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CASUISTIC PAPER

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The assessment of the impact of myofascial training on postural control – a case study

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ABSTRACT

Introduction. A sedentary lifestyle with lack of physical activity contributes to deteriorated balance among healthy young people. Physical activity is import_ant since it stimulates neuromuscular junctions that control body posture, especially at younger age, when greater postural sway may be observed in stabilography compared to adults. Proper work of individual muscle groups is import_ant to maintain proper balance. Abnormal muscle tone can lead to dysbalances that make it difficult o maintain a stable posture in a variety of conditions.

Aim. The aim of the study was to evaluate the effect of a training cycle consisting of stretching of the ilopsoas, rectus femoris, gluteus maximus, hamstring and rectus abdominis, and eccentric training of the above mentioned muscles to improve static and dynamic balance.

Methods. Oobjective and qualitative-subjective were used to assess the results in a man aged 22 yrs. Postural control was tested twice in the patient with the Neurocom International Inc. SMART EquiTest device under static conditions without visual control and with dynamic visual surrounding and unstable support surface. Automatic postural reflexes were also evaluated. In addition, clinical tests were performed.

Results. Myo-fascial training, which included eccentric training combined with lower limb and trunk stretching improved the postural control in the subject.

Keywords. balance, eccentric muscle work, qualitative methods, stretching, quantitative methods

Introduction

Currently, a sedentary lifestyle and physical inactivity contribute to deteriorated balance among young healthy people. The human balance system is extremely important in everyday activity. The ability to maintain balance or postural control in the upright position is based on continuous loss and regaining of balance and the primary goal of this system is to maintain the center of gravity within the support surface defined by the foot contour. The ability to maintain and control static and dynamic balance is a necessary condition for independent functioning in everyday life.[1-3]

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Research shows that the ability to maintain body balance in standing is varied across age groups. The results of stabilography tests indicate an increased range of sway in children, while the reduction in postural sway in adolescents and adults. Interestingly, it is also accepted that there is no difference in the sway tested with stabilography in adults and the physically active elderly, which emphasizes the beneficial effect of physical activity on postural stability.[4] Balance control and position of the body in space are associated with the function of the vestibular system, the visual system, the cerebellum, and the proprioreceptors are also conditioned by the motor function of the musculoskeletal system.[5] It is essential that physical activity stimulates neuromuscular junctions through which body posture is controlled. A study by Mraz et al. presented an example in elderly people.[4] However, it is also important at a younger age, as greater body sway may be observed in stabilography tests compared to adults. Good balance requires both work of fast twitch muscles such as rectus femoris, iliopsoas, biceps femoris, semimembranosus and semitendinosus which when overloaded can increase resting tonus while decreasing their length as well as tonic muscles such as gluteus maximus, rectus abdominis, which when overloaded may react with weakening and reduced tonus. Disturbed muscle tone in the above mentioned muscles can lead to dysbalances that make it difficult to maintain a stable posture in a variety of conditions.[6-8]

The purpose of the paper was to evaluate the impact of a training cycle consisting of stretching of iliopsoas, rectus femoris, gluteus maximus, hamstrings and rectus abdominis, and eccentric training of the above mentioned muscles, followed by stretching for static and dynamic balance, assessed by quantitative methods – objective and qualitative-subjective in a man aged 22.

Case description

A 22 year old man was enrolled in the study. The subject was diagnosed with weaker (but within normal range) control during static and dynamic balance tests and Unilateral Stance Test (Figure 1) in Dynamic Computer Posturography. The subject did not do any physical activity or stretching regularly. He was a healthy person, without any traumas or diseases that could affect the outcome of the test. The patient had a balance test assessment twice - before and after a 10-day training cycle using both quantitative - objective methods - SMART EquiTest and subjective clinical tests. The study was carried out in the Laboratory of Human Motor Organ Pathophysiology in the Center for Medical and Natural Sciences Research and Innovation, the University of Rzeszow. Postural stability under static conditions without visual control and with dynamic visual surrounding and unstable support surface was tested by means of the Neurocom International Inc. SMART EquiTest. This also allows for testing the effects of visual, vestibular and somatosensory stimuli on balance, and to test the power and coordination of automated postural responses. The device consists of a dynamic posturographic platform (dual force plate) capable of evaluating the ground reaction forces under stable and dynamic conditions by means of controlled motion (sagittal motion) and horizontal shift. The second part of the device is the patient's cab integrated with the platform to create the conditions of the moving visual environment (the environment moves according to the patient's postural responses). The patient's control of body balance is hindered during the test because of impossibility to stabilize the eyes at a stable point.

Figure 1. Evaluation of the subject in Computerized Dynamic Posturography

The following tests were used to evaluate the subject: the Sensory Organization Test (SOT) and the Unilateral Stance Test. The Sensory Organization Test allows assessment of the sway of the center of gravity with open eyes and then closed under static conditions (stable ground), on stable ground with moving cabin environment, on unstable ground with fixed environment and eyes opened at first and then without visual control and with open eyes with unstable ground and moving environment. In a SOT test, the movements of the ground and the environment is consistent with the patient's body sway. The SOT test allows objective detection of abnormalities in three sensory systems of the patient responsible for postural control: somatosensory, visual and vestibular. The eyes, feet, and joints of the patient are provided with false information (through the

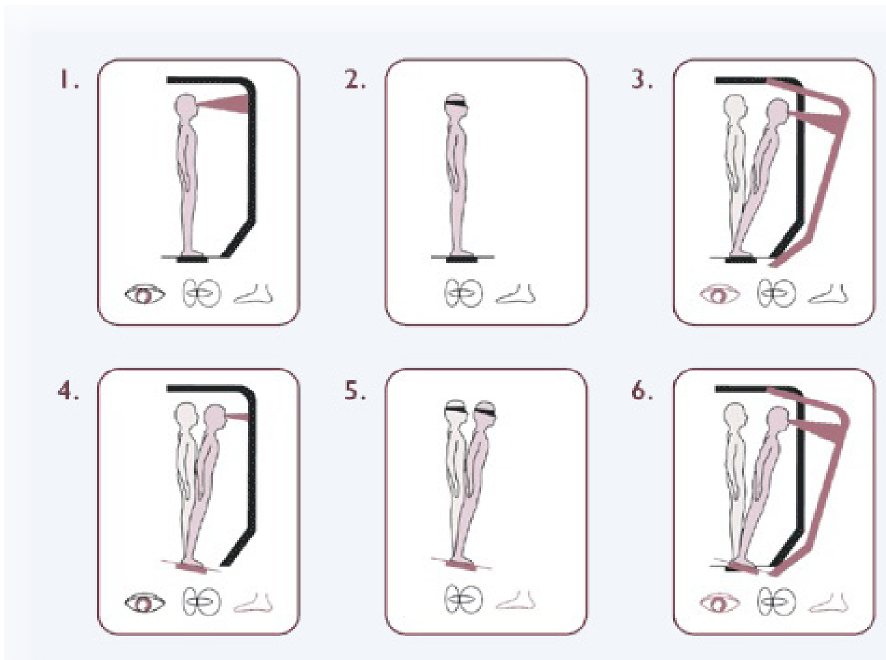

Figure 2. Sensory Organization Test

movement of visual environment (the cab) and/or the ground) as shown in Figure 2. The Unilateral Stance Test evaluates the sway of the subject while standing on one leg both with open and closed eyes.[9]

In addition, the following tests or clinical tests were performed on the subject: 1) Romberg test performed in standing position with feet together and upper limbs flexed to the angle of 90° in shoulder with extended elbows and forearms in supination, 1 min with eyes open and 1 min with eyes closed; 2) Babiński-Weil test consisting of continuous two steps forward and two steps backward with closed eyes for 1 minute, the outcome measure is the angle between the initial and final setting of the tested person; 3) Unterberger's stepping test, consisting of 50 steps with high elevation of the lower limbs with closed eyes with the test measure being the angle between the initial and the final position of the tested person; 4) the pointing test of Barany in which the investigator and the subject stand face to face with the upper limbs outward (90° flexion in the shoulder joints) pointing at each other's index fingers, then the subject closes the eyes and makes flexion of the upper limbs to 180°, next attempting to return to the previous position to point again with the index finger to the investigator's fingers, the test measure is the distance between the subject's and examiner's fingers after the test; 5) Hamstring contracture test with the patient in a long sit with one knee flexed against the chest held with the arm on the same side and attempts to touch the toes of the extended leg with the fingers of the other arm, the outcome measure is the distance from the finger 3 to the hallux of the lower limb; 6) Rectus femoris contracture test in supine with lower legs outside the couch, the patient draws one lower limb to the trunk, in the case of muscle contracture he flexes the hip joint of the other limb, the outcome measure is the distance of the popliteal space from the edge of the couch after the test.[10,11]

The training cycle lasted 10 days. In the first five days, the subject performed stretching of the iliopsoas, rectus femoris, gluteus maximus, biceps femoris, semitendinosus, semimembranosus, and rectus abdominis. From the sixth day to the end of the training cycle, the subject performed both stretching and eccentric inhibition exercises of the aforementioned muscles. Exercises were performed in the following starting positions: prone, supine, long sit, kneeling, and four-point kneeling and standing. Exercises were performed daily in the evening.

Results and discussion

SOT test showed that the test result was within the general norm for the subject's age and height (Figure 3 – Composite column). However, a closer examination of the individual components of the SOT test, showed balance problems in three test components. Trials below the norm are marked red. Trials within the norm were marked green. The norm is presented by gray columns in the chart background. Figure 3 shows the results on the computer screen connected to the device.

Table 1 shows the numerical results of the SOT test performed before the training cycle. The mean result for each test component of three trials was also calculated. All results are given in a numerical scale from 1 to 100, but the results are different for each test component, as illustrated in Figure 3.

After the training was completed, a re-examination was carried out. All the results obtained in the second test were within the norm set out for the subject (Table 2).

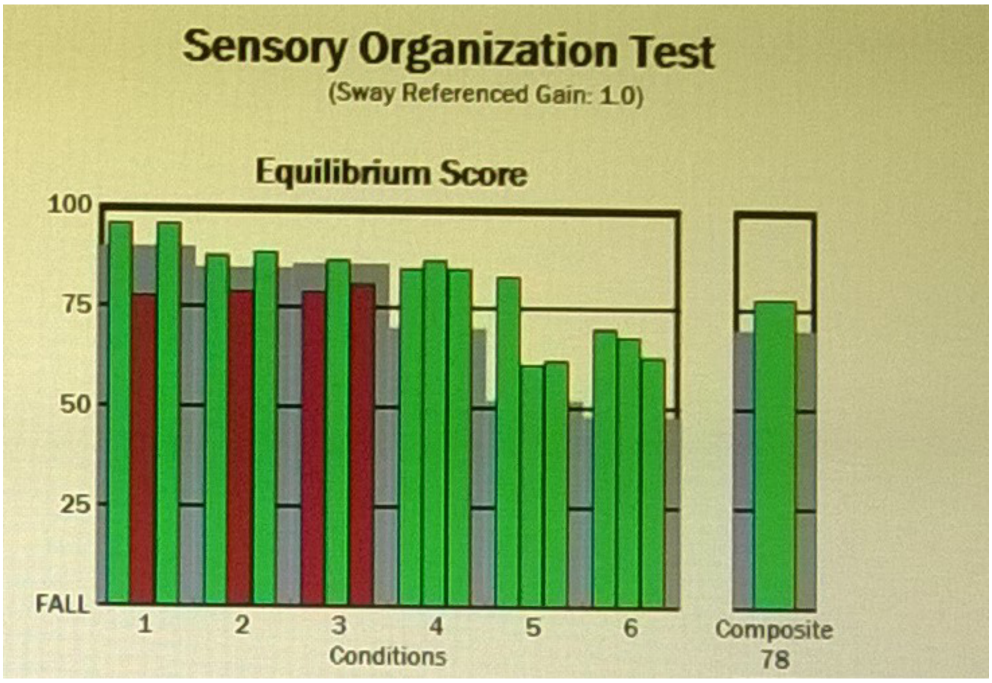

Figure 3. SOT test – before the training cycle

The comparison the results of the SOT test in both examinations demonstrated that five out of six test components improved significantly. In the second examination, a worse test result was obtained only during a test with closed eyes and unstable ground. It is worth noting that during the test on a stable ground also without visual inspection the result was improved (Figure 4).

Analyzing the results of the Unilateral Stance test in the first trial regarding maintaining balance in one leg standing with visual control and without it, a much greater "center of gravity" sway was noted than in a follow-up examination after the training cycle. These differences are illustrated in Figures 5 and 6, and Table 3 based on them. Individual components of the Unilateral Stance test improved significantly in the follow-up examination. It can be concluded that the training cycle has a positive effect on postural control while standing on one leg. Both lower leg and abdominal muscles training can contribute to this (mean results in Table 3 rounded to 0.1).

In addition to double balance assessment with the use of the modern SMART EquiTest device, clinical tests were also performed twice before and after the training cycle in the subject. Table 4 illustrates the

Table 1. SOT test – before the training cycle

SOT test	Trial I	Trial II	Trial III	Mean result (accuracy 0.1)
Eyes open, stable ground and environment	96	78	96	90
Eyes closed, stable ground and environment	88	79	89	85.3
Eyes open, unstable environment	79	87	81	82.3
Eyes open, unstable ground	85	87	85	85.6
Eyes closed, unstable ground	83	61	62	68.6
Eyes open, unstable ground and environment	70	68	63	67

Table 2. SOT test – after the training cycle

Test number	SOT test	Trial I	Trial II	Trial III	Mean result (accuracy 0.1)
1	Eyes open, stable ground and environment	96	94	97	95.6
2	Eyes closed, stable ground and environment	96	94	95	95
3	Eyes open, unstable environment	92	92	92	92
4	Eyes open, unstable ground	93	91	92	92
5	Eyes closed, unstable ground	60	55	66	60.3
6	Eyes open, unstable ground and environment	85	87	80	84

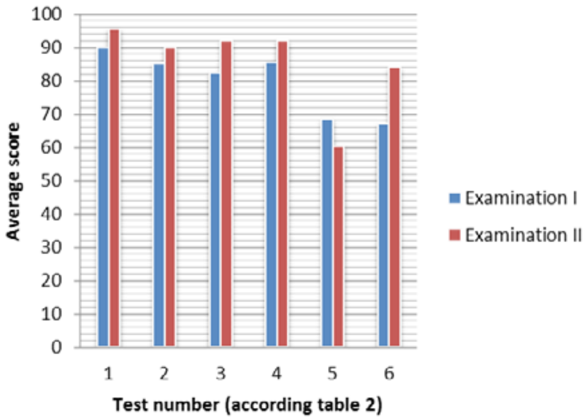

Figure 4. Comparison of mean SOT test results in the examinations I and II

results obtained by the subject in individual tests before and after the training. The results of Romberg test were the same in both examinations, with no significant body sway at 1 minute with open eyes and 1 minute with closed eyes. However, the examination with the SMART EquiTest showed that while standing with open eyes and closed eyes on a stable surface, the subject obtained worse results in the first examination. The results of Babiński-Weil test and Unterberger's stepping test were better in the second examination. It can be concluded that the training positively influenced the results of these tests. The pointing test of Barany was the same in both examinations. Hamstring contracture test and Rectus femoris contracture test were better in the second examination, which may be due to the stretching cycle. Training positively influenced the outcome of clinical trials, in particular improved muscle flexibility (Table 4).

The presented results suggest that applied musculoskeletal therapy, consisting of eccentric work of the trunk and lower limb muscles and the stretching of these muscles positively influenced the dynamic and static balance of the subject. Similarly, Miyake et al. pointed out that stabilization exercises positively influence the dynam-

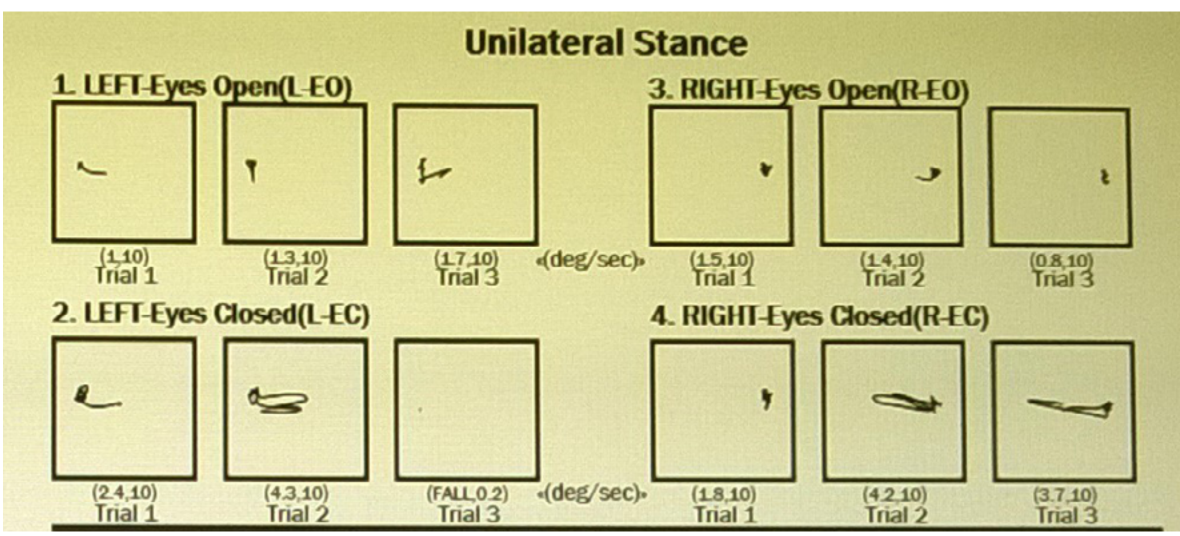

Figure 5. Center of gravity sway in examination I of Unilateral Stance Test

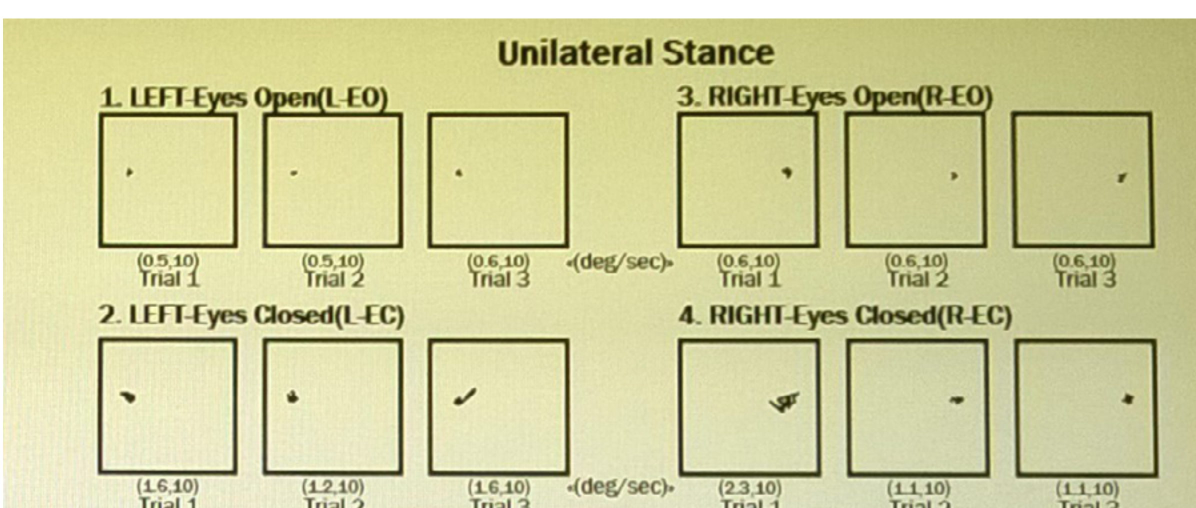

Figure 6. Center of gravity sway in examination II of Unilateral Stance Test

Table 3. Center of gravity sway in examinations I and II of Unilateral Stance Test

Test	Examination I (3 Trials)			Mean result	Examination II (3 Trials)			Mean result	Mean difference
Left LL, EO	1.0	1.3	1.7	1.3	0.5	0.5	0.6	0.5	0.8
Left LL, EC	2.4	4.3	---	3.4	1.6	1.2	1.6	1.5	1.9
Right LL, EO	1.5	1.4	0.8	1.2	0.6	0.6	0.6	0.6	0.6
Left LL, EC	1.8	4.2	3.7	3.2	2.3	1.1	1.1	1.5	1.7

LL – lower limb, EO – eyes open, EC- eyes closed

Table 4. The results of clinical tests in I and II examination

Test	Examination I	Examination II
Romberg test	1 min/1min	1min/1 min
Babiński-Weil test	30°	10°
Unterberger's stepping test	15°	5°
The pointing test of Barany	UL-L: 1cm UL-R: 1cm	UL-L: 1cm UL-R: 1cm
Hamstring contracture test	UL-L: 11,5cm UL-R: 12cm	UL-L: 3cm UL-R: 4cm
Rectus femoris contracture test	LL-L: 4cm LL-R: 5cm	LL-L: 1cm LL-R: 0.5cm

UL – upper limb, LL – lower limb

ic balance of the body.[12] In our study, however, attention was not paid to clenching of the fists or masticator muscles, which may have an impact on the improvement of balance.[13] In light of the observation and analysis of scientific reports, balance seems to be an intrinsic part of overall fitness and training of the body.[12-15] Research show that postural stability can be increased through a variety of training plans. It is important, however, to train the right muscles - those responsible for maintaining stability and balance at the moment of sway. Heleno et al. demonstrated that a five-week training program consisting of sensory exercises improves postural stability in young athletes.[16] As shown Miyake et al. showed this type of workout can also affect the stability of the torso facilitating the operation with the upper limbs, and therefore multi-tasking, referred to as skill – the highest level of the motor control determinants.[14] In addition, the modern SMART EqiuTest device used in the study proved to be a more reliable source of data than clinical tests. Numerous studies indicate that the use of this type of advanced quantitative methods of evaluation based on advanced computer systems provides accurate, complex analysis of imbalances, their causes, and the planning and monitoring of treatment.[17-19]

Conclusion

Myo-fascial training which included eccentric exercises combined with lower limb and trunk stretching improved the postural control in the subject. The case presented proves that the SMART EquiTest from Neurocom International Inc. allowed for a static and dynamic balance assessment with a high sensitivity much more accurate than the human eye, and a subjective assessment of the investigator in clinical tests. A larger sample and using more tests should be employed to draw far-reaching conclusions.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.
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