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Original article

BALANCE TUTOR TREADMILL – A WAY TO IMPROVE KNEE STABILITY

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Abstract

Aim. The study started of the idea of proving and evidenciate once more the eficiency of modern technology in general and of the Balance Tutor in particular, upon human body rehabilitation – the knee in this case.

Methods. The research was conducted at the Balneal and Recovery Sanatorium Techirghiol in 2024 and 20 subjects were included (equally distributed in control group and experimental group), diagnosed with knee sprain of various causes. All of them attended 10 sessions of balneal therapy (various procedures) and physical therapy, for two weeks (10 sessions), in plus, the experimental group used Balance Tutor. All study subjects were evaluated initially and finally with a knee stability test.

For the evaluation of the subjects included in the research, a stability test was used, consisting of measuring in seconds the time of maintaining unipodal support on the Bossu Ball in the affected lower limb. The evaluation was carried out using the timer, both initially, on the first day of treatment, and finally, on the 10th day.

MediTouch's BalanceTutor perturbation treadmill is an innovative device for postural control and balance. The machine consists of a treadmill mounted on a platform with moving force plates. The platform moves medially/laterally and forward/backward to simulate sliding and displacement both when the person is standing and walking, an innovative approach that uses integrated wireless sensors and enables the delivery of numerous types of perturbations controlled, expected and unexpected.

Results and discussions. The arithmetic mean of the values obtained for the control group is 5.1 seconds. The arithmetic mean of progress for the experimental group is 12 seconds. Thus, comparing the arithmetic averages of the 2 groups, there was a difference of 6.9 seconds in favor of the subjects in the experimental group. As a clinical effect, a controlled and proactive challenge of body weight support by the affected knee was achieved, with the improvement of automatic postural adjustment.

Conclusions. As the study demonstrated, Balance Tutor is an inovative and modern device, very efficient in increasing knee stability and accelerate its recovery after a strain, an easy-to-go and attractive way of patients rehabilitation.

First-line tratment for each knee condition consists of conservative management, with a focus on exercise, education and self management. Balance Tutor is an efficient, optim modality to have this purpose solved.

Keywords: physical therapy, Balance Tutor, knee sprain, knee stability.

Introduction

Recovery is a broad, specialized medical branch, which analyses a person's reduced functional abilities following a locomotor disorder, as well as ensuring a new independent life after their restoration, and has as its main purpose the implementation of means of facilitation and compensation, either intrinsic (specific to the patient), or extrinsic, which allow the patient to carry out his activities as close as possible to the normal functional level (Nica, 1998).

Reviewing the components of the bone system, the knee is among the most affected joints, following various injuries. Its conditions can lead to important changes in mobility, stability and functional level, in the way it makes the connection between the leg and the hip, as a basic component of the biomechanics of the lower limb. An essential aspect in knee recovery is the close connection between joint function and the functional importance of the extensor and flexor muscles. Of all the muscles of the lower limb, the most prone to atrophy and atony is the quadriceps muscle. When it no longer works properly, unilaterally/bilaterally, the muscle strength required to support and mobilize the body is reduced and the functional instability of the knee joint appears (Baciu et al., 1981). The knee, the largest joint of the body, due to its position as a load-bearing and intermediate joint of the lower limb, is particularly stressed both during the moment of support, through loading, and during the elevation of the lower limb during the moment of swing necessary for the step. In addition, the knee plays an important role in several common daily moments and activities

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(getting up/sitting on a chair, putting on shoes, climbing/descending stairs, lifting objects from the ground, etc.) or professional.

Sprain is a ligament injury of various stages produced by the abnormal movement of the knee, determined by a force that exceeds the structural resistance. Knee sprains can range greatly in severity and are usually graded to I, II or III. A grade II sprain classification means that the injured ligament is partially torn. If weight is put on the affected leg, the knee may feel unstable and painful (Logerstedt David et al., 2017). Knee ligament sprain is one of the most common orthopaedic and sports injuries (Sbenghe, 1981).

The treatment of moderate sprains is complex and must be performed to prevent subsequent unpleasant sequelae (chronic intermittent knee pain, recurrent sprains, stiffness, insecurity in exertion).

The hypothesis that started from the development of this study was that the introduction of the Balance Tutor perturbation walking device in the recovery program of the patient with knee sprain of degree II results in the improvement of body alignment, increase in mobility, muscle strength and more choice of joint and postural stability.

Methods

The study was carried out in the Techirghiol Balneal and Recovery Sanatorium, over a period of 9 months, February - November 2024 and included a number of 20 patients aged between 25 and 47 years, admitted with the diagnosis of knee sprain grade II. The patients were equally divided into 2 groups: the experimental group and the control group, each with 10 patients.

The diagnosis was made based on the clinical examination, performed by the specialist doctor, in conjunction with the paraclinical examinations (X-ray and MRA).

The objectives of movement therapy were the following:

- postural recovery.
- increasing flexibility.
- toning the muscles of the lower limb.
- increasing mobility.
- decrease in the intensity of pain and/or edema.
- improving balance.
- improving the stability of the affected knee.

All patients included in the experiment followed classic physiotherapy sessions, along with balneal treatment, consisting of electrotherapy, magnetotherapy, massage, herbal baths, for 2 consecutive weeks, with a weekend break - 10 days of treatment, during hospitalization in the recovery center.

Classic physical therapy consisted of free active mobilizations, active with resistance and pedalling the ergometric bicycle for 10 minutes per session. In addition, the subjects of the experimental group also performed 10 minutes of walking on the treadmill with Ballance Tutor disturbances.

MediTouch6's BalanceTutor perturbation treadmill (Manual de utilizare BalanceTutor, Israel, 2020) is an innovative device for postural control and balance. The machine consists of a treadmill mounted on a platform with moving force plates.

The platform moves medially/laterally and forward/backward to simulate sliding and displacement both when the person is standing and walking, an innovative approach that uses integrated wireless sensors and enables the delivery of numerous types of perturbations controlled, expected and unexpected. These types of disturbances can be generated in relation to the specific gait or swing phase of the gait cycle. In addition to expected and unexpected controlled perturbations in place or on the move, the device also allows the exercise of centre of pressure control.

BalanceTutor can be used in neuromuscular, musculoskeletal, vestibular rehabilitation, sports training and fall prevention in the geriatric field. There are varieties of medical indications for which the system can be used:

- Neuromuscular rehabilitation.
- Cerebrovascular accident.
- Cranial trauma.
- Spinal cord injuries.
- Multiple sclerosis.
- Cerebral palsy.
- Peripheral nerve injuries.
- Musculoskeletal rehabilitation.
- Sprains/dislocations/fractures.
- Vestibular rehabilitation.
- Dizziness, vertigo and balance therapy.
- Sports training.
- Rehabilitation after sports injury.
- Improving ADL activities.

When an unexpected disturbance occurs, the body's center of mass moves passively in the direction of the disturbance. The body must react immediately (70-120 ms) to restrain this unplanned passive movement. This reactive postural response aims to stabilize the body's center of gravity within the support polygon, by bringing it back to its original position, or to create a new secure base of support, using a compensatory step. In these two cases the body actively tries to move in the direction opposite to the applied disturbance.

In the Balance Tutor user manual, there are several guidelines based on the above concept, which formulate the appropriate perturbation according to the rehabilitation goals.

Figure 1. Balance Tutor – general presentation

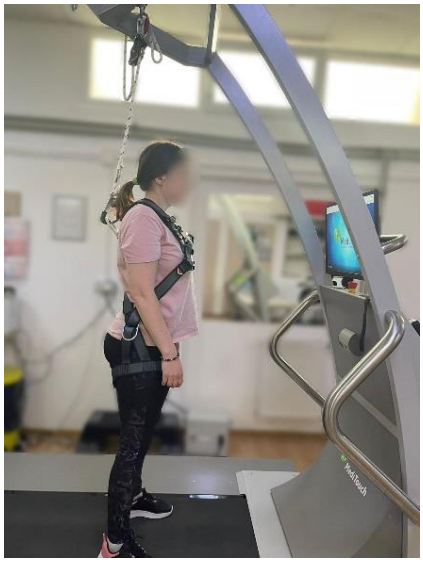


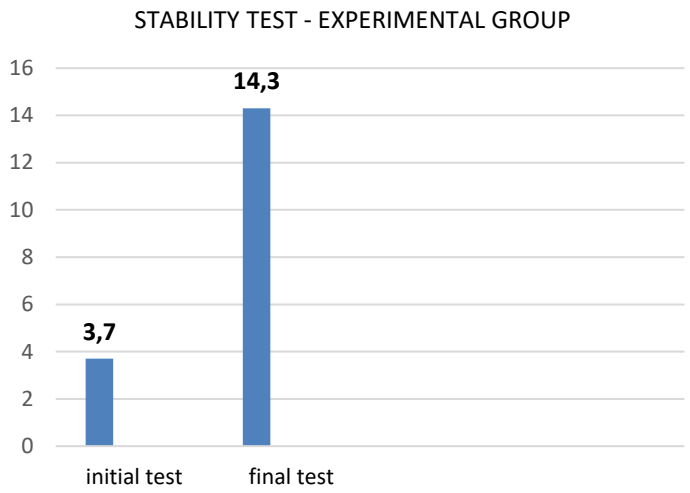
Figure 2. The patient start position on Balance Tutor

For the evaluation of the subjects included in the research, a stability test was used, consisting of measuring in seconds the time of maintaining unipodal support on the Bossu Ball in the affected lower limb. The evaluation was performed using the timer, both initially, on the first day of treatment, and finally, on the 10th day (Fig. 3).

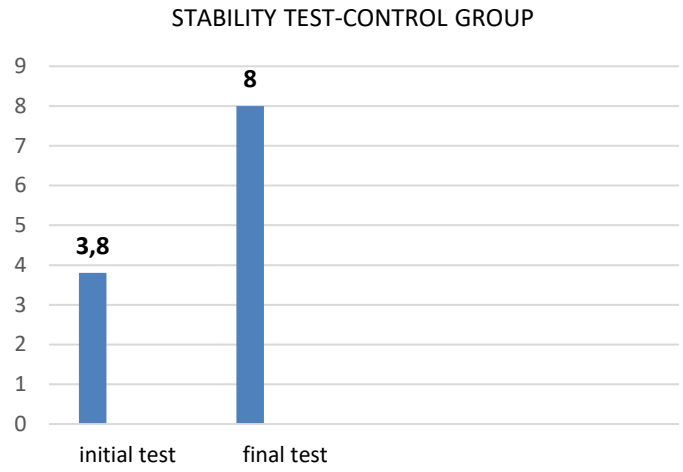
Figure 3. The stability test on Bossu Ball

Results

Considering the stability test measurements, we presented the results put into graphs as it follows.

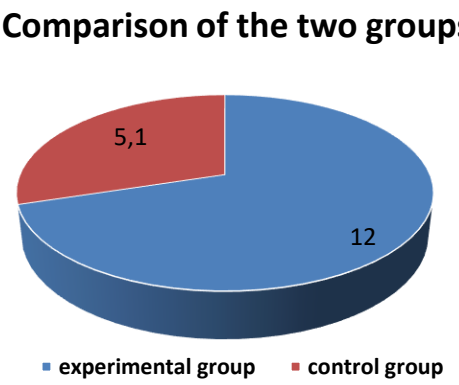


Graph 1. The stability test results – experimental group



Graph 2. The stability test results – control group

The arithmetic means of the values obtained for the control group is 5.1 seconds. The arithmetic mean of progress for the experimental group is 12 seconds. Thus, comparing the arithmetic averages of the 2 groups, there was a difference of 6.9 seconds in favour of the subjects of the experimental group.



Graph 3. Comparison of the two groups

Discussions

Clinicians should administer appropriate clinical or field tests, such as single-legged hop tests that can identify a patient's baseline status relative to pain, function and disability; detect side-to-side asymmetries; assess global knee function; determine a patient's readiness to return to activities and monitor changes in the patient's status throughout the course of treatment (Gray & Buford, 2015). As we already stated, for this study a knee stability test was utilized, in rest, our attention regarding the patient's wellbeing and recovery evolution was upon the objectives above described. Also, as we have mentioned, in the Balance Tutor user manual there are several guidelines, by which the appropriate disturbance is formulated according to the rehabilitation objectives. For the present study, the device was set to achieve the following objectives:

- Proprioceptive and kinesthetics rehabilitation.
- The unique technique of supporting the weight of the forefoot.
- The unique facilitation of the initiation of walking.
- Precise and fast coordination of the quadriceps and hamstrings.
- Neuromuscular coordination training.
- Rapid coordination of the agonist and antagonist muscles of the lower limb during the swing phase.
- Random perturbation in multiple directions while walking.

As a clinical effect, a controlled and proactive challenge of body weight support by the affected knee was achieved, with the improvement of automatic postural adjustment.

The results obtained following the application of the physical exercise program were present in the dynamics of their evolution, starting from the values recorded at the first examination before the start of recovery and at the end of the kinetic program. Comparing the results of the initial evaluation with the final ones of the experimental group, as well as with the results of the final evaluation of the control group, it is observed that the patients who walked on the treadmill with Balance Tutor disturbances obtained significantly increased values in the stability test, as can be seen and from the graphs.

Conclusions

In this study, we wanted to demonstrate the importance of physical therapy in knee sprain recovery, but especially the importance of the Balance Tutor treadmill.

Knee sprain occurs when one or more of the capsuloligamentous containment formations are stressed beyond their physiological limit by forced movements (valgus, varus, hyperflexion, hyperextension, torsion). As one of the recent researches show, knee injuries account also for a substantial percentage of all athletic injuries. Strain and sprain rates varied greatly by sport, sex and age group (Gray & Buford, 2015). Certainly, this inovative device would be of big importance in preventing injuries and/or improving knee functionality for sportive activities as well. First-line tratment for each knee condition consists of conservative management, with a focus on exercise, education and self management (Duong et al, 2023). Balance Tutor is an efficient, optim modality to have this purpose solved.

The introduction of Balance Tutor perturbation treadmill walking was of major importance in the recovery of patients in the experimental group, who had greater progress in mobility and stability than the control group.

In conclusion, we demonstrated the hypothesis of the work, that the usage of the band with disturbances in the recovery program of the patient after knee sprain, results in the improvement of the body alignment, the increase in mobility, muscle strength and especially stability. As the study demonstrated, Balance Tutor is an inovative and modern device, very efficient in increasing knee stability and accelerate its recovery after a strain, an easy-to-go and attractive way of patients rehabilitation.

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