ORIGINAL ARTICLE

The effect of TRX suspension trainer and BOSU platform after reconstruction of anterior cruciate ligament of the knee joint

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Abstract

Background and Study Aim: The tear of the anterior cruciate ligament of the knee joint is experienced by people of all ages for a variety of reasons. The physiotherapy procedures with different equipment help recover lost functions. The aim of this research was to determine the effect of 'TRX' (Total body Resistance eXercise) suspension trainer and platform 'BOSU' (Both Sides Utilized) after anterior cruciate ligament of knee joint reconstruction.

Material and Methods: The study included 20 patients after anterior cruciate ligament reconstruction surgery, 13 women, age (31.7 ± 3.4) and 7 men, age (31.7 ± 3.5) participated in the assessment. The strength of the calf flexors and extensors muscles was assessed by Lovett scale. The range of motion of the knee joint was assessed by goniometer. The static and dynamic body balance was assessed by Fullerton Advanced Balance Scale. The stability of the knee joint was assessed by Lachman test. The statistical data reliability was evaluated using Student's T criterion.

Results: The data obtained showed that stabilization exercises with 'TRX' suspension trainer ant platform 'BOSU' have positive effect on knee joint after reconstruction. In the first and second group strength of the calf flexors and extensors muscles, amplitude of knee joint, static and dynamic balance significantly increased ($p<0.05$). Knee joint stability increased. Comparing both groups' results, there are no statistically significant difference ($p>0.05$).

Conclusions: Physiotherapy exercises with TRX suspension trainer and platform 'BOSU' can help patients to return lost muscles strength, knee joint amplitude, static and dynamic balance and knee joint stability.

Keywords: rehabilitation, physical therapy, injury, fitness, joint stability, muscle

Introduction

Functions of the anterior cruciate ligaments and the mechanism of injury. The main function of the anterior cruciate ligament is to prevent the anterior tibia from slipping relative to the femur. Anterior crucial ligament provides 85 percent. Resistance forces to prevent the front tibia from slipping when the knee joint is bent at 30 ° and 90 °. The anterior cruciate ligament also performs other functions: it limits the hyperextension of the knee joint, it limits the internal and external rotation of the tibia relative to the femur, and it limits the slip of the femur back during weight transfer [1]. Cross ligaments are damaged during direct and indirect contact. Direct contact or stroke - this type of injury usually occurs in contact sports such as football, rugby or basketball. The knee joint is in a forced position subjected to a strong impact. Non-contact injuries: sudden stopping, changing the direction of running when the pavement surface is uneven, jumping on one leg, suddenly twisting the leg through the knee joint, when the ankle joint is fixed, knee joint hyperextension [2]. Treatment of the anterior cruciate ligament should be individualized and tailored to the needs of each patient. In case of anterior crucial ligament trauma, patients can be treated in two ways: conservatively and surgically. Older people who are not physically active are usually treated conservatively. In young patients, active athletes, surgical treatment during anterior crucial ligament reconstruction is most common. The younger and more active the patient, the earlier the surgery is performed. The choice of the most effective treatment must take into account the symptoms experienced by the patient, the clinical examination, the time elapsed since the injury, and the needs for daily physical activity [3].

Physiotherapy is one of the most important rehabilitation methods used in cases of anterior crucial ligament disorders. Rupture of the anterior crucial ligament decreases the muscle strength

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of the injured leg and the amplitude of active movements through the knee joint [4]. Therefore, the scientific literature recommends starting physiotherapy before surgery. Complete restoration of the amplitude of motion through the knee joint in the preoperative period reduces the risk of arthrofibrosis. It has been established that proper preoperative rehabilitation determines the positive course of postoperative rehabilitation and treatment and faster recovery of the patient's physical activity [5]. Various studies are being conducted in many parts of the world to find and adapt the most effective means of rehabilitation and to restore lost knee joint function as quickly as possible and to safely restore a patient to pre-traumatic physical activity levels [6]. The overall goal after anterior cruciate ligament reconstruction surgery is to restore normal knee joint biomechanics and stability, return the patient to preoperative activity levels, and improve health-related quality of life. However, many factors such as fear of re-trauma, persistent pain, knee instability, and weakness can affect a patient's condition after anterior crucial ligament reconstructive surgery [7].

TRX (Total body Resistance eXercise) functional belts are now widely used in gyms and during rehabilitation. [8]. The term "functional belts" was coined by TRX. Due to its versatility, the TRX functional belt system is used in rehabilitation and various sports exercises. The TRX sports system consists of a variety of exercises that use body weight as resistance. By choosing a point of contact with the floor, athletes can increase or decrease body weight and resistance through special exercises [9]. TRX functional belts are suitable for people with any level of physical fitness. With their help, muscle strength, joint stability, balance and endurance are developed 10]. U.S. General Surgeon fact sheets state that moderate-intensity exercises with TRX functional belts promote weight loss and reduce the risk of disease. In addition, TRX functional belts have been used effectively in rehabilitation exercises to restore impaired patient function. During testing, it was shown that exercises with TRX functional belts improved the height of vertical jumps by 9%, hockey players improved skating speed, and 5,000-meter runs accelerated by 47 seconds [9].

The TRX functional belt system allows you to perform many exercises of different intensities depending on the load and stability. Using TRX functional belts creates a constant force that, together with body weight, acquires resistance [10]. Such functional systems use certain principles to perform various exercises, to increase or decrease their intensity. The basic idea of this type of exercise is the principle of stability, which states that the size and position of the support base relative to the center of gravity determine the stability of the exercise [9]. The wider base allows for greater stability depending on the position of the feet: feet together or standing on one foot. Physiotherapy sessions on an unstable balancing platform BOSU (Both Sides Utilized) are gaining more and more popularity [11]. BOSU is an unstable balancing platform that consists of a rubber balance attached to a rigid plastic base. Its name is translated as "Two Sides Up," i.e. "Use of both sides". This means that during the session there is an opportunity to perform exercises based on balance and on a flat surface [12]. Exercises on the platform develop almost all physical qualities: endurance, strength, flexibility, coordination. During the exercises, not only the target muscle groups work, but the straight muscles of the back work actively, which stabilizes the proper position of the body in space, whether it be different static positions or dynamic work. Thus, a proper balance of muscle work is observed, the support-movement system is strengthened, the asymmetry of movement is smoothed, and a proper relationship between the upper and lower torso at the fascia level emerges [12]. In addition, exercises with BOSU are necessary for injury prevention after injuries. Proper selection of exercises can correct various functional disorders of the musculoskeletal system [11].

Purpose. The aim of this research was to determine the effect of 'TRX' suspension trainer and platform 'BOSU' after anterior cruciate ligament of knee joint reconstruction.

Material and Methods

Participants

The study included 20 patients after anterior cruciate ligament reconstruction surgery, all of whom gave voluntary consent to participate in the study and signed the individual's consent. Those who agreed to participate in the study were explained in detail the course of the study and introduced to the possible inconveniences of the study. The study included 20 patients after anterior cruciate ligament reconstruction surgery. A total of 13 women, mean age (31.7 ± 3.4) and 7 men, mean age (31.7 ± 3.5) participated in the assessment of gender distribution. All subjects in the study were randomly divided into two groups. Group I consisted of 10 patients. A total of 7 women and 3 men participated in the study to assess the gender distribution of group I (TRX) patients. Group II (TRX and BOSU) also consisted of 10 patients. A total of 6 women and 4 men participated in the gender distribution of this group.

The study included individuals who met the following criteria:

1. Diagnosed knee anterior crucial ligament rupture;
2. Reconstructive operation of the anterior cruciate ligament of the knee was performed;
3. 25-35 years of age;

4. Non-athletes;
5. Secondary rehabilitation;
6. 6 weeks must elapse after surgery;
7. Women and men participate in the study;
8. Patients without bone tumors, osteoporosis, joint diseases, arthrosis, joint prostheses, chronic kidney disorders, ankle joint instability, neurological diseases are included in the study.

Research ethics

The research was approved by the Bioethics Commission of the Department of Rehabilitation of Klaipeda University (No. 46 Sv - HMRK - 01) and the director of the physiotherapy center of UAB "Jurando". Study participants confirmed their participation by signing the informed consent form. The research protocol carried out according to the Helsinki Declaration.

Research Instruments

For the subjects, the muscle strength, the amplitude of the knee movement, the stability of the knee joint, and the static and dynamic balance of the body were assessed. All tools and methods used in the study were applied without infringing copyright, as their descriptions are open access texts on the Internet. The following instruments were used in the study:

Evaluation of thigh muscle strength

Was assessed with Lovett Scale [13] At the beginning and end of the study, the leg force of all patients undergoing leg flexion and leg extension through the knee joint was measured and the change in muscle strength was assessed. When measuring thigh muscle strength, the muscle strength of healthy and injured leg was also compared. The results obtained for healthy leg muscle strength were not recorded because they were insignificant to achieve the purpose of the study. The strength of the flexor muscles of the knee joint is assessed while the patient is lying on his stomach. The physiotherapist fixes the back of the patient's thigh with one hand and places the other hand on the back of the lower leg. The patient is asked to bend the calf through the knee joint. At that point, the physiotherapist provides resistance to this movement. The strength of the extensor muscles of the knee joint is assessed while the patient is sitting on the edge of the couch. The physiotherapist fixes the patient's thigh with one hand and places the other hand at the middle of the calf, below the knee joint. The patient is asked to place the lower limb through the knee joint. At that point, the physiotherapist provides resistance to this movement. Lovett scale rated: 0 points - No contraction; 1 point - Flicker or trace of contraction; 2 points - Active movement, with gravity eliminated; 3 points - Active movement against gravity; 4 points - Active movement against gravity and resistance; 5 points - Normal power. Max score - 5 points.

Knee joint range of Motion

Assess with Goniometry [14, 15]. In the study "Effect of TRX functional belts and unstable platform BOSU after rupture of the anterior cruciate ligament rupture of the knee joint", the amplitude of active movements through the knee joint was assessed by goniometer. The flexion of the leg joint and the construction of the leg joint were evaluated in all patients. Evaluation was performed at the beginning and end of the study. Bending through the knee joint. The patient is asked to lie on his stomach on the couch. The rear surface of the knee is then inspected for swelling. The patient is asked to actively bend the leg across the knee joint to extract the greatest possible amplitude of movement. During the test, the physiotherapist places the stationary part of the goniometer at the midline of the thigh and the moving part along the midline of the lower leg. The center of the goniometer must coincide with the center of motion in the joint. Maximum Knee flexion -140º degrees; Knee Extension - 0º degrees. It is important to compare the amplitude of the extension of the calf of a healthy and damaged leg through the knee joint. Construction through the knee joint. The patient is asked to lie on his stomach. It is then examined for swelling. The patient is asked to actively bend the leg across the knee joint and stretch. When evaluating the extension of the tibia of the leg operated by the patients through the knee joint, the number of degrees is missing before the complete extension of the tibia through the knee joint, i.e. to 0°. It is important to compare the amplitudes of the calf of a healthy and damaged leg through the knee joint.

Assessment of static and dynamic body balance.

Was performed with Fullerton Advanced Balance Scale (FAB) [16]. In the study "Effects of TRX functional belts and unstable platform BOSU after knee anterior cruciate ligament reconstruction surgery", the assessment of static and dynamic equilibrium was performed using the Fullerton Advanced Balance Scale (FAB). This test assesses both static and dynamic equilibrium [17]. 10 performance based activities in both static and dynamic phases. Items scored on a 5 point ordinal scale (0-4). 0 points - the patient is unable to perform an attack, 1- movements are arrhythmic, oscillation, tremor, extraneous movements, unwilling or unable to close, 2 - increasing the speed of performance decreases the accuracy of movements, balance is maintained for a very short time, 3 points - small inaccuracies, 4 points - normal movement and body position control (maintained balance for a period of time or while walking a set distance). The test is administered for 10-12 mins. Score of 0-40 / 40 points possible (higher scores are better).

Assessment of knee instability.

Was performed with Lachman test [18]. In the

study "Effect of TRX functional belts and unstable platform BOSU after knee joint anterior cruciate ligament rupture reconstruction", knee instability was assessed using the Lachman test. Performance: Lying on your back, legs bent at an angle of 30°. The researcher stabilizes the thigh with one hand and covers the proximal inner part of the lower leg with the other hand. The proximal inner end of the tibia is gently pulled forward. If the front displacement is more than 5 mm, the Lachman test is positive.

Research progress.

The study was performed at UAB "Jurando" Physiotherapy Center. Duration of the study: 19/11/2011 - 19/19/2019. The aim of this study was to identify and compare the effects of two different physiotherapy measures on the restoration of knee joint function in patients after anterior crucial ligament reconstructive surgery. To achieve the goal, the subjects were divided into two groups by random sampling. Group I patients underwent stabilization and strength exercises with TRX functional belts, 3 times per week, duration of one session 1 hour (60 min), group II patients received exercises with TRX functional belts and Bosu unstable platform 3 times per week, one session duration 1 h [60 min). Rehabilitation treatment was started on average 6 weeks after anterior crucial ligament reconstructive surgery. Testing was performed twice: before the study and at the end, which lasted 8 weeks and was performed in 14 physiotherapy sessions. The results are summarized and compared. All subjects underwent 14 visits to the outpatient rehabilitation unit after anterior cruciate ligament reconstruction surgery. During outpatient rehabilitation, patients underwent 14 physiotherapy procedures in the gym, 14 physiotherapy procedures in water, as well as 7 massage procedures and 14 RES procedures. Other procedures were prescribed based on each patient's current medical condition. For example, magnet therapy is used in patients with swelling of the knee joint of the operated leg. Continuous passive motion therapy is used in patients with a bending amplitude across the knee joint <90 degrees. The procedures are applied individually after 30 minutes.

Physiotherapy program

Physiotherapy is one of the most important rehabilitation methods used in patients after anterior cruciate ligament reconstruction surgery. Although the first (TRX) and second (TRX and BOSU) groups had different methods of performing physiotherapy procedures, the main goals of rehabilitation were the same: to increase flexor and extensor muscle strength and reduced range of motion in the knee joint, to restore knee stability and balance, and activity. In the study "Effect of TRX functional belts and unstable platform BOSU after knee anterior cruciate ligament reconstruction surgery" to increase the reduced range of motion through the knee joint and muscle strength, all subjects in the physiotherapy program included exercises on TRX functional belts in various directions. As patients' functional status improved, heavier exercises were used during physiotherapy procedures, increasing the speed of exercise and the number of repetitions. For patients after anterior crucial ligament reconstructive surgery, it is especially important to include balance and coordination exercises in the physiotherapy program. To develop balance and coordination, exercises were performed while standing on an unstable boss BOSU on two legs, one leg, standing with his eyes closed.

Statistical analysis

The study data were processed by IBM SPSS 17.0 (Statistical Package for the Social sciences, version 17.0) program. The software used to calculate arithmetic means, rates, standard deviations, and mean errors. The statistical data reliability was evaluated using Student's T criterion (where $p > 0.05$ means the difference is statistically insignificant and $p < 0.05$ means the difference is statistically significant).

Results

Changes in tibial flexor and extensor muscle strength (fig. 1).

At the beginning of the study and after the study, calf flexor and extensor muscle strength was measured in patients who underwent anterior crucial ligament reconstruction surgery. The mean tibial flexor muscle strength of the group I (TRX) subjects was 2.4 ± 0.51 points at the beginning of the study, and the average score after physiotherapy sessions was 3.9 ± 0.56. Thus, the strength of the tibial flexor muscles increased statistically significantly in the TRX group ($p < 0.05$). The mean tibial flexor muscle strength was 2.6 ± 0.51 points before the study in group II (TRX and BOSU), and 4.3 ± 0.67 after the study. After analyzing the obtained results, it can be stated that in the course of the study, in the TRX and BOSU group, a significant change in the strength of the lower leg flexor muscles was also found ($p < 0.05$). Mean estimates of calf flexor muscle strength between the TRX group and the TRX and BOSU group before and after sessions measured in patients undergoing anterior crucial ligament reconstructive surgery. During the study, a significant change in the strength of the extensor muscles of the leg operated on the patients was observed ($p < 0.05$). In group I (TRX) subjects, the mean tibial extensor strength was 2.4 ± 0.51 points before the study, and the average score after physical therapy sessions was 4.4 ± 0.51. The obtained results show that in group I (TRX) the strength of the extensor muscles of the knee joint increased statistically significantly ($p < 0.05$). At the beginning of the study, in group II (TRX and BOSU), the mean

force of the extensor muscles of the knee joint was 2.3 ± 0.48 points, after the study the mean score was 4.6 ± 0.51. Thus, in group II (TRX and BOSU), the strength of the extensor muscles of the knee joint was also significantly increased (p <0.05). Mean estimates of knee extensor muscle strength did not differ statistically significantly between group I and group II before and after physical therapy sessions (p> 0.05), a better change was found in the second group.

Research groups joint range of motion assessment results (fig. 2).

The amplitude of knee flexion movements was measured in patients after anterior crucial ligament reconstructive surgery. After reviewing the obtained results, it can be stated that a significant change

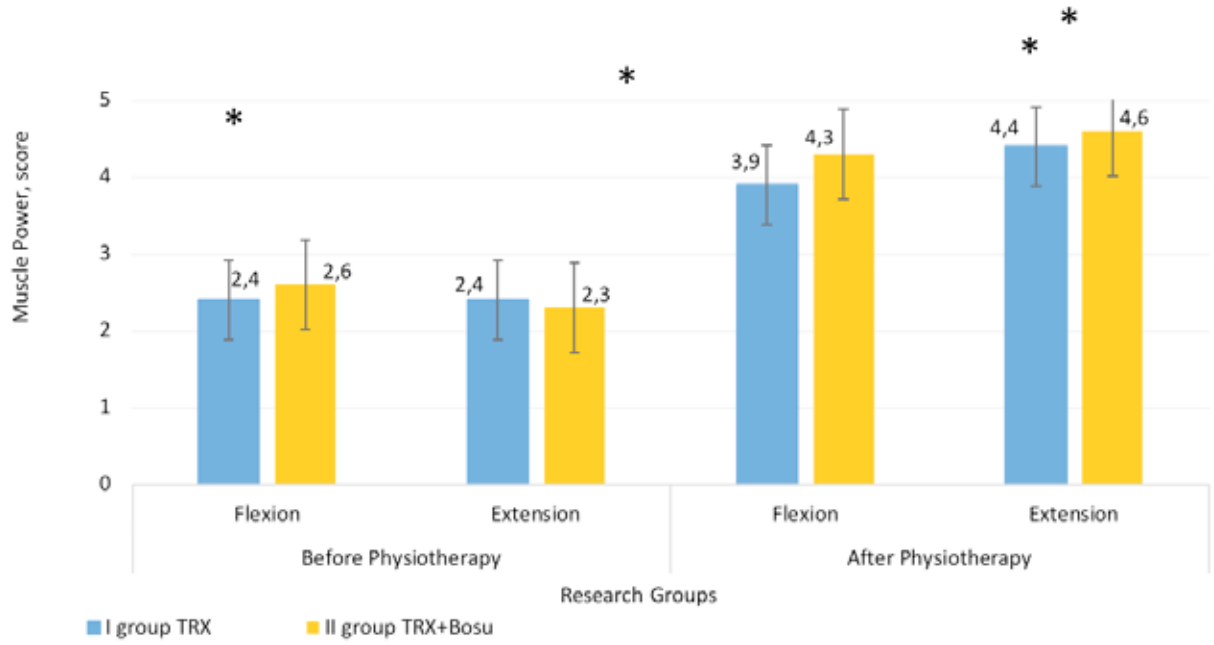

Fig. 1. Research subjects' knee flexor and extensor muscles power. Statistical significance, p<0.05 (*).

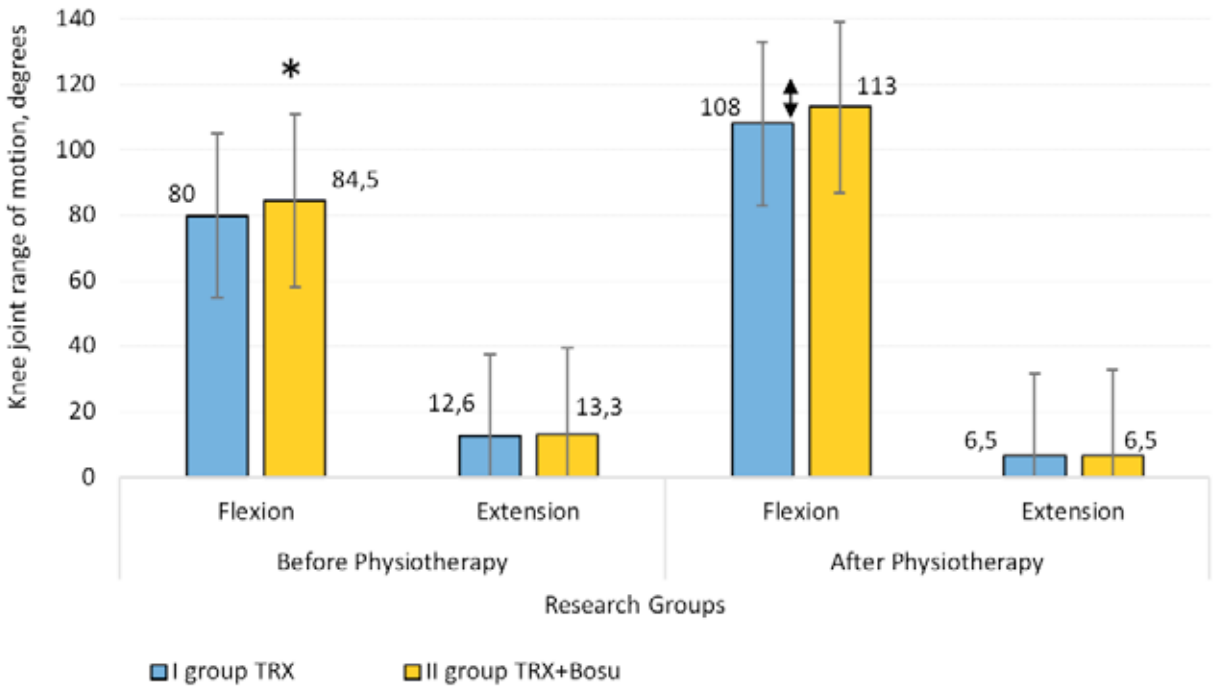

Fig. 2. Research subjects' knee joint flexion and extension range of motion assessment. Statistical significance, p<0.05 (*).

in the amplitude of the flexion movements of the lower leg of the operated leg was observed (p <0.05). The mean amplitude of the knee joint flexion movements of the group I (TRX) subjects was 80 ± 14.9 degrees at the beginning of the study and 108 ± 12.06 after the study. Reviewing the results of group I, it can be stated that the amplitude of knee bending movements increased statistically significantly during the study (p <0.05). At the beginning of the study, the mean amplitude of the leg flexor movements of group II (TRX and BOSU) was 84.5 ± 16.4 degrees, and at the end of the study, the mean degrees were 113 ± 14.56. Thus, at the end of the study, a significant change in the amplitude of the bending movements of the knee joint was also observed in group II (p <0.05). Mean estimates of the amplitude of knee flexion movements between group I (TRX) and group II (TRX and BOSU) before and after physical therapy sessions did not differ statistically significantly (p> 0.05), a better change was found in the second group (TRX and BOSU). The amplitude of knee joint movement movements was measured in patients after anterior crucial ligament reconstructive surgery. Thus, in the course of the study a significant change in the amplitude of the movements of the operated leg calf was observed (p <0.05). At the beginning of the study, the mean amplitude of the knee joint movement movements of the group I (TRX) subjects was 12.6 ± 4.35 degrees. After the examination - 6.5 ± 2.59 degrees. Thus, in group I, a positive change in the amplitude of the examined knee joint movement movements was found (p <0.05). At baseline, in group II (TRX and BOSU), the mean amplitude of knee joint movement was 13.3 ± 4.87 degrees. After the examination - 6.5 ± 2.32 degrees. Thus, in group II, a significant change in the amplitude of knee joint movement movements was also found (p <0.05). The mean estimates of the amplitude of knee joint movement movements between group I (TRX) and group II (TRX and BOSU) before and after physical therapy sessions did not differ statistically significantly (p> 0.05), the same change was found in both groups.

Static and dynamic equilibrium change (fig. 3).

The static and dynamic equilibrium of the subjects was assessed by the Fullerton Equilibrium Test (FPT). The mean score of this test in group I (TRX) before physiotherapy sessions procedures was 23.4 ± 4.45 points, after physiotherapy sessions procedures it increased statistically significantly (p <0.05) and reached 33.2 ± 2.1 points. After calculating the mean score of the group II (TRX and BOSU) FTP test before physical therapy sessions it was 25.2 ± 4.94 points, and after physiotherapy sessions (36.6 ± 1.71) points. Group II (TRX and BOSU) also showed a statistically significant change (p <0.05) after physiotherapy sessions. FPT mean estimates between group I (TRX) and group II (TRX and BOSU) before physical therapy sessions did not differ statistically significantly (p> 0.05), and after physical therapy sessions there was a statistically significant difference (p <0.05), better change was found Study group II (TRX and BOSU).

Change in knee instability (tabl. 1).

The subjects' knee instability was assessed by the Lachman's test. When evaluating individual patient outcomes, it was observed that in both groups of 20 subjects, the Lachman test was positive before physiotherapy sessions procedures (in group I TRX 3 subjects and in group II TRX and BOSU 4 subjects). After the study, the stability of the knee joint improved, a positive test remained in 3 subjects (TRX for 2 patients in group I and TRX and BOSU for only 1 patient in group II).

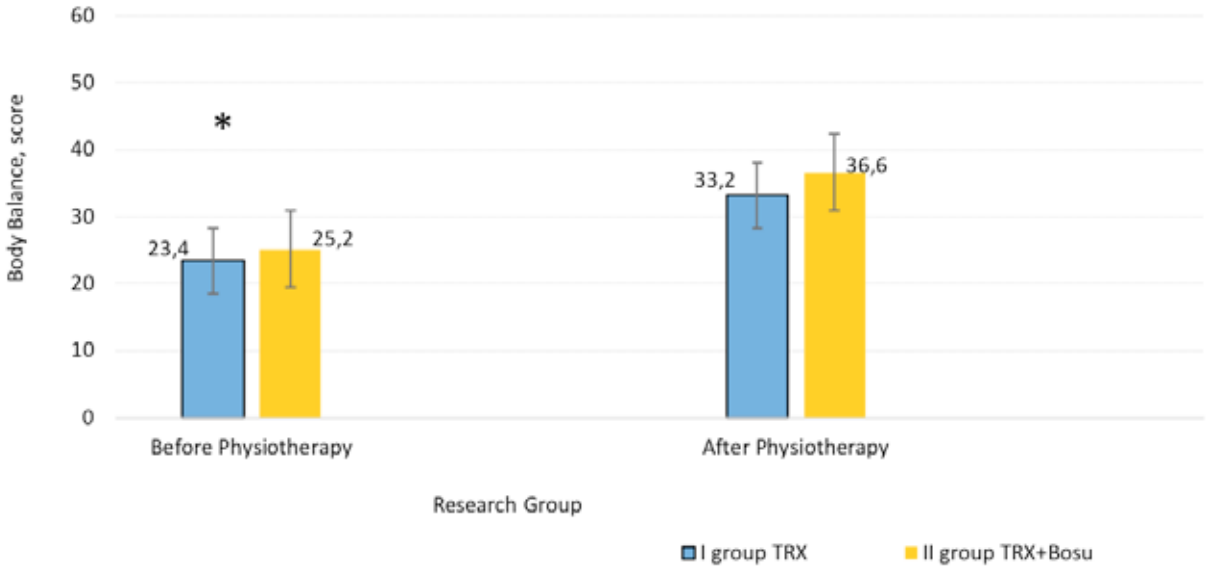

Fig. 3. Research subjects' static and dynamic body balance assessment. Statistical significance, p<0.05 (*).

Table 1. Knee joint stability assessment.

Research groups	Test before Physiotherapy (positive/negative)	Test After Physiotherapy (positive/negative)
I (TRX)	3 patients positive 7 patients negative	2 patients positive 8 patients negative
II (TRX ir BOSU)	4 patients positive 6 patients negative	1 patient positive 9 patients negative

Discussion

This paper analyzes the impact of TRX functional belts and the unstable platform BOSU on those who underwent reconstructive surgery for anterior cruciate ligament rupture. After reviewing the scientific literature, it has been observed that anterior crucial ligament reconstruction surgery often results in a decrease in the amplitude of movements through the knee joint, weakened knee flexor and extensor muscle strength, imbalance and marked knee instability [19]. The data obtained from the study showed that the use of exercises with TRX functional belts and the unstable platform BOSU had a positive effect on all subjects. Thigh muscle strength increased, amplitude across the knee joint, static and dynamic balance improved, knee joint stability was restored. In the study "Effect of TRX functional belts and unstable platform BOSU after reconstruction of the anterior cruciate ligament rupture of the knee joint", two research groups were formed, which differed in the rehabilitation methodology. Group I subjects underwent exercises only on TRX functional belts, and group II subjects underwent exercises on both TRX functional belts and the unstable BOSU platform. Unfortunately, in Lithuania, such studies that would confirm the effect of TRX functional belts and unstable platform BOSU on patients after reconstruction of the anterior cruciate ligament rupture of the knee joint could not be found.

Strength of flexor and extensor muscles of the knee joint.

Many authors point out that anterior crucial ligament reconstruction surgery significantly reduces the strength of the flexor and extensor muscles of the thigh [20]. In the study "Effect of TRX functional belts and unstable platform BOSU after knee joint anterior cruciate ligament reconstruction surgery", knee flexor and extensor muscle strength was assessed by manual knee flexor and extensor muscle strength testing according to Lovett R. W., Martin E. G. [13]. After reviewing the results, the strength of the calf flexor muscles of the I (TRX) group increased statistically significantly ($p < 0.05$). In group II (TRX and BOSU), the strength of the flexor muscles after physical therapy sessions also increased statistically significantly ($p < 0.05$). A better result was found in group II (TRX and BOSU). Similar results were obtained by reviewing the extensor muscle strength of the knee joint. Based on the estimates of the results after the physical therapy sessions with TRX functional belts and unstable platform BOSU, we found that there was a statistically significant ($p < 0.05$) improvement in both group I (TRX) and group II (TRX and BOSU) thigh extensor muscle strength. In summary, it can be stated that in both groups the strength of the flexor and extensor muscles of the knee joint improved statistically significantly ($p < 0.05$). Tugolukov A.V. [10] concluded that physical therapy sessions with TRX functional belts are an additional means to increase muscle strength. Istomin A. G. [8] also recognize the positive effects of using TRX functional belts in rehabilitation to develop knee flexor and extensor muscle strength.

Amplitude of knee joint movements.

Research shows that the amplitude of patient-operated leg movements across the knee joint also decreases after anterior crucial ligament reconstruction. In our conducted study, knee flexion and extension through the knee joint were evaluated with a goniometer. The amplitude of knee joint bending movements in group I (TRX) subjects increased statistically significantly ($p < 0.05$). In group II (TRX and BOSU), the amplitude of calf bending movements also increased statistically significantly ($p < 0.05$). After reviewing the amplitude of the knee joint construction in the subjects, the amplitude of the group I (TRX) construction increased statistically significantly ($p < 0.05$). Regarding group II (TRX and BOSU), the amplitude of knee joint movement movements also increased statistically significantly ($p < 0.05$). In summary, it can be stated that the amplitude of bending and stretching of the knee joint through the knee joint significantly improved in both groups ($p < 0.05$). Ucar M. et al. [21] conducted a similar study to estimate the amplitude of movements across the knee joint. A total of 58 patients participated in the study, who were randomly divided into two groups. Tests were performed 2 times, before and after the study. The first group performed exercises on an

unstable platform 3 times a week, and the second group performed exercises without a platform 3 times a week. After reviewing the obtained results, it can be stated that the higher result was found in the first group.

Static and dynamic body balance.

The literature provides many standardized scales and tests for assessing equilibrium. The Fullerton Equilibrium Test was chosen for the study. The static and dynamic balance of group I (TRX) after physical therapy sessions increased statistically significantly ($p < 0.05$). After reviewing the results obtained in group II (TRX and BOSU), a statistically significant change ($p < 0.05$) was also found after physical therapy sessions. Tikhilov R.M.and colleagues [22] conducted a similar study with unstable platforms after reconstructive surgery. Our results are similar. Akbari A. et al. [23] also conducted a similar study to assess static and dynamic equilibrium using unstable platforms. A total of 60 subjects participated in the study. Subjects underwent balance exercises on unstable platforms 6 times per week for 30 min. Akbari argues that unstable platforms have a positive effect on static and dynamic equilibrium.

Knee instability.

The subjects' knee instability was assessed by the Lachman's test. When evaluating individual patient outcomes, it was observed that before physiotherapy sessions in both groups of 20 subjects, the Lachman test was positive in 7 subjects (TRX group 3 subjects and in the second group TRX and BOSU 4 subjects). After the study, the stability of the knee joint improved, a positive test remained in 3 subjects (2 patients in the first TRX group, and only 1 patient in the second group TRX and BOSU). Comparing the results of both groups, it can be stated that TRX and BOSU are effective methods for training knee joint stability, but in the second group (TRX and BOSU) the results are better. Bettendorf B., [9] agrees that TRX functional belts develop stability. The author has the same opinion Zemkova [11], which states that a BOSU unstable platform can cultivate knee joint stability.

Conclusions

1. In the first and second groups, the strength of the extensor and flexor muscles of the lower leg was significantly increased ($p < 0.05$) by using TRX functional belts and the unstable platform BOSU. However, the results before and after physical therapy sessions did not differ statistically significantly between the groups ($p > 0.05$).

2. In the first and second groups, the amplitude of movements across the knee joint was significantly increased ($p < 0.05$) using TRX functional belts and the unstable BOSU platform. However, the results before and after physical therapy sessions did not differ statistically significantly between the groups ($p > 0.05$).

3. In the first and second groups, the static and dynamic equilibrium was significantly increased ($p < 0.05$) by using TRX functional belts and the unstable BOSU platform. However, the results before and after physical therapy sessions did not differ statistically significantly between the groups ($p > 0.05$).

4. In the first and second groups, knee joint stability was improved by the use of TRX functional belts and the unstable platform BOSU. But the results before and after the physical therapy sessions did not differ significantly between the groups.

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The authors declare no financial support regarding this paper.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding this research.

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