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Original article

THE ROLE OF KINETIC PROGRAMS IN THE IMPROVEMENT OF SEDENTARY ADULTS' POSTURAL BALANCE – CASE STUDY

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Abstract

Purpose: Through this case study paper we intend to prove that the use of our specific, individualized kinetic programs leads to the improvement of the analyzed subject's postural balance.

Methods: To validate the hypothesis we have used the following research methods: the bibliographic research, the questionnaire research method, the observation method and the case study method. For the assessment of the subject's balance we used a series of initial, intermediate and final tests. The study was conducted from July to September 2013. The kinetic programs we used consisted in performing simple bodyweight exercises or exercises that required different equipment, such as bands, stability balls, wobble boards, balance foams, medicine balls and Bosu balls. The subject was submitted to 20 training sessions, 45 minutes each. The balance assessment tests were Romberg, Fukuda and a static and dynamic posturography using the Multitest platform.

Results: At the end of the 20 training sessions using our individualized kinetic programs, the results showed an improvement of the subject's static and dynamic balance.

Conclusions: As a result of the case study research, the hypothesis was confirmed. Therefore, we determined that individualized kinetic programs contribute to the improvement of the subject's postural balance. The positive results determined us to extend the research on larger groups of subjects.

Key words: posturography, static balance, dynamic balance, platform.

Introduction

Sedentariness (lat. sedere = to sit) reflects a distinct class of behaviors which is characterized by low physical activity and energy consumption (≤ 1.5 METs) (Tremblay et. al., 2010).

According to the World Health Organization, physical inactivity is responsible for more than 2 million deaths per year, being amongst the first ten leading causes of disease and functional impairment worldwide (World Health Organization, 2002).

Sedentary lifestyle is a major risk factor for cardiovascular disease, diabetes and obesity. It also increases the risk of colon cancer, dyslipidemia, osteoporosis, depression an anxiety. These diseases can be prevented through a healthy lifestyle which includes daily exercise, tobacco cessation and good nutrition (World Health Organization, 2002).

Kinetic programs are an efficient training method which do not require the use of specific equipment and can be performed by any individual, regardless his age and physical fitness.

Kinetic programs are used in both physical rehabilitation and athletic training and they are designed to enhance ADLs/sports activities and prevent injury. They are not a new nor revolutionary concept, but offer an integrated approach in the process of improving the coordination, strength, flexibility and the overall conditioning of the subjects (Boyle, 2004). Therefore, motivating the individual towards a healthy lifestyle will have long term positive implications on the quality of his life.

Human movements cannot function properly without a normal balance system. Balance is the ability to maintain the body's line of gravity within the base of support with minimal postural sway (Shumway-Cook, et. al., 1988).

Achieveing and maintaining balance depends on a complex integration of the sensory inputs from the visual, vestibular and somatosensory systems as well as on the motor output to the eyes and muscles. One or more of these components can be affected by aging, injury or various diseases therefore resulting a balance disorder in which the individual feels unsteady or dizzy even in static conditions.

Balance disorders are characterized by various symptoms such as vertigo or dizziness, falling or the sensation of falling, blurred vision, confusion, desorientation, headache, lightheadedness, faintness or a floating sensation, anxiety. The symptoms may be transient or last for longer periods of time.

Balance disorders are treatable and the most effective treatment is vestibular rehabilitation therapy. It is an individualised exercise-based rehabilitation program which consists of specific head, body and eye exercises that are designed to retrain the brain to process and integrate the information from the vestibular system in order to create a central nervous system compensation for inner ear impairments. The exercises are simple and they may also be performed at home.

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The Multitest Platform is a static and dynamic platform designed for the computerized analysis of one's ability to maintain his postural balance in various conditions. It also offers information about the factors that affect balance and the different degrees of proprioceptive, visual or vestibular impairment for an accurate diagnosis and rehabilitation prescription.

The test has 6 sequences of 30 seconds each with a 15 seconds rest time in between sequences:

A: stable platform, eyes opened, fixed target;

B: stable platform, eyes closed;

C: stable platform, visual disorientation (optokinetic);

D: unstable platform, eyes opened, fixed target;

E: unstable platform, eyes closed;

F: unstable platform, eyes opened, visual disorientation (optokinetic).

Balance disorders may be diagnosed based on the posturography results and several other specific vestibular tests.

The objective of this case study is to examine the effectiveness of our individualized kinetic programs in the improvement of a 57 year old sedentary subject's postural balance.

The scope is to determine whether such training methods may be suitable for other individuals with balance disorders, offering them the opportunity of performing simple physical exercises which enhance their motivation and desire to workout.

Methods

The subject is a white male, aged 57, who has never practised sports but joggs occasionally. He is overweight (BMI = 27.7) and has high blood pressure (in treatment with Captopril), therefore he had a complete medical check up before being submitted into the training program. He stated that he felt dizzy and had severe headaches from time to time.

The subject was informed about the scope and methods of the research and accepted freely to participate into the study.

The research methods we used for this study are: the bibliographic research, the observation method, the case study method, the questionnaire method (QOLS scale for the self appreciation of the quality of life) as well as some specific assessment tools for balance.

The study was conducted from July to September 2013 in „Le Club" wellness club in Bucharest. The kinetic programs were individualized and applied for 5 weeks. The objectives of our training plan were:

- The improvement of the subject's static and dynamic balance;
- The improvement of the subject's exercise heart rate;
- Weight loss;
- The improvement of the subject's quality of life.

The subject was initially assessed at the end of July. He was submitted to a series of balance tests (Fukuda, Romberg and a static and dynamic posturography using the Multitest Platform).

His resting heart rate is 72 bpm. Considering his medical condition, age and weight, as well as the objectives of the research, we determined an ideal exercise heart rate between 98-130 bpm. We used a Polar training watch to monitor his heart rate during exercise. He also was tested with the Astrand Rhyming cycle ergometer test.

The kinetic programs consisted in simple exercises which required a minimum of equipment, such as bands, a stability ball, a wobble board, a balance foam, a medicine ball and a Bosu ball.

According to Dragnea and Teodorescu (2002), cited by Şerbănoiu and Virgil (2007) the following exercise parameters should be taken into account when designing a training session: exercise duration, frequency, intensity and type. The kinetic programs we designed according to these parameters as follows:

- Duration – 45 minutes. The maximum number of exercises used for each training session was 4-6, in 4 sets of 10 repetitions each. Rest time in between sets varied between 60-120 min, according to the subject's heart rate and overall condition.
- Frequency – 4 times a week for 5 weeks. We designed a training program that the subject could perform at the gym as well as a series of exercises that he could easily perform twice a day at home.
- Intensity – moderate exertion;
- Type – aerobic exercise.

As an example, in table 1 we described some of the exercises we designed for our subject.

Table 1. Kinetic program design

Home exercises	Gym exercises
Walking next to a wall, eyes closed, the subject touches the wall with his index finger	Kneeling on Bosu ball, the subject performs different arm movements and turns the head towards the arm
Standing on a balance foam, eyes opened then eyes closed	Sitting on the stability ball, the subject catches the medicinal ball thrown from different directions
Standing on a balance foam, the subject performs different arm movements (e.g. front/lateral raises) and turns the head towards the arm	Four point kneeling on the Bosu ball, the subject performs opposite arm and leg raise
Squats on the balance foam	Standing on the Bosu ball, the subject catches the medicinal ball thrown from different directions
Unipodal stance on the balance foam, eyes opened/eyes closed	Squats on the Bosu ball

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Unipodal stance on the balance foam, the subject performs different arm movements and turns the head towards the arm	Bosu ball standing rows and chest press with an elastic band

Interim assessment was taken after the first 10 training sessions and we adjusted the workouts according to its results. The final assessment was conducted at the beginning of September.

Results

We systematized the results of the initial assessment in table 2.

Table 2. Initial assessment results

Variables	Results
Initials	J.P.
Gender	Male
Age (years old)	57
Chronic illnesses	High blood pressure
Height (cm)	180
Weight (kg)	90
Body Mass Index (kg/cm^2)	27.7
Blood pressure (mmHg)	135/80
Resting Heart Rate (BPM)	75
Exercise Heart Rate (BPM)	157
Romberg test	Negative
Fukuda test (50 steps)	90^o left laterodeviation
QOLS score	83

The following conclusions may be driven as a result of the analysis of the variables in the table above. The subject's exercise heart rate exceeded the accepted limit. The Fukuda test revealed a left side vestibular weakness but further specific tests were done by an otolaryngologist physician specialized in ear disease in order to establish the diagnosis. The physician determined that no spontaneous nystagmus existed therefore excluding a neurological impairement. The rotatory nystagmus was weaker on the left side and the caloric tests revealed symmetric bilateral vestibular hypofunction.

To assess the subject's own perception about his quality of life, we used the Quality of Life Scale (QOLS). According to C.S. Burckhardt and Anderson, (2003), the average score for the entire population is 90 points, which places our subject below average.

As we may notice in figure 1, the Multitest Platform assessment revealed a marked instability on an instable surface.

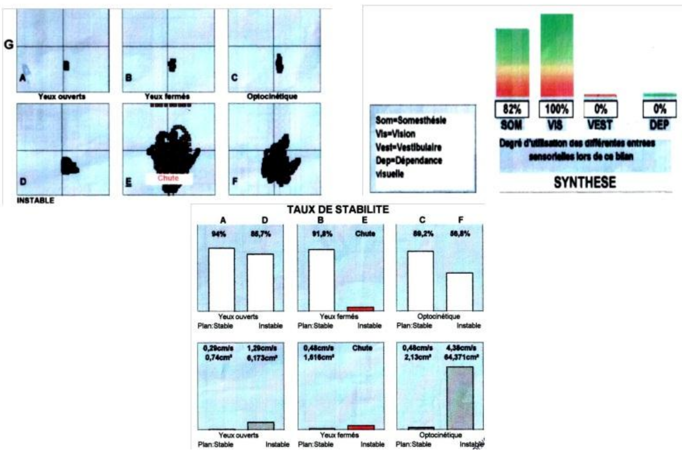

Figure 1. Posturography analysis results - initial assessment

Analyzing figure 1 we may state that the subject is rather unstable even on a steady surface, having an antero-posterior sway (A,B,C). The line of gravity is deviated backwards.

On an unstable surface, with his eyes closed, the subject could not maintain his ballance and reached out for assistance (Chute). The antero-posterior sway increased and the subject became more unstable.

We may see that, in maintaining balance, the visual stimuli are normally integrated in the cortex (100% rate) whilst the vestibular and sensorimotor systems are defficient, with a 82% and 0% rate, respectively.

Even with a vestibular impairment, the subject is not visually dependent, meaning that his brain did not completely suppressed vestibular input to become extremely reliant on the visual one in maintaining his balance (according to the Vestibular Dissorders Association, www.vestibular.org).

The computerized analysis revealed a marked disfunction of the vestibular system which was correlated with the physician's clinical findings. The results were analyzed by the physician and the diagnosis was balance disorder. Her reccommendation was vestibular rehabilitation therapy.

To improve his balance, we used the individualized kinetic programs described earlier. We increased difficulty according to the subject's performance and overall conditioning.

Discussions

The subject began rehabilitation the day after the assessment. Each session took place at 10 a.m. and lasted for 45 minutes. The subject performed a light movement warm up for 10 minutes before the workout.

He was instructed to perform the 10 minutes home exercises twice a day, morning and evenining, in non-training days and once a day, in the evening, on workut days. He adapted really well to the kinetic programs we designed and followed the instructions carefully.

Interim assessment took place after the first 10 rehabilitation sessions and was performed by the otolaryngologisst physician. It revealed an improvement of the subject's static and dynamic balance but the data were not available for the analysis. Based on her reccomendation and our clinical observations we continued the rehabilitation process and we could increase the difficulty level of our workouts.

At the final assessment, we collected the following data, as shown in table 3.

Table 3. Final assessment results

Variables	Results
Weight (kg)	87
Body Mass Index (kg/cm^2)	26.9
Exercise Heart Rate (BPM)	130
Romberg test	Negative
Fukuda test (50 steps)	40^o left laterodeviation
QOLS score	92

Table 3 reflects the improvement of the subject's functional parameters, balance tests results as well as an increment of his final QOLS score. Due to his medical condition, one f the objectives of our training plan was to decrease the subject's exercise rate at a maximum of 130 bpm. Using our individualized kinetic programs this objective was accomplished. We also managed to reduce the subject's weight, further measures needing to be taken into account for better results (e.g. dieting, exercising). By the end of the rehabilitation program, the subject's perception about his quality of life improved. He felt much stable, the headaches diminished and he stopped feeling dizzy. He considered himself to be healthier, fitter and more physically active.

The Multitest posturography revealed a marked improvement in his static and dynamic balance as shown in figure 2.

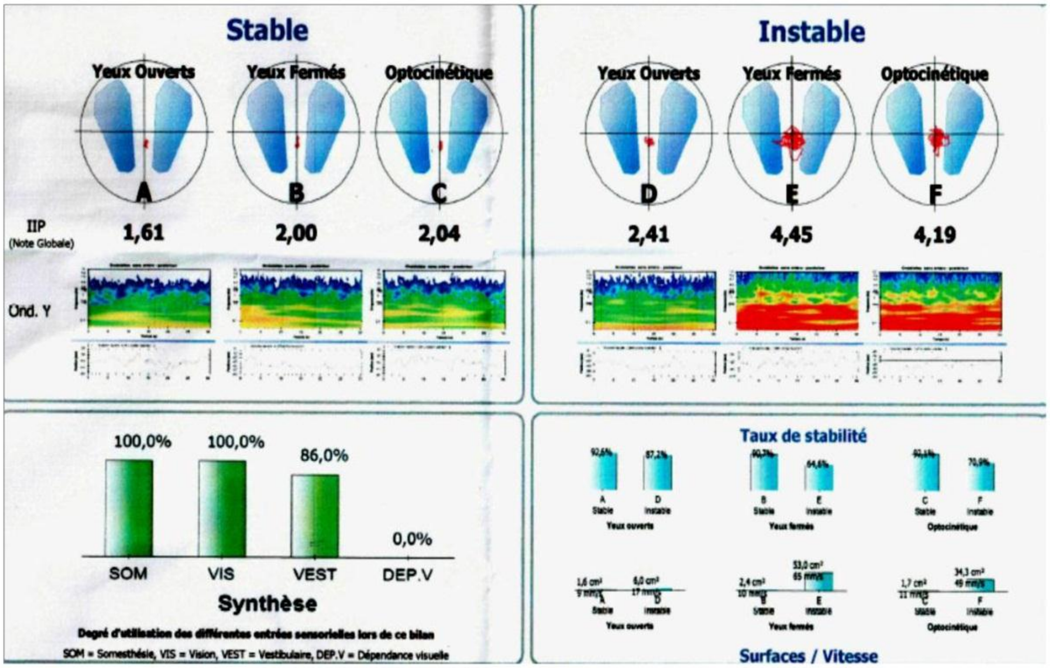

Figure 2. Posturography analysis results - final assessment

Comparing his stability rates (taux de stabilité) at the final assessment with the initial ones, we may note the following:

- On a stable surface, eyes opened, the index had a 1.49% decrease while on an unstable surface it increased with 1.75%;
- On a stable surface, eyes opened, the stability rate decreased with 1.2%, while on an unstable surface it increased with 64.5%. The patient was able to maintain his balance without falling nor reaching for support;
- Both on a stable and unstable surface, with optokinetic stimulation, the rates increased with 3.25% and 24.82%, respectively.

At the final assessment we may notice that the antero-posterior sway decreased, whilst the line of gravity continued to be deviated backwards.

By the time of the final assessment, the subject's vestibular impairment reduced. The degree in which the vestibular input was integrated at a cortical level increased with 86%. Moreover, the Fukuda test revealed a 50^{o} decrease in the left laterodeviation, from 90^{o} to 40^{o}.

Conclusions

As a result of the case study research, the hypothesis was confirmed. Therefore, we determined that our individualized kinetic programs contribute to the improvement of the subject's postural balance.

The positive results determined us to extend the research on larger groups of subjects.

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