Faculty of Physical Education and Sport UK

Department of Physiotherapy

DEEP STABILIZATION SYSTEM DYSFUNCTION

Bachelor thesis

Author: Martin Bøkestad

Supervisor: Mgr Klára Faladová

Adviser: PhDr. Edwin Mahr, Ph.D

April 2008, Prague

Declaration

I declare that this Bachelor Thesis has been based on my own work that took place in Centrum léčby pohybového aparátu in Prague from
07.01.2008 to 18.01.2008. All the information used for this Bachelor thesis has been taken from the list of literature which can be found in the end of this thesis.

15.04.08 Martin Bøkestad

Date, Prague. Martin Bøkestad

Abstract.

Name of the bachelor thesis*:* Deep stabilization system

Aim*:* To learn about the deep stabilization system, how to examine for insufficiency, its relations with breathing, and how to treat it.

Clinical findings*:* The patient is a 34 year old woman with low back pain. She has given birth to two boys the last 4 years and is a full-time mother. Initial Kinesiological Examination revealed problems with the deep stabilization system and the breathing pattern of the patient.

Methods*:* I meet the patient for 5 sessions during a 14 day period. The first session was used for the initial kinesiological examination and the last session for the final kinesiological examination. For therapy I applied; mobilization and relaxation techniques of the lumbar spine, strengthening of the core, sensory motoric stimulation and functional exercises such as "reach".

Results*:* At first, mobilization techniques of the lumbar spine gave good results, but after two sessions pain was worsened. After I have studied the deep stabilization system better, I realize that I should have worked more with strengthening and activation of musculature than with mobilization.

Key words*:* Deep stabilization system, lumbar spine stability, breathing pattern.

Acknowledgements:

First of all I want to thank my supervisor, Mgr Klára Faladová. Without your patience, good help and advice the last three months this thesis wouldn't be possible. Then I want to thank my good friend and colleague Øystein Grønnevik for good cooperation and help during my 3 years in Prague.

Contents.

1. Preface.

This thesis is based on a practice which I had from the 7th of January till the 18th of January 2008 at C.L.P.A. During these 14 days I was given a patient that I a meet a total of 5 times. According to my examinations this patient had deep stabilization dysfunction which I will describe how to examine and treat, according to Doc. Pavel Kolar. I will also add a basic training program in my supplement for the deep stabilization dysfunction by McGill.

From this thesis I hope that students can read and learn some basics of the deep stabilization system dysfunction, about how to perform the examinations and interpret them, and also some basic therapy.

2. General Part.

2.1 Hypothyroidism and its symptoms.

People with underactive thyroid often have joint and muscle problems due to low levels of thyroid hormone, such as:

- Muscle aches, tenderness and stiffness, especially in shoulder and hips.
- Joint pains and stiffness
- Swelling of the knee joint and small joints in the hands and feet
- Carpal tunnel syndrome

Treatment of joint and muscle problems due to hypothyroidism is directed at the underlying thyroid disorder. These problems often improve dramatically with thyroid hormone treatment (11)

2.2 Anatomy of the pelvis.

The bony pelvis is formed by four bones, the hip bones, sacrum and coccyx.

The hip bones are two irregular shaped bones which develop from the fusion of three bones, the ilium, ischium, and pubis. These 3 bones are united by cartilage at the acetabulum, the cuplike depression in the lateral surface of the hip bone which articulates with the head of the femur.

The sacrum is formed by the fusion of 5 sacral vertebras.

The coccyx is formed by the fusion of 4 coccygeal vertebras.

The hip bones are joined at the pubic symphysis anteriorly and to the sacrum posteriorly to form the pelvic girdle. (10)

2.2.1 Pelvic joints and ligaments.

The joints of the pelvis are the lumbosacral, the sacrococcygeal, the sacroiliac joints and the pubic symphysis. Strong ligaments support and strengthen these joints. (10)

The lumbosacral joints; L5 and S1 articulate anteriorly at the intervertebral joint formed by the intervertebral disk between their bodies, and posteriorly at the zygapophysial joints between the articular processes. The facets on S1 face posteriomedially, thereby preventing the L5 from sliding anteriorly. Iliolumbar ligaments unite the ilia and the L5. (10)

The sacrococcygeal joint; is a secondary cartilaginous joint and has an intervertebral disc. It is reinforced by the anterior and posterior *sacrococcygeal ligaments.* (10)

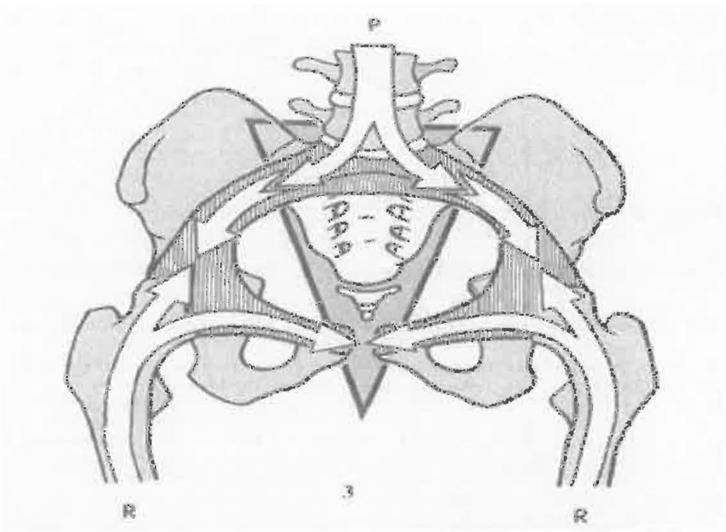
Sacroiliac joints; these are strong, weightbearing synovial joints between the auricular (ear-shaped) surfaces of the sacrum and ilium. These surfaces have irregular elevations and depressions that produce some interlocking of the bones. The sacrum is suspended, and firmly attached between the iliac bones by the *interosseous and sacroiliac ligaments*. The inferior end of the sacrum is joined to the ischium by the strong *sacrotuberos and sacrospinous ligaments,* which restrict the posterosuperior movement of the inferior end of the sacrum. (10)

Pubic symphysis; is a secondary cartilaginous joint formed by the union of the pubic bones. The symphysis is reinforced superiorly and inferiorly by the *pubic ligaments.* (10)

2.2.2 Function of the pelvis:

The pelvis constitutes the base of the trunk. It supports the abdomen and links the vertebral column to the lower limbs. (3)

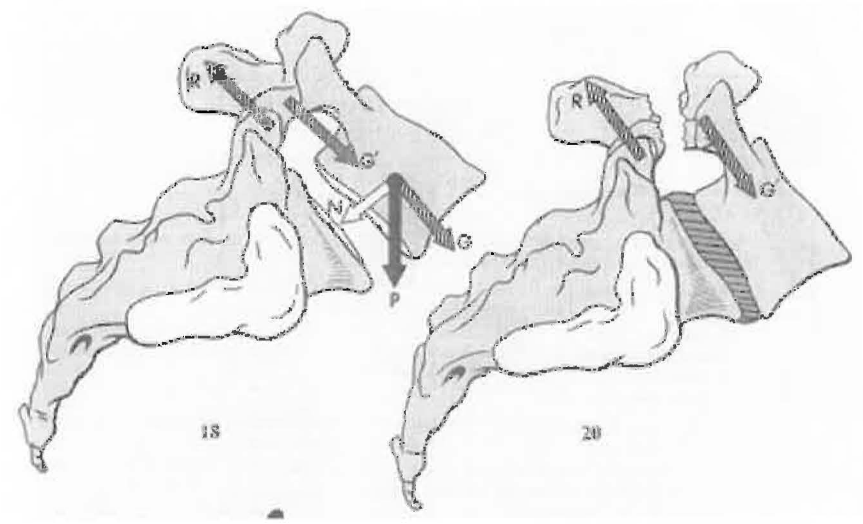
According to Kapandji; "the pelvis as a whole transmits forces from the vertebral column to the lower limbs. The weight (P) supported by L5 is distributed equally along the alae of the sacrum and through the ischial tuberosities towards the acetabulum. Part of the reaction of the ground to the body weight (R) is transmitted to the acetabulum by the neck and head of femur. The rest is transmitted across the horizontal ramus of the pubic bone and is counterbalanced at the symphysis by a similar force from the other side. These lines of force form a complete ring along the pelvic brim" (see picture 1). (3)



(Picture 1)

2.2.3 The lumbosacral joint and spondylo-olisthesis.

The lumbosacral joint is the weak link in the vertebral column. Because of the inclination of the superior surface of S1, L5 tends to slide inferiorly and anteriorly. If the weight P is resolved into its two components, N acting perpendicular to the superior surface of S1 and G acting parallel, it is obvious that the force G will pull L5 anteriorly. This is counterbalanced by the powerful anchoring of the vertebral arch of L5 to S1 (this counter-reaction of the sacral process is expressed as R). These forces act through a point located in the vertebral isthmus, which is the part of the vertebral arch lying between the superior and inferior articular processes. If this isthmus is fractured or destroyed the condition is known as spondylolysis. As the vertebral arch is no longer retained posteriorly on the superior articular processes of S1 the body of L5 slips inferiorly and anteriorly giving rise to spondylo-olisthesis. The only structures that still retain L5 on S1 and prevent further slippage are, on the one hand, the lumbosacral disc with its oblique fibers under tension and, on the other, the paravertebral muscles which go into permanent spasm giving rise to the pain of spondylo-olisthesis (see picture 2). [3]



(Picture 2)

2.3 Anatomy of the vertebral column.

The vertebral column extends from the skull to the tip of the coccyx. It forms the skeleton of the neck and back, and is the main part of the axial skeleton (skull, vertebral column, ribs and sternum). In the adult the vertebral column is 72-75 cm long, of which approximately ¼ is formed by the fibrocartilaginous IV disks. [10]

The vertebral column in an adult typically consist of 33 vertebrae arranged in five regions (7 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 4 coccygeal). [10]

Motion, however, occurs only at the cervical, thoracic and lumbar vertebrae. The 5 sacrum and the 4 coccygeal are fused to form the sacrum and coccyx. (10)

The vertebrae gradually become larger as the vertebral column descends to the sacrum; this is related to the increase in load on the successive vertebrae as the column descends. (10)

2.3.1 Curves of the vertebral column.

Seen from the lateral view the vertebral column in adults has 4 curvatures: cervical, thoracic, lumbar and sacral. The thoracic and sacral are concave anteriorly, whereas the cervical and lumbar are concave posteriorly. (10)

The thoracic and sacral curvatures are *primary curvatures* that develop during the fetal period. (10)

The cervical and lumbar are *secondary curvatures* that develop during infancy. (10)

The cervical curvature becomes prominent when the infant begins to hold its head erect. The thoracic curvature results from the slightly wedge-shaped vertebral bodies that are higher posteriorly. The lumbar curvature becomes obvious when an infant begins to assume the upright posture. (10)

2.3.2 The symphyses between vertebral bodies and the IV disk.

The symphysis between adjacent vertebral bodies is formed by a layer of hyaline cartilage on each vertebral body and an IV disk, which lies between the layers. (2)

The IV disk consists of an outer tense annulus fibrosus and a soft jellylike nucleus pulposus. (12)

The annulus fibrosus consist of collagen fibers and fibrocartilage which keep the nucleus pulposus under tension. (12)

In the cervical and lumbar region they are higher in front and lower behind. The reverse is true in the thoracic region, where disks are lower in front and higher behind. Also the disks increase in thickness from cranial to caudal. (12)

2.3.3 Structure and function of the Lumbar vertebrae;

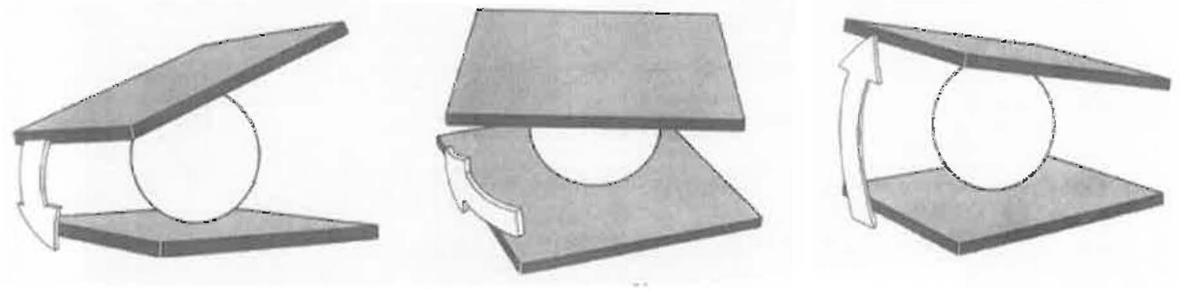
The vertebral body, when viewed superiorly, is somewhat kidney shaped.

The transverse processes are long and slender, and at the base on the posterior surface of each transverse process is a small accessory process, which provides an attachment for the intertransverse lumborum muscle. (10)

The superior articular facets are directed posteriomedially and **the inferior articular facets** are directed anterolaterally. This position of the facets facilitates flexion, extension, and lateral bending of the vertebral column; however, they prohibit rotation. On the posterior surface of the superior articular process are mamillary processes, which give attachment to the multifidus and medial intertransverse muscles. (10)
The spinous processes of the lumbar vertebrae are thick and broad and point posteriorly. (10)

2.3.4 Movements of the lumbar spine and function of the IV disk.

IV disk; Incarcerated under pressure within its casing between the two vertebral plateaus, the nucleus pulposus is roughly spherical. Therefore, to a first approximation, one can consider the nucleus as a ball placed between two planes. This type of joint known as a swivel joint allows three types of movement: Tilting, rotation and gliding. (3)
Therefore this very mobile joint has six degrees of freedom: flexion and extension, lateral flexion, gliding in the sagittal and frontal plane, and rotation (see picture 3). (3)

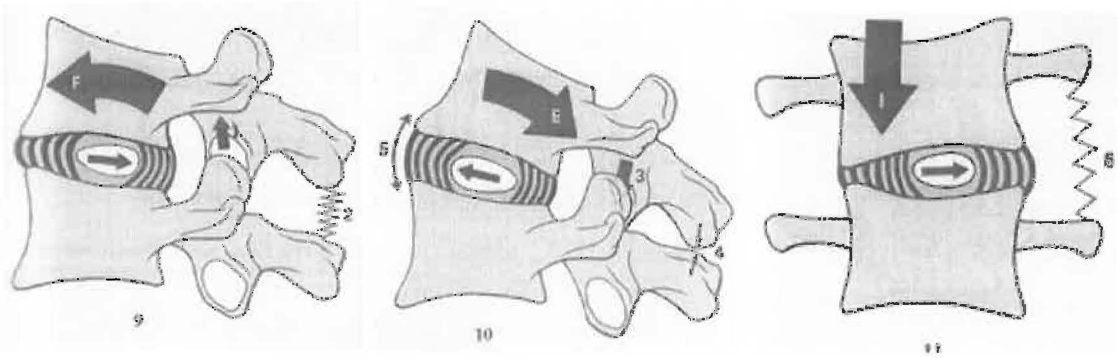


(Picture 3)

During flexion the body of the upper vertebra tilts and slides gently anteriorly in the direction of arrow F reducing the thickness of the IV disk anteriorly and increasing it posteriorly. The nucleus pulposus is driven posteriorly stretching the posterior fibers of the annulus fibrosus. At the same time the inferior articular process of the upper vertebra slides superiorly and to move away from the superior articular process of the lower vertebra (arrow 1). This movement causes the ligaments of the articular processes and the vertebral arch to be stretched, and eventually limit flexion. (3)
During extension the body of the upper vertebra tilts and moves posteriorly in the direction of arrow E. Meanwhile the disk is flattened posteriorly and expanded anteriorly. The nucleus is pushed anteriorly, stretching the anterior fibers of the annulus and the anterior longitudinal ligament. At the same time the articular processes of the lower and upper vertebrae become more

tightly interlocked and the spinous processes touch one another. Hence extension is limited by bony structures and the tension developed in the anterior longitudinal ligament. [3]

During lateral flexion the body of the upper vertebra tilts ipsilaterally while the nucleus pulposus is pushed contralaterally. The contralateral intertransverse ligament is stretched, while the ipsilateral intertransverse ligament is relaxed. The articular processes slide relative to each other so that the contralateral process of the upper vertebra is raised, while the ipsilateral process is lowered (see picture 4). [3]



(Picture 4)

2.3.5 Flexion and extension of the vertebral column: ROM

As a whole the column from sacrum to skull is similar to a joint with three degrees of freedom: it allows flexion and extension, lateral flexion to both sides, and axial rotation. The range of these elementary movements at each individual joint of the column is very small but, in view of the many joints involved, the cumulative effect is quite significant. [3]

Flexion and extension takes place in the sagittal plane. The reference plane at the skull level is the plane of the bite. The angle formed by the plane of the bite between maximal flexion and extension is 250 degrees. This 250 degrees value applies to the maximum range ever attained in particularly flexible individuals. [3]

AREA	ROM
Lumbar spine	Flexion = 60 degrees Extension = 35 degrees
Thoracolumbar spine	Flexion = 105 degrees Extension = 60 degrees
Cervical spine	Flexion = 40 degrees

	Extension = 75 degrees
Total range of column	Flexion = 110 degrees Extension = 140 degrees

(Table 1) [3]

2.3.6 Range of lateral flexion of the whole vertebral column.

Lateral flexion occurs in a frontal plane.

AREA	ROM
Lumbar spine	20 degrees
Thoracic spine	20 degrees
Cervical spine	35-45 degrees
Total range of column	75-85 degrees

(Table 2) [3]

2.3.7 Range of axial rotation of the vertebral column.

Axial rotation occurs in a transversal plane.

AREA	ROM
Lumbar spine	5 degrees
Thoracic spine	35 degrees
Cervical spine	45-50 degrees
Total range of column	85-90 degrees

(Table 3) [3]

2.4 Muscles of the deep stabilization system.

According to Lewit and Kolar the deep stabilization system consist of the; deep spinal extensors, abdominals, pelvic diaphragm, thoracic diaphragm and the deep neck flexors. [5, 7]

2.4.1 Intrinsic muscles of the back.

This group includes all the muscles innervated by the dorsal rami of the spinal nerves. Together they are called the erector spinae. There are two longitudinal columns lateral to the spinous processes. The muscles lie in an osteofibrous canal formed by the bones of the vertebral arches, costal processes and the spinous processes. Posteriorly and laterally this canal is limited by the

TLF. We distinguish lateral superficial from medial deep tracts of the erector spinae. The lateral tract runs from the pelvis to the skull and consists of long muscle bundles. [12]

The lateral tract may be divided into transverse and spinotransversal muscle groups.

The intertransverse muscles consist of:

- The iliocostalis lumborum/thoracics/cervicis
- The longissimus thoracics/cervicis/capitis.

The spinotransversal muscles consist of:

- Splenius cervicis/capitis

The actions of all these muscles supplement each other. The first two are largely responsible for the erect posture of the body and then the two splenii, when contracted on one side, produce rotation of the head to the same side. Bilateral activation causes extension of the spine and head, unilateral activation causes lateral flexion of the spine and rotation of the head to the same side. [2, 12]

The medial tract has a "straight" and an "oblique" component.

The system of straight muscles consists of:

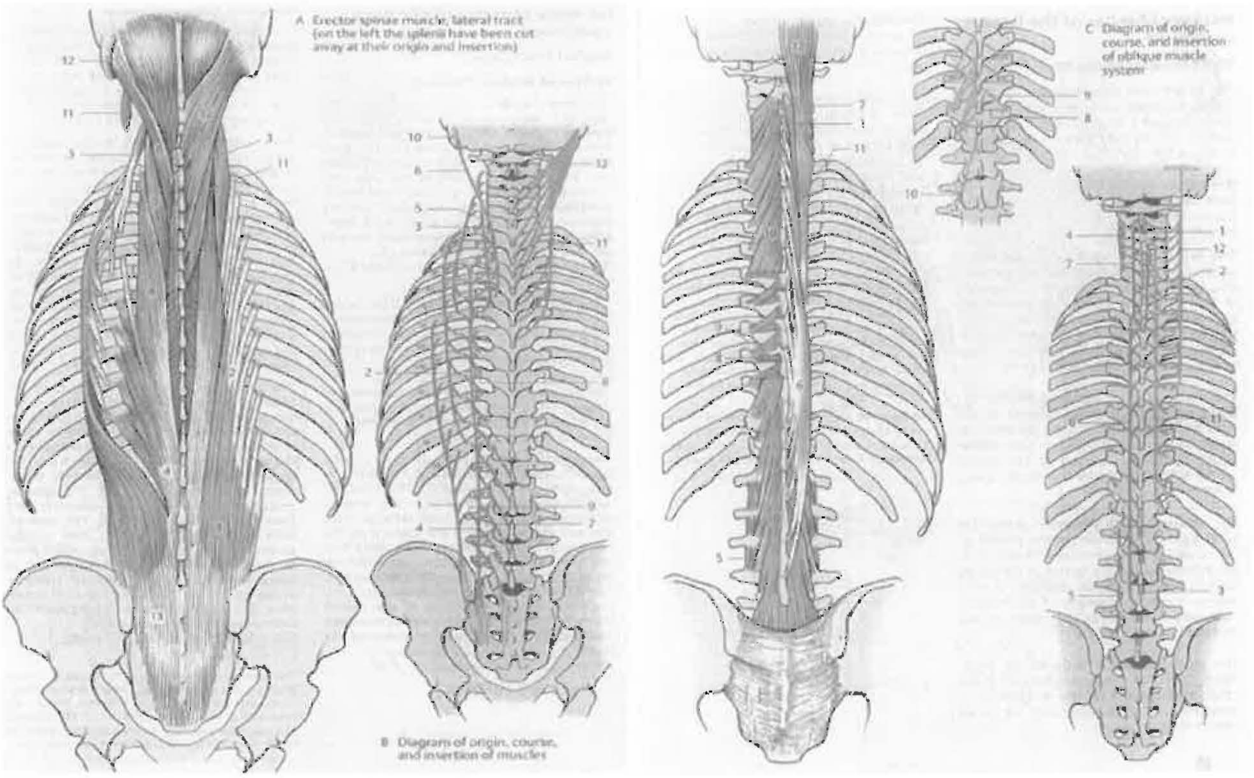
- Interspinalis cervicis/thoracics/lumborum
- Intertransversari cervicis/lumborum
- Spinalis thoracics/cervicis/capitis

The system of oblique muscles consists of:

- Rotatores breves/longi
- Multifidus
- Semispinalis thoracics/cervicis/capitis

The muscles which belong to the straight system function as extensors when both sides are innervated and unilaterally lateral flexors when only one side is innervated. Muscles of the oblique system function when unilaterally innervated as rotators and bilaterally innervated as extensors. The lateral tract is ideal for lumbar extension and creating posterior shear with lumbar flexion· [2, 12]

The medial deep tract: the local muscles are believed to function as position sensors, and segmental stabilizers. The multifidi have been found to be atrophied in individuals with low back pain. [1, 9]



(Picture 5) [12]

2.4.2 Abdominals.

They serve as a vital component of the core. The transversus abdominis has been shown to activate prior to limb movement, theoretically to stabilize the lumbar spine. Patients with low back pain have delayed activation of the transversus abdominis. [1]

There are five muscles in the anterolateral abdominal wall: three flat and two vertical muscles. The three flat muscles include the: [10]

External Oblique is the superficial muscle arising from the external surface of the 5th to the 12th rib, interdigitating with the serratus anterior. Most of its fibers run inferomedially and become aponeurotic in the midclavicular line and attach to the linea alba and the pubic crest. The inferior margin of the external oblique aponeurosis forms the inguinal ligament. [10]

Internal oblique, the intermediate muscle whose fibers run horizontally at the level of the SIAS; the fibers run obliquely upwards superior to this level and obliquely downward inferior to it. It arises from the TLF, anterior 2/3 of the iliac crest and the lateral half of the inguinal ligament. And attach to the inferior boarders of the 10th-12th rib, linea alba, and pectin pubis through the conjoint tendon. [10]

Transversus abdominis, the innermost muscle whose fibers, except the inferior ones, run more or less transversomedially. It arises from the internal surfaces of 7th-12th costal cartilages, TLF, iliac crest, and lateral third of the inguinal ligament, and attach to the linea alba through the aponeurosis, pubic crest and pectin pubis via conjoint tendon. (10)

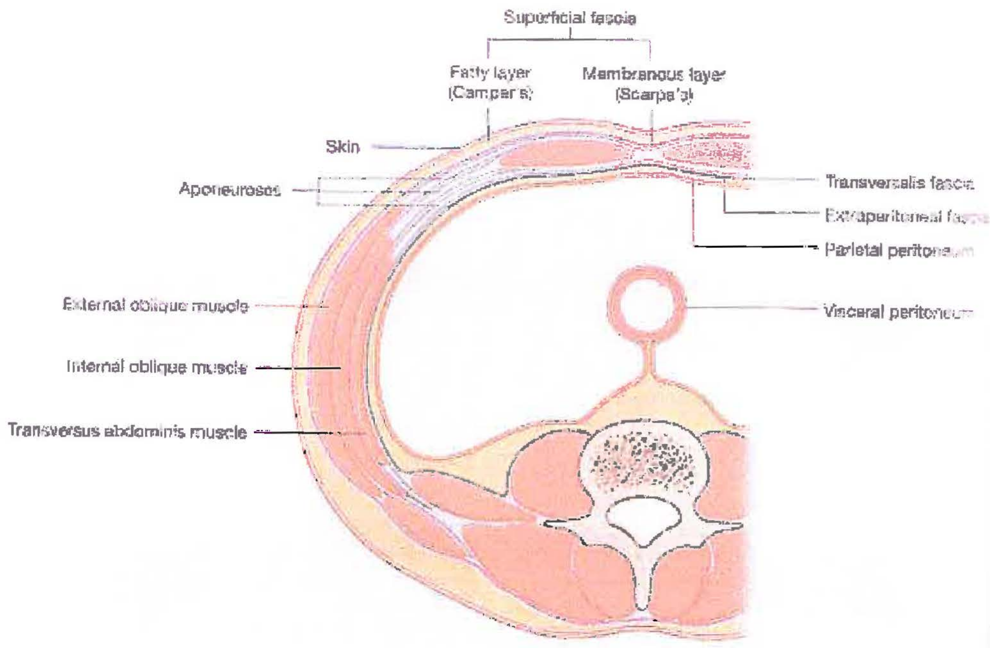
All three flat muscles end anteriorly in the aponeurosis which interlace at the linea alba with their fellows of the opposite side to form the tough, tendinous rectus sheath. The two vertical muscles are within this rectus sheath: (10)

Rectus abdominis: the paired rectus muscles, separated by the linea alba, originates at the pubic symphysis and pubic crest and inserts to the xiphoid process and 5th-7th costal cartilage. (10)

Pyramidalis, is a small triangular muscle that is absent in approximately 20% of people. It lies anterior to the inferior part of the rectus abdominis and runs between the pubis and the linea alba. (10)

Function of abdominals:

- The external and internal oblique compresses and support abdominal viscera, and flex and rotate the trunk.
- The transversus abdominis compress and support abdominal viscera.
- The rectus abdominis flexes the trunk and compress abdominal viscera.
- The pyramidalis tenses the linea alba. (10)



(Picture 6) (2)

2.4.3 Pelvic floor

The pelvic floor is formed by the pelvic diaphragm which consists of the levator ani and the coccygeus muscles. The pelvic diaphragm stretches between the pubis anteriorly and the coccyx posteriorly and from one lateral pelvic wall to the other. (10)

The two levator ani is the largest and most important muscle in the pelvic floor, and consists of three parts: (10)

The pubococcygeus, the main part, arises from the posterior aspect of the pubis and passes back almost horizontally. (10)

The puborectalis form a U-shaped sling that passes posteriorly to the anorectal junction.

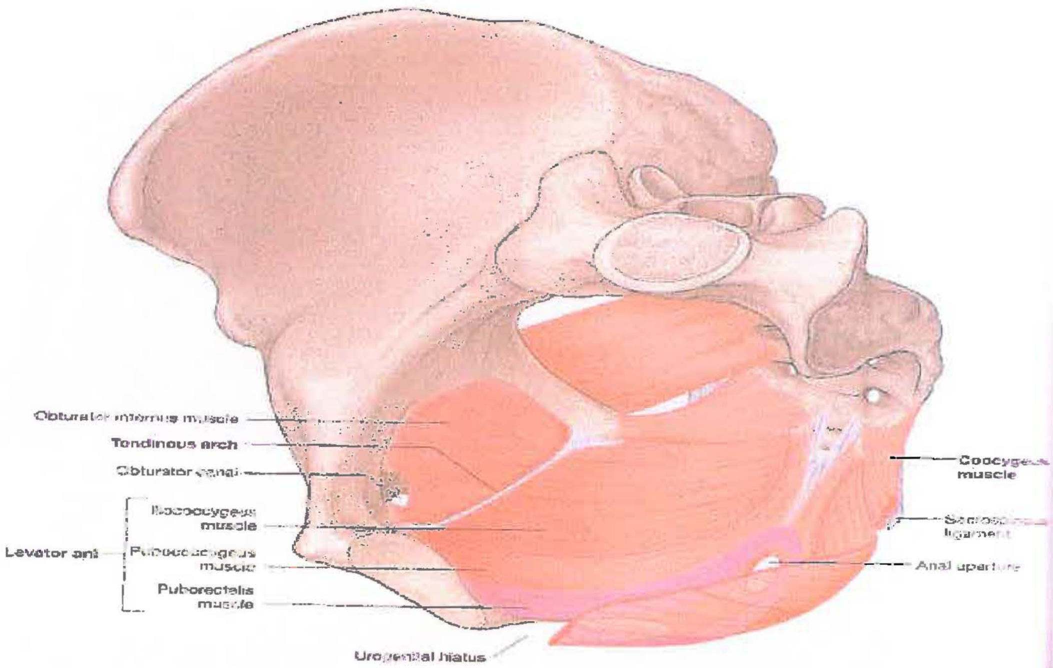
The iliococcygeus is the posterior part of the levator ani. (10)

The levator ani:

- Support the abdomino-pelvic viscera
- Resist increases in intra-abdominal pressure
- Helps to hold the pelvic viscera in position. (10)

The two coccygeal muscles, one on each side, overlie the sacrospinous ligament. They go from the ischial spine to the lateral margins of the coccyx and sacrum. (2)

Participate in supporting the posterior aspect of the pelvis floor. (10)



(Picture 7) (2)

2.4.4 Thoracic diaphragm.

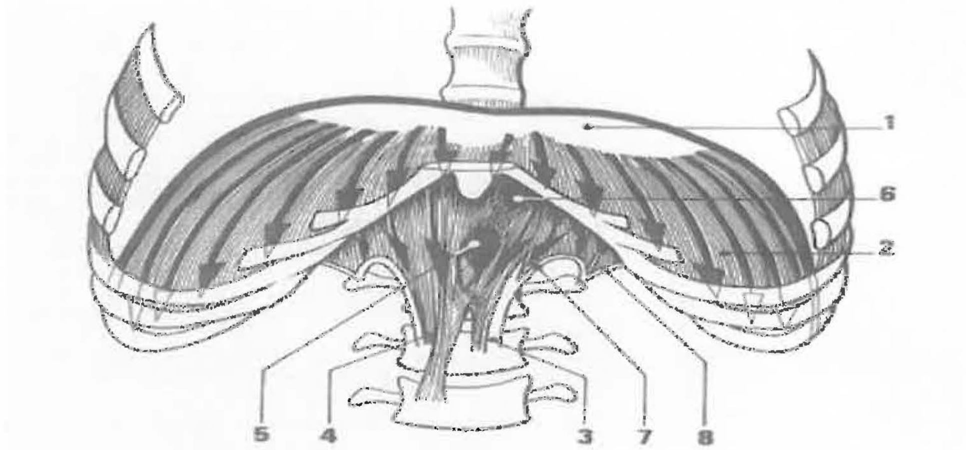
The diaphragm separates the thoracic and abdominal cavities. It consists of a central tendon and a muscular portion, which can be divided into sternal, costal and lumbar parts. (12)

The sternal part goes from the inner surface of the xiphoid to the central tendon. (12)

The costal part arises from the inner surfaces of cartilage of ribs 7-12 by means of individual slips which alternate with the slips of origin of the transversus abdominis. (12)

The lumbar part has a medial and lateral crus. The right medial crus arise from the bodies of the 1st-4th lumbar vertebrae, and the left medial crus from the 1st-3rd lumbar vertebrae. The lateral crus are thickenings of the fascia covering the psoas major and quadratus lumborum muscles. (10, 12)

When the diaphragm contracts the central tendon is pulled down thus increasing the vertical diameter of the thorax. This depression of the diaphragm is eventually stopped by the mediastinal constituents as they are stretched, and by the resistance offered by the abdominal organs. From this moment the central tendon becomes fixed and the muscle fibers, now acting from the periphery of this central tendon, elevate the lower ribs increasing the transverse diameter of the lower thorax. At the same time, with help of the sternum, it also elevates the upper ribs, thus increasing also the antero-posterior diameter of the thorax. Therefore the diaphragm can be considered the basic muscle of respiration as it increases by itself all three diameters of the thoracic cavity. (3)



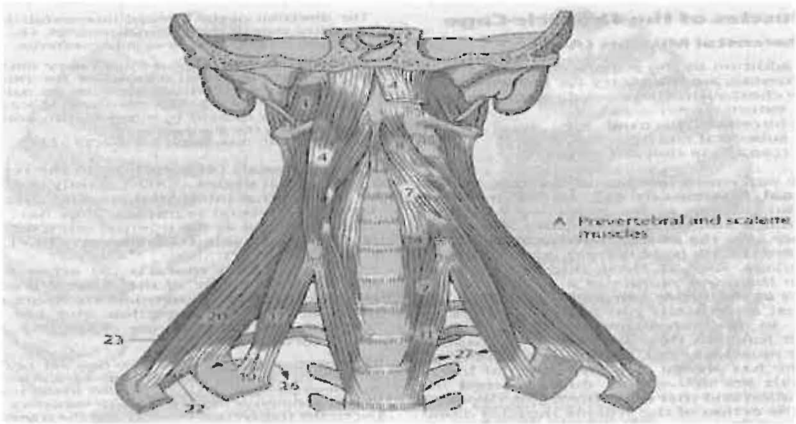
(Picture 8) (3)

2.4.5 Deep neck flexors.

The prevertebral muscles include the rectus capitis anterior, longus capitis and longus colli.

- The rectus capitis anterior helps to flex the head.

- The longus capitis working bilaterally flexes the head. Unilateral activation helps to tilt the head laterally.
- The longus colli working bilaterally flexes the cervical spine, while unilateral activation flexes and turns the cervical spine to the side of activation. [12]



(Picture 9) [12]

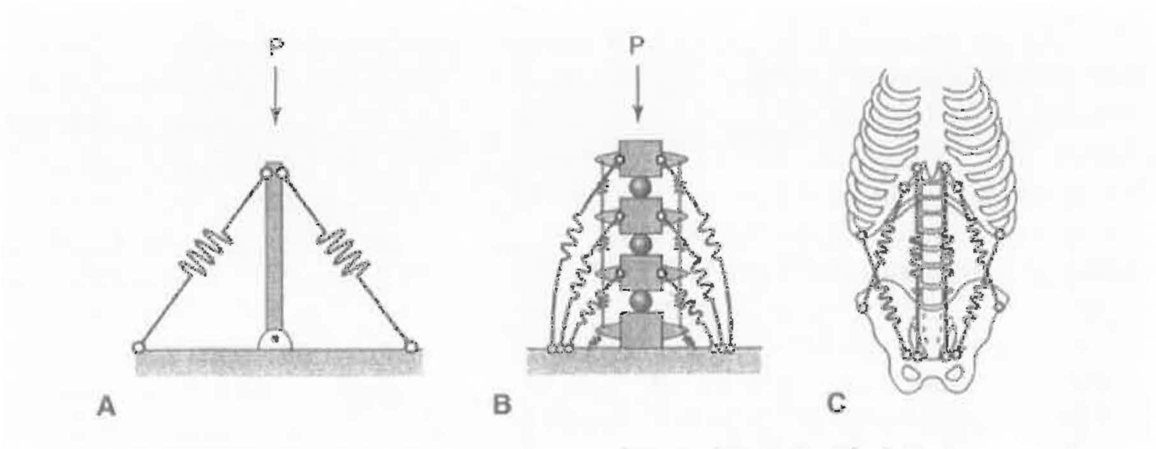
2.5 Stability of the lumbar spine.

Anders Bergmark of Sweden used mathematics to formalize the concepts of energy wells, stiffness, stability and instability. [9]

The concept of stability begins with potential energy. Objects have potential energy because of their height above a certain point. [9]

Important when measuring stability are the thoughts about energy wells and minimum potential energy. If a ball is placed into a bowl it is stable, because if a force was applied to the ball the ball will rise up the side of the bowl, but then come to rest again in the position of least potential energy, which is at the bottom of the bowl, or energy well. Bergmark says that, "a stable equilibrium prevails when the potential energy of the system is at a minimum". [9]

The system is made more stable by deepening the bowl and/or by increasing the steepness of the sides of the bowl. Thus, the idea of stability requires the specification of the undisturbed energy state of a system followed by a study of the system after it is disturbed. If the work of the disturbance is less than the potential energy inherent to the system, then the system will remain stable. If the applied load exceeds a critical value the mechanical system will collapse (determined by potential energy and stiffness). This example is a two-dimensional example. This would be similar to a hinged skeletal joint that only has the capacity for flexion/extension. Spinal joints can rotate in three planes and translate along three axes requiring a six-dimensional bowl for each joint--mathematics enables the examination of a 36-dimesional bowl (6 lumbar joints with 6 degrees of freedom) representing the whole lumbar spine. If the height of the bowl were decreased in any of these 36 dimensions, the ball could roll out. In clinical terms, if a single muscle exerts an inadequate force, or a passive tissue is damaged, this may cause instability. (9)



(Picture 10)

Potential energy is actually used for musculoskeletal application, as a function of stiffness and storage of elastic energy. (PE=1/2*k*x^2) In other words, the greater the stiffness (k), the greater the incline of the sides of the bowls, the more stable the structure. Thus, stiffness creates stability. It has long been known that joint stiffness increases rapidly and non-linearly with muscle activation such that only very modest levels of muscle activity creates sufficiently stiff and stable joints. Furthermore, joints possess an inherent joint stiffness as the passive capsules and ligaments contribute stiffness particularly at the end of ROM (see picture 10). (9)

The motor control system is able to control stability of the joints through coordinated muscle co-activation and to a lesser degree by placing joints in positions that regulate the contribution of passive stiffness. However, a faulty motor control system can lead to inappropriate degrees of muscle force and stiffness, allowing an exit for the ball to roll out, or clinically; for a joint to buckle or undergo shear translation. (9)

Activating a group of muscle synergists and antagonists in an optimal pattern now becomes a critical issue. In clinical terms, the entirety of the stabilizing musculature must work harmoniously to ensure stability together with generation of the required force and desired joint movement. However, only one muscle with inappropriate activation amplitude may produce instability, in other words, unstable behavior could result at lower loads. (9)

Working as a physiotherapist it is not possible to examine the stabilization system of the spine by the use of physics. However, Pavel Kolar has developed a method of examining the deep stabilization system of the spine, in the sagittal plane.

2.6 Muscular imbalance in disturbed co-activation and impaired spinal stabilization in the sagittal plane.

The spinal column forms a fulcrum, stabilizing muscles, which relate to the extremities, i.e., punctum fixum. Faulty position of the spinal column is accompanied by functional imbalance of the muscles of the pelvic, shoulder girdle and extremities, and vice versa. [5]

In the postnatal development, well-balanced muscular co-activation resulting in optimum loading of the spine is completed during the 4th month. At this early stage of development, the final basic posture is established; it remains unchanged even when the child stands up and during further postural development. A child with even a slight lesion of the CNS never reaches this ideal level of co-activation between the two functional systems (phasic, tonic) and the posture of such children when standing is never truly erect. [5]

Similar muscle imbalance doesn't have to be caused by abnormal development, but maybe by affections at a later stage, which result in reflex changes of a stereotypical character.

The muscles responsible for well-centered posture (the deep stabilizers) act as a functional unit. Hypofunction or hyperfunction of a single muscle never remains isolated, but involves the entire complex. We therefore find that weakness of the pelvic floor is usally accompanied by weakness of the neck flexors and vice versa. [5]

Insufficiency of the deep flexors is characteristic for the cervical region, resulting in head reclination with hyperextension of the lower cervical spine and a forward-drawn position of the upper thoracic spine. Fixation by the serratus anterior is insufficient and therefore the rhomboids and the lower and middle trapezius cannot achieve erect posture in the cervical spine, at the same time, the upper trapezius, the levator scapulae, sternocleidomastoids, and the scaleni predominate and function also as auxiliary inspiratory muscles. [5]

Normally co-activation of the abdominal wall, spinal extensors, and the diaphragm controls intra-abdominal pressure and centrates the low thoracic and lumbar spine. Weakness of the abdominal wall and insufficient intra-abdominal pressure results in permanent pelvic anteversion and increased lumbar lordosis. Weakness of the abdominal wall not only induces hyperlordosis and pelvic anteversion, but also prevents extension of the thoracic spine below T5. Lumbar lordosis thus ends in the low thoracic region, usally at the thoraco-lumbar crossing, and kyphosis starts. In the kyphotic segments there is no extension, thus causing an inspiratory position of the thorax and an oblique position of the diaphragm. This position causes the intercostals spaces not to widen in inhalation, thus lifting the thorax as a whole, and inhalation takes place by contraction of the auxiliary respiratory muscles. This condition goes hand-in-hand with weakness of the pelvic floor. At the same time there is disturbed co-activation of the serratus anterior and the lower trapezius, which normally straightens the thoracic spine and facilitates the transversus abdominis. (5)

The mid thoracic spine, i.e., the transitional vertebra T5, plays a very important role both in ontogenesis and pathogenesis. It represents a punctum fixum from where the cervical spine straightens and where the most important postural muscles originate: the splenius cervicis and capitis, the longissimus capitis and the longus colli, and where the longissimus thoracic is attached. The abdominal muscles originate from the 5th rib. (5)

In normal posture, T5 forms the apex of the thoracic kyphosis or the end of the lumbar lordosis. Thus, the area from T4-T6 is the region that functionally divides the upper and lower half of the human body. Clinical examination of this section of the spine is particularly important, because only if there is a well-balanced muscular activity in the entire motor system is it possible to straighten up the spine below T5. It appears that almost every disturbance of muscle activity related to the spinal column as well as to the extremities will affect this region, keeping it in flexion, with kyphosis and movement restriction into extension below T5. The extent of this fixed kyphosis varies, but can reach as far as to the thoraco-lumbar crossing in some cases. (5)

2.7 Normal and abnormal kinesiology of respiration and its relation to spinal stabilization.

Movement of the thorax plays an essential role in respiration, and it is formed to comply with the movements of breathing. The muscles involved can be described as inspiratory and expiratory, and as main and auxiliary respiratory muscles. Auxiliary muscles come into play when great effort is required or under pathological conditions. (5)

During respiration the ribs moves around a ventro-dorsal axis, in a dorso-lateral direction. The ventral ends of the ribs are raised together with the sternum, widening the thoracic cavity in the sagittal plane. The lower ribs (6-8) moves in a dorso-lateral direction, widening the thoracic cavity in the frontal plane. The upper ribs move much less, but in pathological cases these movements may be disturbed, with greater activity of the upper ribs. [5]

In the physiological condition diaphragm is the main respiratory muscle, and also stabilizes posture. The diaphragm acts against the resistance of the abdominal wall, and in co-operation with the abdominal muscles and the pelvic floor control intra-abdominal pressure and stabilization of the lower thoraco-lumbar junction. This stabilization provides a punctum fixum for the iliopsoas muscle. [5]

The activity of the diaphragm depends on the position of the spine and the thorax, which forms a punctum fixum. If the thorax is in an inhalation position (sternum/ribs raised, thoraco-lumbar junction in extension) the activity of the diaphragm is impaired in all its three sections. [5]

Respiration is then limited to the thorax, which is pulled upwards by the auxiliary muscles. Examination of respiratory and stabilizing function is therefore an essential part of the examination and treatment of the locomotor system. [5]

2.8 Examination of the deep stabilization system of the spine in the sagittal plane.

Disturbance of the spinal stabilization is an important factor in back pain and other conditions. We have to bear in mind that any purposeful movement first requires spinal stabilization. Control of spinal stabilization is therefore a prerequisite for successful therapy. [5]

Diagnostic tests.

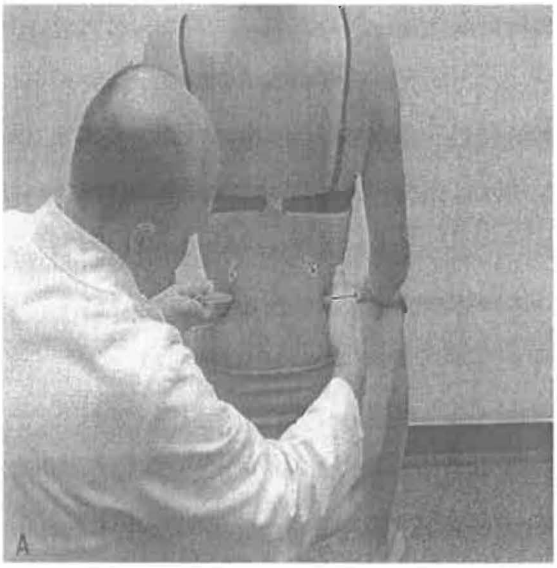
1. Diaphragm test-lateral abdominal wall activation*:* the patient is either sitting erect or in supine position. We palpate below the last rib, at the lateral aspect of the abdominal wall. The patient is told to push against our hands during exhalation, and inhalation. The spine must remain straight. [5]

This test serves to examine to what extent the diaphragm is able to perform its stabilizing function (see picture 11 and 12). [5]

Signs of impairment: the patient exerts minimal counterpressure or none at all. There might be activity during exhalation, but not during inhalation. This shows lack of cooperation between the diaphragm and the lateral abdominal muscles. [5]

The patient substitutes for this dysfunction by exaggerated activity of the rectus abdominis, particularly the upper part, and by increased activity if the paravertebral muscles, especially at the thoracolumbar crossing. [5]

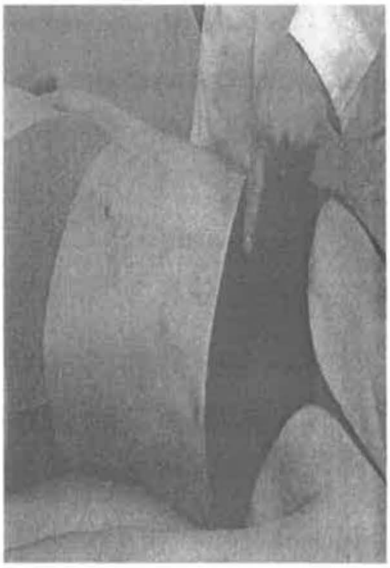
A patient unable to control the activity of the diaphragm in co-contraction with the lateral portion of the abdominal muscles is most likely to have low back pain. (5)

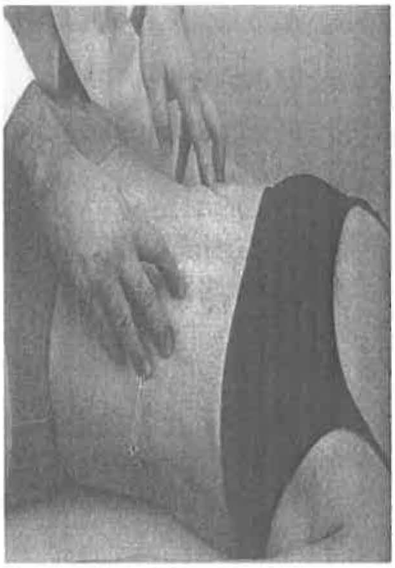


(Picture 11)

(Picture 12)

2. Diaphragm test-stabilization of expiratory thorax position: the patient is first supine with legs extended or slightly flexed, followed by erect sitting position. With our hands we put the thorax and sternum in maximal caudal position while the patient exhales. In this position the patient is told to relax the abdominals completely and then to keep this caudal position while inhaling. With our hands we follow the movement of the sternum and the low false ribs (see picture 13 and 14). (5)
Inability to maintain the caudal position of the chest during inspiration indicates poor spinal stabilization, with insufficient cooperation between the diaphragm and the abdominal wall the patient is not able to control the intra-abdominal pressure. During the test we also check if the lateral aspect of the abdominal wall protrudes below the last rib. If this area bulges, it is a sign of a good cooperation between the posterior diaphragm and the lateral abdominals. (5)
With the patient seated we palpate the costal angle of the ribs and follow their movement during inhalation and exhalation. Normally they should move laterally, but not cranially, and the patient should be able to keep the caudal position also during inhalation (see picture 15). (5)
Signs of impairment: The patient is not able to control the position of the chest and the initial position of the chest is in the inspiratory position, which causes the diaphragm to be in an oblique position. When examining the costal angle they move cranio-caudally, not laterally. (5)

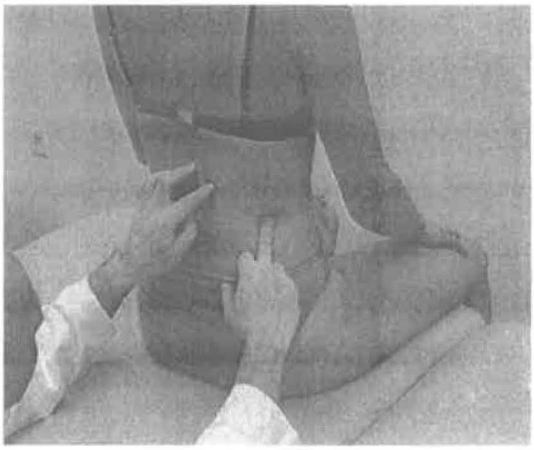

(Picture 13)


(Picture 14)


(Picture 15)

3. Hip flexion test: the patient is sitting erect with legs apart hanging down loosely. We palpate the thoracolumbar crossing and the lateral abdominals. The patient is told to flex his hip slightly and we assess the stabilization of the thoracolumbar spine. During hip flexion the iliopsoas is activated and the point of origin must be stabilized (see picture 16). (5)

Signs of impairment: Increased activity of the paravertebral muscles and the rectus abdominis, mainly upper part and decreased activity of the lateral abdominals. Under such conditions the contraction of the iliopsoas is performed with an insufficiently stabilized lumbar spine (see picture 17). (5)

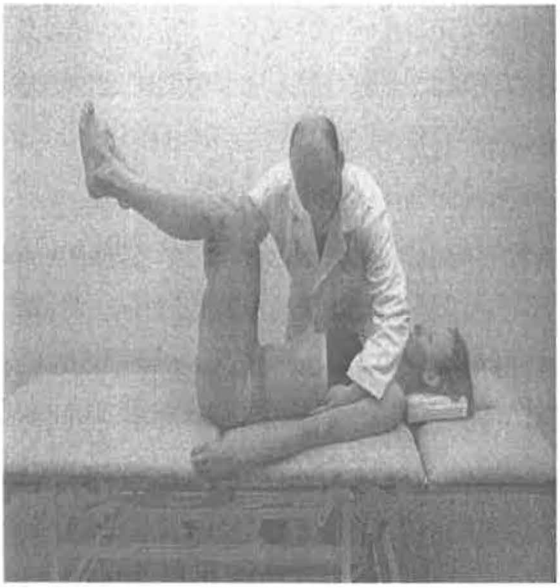

(Picture 16)


(Picture 17)

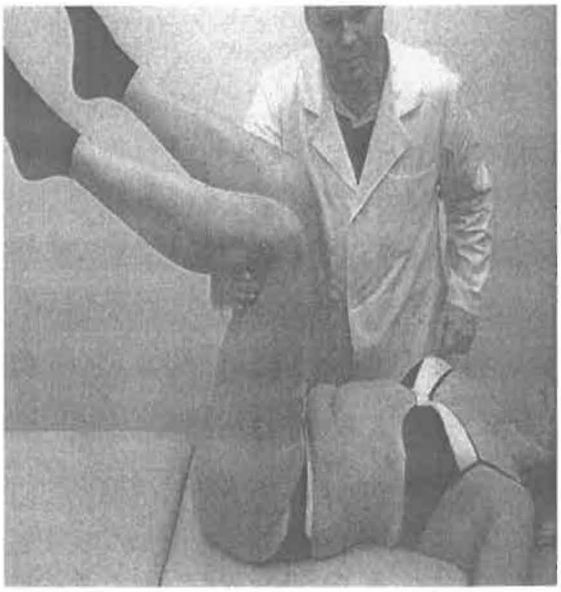
4. Intra-abdominal pressure test: the patient is supine with legs bent at the hips and knees at right angles, in abduction and slight external rotation (supported); the distance between the knees should be the breadth of the shoulders. The patient is told to support himself at the thoracolumbar crossing by the activity of the abdominal wall, while the clinician slowly removes the support (Picture 18). [5]

Signs of impairment: Convexity of the rectus abdominis, and concavity below the lower rib at the level of the costal angle (see picture 19). Trying to straighten the thoracolumbar crossing (for support), increases tension in the rectus abdominis and paravertebral muscles, with no activation of the lateral abdominals. [5]

This is a sign of insufficient co-activation of the lumbar part of the diaphragm and the abdominal muscles, which is essential for stabilization of the lumbar spine. We also note if there is diastases of the abdominal wall, which also is a sign of insufficient stabilization. [5]



(Picture 18)



(Picture 19)

5. Trunk flexion test: the patient is supine with arms along the body. We palpate the ribs as the patient slowly flexes his trunk.

Signs of impairment: the ribs deviate to the side, and there is lateral bulging of the abdominal wall. [5]

6. Arm lifting test: the patient is supine or standing erect with the thorax in a caudal position, and is lifting his arms. [5]

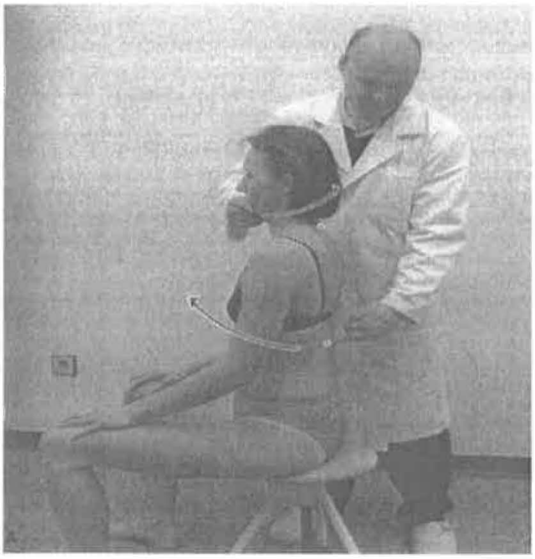
Signs of impairment: if the thorax moves up during this movement, it is a sign of insufficiency of the stabilization system. [5]

7. Neck flexion test: the patient is supine with the legs extended and is told to slowly bend his head and neck. (5)

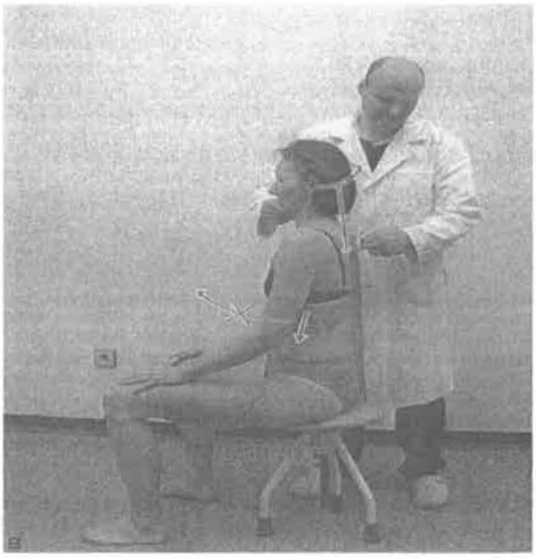
Sign of impairment: the patient moves the head to a forward-drawn position because of overactive strenocleidomastoids and the scaleni. Also there is hyperactivity in suboccipital muscles and spinal extensors. The lateral ribs move in a lateral direction and sometimes also cranially. (5)

8. Seated neck straightening test: the patient is sitting erect and is asked to straighten the cervical spine, moving the head in a dorso-cranial direction (see picture 20). (5)

Signs of impairment: if straightening starts in the thoracolumbar crossing, or in the cervico-thoracic crossing, (should start at T4/5). Extension in the mid thoracic spine is impaired, and there is increased tension in the paravertebral muscles and the adductors of the shoulder blade. Because extension of the mid thoracic spine is impaired the patient activates the sternocleidomastoid, the suprahyoid muscles, and the scalene when trying to straighten up segment T4/5 (see picture 21). (5)



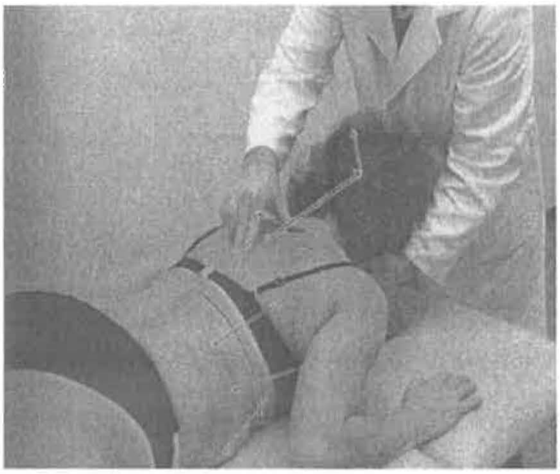
(Picture 20)



(Picture 21)

9. Extension test: the patient is prone and supports himself on his hands, and is told to straighten his cervical and upper thoracic spine. We follow the movement from T5 and caudally, looking for extension, and the position of the shoulder blades which should remain abducted and in a caudal position. Straightening his arms the patient pushes himself up and exhales, and try to make the symphysis the main point of support. (5)

Signs of impairment: Insufficient extension of the mid thoracic spine and exaggerated extension of the thoraco-lumbar region, with increase in tension of the paravertebral muscles. The shoulder blades move together and upwards (see picture 22). (5)



(Picture 22)

2.9 Treatment of insufficient stabilization of the spine (Kolar).

According to Kolar, "stabilization results from the activity of a muscular chain that is not under the control of our will, nor do we know how to activate it deliberately". To make these muscles work, either instruction or explanation is effective, reflex mechanism or manual fixation is required to start with. (5)

According to Kolar, "there are three basic approaches to improving stability";

Reflex locomotion, stimulation of reflex zones activates muscles for a definite purpose. The spinal column, the shoulder blades, and the thorax are brought in to an ideal position, which causes all muscles of the deep stabilization system to function in harmony. (5)

Treating pathological respiration, this has the greatest impact on the intra-abdominal pressure regulation and spinal stabilization. The prerequisite for normal stabilization is that the thorax is in a position like during ontogenesis, i.e., with the sternum and the ribs in a caudal position which is essential for the eccentric contraction of the abdominal wall during inhalation. In this position the diaphragm flattens and contracts at all its parts, and the abdomen widen not only anteriorly, but also the lateral and lumbar part of the abdominal wall widen. (5)

Respiratory movements are first taught in the supine position, and gradually in more demanding positions. The basic task is to teach the patient to breath with the sternum in a caudal position, moving it only antero-posteriorly. Also essential is that the thorax widen in the transversal plane, it is under these conditions the diaphragm and abdominal muscles fulfill their stabilizing function (see picture 23). [5]

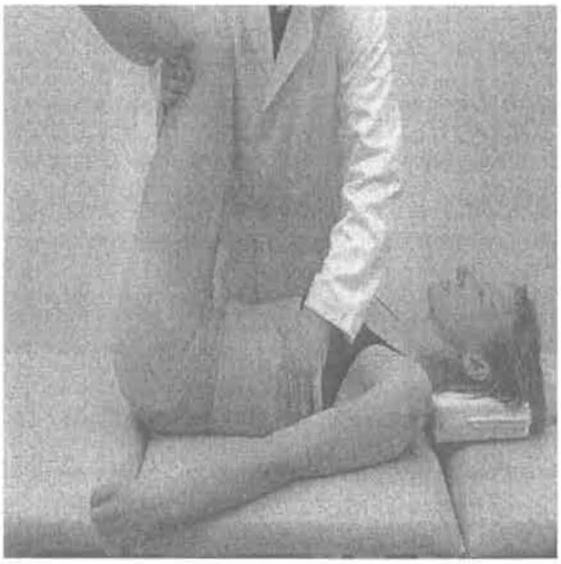
(Picture 23)

Patient's voluntary activity is used in carefully chosen positions fixed by the therapist. [5]
The patient is supine, with hips and knees flexed at right angles, the knees are shoulder breadth apart and in slight external rotation. The sternum and thorax are moved into the caudal position by the therapist while the patient exhales. In this position we ask the patient to support himself on the thoraco-lumbar crossing, and slightly lift his buttocks from the table to activate the abdominal muscles. In this position the therapist fixate the lower ribs at the attachments of the lateral abdominals which automatically brings the lateral abdominals and the diaphragm into action.
Mistakes to be avoided: When slightly lifting the buttocks the ribs must not be moved up by the activity of the rectus abdominis and the ventral part of the diaphragm, this is seen when the abdomen bulges in front. Also when lifting the buttocks, retroversion of the pelvis should be avoided, as is adduction of the shoulder blades accompanied by increased activity of the paravertebral muscles (see picture 24). [5]
The patient is prone with hands clasped behind head, upper trapezius must be relaxed! Support is given to the arms and shoulders to help the patient into extension (most important in the mid thoracic part). In this position it is essential that the patient supports himself on the symphysis while his shoulder blades remain fixed. This position activates the lateral abdominals and the lumbar part of the diaphragm.

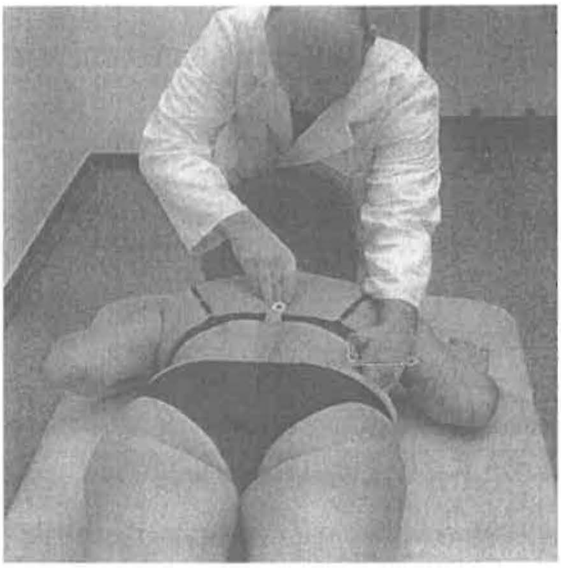
Mistakes to be avoided: The patient flexes the spine while seeking support on the symphysis. He adducts his shoulder blades. [5]

The patient is prone, supporting himself on his hands. He straightens the cervical and thoracic spine by use of his hands to make the symphysis the point of support. In this position, maximal caudal position of the thorax is attempted during exhalation. At this moment, we tell the patient to push against our hands which are on the latero-dorsal aspect of the abdominal wall. Extension should not be above 45 degrees.

Mistakes to be avoided: The patient flexes the thoracic spine and adducts the shoulder blades (see picture 25). [5]



(Picture 24)



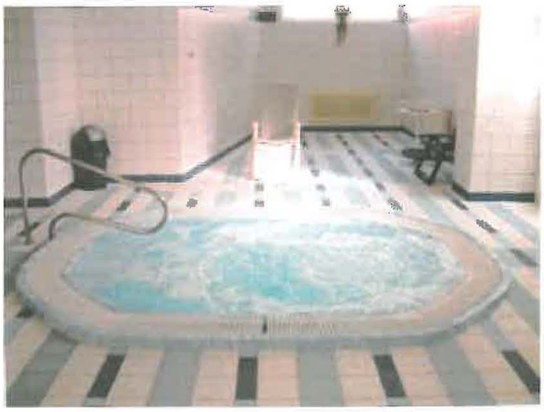
(Picture 25)

3.1 Methods

3.1.1 The clinical place.

C.L.P.A is a medical centre which targets on covering the complex spectrum of the physiotherapy and rehabilitative care. C.L.P.A was opened in January 2002. The C.L.P.A offers highly specialized service in the field of sport medicine (among their clients are AC Sparta Praha and FC Slovan Liberec), comprehensive prevention programmes (mostly used by companies for their employees), and condition-enhancing programmes. They also offer water therapy procedures and relaxation procedures (such as massages, sauna or water massages).

(Picture 26)



(Picture 27)

3.1.2 Period of clinical work placement.

07.01.08-18.01.08

3.1.3 Used appliances and instruments.

At the C.L.P.A they have a fully equipped gym which is directed toward sensory motoric stimulation. I was using the gym for all of my patients doing different exercises on ball, on labile surfaces and with thera band (see supplement).

They also have a physical therapy lab and a hydrotherapy department which I didn't use.

During the 5 sessions with my patient I used the gym for exercises with ball, Thera-band, and SMS. These exercises where directed toward her problem with dysfunction of the deep stabilization system (see supplement for exercise description).

3.2 Anamnesis.

PA:

The patient suffers from low back pain. This pain she experienced for the first time when she was 16 years old playing handball. The movement which provoked a sudden pain in her low back involved full flexion and external rotation in her left shoulder and extension and rotation of whole spine to the left. This pain she had for approximately 3 years.

Then for a longer period she was more or less without pain, but when she was pregnant with her 2nd child, 2 years ago, the pain starting coming back gradually.

Positions/movements that worsen her pain are when she is lifting from the anteflexed position, and when she is lying on her abdomen. A pain relieving position is when she is lying on her back with hips/knees flexed by pulling her knees to her chest.

From her description of the pain there is no sign of sensory (parasthesia), or muscular (weakness, tremors) problems.

The patient also suffers from hypothyroidism, and is at the doctor every 6 months for tests.

AA:

No allergies

Operations:

Appendectomy15 years ago, the scar is 4 cm.

Abuses:

She smokes 7 cigarettes daily, no alcohol.

SA:

She lives on an apartment 3rd floor without elevator.

Married and has 2 children (3 years and 9 months old)

Was active with sports, but is at the moment a full-time mother.

She worked as a financial analyser.

FA:

Father died from heart attack, rest of family is healthy.

Pharmaceutical anamnesis:

Euthyrox 100mg/day was changed with Letrox 100mg/day

The change in medications was because they thought the first medication was the reason of some skin rashes, but the skin rashes are there after the change as well.

Previous rehabilitation:

Exercises on ball for stabilization of trunk.

McKenzie exercise.

Mobilization of the whole lumbar spine

Manipulation of the whole thoracic spine.

Interferential vacupressure current.

Present state:

She describes the pain as going laterally from her lumbar spine on/above the iliac crest. She says the pain is constant, but it is worst in the morning. Before she started treatment the pain also woke her up at night.

- Weight 65 kg
- Height 160 cm
- BMI 25.4

Differential consideration:

Radicular syndrome.

Cauda equina syndrome.

Hypothyroidosis.

Scar from appendectomy.

Postural syndrome.

Referred pain from TrPs in gluteus medius, latissimus dorsi, iliopsoas, erector spinae, multifidi, and rectus abdominis mm.

Coccygeal syndrome

3.3 Initial kinesiological examination.

3.3.1 General appearance.

I can see that she has pain when undressing and when moving onto and off the treatment table. She has a good mood, is nice, and easy to work with.

3.3.2 Posture examination.

Posterior view:

Weight bearing	Standing on medial aspect of both feet.
Heel form and position	Pronation in both subtalar joints, most on the left side
Achilles tendon	Can see on both sides that there is an angle at the tendon because of the pronation in the subtalar joints.
Calf	Symmetrical
Popliteal line	There is more IR in the left hip joint, which is visible on the popliteal lines.
Thighs	Symmetrical
Gluteal lines	Are in the same plane
Hip joints	There is IR in both, most on the left side.
Pelvis	Clockwise rotation
Spine	Convexity of the thoracolumbar crossing to the left.
Thorax	Clockwise rotation
Inferior angle of Scapula	ER, bilaterally.
Medial margin	ABD, bilaterally.
Shoulder	Higher on the left side.

(Table 4)

Lateral view:

Ankle joint	Are in neutral position.
Knee joint	Are in neutral position.
Hip joint	Flexion on both sides.
Pelvis	Great anterior tilt.
Lumbar spine	Hyperlordosis, maximum at the level of L3.
Abdomen	Protrusion of the abdomen, maximum just below the navel
Thoracic spine	Normal kyphosis
Cervical spine	Normal lordosis
Shoulder	Protraction bilaterally, anterior elevation on the left side.

(Table 5)

Anterior view:

Transverse arch of feet	Flat on both sides
Longitudinal arch of feet	Flat on both sides
Calves	Symmetrical
Knees	Valgosity
Patella	Is lower on the left side, and also vastus medialis on the left side is more flaccid.
Thighs	Left thigh is more flaccid and is easy seen on the lower vastus medialis.
Pelvis	Clockwise rotation
Abdomen	Contour of the abdomen is good, in relation to the plumb line the navel is slightly to the right, there are no grooves around the rectus abdominis, and the lower thorax is only slightly visible.
Trunk	The clockwise rotation is more evident in the anterior view; the whole trunk is also situated more to the right of the plumb line.
Sternum	The plumb line passes through the sternocostal

	junction, so the whole sternum is to the right of the plumb line.
Clavicle	Is higher on the left side.
Shoulder	There is protraction of both shoulders, more on the left side, and the left shoulder is also elevated.
Head position	The head is also to the right of the plumb line, which passes through the left eye.

(Table 6)

Conclusion of the posture examination:

From the posterior view (table x); the pronation in the subtalar joints, and the medial weight bearing of the sole lead me to the examination of the feet (see below).

The IR of the hip joints, the clockwise rotation of the pelvis and trunk, and the convexity of the thoracolumbar crossing to the left, lead me to the examination of the hip joint and the lumbar spine (see below).

From the lateral view (table x); the flexion of the hips, the hyperlordosis of the lumbar spine and the protrusion of the abdomen lead me to the examination of the short hip flexors and erector spinae, and to the examination of the weak abdominals and glutei.

The shoulder protraction leads me to the examination of the short pectoralis muscles and to the examination of the weak rhomboidei and middle/lower trapezius.

In the anterior view (table x); the flat feet also guided me to the examination of the feet.

The position of the upper body to the right of the plumb line is the reason why I did the scale test.

The higher left shoulder girdle is why I did the examination/palpation of the upper trapezius and the scaleni.

3.3.3 Anthropometrical measurement.

Spine distances:

Thomayer	Negative, reaches with the fingers to the floor. During the test there is no kyphosis in the lumbar spine, and it is also painful for the patient on stooping and returning to the initial position.
Shober's	Normal=4-6cm.

	Result=5cm
Stibor's	Normal=7-10cm Result=7cm
Latero-flexion	Normal= 20-25 cm Result right side= 23cm Result left side= 20cm
Otto's distance	Normal= 5.5cm Result= 5.5cm
Scale test	Left side= 31 kg Right side= 34 kg

(Table 7)

Conclusion from the anthropometrical examination:

The Thomayer test is negative, but the pain on stooping and returning to the initial position tells me that there might be the painful arch, which is an indication of muscular or ligamental lesion. There is also no kyphosis of the lumbar spine, but the shober's test which measures the mobility of the lumbar spine is negative, so the movement is normal.

The difference in latero-flexion might be a result of the clockwise rotation of the pelvis and trunk. It may also be due to blockage of the facet joints of the lumbar spine.

3.3.4 Gait evaluation.

The contact of the heels and the lift off from the toes is normal.

Longitudinal and transversal arches of feet are flattening during walking.

There is lateral deviation/tilting of the pelvis

There is poor synkinesis of arms and trunk. Right and left arm are moving together, and the trunk seems "locked" into the clockwise rotation.

In backwards walking lordosis increases.

Walking on heels and toes without any problems, strength and balance is good.

Trendelemburg; Negative, but the patient has problems with balance and with shaking in the weight bearing leg.

Conclusion of the gait examination:

The flattening of the arches during walking tells me that there is not sufficient strength of the plantar muscles.

The lateral tilt/deviation of the pelvis tells me that the lateral hip girdle muscles might be weak.

The increased lordosis in backwards walking tells me that the hip extensors (mainly gluteus maximus) are not strong enough to do the movement.

3.3.5 Basic movement patterns examination (Janda)

Hip extension	Movement is initiated and executed in same way on both right and left side: 1.Contralateral lumbar erector spinae 2.Ipsilateral erector spinae 3.Hamstrings 4.Gluteus maximus
Hip abduction	Movement is initiated and executed in same way in both the right and left hip. It is difficult to say if it is the tensor fascia latae or the quadratus lumborum that initiates the movement, but there is both flexion of the hip and lateral elevation of the pelvis.
Curl up	Is performed with activity of the abdominals, but it is painful for the patient.
Push-up	Stabilization of the scapula is very good
Neck flexion	Fluent movement with a good arch.
Shoulders	The movement is good and is initiated in the glenohumeral joint and with activation of the shoulder girdle around 60 degrees in both the right and left shoulder.

(Table 8)

Conclusion of the basic movement patterns examination:

Both the hip extension (gluteus maximus) and the hip abduction (gluteus medius) is a problem for the patient. These findings lead me to test the strength of these muscles since both of these muscles are essential in several roles (ambulation, stabilization of trunk and pelvis, and in transferring forces from the lower extremities to the pelvis and spine). Poor endurance and strength of these muscles have been shown in patients with low back pain [(1)]

3.3.6 Palpation examination.

Examination of soft tissues:

Cutis, in the thoracolumbar area there is no HAZ, and the skin is free and moveable.

Subcutis, kibler's fold is difficult to perform in the lower lumbar area, but it is possible in the thoracolumbar crossing.

Fascia, there is no restriction of the thoracolumbar fascia

Muscles, palpation in the lying position tells me that there is general hypotonus of the muscles of the whole body.

I didn't find trigger points in the gluteus medius, latissimus dorsi, iliopsoas, erector spinae, multifidi, or the rectus abdominis.

Scaleni and sternocleidomastoid are of normal tonus.

Upper left trapezius is in hypertonus and is also tender on palpation.

Examination of scar after appendectomy:

Scar is freely movable and not painful.

Examination of the Os coccygei:

Not painful on palpation

Conclusion of palpation:

There is hypertonus of left upper trapezius.

3.3.7 Hypermobility examination

Backward bend	C
Thomayer	A
Rotation of the trunk	A, to both sides.
Rotation of the cervical spine	A, to both sides.
Ext of MCP joints	A, on both hands.
Lateral flexion of the trunk	B, to the right side. A, to the left side.
Elbow ext with clasped forearms	C
Horizontal ADD in shoulder	B, to both sides.
Contact of hands behind trunk.	No contact with the right hand on the back. Contact with the left hand on the back.
Scarf test	A

(Table 9)

Conclusion from the Hypermobility examination:

There is not constitutional or local hypermobility in the patient.

3.3.8 Examination of muscles tending to shortness.

Upper trapezius	Right side, there is higher ROM compared to the left side, and medium end feel. Left side, there is decreased ROM with a hard end feel.
Levator scapulae	Right side, there is higher ROM compared to the left side, and hard barrier. Left side, there is decreased ROM with a hard end feel.
Pectoralis minor	Is short on both sides
Pectoralis major	Normal ROM on both sides
Hamstrings	Right side, ROM is normal, but it is painful in the back on the contralateral side. Left side, ROM is normal.

Lumbar erector spinae	Normal ROM
Triceps surae	Slight shortness
Hip flexors	Normal ROM on both sides

(Table 10)

Conclusion of examination of muscles tending to shortness:

The left upper trapezius and left levator scapulae is short.

Hamstrings test on the right side causes pain in the back on the contralateral side. This can be crossed lasegue's, or problem with tight hamstrings.

3.3.9 Examination of muscles tending to weakness.

Gluteus maximus	Right side, 3+ Left side, 3+
Gluteus medius	Right side, 3+ Left side, 3+
Rectus abdominis (Janda sit-up)	5
Lower trapezius	Right side, 3+ Left side, 3+
Serratus anterior	Right side, 5 Left side, 5
Rhomboidei	Right side, 4- Left side, 4-
Middle trapezius	Right side, 4- Left side, 4-
Deep neck flexors	5

(Table 11)

Conclusion of examination of muscles tending to weakness:

There is weakness of glutei and retractors of scapulae.

3.3.10 Test of the deep stabilization system function (Doc. Pavel Kolar)

Test 1. Diaphragm test

- Lower costum moves cranially.
- Also the patient has problems with doing this procedure

Test 2. Intra-abdominal pressure test.

- There is poor activation of lateral abdominals.
- Slight hyperfunction of the rectus abdominis.
- No movement of the umbilicus cranially.
- There is increase in hyperlordosis.
- No concavity of the abdominals in the inguinal area.

Test 3. Test of extension.

- No hyperactivation of paravertebral mm
- Exaggerated extension of the thoraco-lumbar region
- No activation of lateral abdominals
- No convexity of lateral abdominals.
- Small scapula adduction and elevation.

Conclusion of the test of the deep stabilization system:

Test 1. Positive, both the cranial movement of the ribs and the difficulties for the patient in performing this test is signs of dysfunction.

Test 2. 3/5 signs are positive. This includes the poor activation of the lateral abdominal muscles, slight hyperfunction of the rectus abdominis, and the increase in hyperlordosis.

Test 3. 3/5 signs are positive. There is no activation of the lateral abdominal muscles, there is a small scapula adduction and elevation, and there is exaggerated extension of the thoraco-lumbar region.

That these tests are positive is a sign of deep stability system dysfunction.

3.3.11 Examination of the breathing pattern.

She has an upper thoracic breathing pattern.

I try to educate her to breathe in to the stomach while the sternum and ribs are in the caudal position, which activates all parts of the diaphragm and during inhalation causes the abdominals to work in an eccentric way.

When she is breathing out I tell her to tense her stomach and pelvic floor muscles to see if provokes her symptoms.

Conclusion of the examination of the breathing pattern:

There is poor activity of the diaphragm, which is another sign of the core stability problem.

When she tenses her abdominal muscles and the pelvic floor simultaneously it is not provoking her symptoms, which excludes the cauda equina syndrome.

3.3.12 Neurological examination.

Sensory examination:

Pain	Pinprick sensation, without pathological signs.
Light touch	Skin stroking, without pathological signs.
Position sense	Without pathological signs.
Two-point discrimination	Without pathological signs.

Deep tendon reflexes examination:

Patellar	1, on both sides
Achilles	2, on both sides
Plantar	2, on both sides

(Table 12)

Conclusion of the neurological examination:

All neurological tests are negative, which excludes the radicular syndrome.

3.3.13 Examination of passive movements between C0/C1 (Lewit/Holubarova)

Anteflexion	Normal ROM
Retroflexion	Normal ROM
Lateral Flexion	Normal ROM to both sides.
Rotation	Normal ROM to both sides.

(Table 13)

Conclusion of the joint play examination C0/C1:

There is no restriction.

3.3.14 Lumbar spine examination (Lewit/Holubarova).

Active movements:

Anteflexion	During the test there is no kyphosis of the lumbar spine, and it is also painful for the patient on stooping and returning to the initial position. There is also no sign of scoliotic recurvation
Lateral flexion	To the right, there is an angle of the spine in the ThL crossing and no rotary synkinesis of the pelvis. To the left, there is an angle of the spine in the area of L3 and no rotary synkinesis of the pelvis.
Retroflexion	It is painful for the patient and the fold doesn't reach the sacrum. I can also see that the rotation of the upper body clearly.

(Table 14)

Joint play:

Springing	The whole lumbar spine feels stiff and in the lower segments (L3-S1) it is painful.
Retroflexion	The movement feels normal, but causes a small pain.

(Table 15)

Passive movements:

Anteflexion	There is separation between L1/L2 and L2/L3. Between L3-S1 movement is restricted. During this examination the patients feels relive of pain.
Lateral flexion	To the right side, there is restriction in the upper part of the lumbar spine. To the left side, there is restriction in the lower lumbar spine.

(Table 16)

Interspinous ligaments are painful on palpation.

Conclusion of lumbar spine examination:

On active anteflexion there is pain both on stooping and returning to initial position for the patient which tells me that there might be a muscular or ligamental problem.

On active lateroflexion there is no rotary synkinesis of the pelvis which is a sign of blockage of the lumbar spine, and/or in the sacroiliac joints.

On active retroflexion the fold doesn't reach the sacrum and there is clockwise rotation of the trunk which is a sign of blockage in the lumbar spine.

On passive examination I find that the lumbar spine is stiff and little movable, especially in the lower part.

3.3.15 Examination of the pelvis and the SI joints (Lewit/Holubarova)

Pelvis:

Crista iliaca are in the same horizontal plane.

SIPS are in the same horizontal plane.

SIAS are in the same horizontal plane.

SIAS are lower than SIPS.

SI joints:

Overtake phenomenon is negative on both sides.

Patrick's phenomenon is negative on both sides.

Spine sign is negative on both sides.

Adduction test is negative on both sides.

Springing examination, there is movement on both sides.

Conclusion of examination of pelvis and SI joints:

There is great anterior tilt of the pelvis.

There are no blockages of the SI joints.

3.3.16 Examination of the hip joints (Lewit).

Active movements:

Flexion	Right side, 100 Left side, 100
Extension	Right side, 5 Left side, 5 Extension in both hips causes pain in the low back of the patient.
Abduction	Right side, 30 Left side, 30
Adduction	Right side, 15 Left side, 15
External rotation	Right side, 30 Left side, 30
Internal rotation	Right side, 15 Left side, 15

(Table 17)

Passive movements:

Flexion	Right side, 115 Left side, 115

Extension	Right side, 15 Left side, 15
Abduction	Right side, 40 Left side, 40
Adduction	Right side, 25 Left side, 25
External rotation	Right side, 35 Left side, 35
Internal rotation	Right side, 15 Left side, 15

(Table 18)

Resisted movements:

ER and IR against isometric resistance are painful.

Conclusion of examination of hips:

There are no problems in movement.

The pain in the resisted ER and IR is a sign of muscular problems.

3.3.17 Joint play examination of the feet (Lewit/Holubarova)

There is good movement in the MCP joints, and also between each MCP joints (1-5) of both feet.

Lisfranc and Choparts joints are of normal movement in both feet.

Talocrural joint is of normal movement in both feet.

Proximal tibiofibular joint on the right side is painful, but normal movement.

Proximal tibiofibular joint on the left side is of normal movement.

There is hypotonus of the plantar muscles.

Conclusion of the joint play examination of the feet:

No problems with movements.

Hypotonus of the plantar muscles of both feet.

3.3.18 Conclusion of the initial kinesiological examination.

Radicular syndrome:

There where no pathological findings on the neurological examination which excludes it as the source of the patients problems.

Cauda equina syndrome:

I did the provocation test, where the patient tenses the abdominals together with the pelvic floor muscles, and it was negative.

Hypothyroidosis:

It may the cause of the problem (see part 2.2.1), but it is a question for the doctor.

Scar from appendectomy:

On examination the scar was moveable and there was no pain when examining.

Postural Syndrome:

From the postural examination the great anterior tilt, lumbar lordosis, and protruding abdomen are important findings.

Gait examination revealed bad synkinesis of arms, and a "locked position" of the trunk, which stayed in clockwise rotation.

The Trendelemburg test was difficult for the patient which had difficulties with keeping her balance.

Basic movement patters examination reveals weakness of glutei, which is confirmed by the muscle strength testing.

The most important findings for the postural syndrome are the tests of the deep stabilization system. These tests revealed:

- Poor diaphragm activity.
- Overactivity of the rectus abdominis.
- Poor activation of the lateral abdominals.

Examination of the breathing pattern confirmed little activity of the diaphragm.

On examination of the lumbar spine there were problems with synkinesis of pelvis with latero-flexion. Both hyperextension and flexion were painful and not fluent, and together with the passive examination these findings gave me the thought of blockages in the lumbar spine.
The hypotonus of the plantar muscles and the flat feet are also signs of postural syndrome.

Referred pain from TrPs in gluteus medius, latissimus dorsi, iliopsoas mm, erector spinae, multifidi, and rectus abdominis:
On palpation I couldn't find trigger points in the gluteus medius, latissimus dorsi, iliopsoas, and erector spinae and rectus abdominis.

Coccygeal syndrome:
The coccyx was not painful on palpation.

Final Conclusion: Deep stabilization system dysfunction.

3.4 Short-term and long-term rehabilitation plan

Short-term:

- Decrease pain
- Breathing education, facilitate the diaphragm breathing
- Decrease lumbar lordosis
- Improve pelvis position
- Strengthen gluteus maximus and medius
- Unblock lumbar spine
- Relax left upper trapezius
- Relax external and internal rotators of hip

Long-term:

- Re-educate the breathing pattern
- Improve core stability
- Start on sensory motoric stimulation
- Maintain strength
- Improve activities of daily living

3.5 Rehabilitation

First session (09.01.08)

Initial kinesiological examination (see page 35-48)

Therapy:

- Mobilization into flexion of the lumbar spine (Lewit/Holubarova)
- PIR traction of the lumbar spine (Lewit/Holubarova)
- Correction of breathing and strengthening of abdominals.

Self-therapy:

- Do strengthening exercises for abdomen and glutei
- Use her relive position for lumbar traction

Effect of therapy:

- The patient feels relive of pain.
- There is still restriction of the lumbar spine into flexion.

Second session (11.01.08)

Present state:

- She feels much better after Wednesday's therapy and has been better during the last two days.

Control examination:

- There is still restricted movement between L3-S1 and the passive movement into flexion of lumbar spine relives pain.

Therapy:

- Mobilization into flexion of the lumbar spine between L3-S1(Lewit/Holubarova)
- PIR traction of the lumbar spine (Lewit/Holubarova)
- PIR of hip external and internal rotators on both sides
- PIR of levator scapulae and upper trapezius.
- Correction of breathing and strengthening of abdominals.
- Strengthening of gluteus maximus and medius

Self-therapy:

- Do strengthening exercises for abdomen and glutei
- Use her relive position for lumbar traction

Effect of therapy:

- The patient feel relive of pain
- Active movements are still painful and not fluent.
- Not noticeable increase in lumbar spine when examining passive flexion.

<u>*Third session (14.01.08)*</u>

Present state:

- More painful after the weekend. Lying on the stomach is not possible.

Control examination:

- Lumbar spine is painful on palpation. Passive movement into flexion of the lumbar spine gives relive of pain. Since this position gives relive I decide to do therapy as the two last sessions.

Therapy:

- Mobilization into flexion of the lumbar spine (Lewit/Holubarova)
- PIR traction of the lumbar spine (Lewit/Holubarova)
- PIR of hip external and internal rotators
- PIR of levator scapulae and upper trapezius
- "Reach exercises"
- Correction of breathing and strengthening of abdominals.

Self-therapy:

- Do strengthening exercises for abdomen and glutei
- Use her relive position for lumbar traction

Effect of therapy:

- There is relive of pain when doing the therapy
- Still painful when lying on abdomen

<u>*Fourth session (16.01.08)*</u>

Present state:

- Immediately after Monday's treatment and exercises she was without pain, but during Monday evening and on Tuesday pain increased and the only position which gave relive was Mckenzie into extension.

Control examination:

- There was no examination.

Therapy:

- Pain was so great today that the only therapy was interferential vacupressure current.

Self-therapy:

- Do strengthening exercises for abdomen and glutei
- "Reach exercises"

Fifth session (18.01.08)

Present state:

- There is still pain and the position which gives relive is the Mckenzie into extension.

Control examination:

- I did a test for ligamental pain (Lewit) which was positive.

Therapy:

- Started her on sensory motoric stimulation
- "Reach exercises"
- Correction of breathing and strengthening of abdominals
- Final kinesiological examination

3.6 Final kinesiological examination

3.6.1 Posture examination.

Posterior view:

Weight bearing	Standing on medial aspect of both feet.
Heel form and position	Pronation in both subtalar joints, most on the left side
Achilles tendon	Can see on both sides that there is an angle at the tendon because of the pronation in the subtalar joints.
Calf	Symmetrical
Popliteal line	There is more IR in the left hip joint, which is visible on the popliteal lines.

Thighs	Symmetrical
Gluteal lines	Are in the same plane
Hip joints	**There is still IR in both, but a little improved.**
Pelvis	Clockwise rotation
Spine	Convexity of the thoracolumbar crossing to the left.
Thorax	Clockwise rotation
Inferior angle of Scapula	ER, bilaterally.
Medial margin	ABD, bilaterally.
Shoulder	**It is still higher on the left side, but a little improved.**

(Table 19)

Lateral view:

Ankle joint	Are in neutral position.
Knee joint	Are in neutral position.
Hip joint	Flexion on both sides.
Pelvis	Great anterior tilt.
Lumbar spine	Hyperlordosis, maximum at the level of L3.
Abdomen	**Slight improvement and a little less protrusion of the abdomen.**
Thoracic spine	Normal kyphosis
Cervical spine	Normal lordosis
Shoulder	Protraction bilaterally, **less anterior elevation on the left side.**

(Table 20)

Anterior view:

Transverse arch of feet	Flat on both sides
Longitudinal arch of feet	Flat on both sides
Calves	Symmetrical
Knees	Valgosity
Patella	Is lower on the left side, and also vastus medialis on

	the left side is more flaccid.
Thighs	Left thigh is more flaccid, which is easy seen on the lower vastus medialis.
Pelvis	Clockwise rotation
Abdomen	Contour of the abdomen is good, in relation to the plumb line the navel is slightly to the right, there are no grooves around the rectus abdominis, and the lower thorax is only slightly visible.
Trunk	The clockwise rotation is more evident in the anterior view; the whole trunk is also situated more to the right of the plumb line.
Sternum	The plumb line passes through the strenocostal junction, so the whole sternum is to the right of the plumb line.
Clavicle	**Is still higher on the left side, but a little improved.**
Shoulder	There is protraction of both shoulders, more on the left side, **and the left shoulder is less elevated.**
Head position	The head is also to the right of the plumb line, which passes through the left eye.

(Table 21)

3.6.2 Gait examination

There is less lateral deviation/tilting of the pelvis

There is better synkinesis of arms, but the trunk still seems "locked" into the clockwise rotation.

In backwards walking lordosis increases, but less than before strengthening exercises of the glutei.

3.6.3 Basic movement patterns examination (Janda)

Hip extension	Movement is still initiated by the contralateral and then the ipsilateral erector spinae, but there **is simultaneously activity of the hamstrings and gluteus maximus on both sides.**
Hip abduction	There is still flexor mechanism and lateral elevation of the pelvis, **but less on both sides.**
Curl up	Is performed with activity of the abdominals, is still painful for the patient.
Push-up	Stabilization of the scapula is very good
Neck flexion	Fluent movement with a good arch.
Shoulders	The movement is good and is initiated in the glenohumeral joint and with activation of the shoulder girdle around 60 degrees in both the right and left shoulder.

(Table 22)

3.6.4 Examination of muscles tending to shortness.

Upper trapezius	Right side, there is higher ROM compared to the left side, and medium end feel. Left side, **there is better ROM with a medium-hard end feel.**
Levator scapulae	Right side, there is higher ROM compared to the left side, and hard barrier. Left side**, better ROM with a medium-hard end feel.**
Pectoralis minor	Is short on both sides
Pectoralis major	Normal ROM on both sides
Hamstrings	Right side, ROM is normal, but it is painful in the back on the contralateral side. Left side, ROM is normal.
Lumbar erector spinae	Normal ROM

Triceps surae	Slight shortness
Hip flexors	Normal ROM on both sides

(Table 23)

3.6.5 Examination of muscles tending to weakness.

Gluteus maximus	**Right side, 4-** **Left side, 4-**
Gluteus medius	**Right side, 4** **Left side, 4**
Rectus ABD (Janda sit-up)	5
Lower trapezius	Right side, 3+ Left side, 3+
Serratus anterior	Right side, 5 Left side, 5
Rhomboidei	Right side, 4- Left side, 4-
Middle trapezius	Right side, 4- Left side, 4-
Deep neck flexors	5

(Table 24)

3.6.6 Test of the deep stabilization system function (Doc. Pavel Kolar)

Test 1. Diaphragm test

- **Lower costum moves less cranially and a little laterally.**
- It is still difficult for the patient.

Test 2. Intra-abdominal pressure test.

- **There is better**, but not good activation of lateral abdominals.
- Slight hyperfunction of the rectus abdominis.
- No movement of the umbilicus cranially.
- There is increase in hyperlordosis.
- No concavity of the abdominals in the inguinal area.

Test 3. Test of extension.

- No hyperactivation of paravertebral mm
- No activation of lateral abdominals
- No convexity of lateral abdominals.
- Small scapula adduction and elevation.

3.6.7 Examination of the breathing pattern.

She still has an upper thoracic breathing pattern, but it is improved and **higher diaphragm activity.**

3.6.8 Lumbar spine examination.

Active movements:

Anteflexion	Still no kyphosis of the lumbar spine, and still painful on stooping and returning to the initial position.
Lateral flexion	To the right, there is still an angle of the spine in the ThL crossing and no rotary synkinesis of the pelvis. To the left, there is still an angle of the spine in the area of L3 and no rotary synkinesis of the pelvis.
Retroflexion	It is painful for the patient and the fold doesn't reach the sacrum. I can also see that the rotation of the upper body clearly.

(Table 25)

Passive movements:

Springing	The whole lumbar spine feels stiff and in the lower segments (L3-S1) it is painful.
Retroflexion	The movement is normal.
Anteflexion	There is separation between L1/L2 and L2/L3. Between L3-S1 movement is restricted.
Lateral flexion	To the right side, there is restriction in the upper part of the lumbar spine. To the left side, there is restriction in the lower lumbar

	spine.

(Table 26)

3.6.9 Examination of the hip joints (Lewit).

Resisted movements:

ER and IR against isometric resistance **are no longer painful**

3.7 Therapy effect evaluation, prognosis.

If I compare the initial kinesiological examination with the final I can see that there are some small improvements, but feel that after 5 sessions I should have gained better results.

If the patient exercises regularly and improves ADL, I think the low back pain may go away.

4. Conclusion

At the first session the examinations lead me to the suspicion of blockages in her lumbar spine and therefore I applied mobilization. For the second session she was very satisfied and said that what I did helped a lot, so I decided to continue with the same therapy, which after the session felt very good according to the patient. Then the last week of therapy was troublesome, the relive position had gone from flexion of the lumbar spine to extension of the lumbar spine, and the pain was so great that most of my planned therapy was not possible.

If I had started the practical tomorrow I would have done things a little different. After I have studied the deep stabilization system I have better knowledge, and therefore I would probably have chosen exercises which would have been more suitable for the patient. Also I think I got too focused on the mobilization techniques, even tough it gave relive the first time I should have been more aware when the patient only felt better for 1-2 days and tried to make the strengthening of the core and coordination of breathing the main goals of treatment.

5. List of literature.

1. BRUKNER P., KHAN K., 2006 *Clinical Sports Medicine*, 3rd edition. Australia: McGraw-Hill. ISBN 007471520-8.

2. DRAKE R.L., VOGL W., MITCHELL A.W.M., 2005. *Gray's anatomy for students*, 1st edition. Spain: Elsevier Churchill Livingstone. ISBN 0-443-06612-4.

3. KAPANDJI I.A., 1974. *The physiology of the joints. Volume three: the trunk and the vertebral column*, 2nd edition. China: Churchill Livingstone. ISBN 0-443-01209-1.

4. KENDALL F.P. et al., 2005. *Muscles testing and function with posture and pain*, 5th edition. USA: Lippincott Williams & Wilkins ISBN 0-7817-4780-5.

5. KOLAR P., 2007. *Facilitation of agonist-antagonist co-activation by reflex stimulation methods. Rehabilitation of the Spine a Practitioner's Manual*, 2nd edition. USA: Lippincott Williams & Wilkins. ISBN-13: 9780 7817 2997 0

6. LEWIT K., 1999. *Manipulative therapy in rehabilitation of the locomotor system.* 3rd edition. Great Britain: Butterworth Heinemann. ISBN 0 7506 2964 9

7. LEWIT K., 2007. *Managing common syndromes and finding the key link: Rehabilitation of the Spine a Practitioner's Manual*, 2nd edition. USA: Lippincott Williams & Wilkins. ISBN-13: 9780 7817 2997 0

8. LIEBENSON C., 2007. *Functional stability training. Rehabilitation of the Spine a Practitioner's Manual*, 2nd edition. USA: Lippincott Williams & Wilkins. ISBN-13: 9780 7817 2997 0

9. MCGILL S.M., 2007 *Lumbar spine stability: Mechanism of injury and restabilization. Rehabilitation of the Spine a Practitioner's Manual*, 2nd edition. USA: Lippincott Williams & Wilkins. p. 93-111. ISBN-13: 9780 7817 2997 0

10. MOORE K.L., DALLEY A.F., 1992. *Clinically oriented anatomy*, 4th edition. Canada: Lippincott Williams & Wilkins. ISBN 0-683-06141-0.

11. NIPPOLDT T., 2006. *Hypothyroidism: Does it cause joint pain?* Retrieved 20th march 2008 from Mayoclinic.com, tools for healthier lives. (http://www.mayoclinic.com/health/hypothyroidism/AN00069)

12. PLATZER, W., 2003. *Colour atlas of human anatomy, Vol.1 Locomotor system.* 5th edition. Germany: Thieme. ISBN 1-58890-159-9.

13. TRAVELL J.G., SIMONS A.G. 1993. *Myofascial pain and dysfunction, the trigger point manual, the lower extremities.* USA: Lippincott Williams & Wilkins. ISBN 0683-08367-8.

14. TRAVELL J.G., SIMONS A.G. 1993. *Myofascial pain and dysfunction, the trigger point manual, the upper extremities.* USA: Lippincott Williams & Wilkins. ISBN 0683-08363-5

6. Supplement.

6.1 Ethics committee agreement.

CHARLES UNIVERSITY PRAGUE
FACULTY OF PHYSICAL EDUCATION AND SPORTS
José Martího 31, 162 52 Prague 6 – Veleslavín
Phone (02) 2017 1111
http://www.ftvs.cuni.cz/

Application for
Opinion of UK FTVS Ethic Committee
On the project of Bachelor Thesis including human participants

Title: Deep stabilization system dysfunction

Project type: Bachelor Thesis

Authors (crucial author): Martin Bakstad

Supervisor (in case of student project): Mgr. Klára Faladová

Project description:
The case report of rehabilitation the patient with [illegible] ......elaborated with the vocational sight of physiotherapist in Cervical Thoracic..... [illegible] [illegible] (Health care [illegible])
No one invasive procedure will be applied.

Proposal of Agreement ([illegible])

Prague 10.04.05....

Author's signature Martin Bakstad

Statement
UK FTVS Ethic Committee

Committee members: Ass. Prof. [illegible], M.D., CSc.
Prof. Ing. Václav Bunc, CSc.
Prof. PhDr. Pavel Slepička, DrSc
Ass. Prof. Jan Heller, MD., CSc.

The project was authorized by Ethic Committee UK FTVS with reference number: 0104/2006

Date: 10. 4. 2005

Ethic Committee UK FTVS evaluated submitted project and found no discrepancy to valid principles, instructions and international guidelines for biomedical research, including human participants.

Author of project fulfilled necessary conditions for the agreement of Ethic Committee.

Faculty stamp

Signature of EC chairman

International student office
Phone: [illegible]
E-mail: [illegible]

6.2 Abbreviations.

C0: occipital bone

C1: first cervical vertebra

T4: fourth thoracic vertebra

T5: fifth thoracic vertebra

T6: sixth thoracic vertebra

L3: third lumbar vertebra

L5: fifth lumbar vertebra

S1: first sacral vertebra

ER: external rotation

IR: internal rotation

ABD: abduction

IV: intervertebral

ROM: range of motion

TLF: thoraco-lumbar fascia

SIAS: spina iliaca anterior superior

SIPS: spina iliaca posterior superior

PIR: post isometric relaxation

SMS: sensory motoric simulation

BMI: body mass index

TrPs: trigger points

HAZ: hyper algesic zone

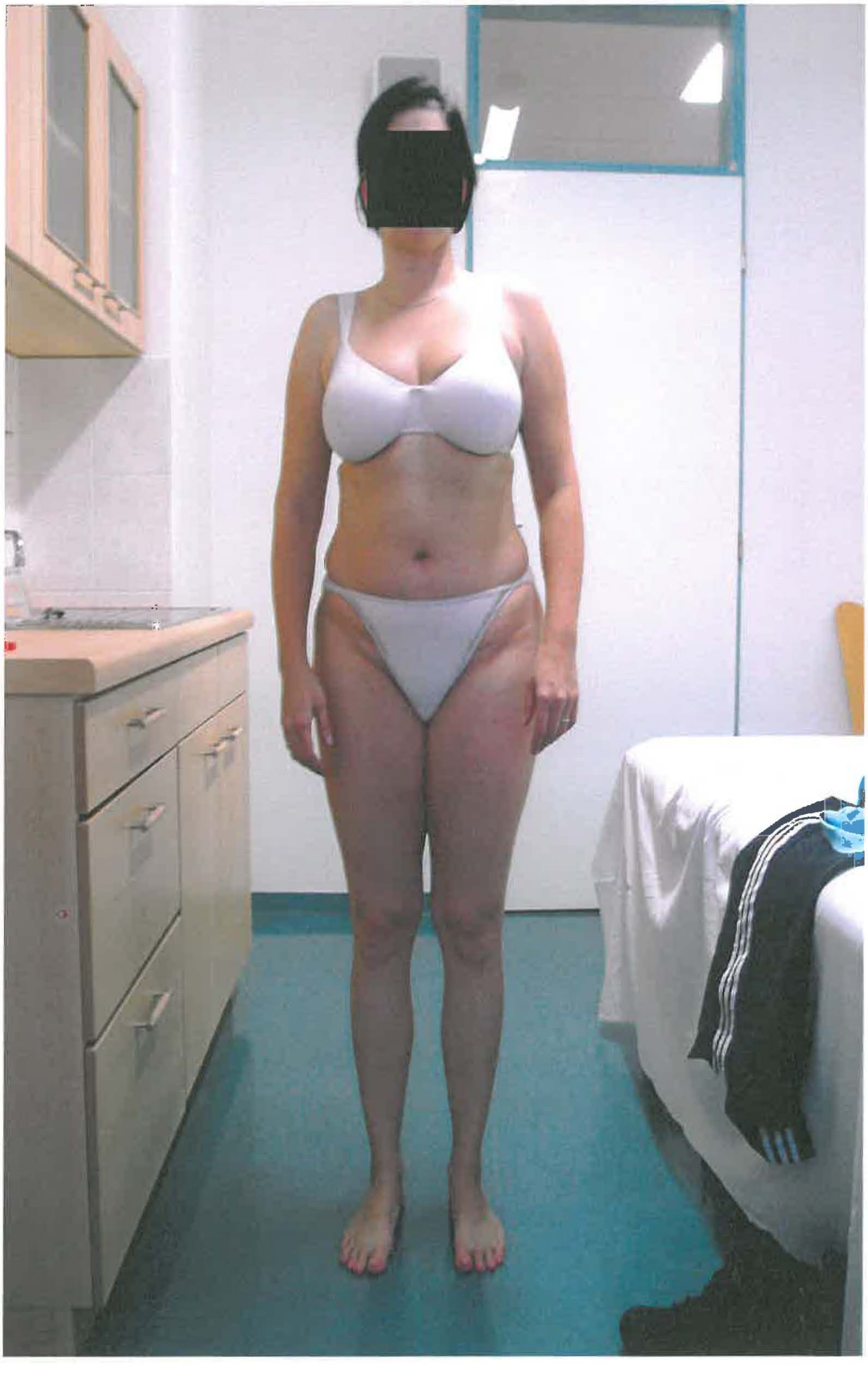
Mm: muscles

SI: sacro-iliac

MCP: metacarpo-phalangeal

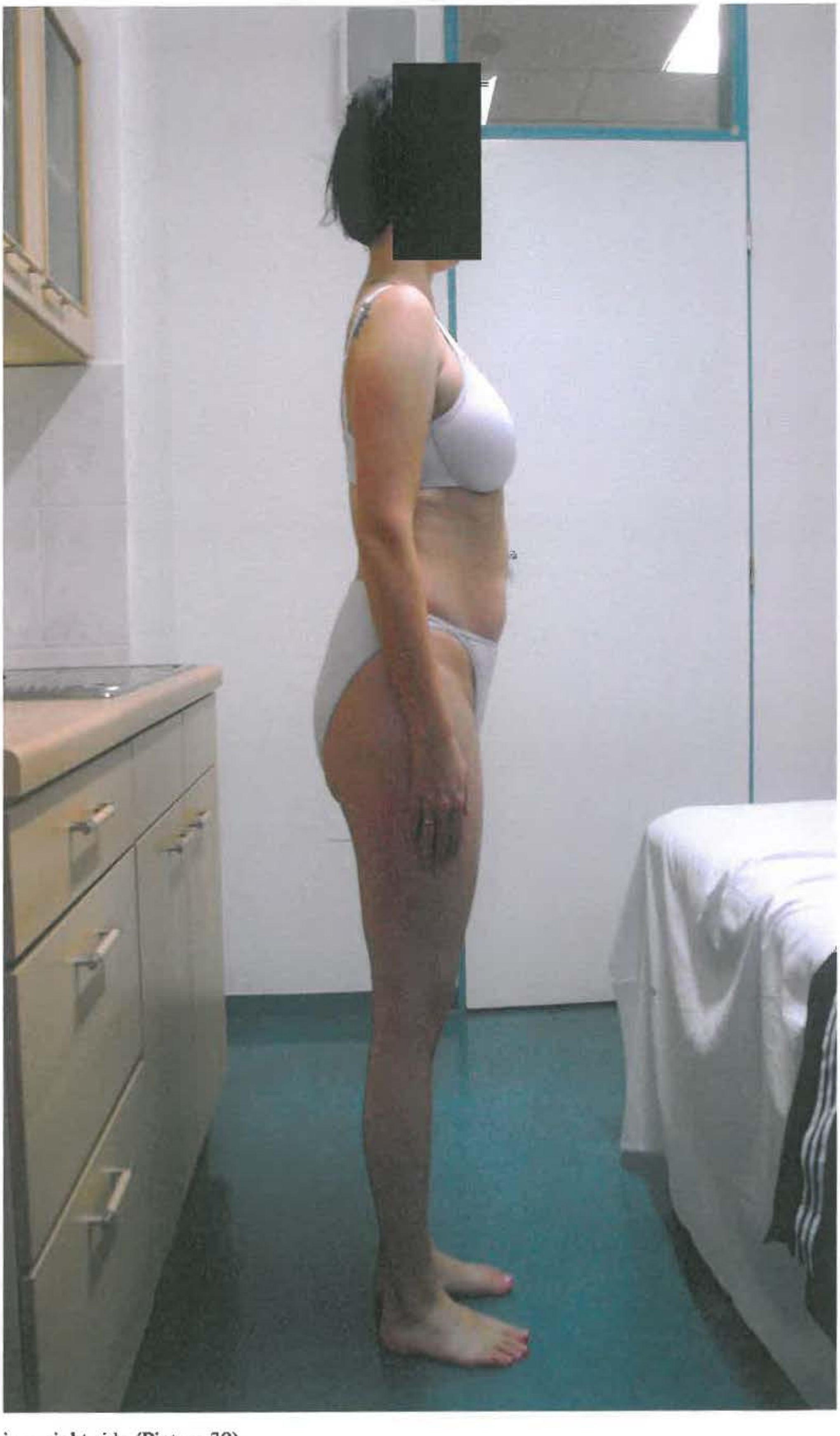
ADL: activities of daily living

6.3 Pictures of the patient.



Anterior view (Picture 28)

Posterior view (Picture 29)



Lateral view, right side (Picture 30)

Lateral view, left side (Picture 31)

Hyperextension of the spine (Picture 32)

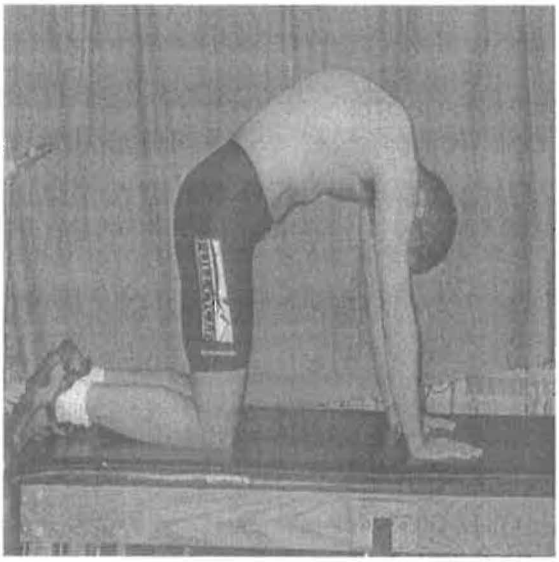
Lumbar curvature during flexion (Picture 33)

6.4 The beginner's program for stabilization.

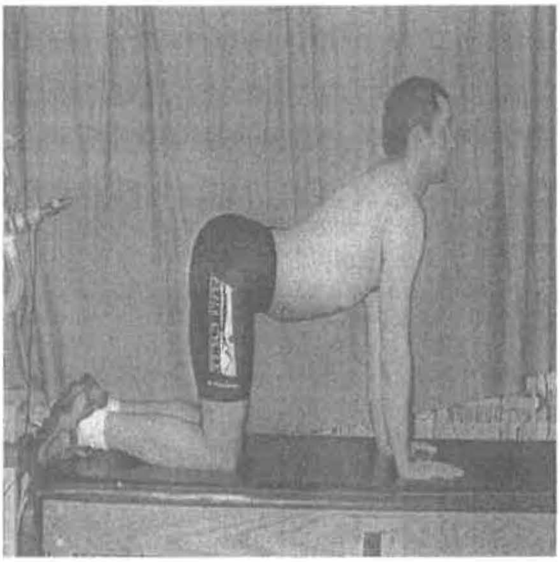
The Cat-Camel exercise facilitates motion for the spine with very low loading of the intervertebral joints, reduces viscous stresses for subsequent exercise, and flosses the nerve roots through the foramina at each spine joint. It has been found that 5-6 cycles are sufficient to reduce most viscous stresses.

(See picture 34 and 35) [8]

The flexion-extension stretch is performed by slowly cycling through the full spine flexion to full extension. It is intended as a motion exercise, not a stretch, so the emphasis is on motion rather than pushing at the end ranges of flexion and extension. [1, 8, 9]



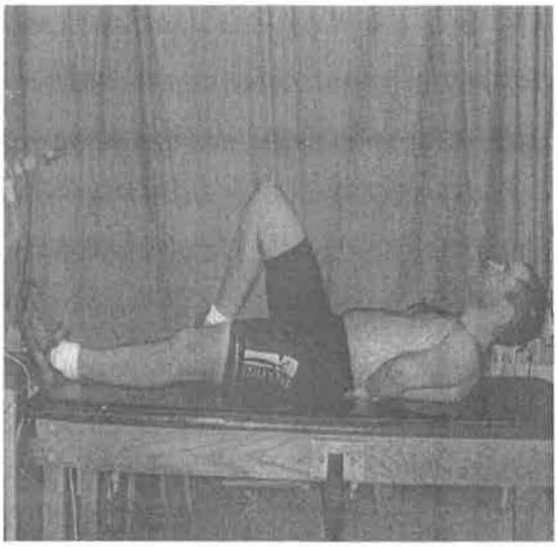
(Picture 34)



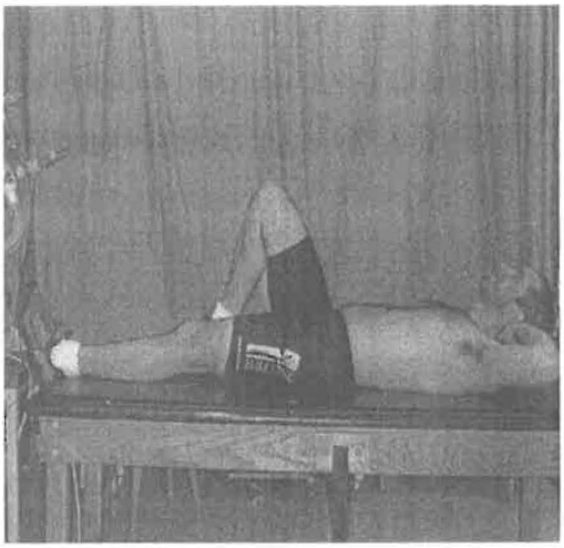
(Picture 35)

The Cat-Camel is followed by anterior abdominal exercises, in this case, **the curl up.** The patient is lying on his back with his arms under the lumbar region to help stabilize the pelvis and support the neutral spine. Only one leg is bent to assist in pelvic stabilization and preservation of the neutral lumbar curve. The patient then lifts his head and shoulders of the ground to activate the rectus abdominis, without changing the curvature of the spine.

Additional challenge can be created by raising the elbows from the floor and generating an abdominal brace or co-contraction (See picture 36, 37) [1, 8, 9]

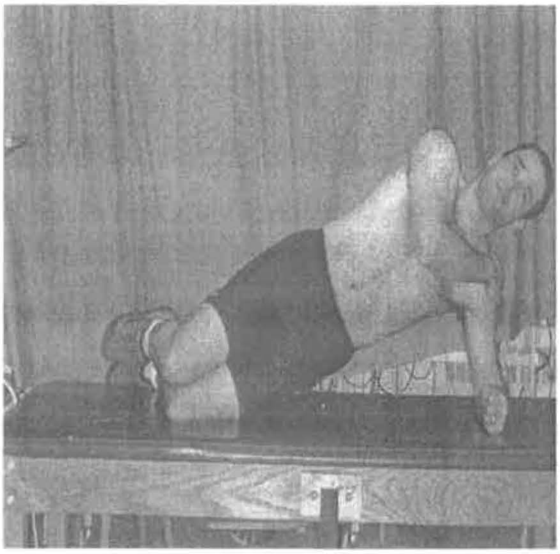


(Picture 36)

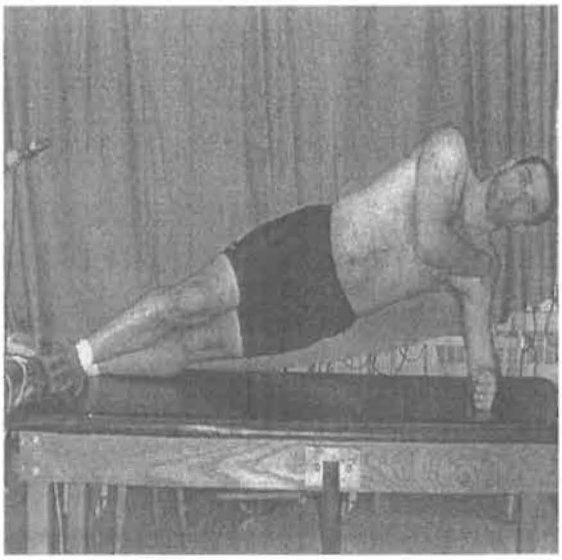


(Picture 37)

The curl up is followed by **the side bridge** which exercises the obliques, quadratus lumborum and transversus abdominis. The patient may support the lower body with the knees which reduces the demand of the patient or on the feet which increases the muscular challenge, but also the spine load (See picture 38, 39) [1, 9]



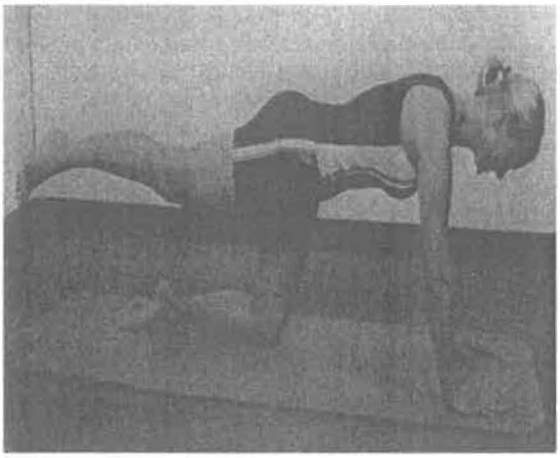
(Picture 38)



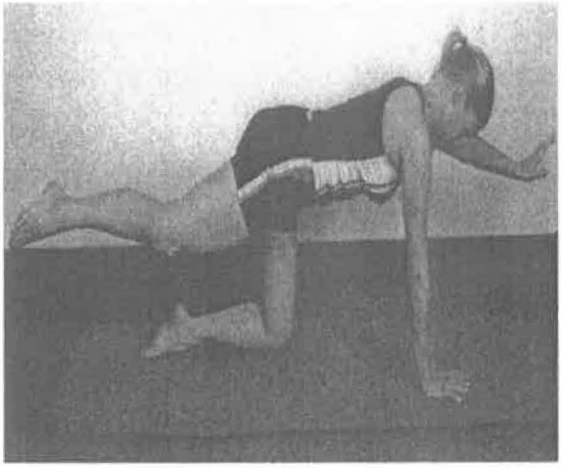
(Picture 39)

The extensor program consist of the leg extensions and the birddog exercise. **The leg extension:** the patient is standing on all four and does extension of one leg, than the other (see picture 40). [8]
Birddog: the patient is standing on all four and does extension of the leg and simultaneously the opposite arm. [8

When performing the leg extension and the birddog exercises it is important to brace/tense the abdomen (see picture 41). [1,8]



(Picture 40)



(Picture 41)

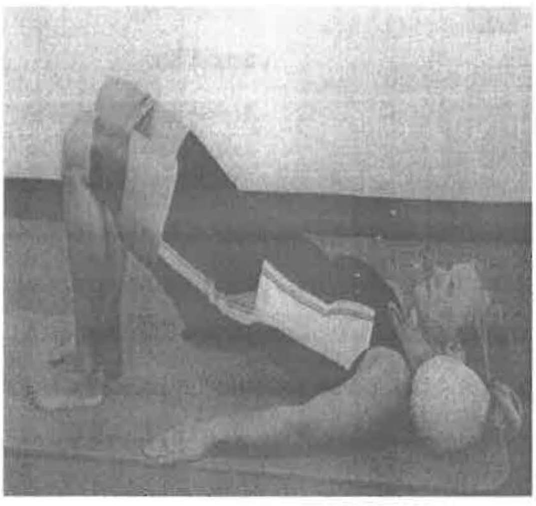
6.5 Exercises used with the patient.

The clam: the patient is in the sidelying position, the knees and hips are slightly flexed, and the ankle and hip joints are in the same plane. The patient now elevates the upper lying knee. It is important that the ankles touch through the whole exercise. [1]

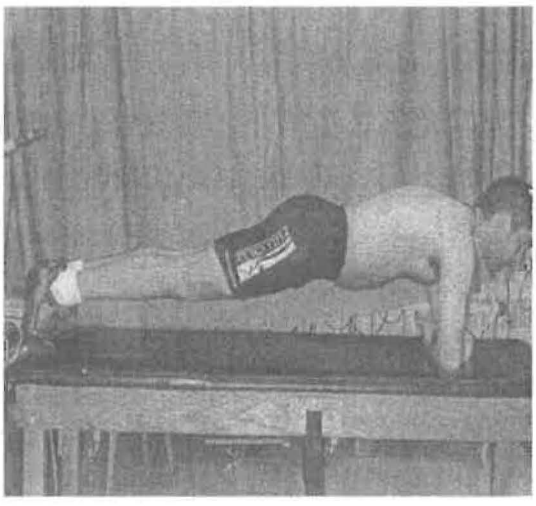
Exercises: Gluteus medius

Pelvic lift: the patient is supine with knees and hips flexed, and the feet on the floor. In this position the patient elevates his pelvis and makes the feet and the upper back/shoulders the area of support (See picture 42) [1,8]

Exercises: Lower erector spinae and gluteus maximus



(Picture 42)



(Picture 43)

Prone bridge: the patient is prone supporting himself on the elbows and forearms and the knees. In this position the patient performs breathing in through the nose, and out through the mouth to facilitate diaphragm. In the picture the patient is supporting himself on the toes, this for advanced exercise (See picture 43). [1, 9]
Exercises: Abdominals

Side bridge: the patient is in the sidelying position, supporting himself on the elbow and knees (See picture 38) [1, 9]
Exercises: The obliques, quadratus lumborum and transversus abdominis.

Hip extension on ball: the patient lies with his stomach on the ball with the knee in 90 degrees flexion and performs extension of the hip.
Exercises: Gluteus maximus.

Reach exercise: This exercise I used with Thera-band. The patient is standing erect with the arms along the side of the body. With the Thera-band in one hand (attached to a wall) the patient takes this arm and "reaches" diagonally up and towards the other side.
Exercises: This exercise I used for the clockwise rotation of the trunk, trying to make the whole muscle group activate and strengthen to lessen the clockwise rotation of the trunk.