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Research Article

Core Stability Program and Lower Extremities Proproception, Strength, Endurance and Functional Ability

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Abstract

There is limited information on lower extremities proprioception and core stability. The purpose of the present study was to investigate the effectiveness of a core stability program on the lower extremities proprioception of collegiate students. In addition, the study examined the effect of program on muscles strength, joint position sense (JPS), muscles endurance and functional ability. Nineteen college-aged individuals followed a core stability program for 3 weeks, 4 times per week. Assessments were performed at the begging and the end of study. Biodex Stability System was used to assess balance ability. The Isokinetic dynamometer was used to assess knee concentric muscles strength 60 and 180°/sec, and joint position sense (JPS). Knee extensors and flexors muscles strength endurance was measured by the single-leg squat test on a step, and functional ability through the hop and triple hop tests. At the end of 3 weeks the core stability program increased ($p < 0,05$) the balance ability. Likewise, improvements were observed on the JPS ($p < 0,05$), muscles endurance ($p < 0,05$) and functional ability ($p < 0,05$) of 2 extremities. The core stability exercises, improved balance ability knee muscles endurance, functional ability and knee joint position sense.

Keywords: Trunk; Pilates; Balance

Introduction

Proprioception is an important component of balance and proper postural control. Is perceiving the position or movement of extremities and body segments in space [1,2]. The sense of position of a joint depends on afferent signals from joint, muscle and skin receptors [1-4]. Joint mechanoreceptors have the ability to detect the actual joint position and joint motion. Proprioception allows an individual to maintain joint stability during static and dynamic posture [5]. Hanney [6] states that proprioception is "the reception of stimuli produced within organism", whereas balance is "physical equilibrium".

Balance exercises aimed at improving proprioception; train the brain to recognize the body's segment position every moment. It is important that balance exercise programs improve proprioception not only during the rehabilitation phase, but also during the competition period. This means that balance improvement protects athletes from possible forthcoming injuries [7-9]. That's the reason why many scientists [10,11] support that balance exercises are essential to athletic performance and should be incorporated into an athlete's daily training.

Similarly, indirect proprioception training of the lower extremities can be very useful in the rehabilitation field,

actually in cases where balance exercises cannot be performed direct from upright position.

On the other hand, pilates is an exercise approach developed in the early 1900s that is based on body-mind spirit interaction combined with biomechanics, motor learning, and core stability. During a Pilates exercise session, mental effort focuses on activating specific muscles in a functional sequence at controlled speeds, emphasizing quality, precision and control of movement with specific attention to breathing and proprioception [1,12].

Pilates method can be defined as a comprehensive body - mind conditioning, with main goals which are efficient movement, core stability and enhanced performance [1,2]. It has very positive effects on health such as decreasing cardiovascular risk, preventing osteoporosis, shaping the body and promoting balance and flexibility [3]. According to Levine et al. [4]. Pilates method focuses on building motions and activities that helps to strengthen minor muscles, which, in turn, helps to strengthen major muscles [5]. In literature, there have been a lot researches on general effects of Pilates exercise but there is no data regarding the effect of Pilates exercise on lower extremities proprioception ability in healthy college students. Balance ability can be improves through the Pilates method, which stabilizes the core, where exercises performed by seated, supine or prone position without incurring lower extremities?

Usually at the acute phase of a lower extremity injury, the weight transference is very difficult or even prohibitive. Therefore, indirect proprioception training of lower extremities (via pilates method) accelerates the recovery period of injury. The aim of the study was to investigate the effect of core stabilization exercises, via pilates, on proprioception ability of healthy college students. In addition, joint position sense, strength and endurance of knee flexors and extensors and functional ability were examined whether were affected.

Material and Methods

Participants

The study was conducted on 19 undergraduate students, males and females, of the Department of Physical Education and Sport Sciences at the Democritus University of Thrace (DPESS, DUTH), aged 20 to 22 years. The participants performed a specific core stability program (pilates exercises) for 3 weeks, four times per week.

Exclusion criteria for the participants included a history of lower extremity surgery or fracture, joint swelling or any systemic disease that might interfere with sensory input. The experimental procedures were in accordance with ethical standards of the Committee on Human Experimentation at the Institution where the work was conducted and with the Helsinki declaration of 1975 and were approved by the Ethical Committee of the Democritus University of Thrace.

Measures

All measurements were recorded at baseline and after 3 weeks training program. The researcher involved with group assignment was not informed about either the exercise or the control group. The measurements were obtained by the same researcher. The demographic information of the participants was recorded.

Balance assessment

Balance ability assessment was performed with Biodex Stability System, which is a dynamic postural stability assessment and training system, assesses the ability of the body to balance on an unstable platform [13-15]. In the Biodex test, the participants maintained single-limb stance for 20 s, with the Biodex platform (level of difficulty: 1) set to freely move by up to 20° from level in any direction. From the variance of the platform displacement (°), instability indices (I) Total (SI), Anterior-Posterior (API) and Medial-Lateral (MLI) was computed from the Biodex system. Three test trials were carried out and the one with the lowest Ii (best performance) was further processed.

Dynamometric assessment

The subjects were secured with straps on the seated position on the chair of an isokinetic dynamometer (Cybex 6000, USA) at a hip joint angle of 110° (180° is the supine position), with the dynamometer lever and knee joint axes being visually aligned [16] . After a standardized warm-up, three successive cycles of maximal effort knee extension–flexion contractions were performed at two different angular velocities, first at 60°/ s and then at 180°/s. Visual feedback of the recorded joint moment values was provided. For each angular velocity, muscle group and leg, the contraction with the highest peak moment value was considered for further analysis.

The JPS (Joint Position Sense) measurements were conducted too at isokinetic dynamometer (Cybex 6000, USA), where subjects were secured with straps on the seated position at a hip joint angle of 110°, with the dynamometer lever and knee joint axes being visually aligned [16], blind-folded to remove visual input. The lower leg of the subject was moved from full extension 0° to 90° knee flexion in order to familiarize subject with the range of motion. After that, the researcher moved and positioned the leg at a randomly position for 2 seconds, while informing the subject that was the «point» (the position should have put their leg). Then, since the researcher returning the leg at the initial position (full extension) asked the subject find the point. The degrees deviating from the «point» were recorded. This procedure was repeated for 3 times per leg [17,18].

Endurance assessment

Endurance of knee extensors and flexors muscles was measured by the single-leg squat test were subject stand on one leg at a 50 cm step. Subjects were instructed to stand on one leg while the other leg was lifted off the ground in front of the body so that the hip was flexed to approximately 45° and the knee of the non-stance leg flexes approximately 90°. Subjects were instructed not to contact the non concerned leg with the concerned stance leg at any time during the activity. The arms crossed over their chest. The subjects were instructed to squat down as far as they were able without losing their balance and return to initial position. They were repeating this movement with the other leg. The goal was to perform the greatest possible number of repetitions until they felt exhausted [19].

Functional ability assessment

Functional ability was assessed by hop and triple hop tests. At hop test the subject was instructed to jump off one leg and to land on the same leg, without losing balance or stepping onto the opposite leg. If the subject lost their balance, he/she was required to complete that hop again. The test was completed with the arms free; that is the subject's arms could be used to assist with balance and to generate momentum during the jump. Three trials for each leg were performed and the greater jump was used for analysis [15,20]. The same process was applied for triple hop test. The only difference was that this time the subject performed 3 sequent jumps with the same leg [15,21].

Procedures

Pilates exercise core stability program

The subjects performed core stability exercises for 4 days a week during 3 weeks. All pilates sessions were given and supervised by the same experienced instructor. The 19 subjects were divided in smallest groups of 3 for more effective exercise supervision. Each session consisted of 14 exercises, 8 for abdominal muscles (one exercise repeated) and 5 for dorsal muscles.

The abdominal exercises performed in 3 stations (mat, swissball and reformer) while the dorsal exercises performed on mat. A soccer ball, an elastic resistance band and a stopwatch were used.

The dorsal exercise was the same each time. The reason was that the dorsal exercise mainly done for abdominal rest. The protocol was based on the principle of progression as with the passage of weeks the exercise time was increased.

A week before the start of program, the participants of experimental group, were taught the correct breathing technique and the six main pilates principles. At first week each exercise performed for 30 seconds, regardless of repetitions. At second and third week the time of each exercise increased at 45 seconds and 60 seconds respectively. The exercises were of low intensity and were performed in slow. Table 1 shows the exercise program. The exercises 1, 2, 3, 10 performed on mat, 4, 5, 6 on swissball and 7, 8, 9 on reformer. For exercise on reformer, each participant worked in different resistance level, according to his/her strength ability.

Analysis

SPSS statistic package was used for the analysis. Means and standard deviations were calculated. Analysis of variance (ANOVA) for repeated measures was performed on recorded times to detect differences for each limb. Statistical significant was accepted at $p<0.05$.

Results

According to the results, the subjects demonstrated significant improvements in total stability index (*p=,016< ,05*) and in anterior-posterior index (*p=,012< ,05*), in joint position sense (*p=,016< ,05)*, in muscle endurance (*p=,007< ,01*) and in functional ability (*p=,000 < ,001, p= ,009< ,01*) for the right leg. Similarly, significant improvements in SI (*p=,033 < ,05)* and medio-lateral index *(p= ,042< ,05)*, in joint position sense (*p=,018 < ,05)*, in extensors strength (60°/s) (*p= ,039< ,05),* in muscle endurance (*p=,009< ,01*) and in functional ability (*p=,000 < ,001, p= ,001< ,01*) for the left leg (Table 2).

Discussion

The main objective of this study was to investigate the effectiveness of a core stability program (via Pilates method) on the lower extremity proprioception, strength and functional ability of healthy collegiate students. We found that core stability program affects balance ability and improves muscles endurance, functional ability and knee joint position sense of the subjects.

In previous researches, where the aim was to investigate the effectiveness of a Pilates program on lower extremities balance ability, the duration of intervention programs was primarily 8 weeks [13,22,23], while some other lasted 10 [24] and 12 weeks [25]. In the present study instead, despite the short duration (3 weeks), which was observed in previous studies involving specific cohort of groups such as the elderly [26], people with chronic low back pain [27] and patients with Parkinson's disease [28], there was a statistically significantly improvement in the balance ability of lower limb of participants, who performed the exercises on 3 different instruments (reformer, mat, swissball). This variety of instruments not

observed in previous studies, where researchers used one or two instruments.

The finding of balance ability improvement in response to indirect proprioception training of lower extremities through core stability exercises, agrees with previous reports on healthy and diseased subjects [23-25,28,29]. At this point we must note that no one of the participants had previous experience of the Pilates method. In addition, any kind of exercises who affected the abdominal and back muscles was not allowed during the study, which leads us to conclude that the observed improvements were derived exclusively from the stability program.

Concerning to the results of secondary purpose of the study, the findings of joint position sense of knee, muscles endurance and functional ability of lower extremities improvement, were similar with previous studies. More specific, in their research Ozdemir et al., [12] found that after the implementation of a Pilates exercise program for 8 weeks, were lower extremities were participated at the exercises performance, the joint position sense of knee improved significantly as at present study, where the lower extremities did not involved. In addition, according to the results of previous studies, the muscles strength [26], muscles endurance and the functional ability [30] of lower extremities were improved significant after a Pilates exercises program. These results are partly consistent with the results of our research, as well as muscle strength did not appear to be affected by core stability program, a result that agrees with Cosio-Lima et al. [29] study.

The present findings show that a 3-weeks core stability program, through Pilates method, improves indirect the balance ability, the position sense of knee, the muscles endurance and the functional ability of lower extremities in healthy collegiate. This leads us to the conclusion that the proprioception of the lower extremities can be improved indirectly, which is very useful in the field of rehabilitation.

Based on the results of this study, the researchers plan to examine the effectiveness of exercise program to individuals who due to a lower extremity injury (ruptured anterior cruciate, sprained ankle) cannot perform balance exercises from a standing position. Thus, the trauma recovery process is accelerated and the individual returns to the pre-injury situation earlier.

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