Introduction

This publication is intended to serve as guide for those who are health-aware, wish to avoid health problems and would like to feel healthy and fit. It is based on long-standing experience. The movement quality when performing compensatory exercises follows its rules. The choice of exercises, the methods and correct descriptions are therefore based on recognized facts. We hope this brochure becomes a practical guide for everyday purposeful exercise.

This publication focuses on the most overloaded areas of the locomotor system.

- Neck and the upper part of the trunk
- Low back, pelvis and hip joint
- Lower extremities

These areas are of great significance for the life of an individual as they provide the basic human motor behaviour: walking and body posture. Exercising them is important to ensure that any movement is possible without subsequent health issues.

The attention is paid to the descriptions of compensatory exercises to ensure the quality of the exercise performance and optimal results. The exercises are grouped into methodical steps for compensation of given locomotor deficiencies. We follow the principle of gradation, that is, we proceed gradually from the simplest to the most demanding. As every person’s motor skills vary a lot, it is not possible to apply these methods on everyone to the same extent. Someone may need longer time to do a certain exercise or even quits with it there, while others may wish to proceed at a faster pace. Some of these exercises may be performed during the day or while doing other everyday activities. However, do not look at these as invariable guaranteed sets that would have a positive effect on everybody. Contemporary worldwide trends decline from constantly repeated exercise sets with a fixed movement pattern, as they may even enhance muscle imbalance, especially when practiced in bigger groups. An incorrect execution of a movement gradually fixes a wrong movement pattern causing the opposite effect - problems remain and no improvement takes place.

The Significance of Compensatory Exercise

Compensatory exercises, also termed balancing, are irreplaceable in the prevention of functional disorders, especially the locomotor system disorders.

The locomotor system takes an exceptional position, as it produces the overall movement of the organism. It generates all movements, ranging from the top-performance level to everyday activities. Top-performance activities often push the human functional physiological abilities to their limits and thus may easily overload or even damage the locomotor system. In common population it is basically the overload of certain parts of the locomotor system due to incorrect movement patterns (we can also speak of locomotor behaviour), long-lasting activities in static positions or as a result of incorrectly preformed compensatory activities. Also, people who have already included exercise in their daily routines may suffer from the organism overload due to faulty execution of particular locomotor activities, for example when doing muscle strengthening or activities that give a little respect to the joint system condition such as running. The locomotor system's resistance to various stimuli, the overload in particular, is relatively small, since human movement is under conscious control. This may lead to undesirable changes in the locomotor system.

However, compensatory exercises can reduce the negative effect of overloading and maintain the optimal functional ability. Compensatory exercises are also used to eliminate functional disorders that may cause further morphological changes in the skeletal and muscle tissue. Therefore, to maintain the muscle balance it is highly advisable to include compensatory exercises in the exercise program at every age.

The locomotor system as seen from different perspectives

To reach the effect desired, the compensatory exercises must be selected with respect to the physiological function of the locomotor system. The proper knowledge of these principles and identification of the causes of inappropriate physical activities is crucial for effective compensation.

The locomotor system function is based on its own specific principles we need to be aware of. Its optimal function depends on the muscle balance between two systems of muscular fibres. The muscle fibres have different characteristics that are encoded and impossible to be changed. The number of a given fibre type varies in individual muscle structures and thus determines their function.

Muscles are classified in the following two categories:

1. Tonic muscles, also referred to as postural, are characteristic of a slower process of contraction. They are rich in blood supply, and thus they are fatigue-resistant. They have better regeneration abilities and get activated faster in movement patterns, particularly in extreme situations. They are prone to develop resting tightness during the course of life, which is a feature to focus on. It shows predominantly in the adaptation process that prevails over the natural locomotor behaviour. This situation takes often place in sports, or in training practice, especially due to incorrect muscle-strengthening. The tightness of tonic muscles also occurs in population with prevailing sedentary life, even as early as in childhood.

Muscles with prevalence of tonic function and thus with tendency to develop thightness:

m.triceps surae, especially m.soleus	triceps muscle of calf
m.rectus femoris	straight muscle of thigh
m.tibialis posterior	posterior tibial muscle
m.tensor fasciae latae	tensor muscle of fascia lata
m. iliopsoas	iliopsoas muscle
adductor femoris	thigh adductor
m. piriformis	piriform muscle
m. quadratus lumborum	lumbar quadrate muscle
m. pectoralis major and minor	major and minor pectoral muscle
m. trapezius – upper part	trapezius muscle – upper part
m. sternocleidomastoideus	sternocleidomastoid muscle
m. levator scapulae	elevator muscle of scapula

2. Phasic muscles - respond promptly to stimulation, however, they have not as much blood supply and therefore they are fatigable. They also show poorer regeneration abilities, with a tendency to weaken and even reluctance to get involved in muscle contraction.

Muscles with prevalence of phasic function and thus with tendency to develop weakness:

mm. peronei	peroneus
m. tibialis anterior	anterior tibial muscle
mm. vasci	thigh quadriceps – inner and outer ligaments
m. gluteus maximus,medius,minimus	gluteal muscles

mm. abdomini	abdominal muscles
m. trapezius, medium and lower part	trapezius muscle – middle and lower parts
mm. rhomboidei	rhombic muscles

These two types of muscles form two subsystems with different functional characteristics:
1. Tonic system **-** the system of tonic muscles facilitates long-lasting muscle performance with slow start and process.
2. Kinetic system **-** the system of phasic muscles facilitates emergency muscle performance with fast start and process.
Both cooperation and synergism exist between these two subsystems. This is due to the fact that tonic activity, ensuring the position, creates the initial level of kinetic activity. Both subsystems therefore react to the same stimulus, but antagonistically. The kinetic system has an inhibiting effect on the tonic system and basically works on the principles of reciprocate inhibition. However, the tonic system can work both with the mechanism of simultaneous innervations of agonist and antagonist and with the mechanism of reciprocal innervations. Reciprocal innervation takes place only in a slow motion. When there are higher demands on the muscle force both systems are engaged.

Movement patterns

Muscle balance is prerequisite for economical movement, that is, for acquiring quality movement patterns. The patterns can be described as an integrated chain - a system of conditioned and unconditioned reflexes perceived as movement. During repeated movement the same muscles are activated and a firm structure is formed between them with a specific combination of muscle involvement. The activity of muscles during movement is not accidental, but given both by the length of involvement and its intensity. Therefore most movements (movement patterns) are a part of our program. During the course of life these patterns change in reaction to changes of external and internal environment. All individuals have their own particular movement patterns. Nevertheless, there are some general characteristics which can help us judge the movement economy and the quality of the movement pattern.

Locomotor activities form movement patterns. When performing the same action, the same combination and sequence of muscles is activated out of a larger group of muscles with a

broad range of combination. This monotonous repetition of combinations causes overloading of joint structures, produces adaptation changes and results in muscle tightness or weakness. Tight muscles display increased muscle tonus and become dominant in the muscle chain. They are often activated during all motions and thus strengthened. That leads to significant overloading in the whole area. Based on the reciprocal inhibition, shortened muscles also induce inhibition in their antagonists. These respond by decreasing muscle tonus, reducing the muscle power, weakening and changing the position in the pattern.

Muscle imbalance

As a result of long-term overloading, all the previously mentioned characteristics of muscles will take place and produce muscle imbalance. The muscle imbalance typically occurs in the following areas:

-*the area of the neck and the upper part of the trunk*
-*the lumbar area*
-*the area of the pelvis and hip joint*
-*the area of the lower extremities*

The area of the neck and the upper part of the torso: the connection of the spine with the skull displays certain instability, which requires permanent tension of the neck muscles (extensors). Muscle imbalance in this area usually results from a disproportion between the flexors of the head and neck on the front side of the cervical spine (especially between the long muscle of the head and the neck) and the deep extensors on the back side. Muscle imbalance is also worsened by tightness of the upper part of the trapezius muscle. This results in the forward lean of the head and increase in the forward curve of the cervical spine. As a result of this, the muscle balancing the head, the head levator, is shortened.

In the upper part of the body the muscle imbalance is manifested by shortened pectoral muscles and weakness of the back muscles (lower and medial part of the trapezius muscle, lower part of the rhombic muscles and the serrate muscle).

The lumbar area: involves predominantly the lumbosacral transition. If the pelvis is not properly stabilized during movement, this area is often engaged in the movement, which results in unnecessary activation of tonic muscles (lumbar quadrate muscle, erector muscles in the lumbar area) that become gradually shortened and tight, and, thus gain dominance.

The area of the pelvis and hip joint: movements in this central axial joint are based on cooperation of muscle couples (agonists and antagonists), which affect the movement and alignment in other parts of the body. The muscles that tend to be hyperactive and tight are e.g. iliopsoas muscle, straight muscle of the thigh and tensor of fascia latae. These muscles provide the hip joint flexion. As opposed to this, gluteal muscles that tend to be hypoactive and weak provide the hip joint extension. If there is an imbalance between these two groups of muscles, the imbalance may finally cause a functional disorder. The abdominal muscles playing a very important role in this area tend to be tight and thus do not provide sufficient support for the low back. If they are not strong enough, they are unable to prevent the lumbar spine from overloading and their function as an abdominal compressor is insufficient. The consequent imbalance can affect the pelvic tilt, which increases the forward low back curve and leads to painful conditions. If such a situation remains, structural changes of the osseous tissue will occur. And as this is also a place where the centre of body mass is located, this imbalance has a negative impact on other areas of the whole body, especially the spine.

***The area of lower extremities*:** the alignment of the lower extremity axis is affected by the hip joint position. Insufficient function of muscles surrounding some or all the joints of the lower extremities may increase declinations from the axis. The postural function of the lower extremities is related to the knee position and foot arch condition. The foot arch is one of the most important postural and movement mechanisms, which also affects the balance maintenance. This implies that any imbalance occurring around any of the lower extremity joints affects the general alignment of the lower extremities as related to their axis, and thus affects the overall body posture.

Pct.1
Pct.2
Pct.3

Practical application

Based on the information above, the compensatory exercises will be effective only when following the principles written below:

- ***Chose quality exercise methods, follow the exercise instructions properly.***
- ***Chose optimal number of repetitions and vary the exercise.***
- ***Perceive the movement and information from the joints, muscles and tendons. More information comes from root joints (shoulders, hip) and so it is necessary to focus on the information from the relevant muscles.***
- ***Pay attention to neutralizing, stabilizing, balancing (the synergists) muscle groups.***
- ***Consider the fact that the first three vertebrae cause tonic changes in the muscles of the extremities. In backward lean of the head, the upper extremity extensors and lower extremity flexors are irritated. The opposite situation occurs in the forward lean.***

How to exercise and what to focus on

According to the specific focus and prevailing physiological effect, compensatory exercises are divided as follows:

- relaxation
- stretching
- strengthening

To reach the desirable effect of the exercise it is necessary to:
- target a specific area
- use a method corresponding to the character of the change in the locomotor system

Relaxation exercises

Relaxation exercises are purposefully used for a particular joint or locomotor segment. The significance of relaxation lies, above all, in the renewal of the joint free motion.
During the relaxation exercises the following occurs:

1 Alternation of pressure and pull on the bone connections, which improves blood circulation and therefore metabolism in the joint structures that are poor in blood supply.
2 Blood circulation improvement in joints warms up the joints, which has a positive impact on the mechanical characteristics of connective tissues.
3 Joint movements support the production of the synovial fluid, which facilitates fraction of the joint.

4 When stimulating the proprioceptors in the articular area, the transmission of information to the nerve centres is increased and the perception of position enhanced.
5 The indirect impact on the muscles around the joint and their reflexive relaxation.

Stretching exercises

Stretching exercises enable the restoration of the normal, physiological length of the shortened muscles and muscles that tend to be tight (i.e. hyperactive). Tight muscles become inferior as they lose the ability of intensive contraction after full stretching.

During stretching the following occurs:

- Compensation of imbalance between the hyperactive muscles and their functionally weakened antagonists.
- Modification of tonic tension of the muscle fibres and improvement of mechanical characters of their connective constituent.
- Decrease in the pull developed by tight muscles in their attachments to the bone.
- Significant prevention from joint blocks.
- Facilitation of the full range of motion in the joint.
- Improvement of body posture.

Basic rules for relaxing and stretching

1. Steady, comfortable position.
2. Absolute relaxation
3. Clear exercise effect
4. Continual movements, eliminate swinging movements
5. Stretched muscles must not have the anti-gravitating function
6. Stretching under conscious control
7. Stretching must not be painful
8. Sometimes we only relax, sometimes we stretch
9. The use of reflexive mechanisms:
    a) Tension of an agonist – inhibition of an antagonist
    b) Post-isometric relaxation
    c) Adequate resistance or pressure, use of gravitation
    d) Decrease in muscle tension when breathing out
10. Fixation of the central and peripheral attachment
11. Concentrate on the exercise, do not do it mechanically

Strengthening exercise

The aim of the strengthening exercise is to increase the function of weakened muscles or muscles that tend to weaken.

During stretching the following occurs:

- Increase in the resting tonus of the muscles
- Correction of tonus imbalance in the particular movement segment
- Improvement of the muscles' ability to work economically
- Elimination of functional inhibition, improvement of inner muscle coordination

Basic rules for strengthening

1. Before strengthening the hyperactive muscles must be relaxed and stretched.
2. Strengthen in places of shortening, approximation of attachments.
3. Strengthen while breathing out; it minimizes the danger of breath holding.
4. Choose simple and easy exercises.
5. Activate only weak muscles, hyperactive muscles have to remain relaxed (otherwise we are enhancing the muscle imbalance and inhibition of weak muscles).

The resistance-strengthening must follow the principles below:

b) Muscle condition and fitness
c) Number of repetition (optimally 10) and accuracy of execution
d) Duration of hold
e) Eccentric contraction (inhibition moment)

The brief outline of effective compensation exercises aims to eliminate muscle imbalance and minimize all health risks resulting from contemporary sedentary lifestyle, and, also, low-quality compensation. The appropriate exercises support effective compensation and ensure aging with dignity. It slows down the process of body function deterioration significantly and helps to prevent from many ailments. According to the specialists, regular and correctly selected exercise helps to prolong life by 8 – 14 years. Research has shown that exercise reduces stress, anxiety and depression. The correct, quality movement has to be well-considered and beneficial for our organism. The method of programming and forming the movement has its rules, introduced here to be followed, since the compensation procedures are based on them. Only one's own movement experience can positively influence morphological functional changes in the locomotor system.

Use in top-performance sport

The top-performance sport, defined by specific load given by various sport branches, closely influences the locomotor system. Nowadays, the number and difficulty of competitions increases. Therefore, the demands lain upon athletes increase as well. Human organism, no matter how trained, has limits that are to be respected, otherwise damage may occur. Contemporary methods of training are characterized by a great amount of specialized load. A lot of training methods and procedures reach the limit of physiological tolerance and one-sided load causes local overload. This all eventually leads to worsening of the muscle imbalance, inducing negative changes in the locomotor system, and thus deterioration of the performance quality. If we add the today routine compensation based on simple copying a top athlete, then we are likely to harm the athlete. Also, the unsuitable compensation exercises, especially those performed in improper positions, worsen the muscle imbalance, the joint overload etc. It should be noted that each individual, being an athlete or not, has his or her own movement pattern. What may be beneficial for one may easily be harmful for the other. To compensate the training load effectively, it is necessary to take advantage of the instructions stated above.

For better understanding, read the following example:

A basketball player runs around the court and overloads especially the weight-bearing joints that function as shock absorbers of the contact of the lower extremities with the floor. Apart from the lower extremities, the overload refers also to the lumbar spine that maintains the slight forward lean of the upper body when dribbling. This results in strengthening the hypertonic muscles of the chest and back. Such overload requires effective compensation based on the rules given above. But do we compensate this overload according to the character of the movement and load (not just in basketball)? Do we really compensate overloaded muscle groups according to all the principles mentioned? For example, the straight muscle of the thigh (rectus femoris) is usually stretched in the standing position with the leg bent at the knee by pulling the foot towards the buttocks without using the proper breathing pattern and influence of the pelvic tilt with the gluteal muscles tightened. The pectoral muscles are stretched as the first stretching exercise following the training load with the support of the elbow against the door frame; and abdominal muscles are strengthened without previous stretching of antagonistic muscle groups (low back)!

Result: Basically, the muscles are not stretched as they should be. We may feel that the muscle is active, however, the muscle naturally tries to resist the overstretching, since it is stretched in a position (e.g. standing), in which it also takes the antigravity function, and thus can not be relaxed sufficiently. This may cause micro-traumas that may cumulate and result in serious health problems.

The practice made us create clear instructions for compensation of muscle imbalance and sport load, based on a proper knowledge of neurophysiologic principles and characteristics of the correct, quality movement. It should be noted that to reach the desired effect of an exercise, the movement must comply with the neurophysiologic criteria of the movement quality. Specific components of each movement are vital for the movement quality in general.

Each movement must involve the following components:

- *Static,* antigravity component that is involved in every action originating from various positions where anti-gravity force is used,
- *Dynamic,* developing the correct coordination relations between muscles, necessary to form the movement patterns,
- *Breathing,* influencing especially the development of the breathing function to provide energy supply to the working muscles,
- *Relaxation,* supporting the relaxation of muscles and influencing the psychic activity.

Example: *athletics – 400m run*
Static element: *kneeling in the starting blocks as the starting position, if this position is incorrect, there will be a negative impact on the results because of a bad start.*
Dynamic element: *the run itself, characteristic for the runner's movement pattern, synergy of all collaborating muscle groups.*
Breathe element: *the necessary oxygen intake to reach the goal.*
Relaxation element: *when reaching the goal, the tension is relaxed and there may be satisfaction with the result.*

If we apply the knowledge of the quality of motion and its rules to the compensation of exercise load, choose the correct positions and sequence of exercises, we will undoubtedly contribute to the renewal of muscle balance and avoid possible damage.