or slack this ligament, like pregnancy, can compromise the integrity of the SI joint by relaxing the pressure of

ilium against sacrum. Several other ligaments reinforce, though. Posteriorly, the long and short posterior SI ligaments connect ilium to the posterior surface of sacrum. Anteriorly, the capsule of the joint is thickened to form the anterior SI ligament. It prevents the anterior edges from separating. A way from the SI joint, the sacrospinous and sacrotuberous ligament anchor sacrum to the spine of ischium and the tuberosity of ischium. They prevent forward rotation of the sacrum.
(5)

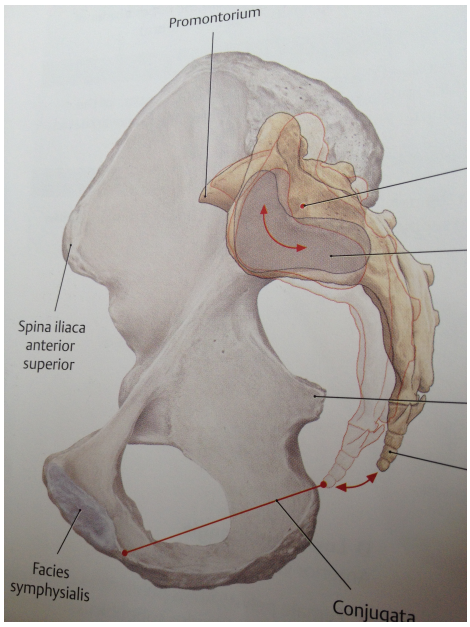

Figure 10 The sacroilic joint movement

2.4 Etiology and epidemiology

Lumbago is a common musculoskeletal symptom/diagnosis and collective term for nonspecific low back pain and includes many conditions that have in common that they cause pain in the lumbar spine. A variety of diseases and disorders can affect the lumbar spine. In lumbago, no neurological damage has been done, opposed to sciatica where the sciatic nerve is affected and pain radiates down the legs.
(6)

2.4.1 Definitions

2.4.1.1 Acute lumbago

A tear or a muscle sprain, usually occurring within 24 hours of heavy lifting/overuse of the low back, most commonly causes acute low back pain that does not extend to the leg.

2.4.1.2 Chronic lumbago (more than 3 months)

Can have several possible causes, most notable:

- Mechanical- Chronic strain of the muscles of the low back may be caused by obesity, pregnancy, uncomfortable position at work, bending or other stressful postures.
- Psychogenic- Back pain that is out of proportion to a minor injury, or that is unusually prolonged may be associated with a somatoform disorder or other psychiatric disturbance.

(12)

2.4.2 Causes

In the lumbar region there are several muscles that can cause pain, especially during inactivity and excess or unnecessary strain. The spine of the lower back is often the victim of postural errors, distortions and scoliosis. This can cause overloading of the muscles along the spine. Strain and changes in intervertebral discs often cause pain. This can be seen on radiographs as reduced disc height and calcification along the edge of the vertebrae. Back pain, decreased function, weakened muscles and/or muscle weakness in the interaction of the hip and spine is very common and is often due to inactivity. Along the spine there are ligaments that can become inflamed and cause pain. The stability of the trunk and posture are usually two very important factors leading to overloaded muscles, because poor posture and trunk stability leaves some muscles overused, while other important muscles can be almost inactivated.

(21)

2.4.3 Clinical picture

Although very varied in both clinical picture and symptoms, there are several clinical signs that can reveal lumbago. A patient can have every symptom, or just a few.

- Pain across the lower part of the back that sometimes radiates into the buttocks, the back of the thigh or to the groin. The pain is usually worse on movement.
- Limitation in movement of the spine, especially flexion and extension.
- Spasms of the muscles surrounding the spine and causing a stiff back.
- With severe pain and spasm, the back may tilt to one side causing a change in posture or a limp.

- The pain is sometimes accompanied by a tingling sensation or numbness in the back or buttocks or leg, which may pass right down into the foot. This is called sciatica, and it indicates irritation of the sciatic nerve, which passes down from each side of the spine to the feet.
- Poor posture.
- Poor cooperation between m. Diaphragma and the pelvic floor muscles.
- Antalgic gait.

  (12)

2.4.4 Diagnosis and clinical examination

To diagnose lumbago, we need to collect important data from the anamnesis, as this often can gives a good idea about the problem, as well as a thorough clinical examination. Important factors in the anamnesis include location of pain (if possible), severity of the pain, if the pain increases (or decreases) with a specific movement or at a time of day.

Imaging methods as MRI, X-ray or ultrasound can help to exclude such as disc herniation, fracture etc.
(16)

Examinations include:

- Posture examination
- Dynamic spine tests
- Pelvis examination
- Palpation of skin, fascia and muscles
- Gait examination (tip toes and heels)
- Muscle length test of lower extremity muscles
- Joint play according to Lewit
- Sensation of dermatomes in the lower extremity
- Deep tendon reflexes of lower extremity
- Breathing examination
- Movement patterns (legs- abduction and extension)

- Special tests; Patricks sign, Laesegue, Trendlenburg, Vele test, Thomayer, Romberg

(9)

2.4.5 Treatment

The main goal of treatment is to achieve adequate pain relief for the patient can resume normal activity, because the activity itself the important measure of healing. Short-term drug treatment or other symptomatic measures such as manipulation may be required. Previously, it was common to recommend rest for back pain, but it is now becoming more common recommending activity and exercise. In Norway, the most used treatment method is suspension training and sling treatment. These types of exercises have been shown to have good results for many back problems. The aim of the sling treatment is to enable weakened /inactive muscles, restore normal muscle interaction and thereby relieve the overloaded muscles. In many cases this will cause immediate pain relief and improved function. It is also very important to correct the posture and cooperation of trunk stabilizators. There is no proven therapy that has a completely positive effect, although therapy according to McKenzie has shown to have a good effect on acute cases.

(3,4,7,9,10,20)

2.4.6 Therapeutic approaches

The therapy for lumbago should follow symptoms, and should be focused on getting the daily life as unproblematic as possible, as well as relieving pain. We have ranges of different approaches, and the therapy of acute and chronic pain varies. Usually it is smart to start with several types of therapy, and find what works best for the patient. It is very useful to combine manual exercises or strengthening with physical therapy that targets the secondary problems, like pain, hypertrophy or oedema. Here we can use electricity (TENS or other low frequency currents), ultrasound, laser (flat applicator over large area, point laser for deep penetration), heat (hot roll, parafango), and deep oscillation to name a few.

In more manual techniques we also have lots of possibilities, but the essentials of it is to stretch shortened muscles, get the joints moving, strengthening weak muscles and improving the breathing pattern. This should improve the function greatly and decrease the pain. PIR according to Voss of shortened, overused muscles (m. iliopsoas, hamstrings, m. piriformis etc.) can be smart to decrease shortness, pain and Trp. If the

patient has wrong movement patterns in the lower extremities, we can do PNF to activate the muscles in inactivity while relaxing others against or without resistance. SST can be used to relax overused muscles and remove the Trp, and the patients find it very soothing. Joint play of vertebrae or pelvic girdle (SI joint) can open joints that have been locked, and this can relax or improve function of the patient.
(18, 3, 4, 9, 17,20)

2.4.7 Dynamic neuromuscular stabilization

DNS according to PaedDr. Pavel Kolar is a method of intrinsic locomotor system stabilization. It is a manual rehabilitive approach to activate the integrated stabilization system to improve function of the whole body. It is used as an overall strategy designed to better understand the neurophysiological principles of locomotor function. Dr. Kolar based the concept on the scientific principles of developmental kinesiology and reflex locomotion (according to Vojta). It concentrates on movement patterns from developing babies, and the cooperation between diaphragm and pelvic floor diaphragm, and thereby connection of the trunk and lower extremities. He focuses on not one muscle, but muscle chains. If the stabilizing system of the spine is working correctly, low back pain due to for example poor posture, can be diminished. If one muscle (or even a part of it, like Trp) is dysfunctional, then the whole stabilizing function is disturbed. To apply this theory in exercise we use specific functional exercises that target the integrated stabilizing system. The ultimate strategy is to teach the brain to maintain central control and stability of movement restored during therapy sessions. This is achieved by activation of the stabilizers when placing the patient in the primal developmental positions.
(23)

2.4.8 Pharmacology

Some people find conventional painkillers such as paracetamol or aspirin can be effective as the first-line treatment for symptoms of back pain. In some cases, anti-inflammatory drugs such as ibuprofen can be used. The doctor may also prescribe other similar drugs in stronger doses, depending on the specific needs of the individual. Spasmolytics like carisoprodol and cyclobenzaprine are also commonly prescribed as muscle relaxants.
(18)

2.4.9 Surgical intervention

Low back surgery is only capable of correcting anatomical conditions that result in either spinal instability or nerve pinching. If either of these problems is present on an imaging study and the patient's symptoms fit with the clinical and radiographic picture, then spine surgery may be indicated. The two important factors for a surgeon will be the level of pain and functionality level.
(19)

2.4.10 Self-treatment

If one suffers from lumbago, a few easy points will surely improve the condition:

- Regular gentle exercise- walking, swimming or back-pain exercises
- Reduce excess weight-bearing
- Reducing stress, or managing stress better
- Improving the posture in sitting and standing
- Take care when lifting heavy objects
- Breathing through the abdomen, rather than the chest
- Hot and cold treatment, like a hot bath or an ice pack
- Relaxation, relieve muscle tension

2.4.11 Prognosis

The prognosis is good for acute low back pain, but symptomatic measures may be necessary, although no specific treatment interventions have documented significant effect on the group level.

For chronic pain as in acute, it is much easier to get rid of the pain for a while rather than curing it. To completely rid one self of chronic low back pain, there are several important things to consider, and one needs to take the rehabilitation very seriously to obtain good results. Usually, a change in posture, daily living routines, and a more active lifestyle is needed. There are of course exceptions, but if no neurologic damage is done, the therapy progress should be steady towards full recovery.

3 Special Part

3.1 Methodology

The bachelor practice took place in Monada, which is a private clinic southeast in Prague. I was there from 3.2-14.2 2014. The clinic specializes in neurologic diseases, joint pain, postural inefficiencies, disk herniation, cervical spinal pain, headaches and migraines to name a few. They also specialize in child motor disorders, and we saw many children with different diagnoses. (22)

My time there was supervised by Mgr. Veronika Sedlicka, she specializes in DNS by Kolar. Everything I have done in the practice has been in cooperation or supervision by her.

My case study was fully informed from the first day we met, and this has been approved by the ethics committee of the faculty of physical education and sports at Charles University in Prague. The ethics form can be found near the end of the thesis.

3.2 Initial kinesiologic examination

Examined person: I.N (f)

Date of birth: 15.12.1965

Diagnosis: Sacral lumbago, lumbar lumbago and lower thoracic lumbago. M545 and M546.

Status presens:

Subjective: The patient is in a good mood when we meet her. She says there is no pain now, because she came right from a lymphatic massage. She will stay at Monada for a week.

Objective: Moving very carefully. Antalgic gait in the stance phase.

Height: 165 cm

Weight: 75 kg

BMI: 27,5

3.2.1 Anamnesis

Chief complaint:

Lumbar, sacral and thoracic lumbalgia/vertebroalgenic. Especially problematic in positional change and heavy loading. The patient has several jobs, which makes it hard for her to find time to exercise and/or treat the problem. No irritation symptoms, no radicular irritation. Hyperkyphosis of Th spine. Hypermobility and severe muscle dysbalance.

History of present problem:

Problems started when she was young and fell from a garage. Maximum of problems in lumbar part spreading to hips, but not to the legs. Has trouble sleeping through the pain, so feels tired throughout the day. The pain has increased in quality and quantity after the hysterectomy.

Family history:

No one in her family has any back problems, both parents are still healthy.

Medical history:

Bad contusion of the low back when she was 10 years old. She fell from a garage on her back, breaking a finger on the right hand in the process. She has also had problems with drain of lymphatic fluid in her lower extremities since she was 20 years old, and drain mechanically by massage regularly. Suffers from hypothyroidism. Rheumatologic examination last week with suspected M.bechterev, but the tests were negative.

Past surgeries:
Total hysterectomy in 2010, appendectomy in 2004. Both were done by laparoscopy, and she does not have any problems with scars or movement of the area.

Medication:
I.N is on Eutirox for hypothyroidism, plus infusion with ¼ .liters daily; Natrium-salicilicum, Novalgin, mesochain (1%) and magnesium (to hinder cramp twice a week). She also uses Milgama (vitamin B6), and has one injection every week. She used to take Paracetamol regularly, but has stopped because of lack of effect.

Allergies:
None.

Abuses:
Non-smoker and non-drinker.

Gynecological anamnesis:
One pregnancy, no period after the hysterectomy.

Living situation:
Lives with her son in a 1st. floor apartment.

Occupation:
Nurse, teacher and works in a nails salon. She is used to heavy lifting from being a nurse at a retirement home.

Sport:

Swims once a week (breaststroke), curling once a week, also does an abdominal exercise program daily.

Prior rehabilitation:

Went to physical therapy for a month in 2012, but did not have the effect they had hoped. They used ultrasound and diadynamic currents, both were applied between the scapulas. She also had regular massages and vacuum therapy, but stopped when the effects stalled.

Excerpt from patient's health care file: X-ray examination- conclusion:

-Wedged vertebras Th8-10

-Thoracic hyperkyphosiskyphosis

-Flat lordosis

-Horizontal position of the sacral bone

-L5-S1 space is angular

-Intervertebral spaces without are OK

-No instabilities.

3.22 Examination by physiotherapist

Posture:

Back

- Swelling of both whole legs

-Sinister convex scoliosis in Thoracic- spine

-Hypertrophy of upper Trapezius

-Barrel chest

-Left shoulder is higher

-Lower angle scapulae are protruding

Left/Right Side

-Plantar flexion of ankles

-Hyperextension in both knees

-Hyperlordosis of lumbar spine (L3-L5)

-Hyperkyphosis of middle Thoracic spine

-Protrusion of shoulders and head

-Apparent upper and lower cross syndrome

Front

-Bad circulation of lower extremity

-Hallux valgus on the right foot

-Varosity of the ankle

-Femur in internal rotation

-Overactive upper part of rectus abdominis, weak in lower part

-Left clavicle protruding

-Overactive Sternocleidomastoideus.

3.2.3 Pelvis examination

Slight retroversion, but within physiological limits. Everything else is in line.

3.2.4 Dynamic spine tests

Flexion/Thomayer: Hypermobile, able to hold palm on the floor, little movement of lumbar spine. Very rigid movement.

Extension: Good ROM, most of the movement happens in lumbar spine. Feels uncomfortable for the patient.

Lateroflexion: No problem to either side. Good ROM, no pain and fluent movement.

3.2.5 Gait

Forwards:

-Short heel strike

-Little rolling

-Wobbles

-Hyperactivity of low back

-No use of toes

Backwards:

-Much hesitation

-Unstable (side to side)

-Using toes

-Anteversion of pelvis

Tip toes:

-Better balance to the sides

-tires quickly

Heels: -

Very unsteady, not able to perform it correctly

3.2.6 ROM

Table 8 ROM in hips special part

Lower extremities: Hips	Right	Left	Note
Flexion	120	120	Physiological
Extension	15	15	Physiological
Abduction	40	45	Slight difference, minimal
Adduction	20	20	Physiological
Internal rotation	25	30	Slightly hypomobile, right being worst, soft barriers
External rotation	45	45	Physiological

3.2.7 Muscle length test according to Janda

Pectoralis major: Shortened on both, right side has softer barrier.

Flexors of the lower extremity: Right: No shortness, soft barriers. Left: Adduction of leg, but soft barrier. The other muscles have good ROM and soft barriers.

Hamstrings: Both reach 90 degrees in passive supine line, no pain.

Piriformis: slight shortening of both, no difference, but the patient gets cramp fast.

3.2.8 Joint play according to Lewit

Sacroiliac joint- both sides have solid movement and a soft end feel.

Springing of lumbar/lower thoracic spine- Up to Th4 the movement is good, but from Th5-Th9 it is very stiff, almost no motion.

Lumbar spine in all directions: L5-L3 is hypomobile and rigid, and L1-L3 is hypermobile.

Unspecified springing of lower ribs- the ribs all move fine, soft end feel.

Traction of the hips: slightly hypermobile, no pain.

Patella: Moves fine lateromedially, but smaller movement and rigidity in craniocaudal direction.

3.2.9 Palpation

Skin and fascia of the trunk: Anterior- Skin and fascia is slack/hypermobile, there is a lot of excess skin. The exception is the fascia around the upper rectus abdominis. There, the fascia is stiff and rough. Posterior- Same results, but the stiff place on the back is over Trapezius. Here the skin and fascia moves worse and rougher in all directions.

Muscles:

Iliacus: In hypertone, painful upon palpation.

Quadriceps: In hypertone, but not painful touching.

Paravertebral muscles L-spine: Hypertrophy and hypertone, some pain when touched.

Paravertebral muscles Th-spine: Hypertrophy and hypertone, very painful when touched. Positive spine-sign.

Intercostal muscles: Slightly painful, low mobility of ribs.

Rectus abdominis: Lower part seems to be in hypotone, while the upper part is in hypertone with trigger points. Painful in touch.

Transverse abdominis: Weak and in hypotone.

3.2.10 Neurologic examination

Table 9 Sensation in dermatomes on the lower extremity

Dermatome	Sensation	
	Left	Right
L2	Normal	Normal
L3	Normal	Normal
L4	Normal	Normal
L5	Normal	Normal
S1	Normal	Normal
S2	Normal	Normal

Deep reflexes:

Table 10 Deep reflexes

Tendon tested:	Tendon reflex	
	Left	Right
Patellar (L2-4)	Physiological	Physiological
Achilles (L5-S2)	Physiological	Physiological
Medioplantar (L5-S2)	Physiological	Physiological

Note: On the place with hyperkyphosis (upper thoracic area) straight over the spinous processes, there is lower sensation. We took two fingers there and asked I.N how many fingers we pressed, she said one. In all other areas, the sensitivity is good.

3.2.11 Breathing

I.N has what seems to be the beginning stage of a barrel chest. The mobility and shape of the rib cage is rounded and she breaths shallow with the upper thorax and neck. Not able to breathe to a point around the inguinal line without the support of muscle contractions.

3.2.12 Movement pattern

Leg abduction: Quadratus mechanism in both legs.

Leg extension: No activity in thoracic paravertebral muscles, hyperactivity of lumbar paravertebral muscles.

3.2.13 Special tests

Patrick`s sign: Negative

Laesic: Negative

Trendlenburg: Negative, but unstable on one foot.

Vele test: Negative

Thomayer: Hypermobile, palms on the ground.

Romberg: Negative

3.2.14 Conclusion of examination

I.N has spinal curves that would suggest pain and low stability in the spine. The low lumbar hyperlordosis and middle thoracic hyperkyphosis gives problems to surrounding soft tissue, therefor she has several hypertonic muscles with trigger-points. She is not as

active as she should have been, but is very eager to work hard this week. We need to work on movement patterns of the lower extremity and to stabilize the pelvic floor muscles, because she needs much better stability to get rid of the pain. We also need to increase the mobility of the thoracic area of the spine, and try to lengthen the whole spine. She is breathing shallow, upper thorax breaths, which does not help either stability or the low back pain. The lymphedema in the lower extremity is not good, but the doctors will address this with frequent mechanical drainage.

3.2.15 Goal of therapy

-Better stability of the trunk

-Decrease of pain and stiffness

-Relax hypertonic muscles

-Activate weak muscles

-Improve circulation of lower extremity

-Straighten the spine

-Improve deep breathing

-Improve movement pattern

-Improved ADL

-Improve joint play

3.2.16 Therapy proposal

-Stabilization exercises for activation of pelvic floor muscles

-Relaxation/removal of trigger-points in upper rectus abdominis

-Correct pathological movement pattern in the lower extremities

-PIR of hypertonic muscles

-Sensory motoric stimulation of lower extremities

-Breathing exercise to widen the rib cage and push the air down

-Soft tissue techniques on low mobility skin/fascia

-“Big-ball” exercises for the low back pain

-Joint play in spine, especially thoracic spine

3.3 Therapy course

Date: 09.02.14

Status presens:
I.N has pain in her back, but says she can move with relative ease. We can see antalgic gait too suggest she the pain is worse than she tells us. She has just had a lymphatic drain massage, but did not get a positive effect.

Goals of today`s therapy session:
-Straighten the spine
-Activate pelvic floor muscles
-Decrease pain
-Improve stability of the trunk
-Improve ADL
-Improve gait and balance

Therapy proposal:
-Dynamic neuromuscular stabilization
-Sensory motoric stimulation of LE
-Gait exercise
-Activation of deep stabilizing muscles of the spine

Procedure:
Since she is warm from the massage, we start immediately with dynamic neuromuscular stimulation, with I.N positioned on her knees and hands. The patient needs to focus on pushing the thoracic spine down, opening the fingers, stable shoulders and pelvis, relaxing rectus abdominis and breathing out to her sides while moving slightly

forwards. After this we move her supine, to activate the pelvic floor muscles in a comfortable position. Deep breathing against a point anteriorly in the groin.
After the DNS, we continue with gait and balance. We lay a soft mat on the floor, to soften up the contact with her feet. This also makes it harder with balance. I.N is walking in the right stereotype slowly to feel her balance. We then use a balance board in sensory motoric stimulation of the lower extremity. We do not need to push or distract her in any way since this is the first time she tries it.

Results:
After some minutes, I.N is able to breathe deeper and out to points applied. She has problems straightening the spine, but this also gets better after some time. She says the pain decrease with the stabilization exercises. On gait, I.N does not have a good footprint or balance. If we support her when there is need, she is able to concentrate and achieve better results. She is afraid of falling, but improves in gait. She had problems keeping the right position of sensory motoric stimulation, and therefor we did not achieve any positive results.

Self-therapy:
Hands and knees position: We want her to learn this exercise correctly so she can do it at home several times during the day.
Sitting breathing exercise: The patient sits with her hands pushing the rib cage down and to the sides. This relaxes rectus abdominis, and allows deeper, pelvic breathing. She can decide her self if she wants to breathe to a point or just try to expand the waist.

Date: 10.02.14

Status presens: I.N is in a good mood, but is not feeling good. She is very stiff, and careful in every movement. We will try to be as passive as possible today.

Goals of today`s therapy session:
-Straighten the spine
-Activate pelvic floor muscles
-Decrease pain

-Improve stability of the trunk
-Improve ADL

Therapy proposal:
-Dynamic neuromuscular stabilization→ Stabilization of the spine
-Traction of lumbar spine
-Movement pattern training for activities of the daily living
-Activation of pelvic floor muscles

Procedure:
We warm up with checking ROM and fluency in flexion, extension and lateroflexion to both sides. We start with dynamic neuromuscular stimulation, with I.N positioned on her knees and hands. The patient needs to focus on pushing the thoracic spine down, opening the fingers, stable shoulders and pelvis, relaxing rectus abdominis and breathing out to her sides while moving slightly forwards. This is straining her hands, so we move to a position more suited to her. We do this in side lying with a ball under the contralateral leg to support the pelvis. Same procedure and movement as on hands and knees, but without the pressure of her weight.
We also do traction of the lumbar spine in acute state, according to Lewit. The patient finds this comfortable.
ADL training:
-We work on flexion of the trunk with semi-flexed knees, especially to keep the straight spine and move in inspiration.
-We teach her how to keep the straight back when leaning on arms.

Results:
Dynamic spine tests:
Flexion: Better movement particularly in thoracic spine. Still antalgic movement pattern. Painful in first 20 degrees.
Extension: Better movement in thoracic part. No pain.
Lateroflexion: Good movement, no pain.

Self-therapy:
Hands and knees position: We want her to learn this exercise correctly so she can do it at home several times during the day.
Sitting breathing exercise: The patient sits with her hands pushing the rib cage down and to the sides. This relaxes rectus abdominis, and allows deeper, pelvic breathing. She can decide her self if she wants to breathe to a point or just try to expand the waist.

Date: 11.02.14

Status presens: I.N is more relaxed today, and is moving better. She did the home exercises twice, which is good. She also had a lymphatic massage before this session, but it did not give any results.

Goals of today`s therapy session:
-Straighten the spine
-Activate pelvic floor muscles
-Decrease pain
-Improve stability of the trunk
-Improve ADL
-Decrease activity of upper rectus abdominis

Therapy proposal:
-Dynamic neuromuscular stabilization
-Traction of lumbar spine
-Soft tissue techniques on rectus abdominis
-Deep abdominal breathing
-PIR on Pectoralis major

Procedure:
After a warm up with dynamic spine and gait exercise, the patient is ready. We start with dynamic neuromuscular stimulation, with I.N positioned on her knees and hands. The patient needs to focus on pushing the thoracic spine down, opening the fingers, stable shoulders and pelvis, relaxing rectus abdominis and breathing out to her sides

while moving slightly forwards. After this we move her supine, to activate the pelvic floor muscles in a comfortable position. Deep breathing against a point anteriorly in the groin. Then we do PIR on both pectoralis major supine. After this we do unspecific mobilization of the lower ribs by moving them dorsolaterally with the patient supine. The last thing we do is therapy of trigger-points on rectus abdominis. Most of the pain points are located in the upper part.

Results:
The patient is able to breath deeper, ROM of pectoralis major is bigger and patient feels more relaxed after treatment. There is still some pain/aching. No improvement in spine and paravertebral muscles.

Self-therapy:
Same as yesterday. We repeat the positions, so I.N is sure how to do them.
Hands and knees position: We want her to learn this exercise correctly so she can do it at home several times during the day.
Sitting breathing exercise: The patient sits with her hands pushing the rib cage down and to the sides. This relaxes rectus abdominis, and allows deeper, pelvic breathing. She can decide her self if she wants to breathe to a point or just try to expand the waist.

Date: 13.02.14

Status presens:
Subjective: The patient is feeling OK today. She normally has problems in sitting, but yesterday she watched a three-hour movie in the cinema without any problems. Feeling some pain today, but more aching.
Objective: I.N looks to be in discomfort, and is not moving well. She did not do the exercises after last session.

Goals of today`s therapy session:
-Straighten the spine
-Activate pelvic floor muscles
-Decrease pain

-Improve stability of the trunk
-Myorelaxation

Therapy proposal:
-Dynamic neuromuscular stabilization
-PIR of hypertonic hip muscles
-Deep breathing
-Soft tissue techniques of hip muscles

Procedure:
We start with dynamic neuromuscular stimulation, with I.N sitting upright. The patient needs to focus on keeping the good posture, relaxing rectus abdominis and breathing out to her sides. From there, we move on to one-leg raise in the same position, to inspect/correct movement pattern and the stability of the trunk. We also try to promote relaxation in a low kneeling position, where the patient is on elbows and knees in full flexion. This makes it easier for her to feel the movement of the thorax, while straightening the spine and activating transverse abdominis. We do soft tissue techniques on skin, fascia and muscles around the hip (as inspection) and continue with PIR of the hamstrings in supine line, before finishing with PIR of Piriformis in prone position. Patient felt some pain in PIR of Piriformis. These were the two muscles in hypertone and pain during palpation.

Results:
The patient is able to relax rectus abdominis in sitting position, but has problems keeping her posture. The hamstrings have better ROM, and not painful. The therapy for Piriformis did not give any immediate results. Patient is happy and more relaxed after the therapy.

Self-therapy:
Hands and knees position: We want her to learn this exercise correctly so she can do it at home several times during the day.
Sitting breathing exercise: The patient sits with her hands pushing the rib cage down and to the sides. This relaxes rectus abdominis, and allows deeper, pelvic breathing. She can decide her self if she wants to breathe to a point or just try to expand the waist.

We also show her a way to relax Piriformis; by lying supine with one leg crossed over the other. Maximal flexion of the hip, and I.N can use her hands to hold the position and apply pressure.

Date: 14.02.14

Status presens:
Subjective: The patient says she is feeling good in the trunk, but the lymphedema is worse today than before. Can also feel some restriction in the low back, not painful.
Objective: In flexion and lateroflexion of the trunk, there is not much movement from L5-L2

Goals of today`s therapy session:
-Straighten the spine
-Activate pelvic floor muscles
-Decrease pain
-Improve stability of the trunk
-Open blocked joints
-Improve ADL

Therapy proposal:
-Dynamic neuromuscular stabilization
-Joint play of the Sacroiliac joint
-Exercises for the daily living
-Deep breathing→ activation of transverse abdominis

Procedure:
We start with soft stretching of thoracic and lumbar spine, as well as hamstrings, Piriformis and Iliopsoas. When the patient is warm we continue with springing of the Sacroiliac joint (scissors), joint play of lumbar spine in flexion, extension and lateroflexion and last traction of the hips. After this, we move to stabilisation of the trunk. Dynamic neuromuscular stabilisation in sitting position. She concentrates on

keeping the posture and breathing down to her pelvis. From this position, we can work on one-leg raise to stabilize to make the muscles work against more power.
After this we try another position, on all four, hands and knees. We focus on a straight spine (especially in thoracic spine), relaxed shoulders and that everything is in line.
ADL training: First, we work on getting from supine to sitting. I.N needs to fill the abdomen with air before the movement, to increase the space between the vertebras.
At work, I.N has the most problems with transfer of patient, as she often strains her back like this. We therefor practice on two things: Moving patients in bed and from sitting to standing/wheelchair/bed. When she shows us, we quickly see she is using her back instead of her legs to lift the patients. We teach her to stand like a surfer, and how to lock the patient`s legs by pressing her knees against theirs.

Results:

We unlocked the sacroiliac joint on both sides, but did not have the best results in the lumbar spine. The lower segments (L5-L3) is still rigid and hypomobile, while the upper part (L1-L3) is still hypermobile. In traction of the hip, there is no problem, moving fine with soft barriers.
I.N seems to concentrate when we teach her correct movement of the ADL, and does it correctly after a few attempts. It is very important for her to use her legs, not her back when lifting patients at work, and she understands it.

Self-therapy:

Same as yesterday.
Hands and knees position: We want her to learn this exercise correctly so she can do it at home several times during the day.
Sitting breathing exercise: The patient sits with her hands pushing the rib cage down and to the sides. This relaxes rectus abdominis, and allows deeper, pelvic breathing. She can decide her self if she wants to breathe to a point or just try to expand the waist.
We also show her a way to relax Piriformis; by lying supine with one leg crossed over the other. Maximal flexion of the hip, and I.N can use her hands to hold the position and apply pressure.
We also want her to move correctly at home, to prepare for work again.

Date: 14.02.14

Status presens:
Second therapy session today. The patient is feeling good from the last session, but is feeling tension in the upper back/neck.

Goals of therapy session:
-Relieve tension
-Decrease pain
-Improve ADL
-Improve balance
-Straightening of the spine
-Deeper breathing

Therapy proposal:
-Dynamic neuromuscular stabilization
-Sensory motoric stimulation of LE
-Gait exercise
-Activation of deep stabilizing muscles of the spine

Procedure:
I.N has just been doing the self-therapy, so we start immediately with dynamic neuromuscular stimulation, with I.N positioned on her knees and hands. We do not instruct, but want to see how she does it. The patient needs to focus on pushing the thoracic spine down, opening the fingers, stable shoulders and pelvis, relaxing rectus abdominis and breathing out to her sides while moving slightly forwards. After this we move her supine, to activate the pelvic floor muscles in a comfortable position. Deep breathing against a point anteriorly in the groin.
We continue with gait and balance. We lay a soft mat on the floor, to soften up the contact with her feet. This also makes it harder with balance. I.N is walking in the right stereotype slowly to feel her balance. We then use a balance board in sensory motoric stimulation of the lower extremity. We do not need to push or distract her in any way since this is the first time she tries it.

Results:

After some minutes, I.N is able to breathe deeper and out to points applied. She has problems straightening the spine, but this also gets better after some time. I am very happy though, to see the quality of the exercises without our instructions. She is doing it correctly and is able to achieve the goals without supervision. She again says the pain decreases the most with the stabilization exercises.

On gait, I.N does not have a good footprint or balance. If we support her when there is need, she is able to concentrate and achieve better results. She is afraid of falling, but improves in gait. She had problems keeping the right position of sensory motoric stimulation, and therefor we did not achieve any positive results.

Self-therapy:

Same as usual. This is what we get the best results with, and the patient will get bigger improvement now that she is familiar with the exercises, as it requires a lot of concentration.

Hands and knees position: We want her to learn this exercise correctly so she can do it at home several times during the day.

Sitting breathing exercise: The patient sits with her hands pushing the rib cage down and to the sides. This relaxes rectus abdominis, and allows deeper, pelvic breathing. She can decide her self if she wants to breathe to a point or just try to expand the waist.

3.4 Final kinesiologic examination

Examined person: I.N (f)

Date of birth: 15.12.1965

Diagnosis: Sacral lumbago, lumbar lumbago and lower thoracic lumbago. M545 and M546.

Status presens:

Subjective: I.N is in a good mood and feels much better than on Monday.

Objective: Still moving carefully, with antalgic gait. It is better however, and she is more comfortable in the stance phase.

Height: 165 cm

Weight: 73 kg

BMI: 26,8

3.4.1 Anamnesis

Chief complaint:

Lumbar, sacral and thoracic lumbalgia/vertebroalgenic. Especially problematic in positional change and heavy loading. The patient has several jobs, which makes it hard for her to find time to exercise and/or treat the problem. No irritation symptoms, no radicular irritation. Hyperkyphosis of Th spine. Hypermobility and severe muscle dysbalance.

History of present problem:

Problems started when she was young and fell from a garage. Maximum of problems in lumbar part spreading to hips, but not to the legs. Has trouble sleeping through the pain, so feels tired throughout the day. The pain has increased in quality and quantity after the hysterectomy.

Family history:

No one in her family has any back problems, both parents are still healthy.

Medical history: Bad contusion of the low back when she was 10 years old. She fell from a garage on her back, breaking a finger on the right hand in the process. She has also had problems with drain of lymphatic fluid in her lower extremities since she was 20 years old, and drain mechanically by massage regularly. Suffers from hypothyroidism. Rheumatologic examination last week with suspected M.bechterev, but the tests were negative.

Past surgeries: Total hysterectomy in 2010, appendectomy in 2004. Both were done by laparoscopy, and she does not have any problems with scars or movement of the area.

Medication: I.N is on Eutirox for hypothyroidism, plus infusion with ¼ .liters daily; Natrium-salicilicum, Novalgin, mesochain (1%) and magnesium (to hinder cramp twice

a week). She also uses Milgama (vitamin B6), and has one injection every week. She used to take Paracetamol regularly, but has stopped because of lack of effect.

Allergies: None.

Abuses: Non-smoker and non-drinker.

Gynecological anamnesis: One pregnancy, no period after the hysterectomy.

Living situation: Lives with her son in a 1st. floor apartment.

Occupation: Nurse, teacher and works in a nails salon. She is used to heavy lifting from being a nurse at a retirement home.

Sport: Swims once a week (breaststroke), curling once a week, also does an abdominal exercise program daily.

Prior rehabilitation:
Went to physical therapy for a month in 2012, but did not have the effect they had hoped. They used ultrasound and diadynamic currents, both were applied between the scapulas. She also had regular massages and vacuum therapy, but stopped when the effects stalled.

Excerpt from patient's health care file: X-ray examination- conclusion:
-Wedged vertebras Th8-10
-Thoracic hyperkyphosiskyphosis
-Flat lordosis
-Horizontal position of the sacral bone
-L5-S1 space is angular
-Intervertebral spaces without are OK
-No instabilities.

3.4.2 Examination by physiotherapist

Posture:

Back

- Swelling of both whole legs

-Sinister convex scoliosis in Thoracic- spine

-Smaller, but still clear hypertrophy of upper Trapezius

-Barrel chest

-Left shoulder is higher

-Lower angle scapulae are protruding

Left/Right Side

-Plantar flexion of ankles

-Hyperextension in both knees

-Hyperlordosis of lower lumbar spine (L3-L5)

-Hyperkyphosis of middle Thoracic spine (about Th4-Th10)

-Protrusion of shoulders and head

-Apparent upper and lower cross syndrome

Front

-Bad circulation of lower extremity

-Hallux valgus on the right foot

-Varosity of the ankle

-Femur in internal rotation

-Better rectus abdominis, but still hypertone of upper

-Left clavicle protruding

-Overactive Sternocleidomastoideus.

3.4.3 Pelvis examination

Slight anteversion, but within physiological limits. Everything else is in line.

3.4.4 Dynamic spine tests

Flexion/Thomayer: Hypermobile, able to hold palm on the floor, little movement of lumbar spine. Much better movement, painless

Extension: Good ROM, most of the movement happens in lumbar spine. Feels uncomfortable for the patient.

Lateroflexion: No problem to either side. Good ROM, no pain and fluent movement.

3.4.5 Gait

Forwards:

-Longer heel strike

-Little rolling

-Wobbles, but less this time

-Hyperactivity of low back

-Uses the toes

Backwards:

-Much hesitation

-Unstable (side to side)

-Using toes

-Anteversion of pelvis

Tiptoes:

-Better balance to the sides

-Tires quickly

Heels:

-Very unsteady, not able to perform it correctly

3.4.6 ROM

Table 11 ROM in hips final examination

Lower extremities: Hips	Right	Left	Note
Flexion	120	120	Physiological
Extension	15	15	Physiological
Abduction	40	45	Slight difference, minimal
Adduction	20	20	Physiological
Internal rotation	25	30	Slightly hypomobile, right being worst, soft barriers
External rotation	45	45	Physiological

3.4.7 Muscle length test

Pectoralis major: Shortened on both, both sides with a soft barrier.

Flexors of the lower extremity: Right: No shortness, soft barriers. Left: Adduction of leg, but soft barrier. The other muscles have good ROM and soft barriers.

Hamstrings: Both reach 90 degrees in passive supine line, no pain.

Piriformis: slight shortening of both, no difference, the patient gets cramp fast.

3.4.8 Joint play according to Lewit

Sacroiliac joint- both sides have solid movement and a soft end feel.

Springing of lumbar/lower thoracic spine- Up to Th4 the movement is hypermobile, but from Th5-Th9 it is better and bigger movement.

Lumbar spine in all directions: L5-L3 is hypomobile and rigid, and L1-L3 is hypermobile.

Unspecified springing of lower ribs- the ribs all move fine, soft end feel.

Traction of the hips: slightly hypermobile, no pain.

Patella: Moves fine lateromedially, but smaller movement and rigidity in craniocaudal direction.

3.4.9 Palpation

Skin and fascia of the trunk: Anterior- Skin and fascia is slack/hypermobile, there is a lot of excess skin. The exception is the fascia around the upper rectus abdominis. There, the fascia is stiff and rough. Posterior- Same results, but the stiff place on the back is over Trapezius. Here the skin and fascia moves worse and rougher in all directions. Still has very poor circulation.

3.4.10 Muscles

Iliacus: In hypertone, painful upon palpation.

Quadriceps: Normal tone, not painful touching.

Paravertebral muscles L-spine: Hypertrophy and hypertone, some pain when touched.

Paravertebral muscles Th-spine: Hypertrophy and hypertone, painful when touched. Positive spine-sign, although not as big reaction as last time.

Intercostal muscles: Slightly painful, low mobility of ribs.

Rectus abdominis: Lower part seems to be in hypotone, while the upper part is in hypertone. Painful in touch, but for now there are no triggerpoints.
Transverse abdominis: Weak and in hypotone.

3.4.11 Neurologic examination

Table 12 Sensation in dermatomes on the lower extremity final

Dermatome	Sensation	
	Left	Right
L2	Normal	Normal
L3	Normal	Normal
L4	Normal	Normal
L5	Normal	Normal
S1	Normal	Normal
S2	Normal	Normal

Deep reflexes:

Table 13 Deep reflexes final

Tendon tested:	Tendon reflex	
	Left	Right
Patellar (L2-4)	Physiological	Physiological
Achilles (L5-S2)	Physiological	Physiological
Medioplantar (L5-S2)	Physiological	Physiological

Note: On the place with hyperkyphosis (upper thoracic area) straight over the spinous processes, there is lower sensation. She is able to detect two fingers first, but when we make it more difficult for her (changing fingers faster) she is not able to differentiate.

3.4.12 Breathing

I.N has what seems to be the beginning stage of a barrel chest. The mobility and shape of the rib cage is rounded and she breaths shallow with the upper thorax and neck. The difference now is that she easily can breathe into a point on the lower abdomen, activating Transverse abdominis. This requires concentration, and after a while, she breathes upper thoracic again.

3.4.13 Movement pattern

Leg abduction: Quadratus mechanism in both legs.

Leg extension: No activity in thoracic paravertebral muscles, hyperactivity of lumbar paravertebral muscles.

3.4.15 Special tests

Patrick`s sign: Negative

Laesic: Negative

Trendlenburg: Negative, and more stable on one foot.

Vele test: Negative

Thomayer: Hypermobile, palms on the ground.

Romberg: Negative

3.4.16 Conclusion of examination

I.N still has spinal curves that would suggest pain and low stability in the spine. The low lumbar hyperlordosis and middle thoracic hyperkyphosis give problems to surrounding soft tissue. She has several hypertonic muscles with trigger-points, and although we remove the ones we come over, they will return because her problem persists. With that said, the full week the patient had has improved her in many areas. She still needs to work stabilizing the pelvic floor muscles, because she needs much better stability to get rid of the pain completely. We improved the mobility of the thoracic area of the spine, and she will try to lengthen the whole spine at home in the coming weeks. She is still breathing shallow, upper thorax breaths, which does not help either stability or the low back pain, but she is now able to breathe much deeper when she is relaxed and concentrated. She says this relieves much of the pain. The lymphedema in the lower extremity is the same or worse, and it is a concern with the bad circulation.

3.5 Evaluation of therapy effectiveness

I think we made good progress with the patient. The first day, she was moving very carefully and we could see she was in pain. The last day, she had a completely different body language. She was laughing, talking and showed us her progression in different exercises. We did not expect to "fix" her in one week, but it was very nice to see that with regular exercising, she could be without pain from what she has learned here.

In my opinion, she responded best to dynamic neuromuscular stabilization. Many patients thought it was to slow, wanted more traditional exercise to help them. I.N however, was able to fully concentrate and relax in the different positions. In the first days, we were mostly concerned with the breathing, but after a day or to, I was amazed to see how much she could correct her posture, at least for a few minutes. For the more conversional exercises like PIR, PNF, joint play and soft tissue techniques we had more mixed results. I think this is because she is hypermobile and the circulation is so decreased. We used joint play quite often and opened several blocked joints, but I think this is a result of the instability, and after a few days, the same joints were blocked again. It was pretty much the same with PIR and soft tissue techniques. We changed the tonus, and after a few days, it was the same. It also did not do much against her pain, because of that, we mostly focused on dynamic neuromuscular stabilization.

It is difficult to know if this will stabilize the spine over a long period, but I think if she continues with the exercises daily, she will be without pain and the deep stabilization system will work much better as a unit.

On the negative side, I am still concerned with the low circulation especially in the lower extremity. The drain massage did not have effect, but the doctors say it will get better with exercise and a healthy diet. If she can find a way to improve this condition, I think this too will help the pain in back. I would also have liked to work more with gait and balance. We intentionally rated this as a second-grade problem, but I am certain that she would have benefitted greatly from better balance and a more fluent gait. We did

however show her correct gait pattern, and she is walking much better now than the first visit.

I was very surprised to learn that I.N has never been taught how to move when transferring patients at a retirement home. She has been lifting heavy loads for many years and this is a big part of her problem. I think for me, the most important thing we have done with her is to teach her transferring that does not strain the low back. She has not had time or energy to exercise regularly, but this week when that was all she had to do, she took it very seriously and worked very hard.

4 Conclusion

The first time I met the patient was in my 5th day at Monada. We chose her because she was a nurse, and thought it was exciting with extra time and care. She had not been examined when we met her, so we got to look at her with fresh eyes and without bias. This gave me a great opportunity to see the improvement from the first day of her therapy. We had six therapy sessions during my time with her. Even though her English was limited and my Czech absent, we were able to communicate quite well, often through Mgr. Sedlicka. I was able to provide any therapy I wanted, so I got to practice several examination and therapy techniques learned from the school, in addition to learning a new way to look at low back pain through DNS by Kolar. This was very interesting, and taught me to much faster and easier come to conclusions in lifestyle related postural problems, which I expect to see more of when I will be working.

I have learned a lot from the therapy and collecting theoretical knowledge on low back pain. I improved on a fast but thorough examination, therapy principles, when to apply different techniques and much more. I also have a better idea of the clinical picture and influence of low back pain on the whole body. It was very satisfying to achieve a good result, but also teach her self-therapy and better posture at the workplace, as this will spare her low back considerably. Especially the DNS concept requires a great deal of patience from the patient, and this contributed to the good result. Had we had an impatient patient, I doubt the result would have been as successful.
The prognosis of the patient is good. In the final examination, she knew how to move correctly and had stopped moving antalgic. She fully understood the importance of moving right and how to combat the pain if it should return. ROM was good, and I do not believe any degenerative changes have occurred. I also think that if the doctors can do something about the poor circulation of the lower extremities, she will be in even better condition. It is however very important that she continues exercising at home, and she needs to take time to do this. She was able to perform all the exercises needed on the day of the final examination, and she understood the importance. If she does this, I do not think the pain will bother her to a large degree.

5 Appendices

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6 Supplement

6.1 List of tables

6.2 List of figures

Figures 1-5: (1)

6.3 List of abbreviations

DNS= Dynamic neuromuscular stabilization
ROM= Range of motion
SST= soft tissue techniques
Acc= according
ADL= activities of the daily living
MRI= magnetic resonance imaging
Lig= ligament
ABD= abduction
ADD= adduction
M= musculus
Deg= degrees
Fex= for example
SI= sacroiliac
TENS= transcutaneous electric nerve stimulation
PIR= post isometric relaxation
Trp= triggerpoint
SST= soft tissue techniques
BMI= body mass index
Th= thoracic
LE= lower extremity

6.4 Informed consent form

6.5 Approved application for ethics board review