



## APPLICATION OF ANALYTICAL EXERCISES AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION FOR STATIC, DYNAMIC BALANCE AND POSTURAL CONTROL IMPROVEMENT

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### ABSTRACT:

**Purpose:** to assess the recovery of static, dynamic balance and postural control while overcoming muscle imbalance after an anterior cruciate ligament reconstruction by applying analytical exercises.

### Material and methods:

**Material:** 15 men (mean age 25.16) were observed in the span of 14 weeks (three and a half months) after anterior cruciate ligament reconstruction. They underwent physiotherapy, including analytical kinetic chain exercises in hospital, ambulatory and at home conditions.

Research, measurement, and evaluation **methods** include range of motion in the knee joint, manual muscle testing (MMT), static and dynamic balance tests, and postural control tests. Statistical methods include statistical data grouping, Cronbach's test, descriptive method, testing of statistical hypotheses, and correlation analysis. The data was processed with SPSS v.24.0 for Windows.

**Results:** The results show a change in the static postural control with a 1/4-point deviation from the standard. This requires the inclusion of additional sensorimotor exercises in combination with other specific and general strengthening exercises.

**Conclusion:** From the performed observation and the obtained results, compared to those of 20 healthy men, the following conclusion has been drawn: the analytical exercises for lower extremities lead to the overcoming of dysfunction and increased stability in the extremities. The physiotherapy programme should include sensory stimulation exercises tailored for strengthening the weakened muscles and should contribute to the overcoming of muscle imbalance.

**Keywords:** reconstruction of the anterior cruciate ligament, analytical exercises, static, dynamic balance and postural control,

### INTRODUCTION

The anterior cruciate ligament rupture is one of the most frequent traumas in the knee joint. The most common trauma mechanisms are: sharp external rotation of the femur to the tibia with a fixated foot; hyperflexion of the knee joint, or a direct blow. This type of trauma is common among sport athletes and people of active age. The treatment is surgical or conservative, although the surgical method is recommended. Kinesitherapy plays a great role in the postoperative period for restoring joint functionality and range of motion, as well as strength and endurance of the surrounding tissue (ligaments, muscles, etc.) [1, 2].

In most cases of musculoskeletal and nervous system traumas, and diseases, postural control is impaired. Certain conditions, such as spinal distortions, bone fractures, degenerative joint diseases, nervous system impairments etc., also affect postural control. Posture and movement regulation is performed by spinal cord neurons, supraspinal centres in the brain stem, the small brain, basal nuclei, and cerebral cortex [3].

After reconstruction of the anterior cruciate ligament (ACL), the range of motion in the knee joint is limited and the strength of the muscles moving the knee becomes reduced. Swelling of the knee is typical for patients in the postoperative period. The edema affects the range of motion in the knee and provokes pain. Cryotherapy helps in managing the swelling process [4]. The kinesitherapy programme includes active, isometric and analytical exercises. In this study, the emphasis is placed on the importance of analytical exercises. These exercises are an irreplaceable tool in the recovery process after ACL reconstruction because they target a specific muscle.

*The purpose* of the study is to assess the recovery of static, dynamic balance and postural control, and the overcoming of muscle imbalance after anterior cruciate ligament reconstruction by applying analytical exercises.

## MATERIAL AND METHODS

The sample population of this study includes 15 men at the age of 25-26 years who underwent an anterior cruciate ligament reconstruction and were observed in the span of 14 weeks (three and a half months). They conducted physiotherapy in hospital, ambulatory and at home conditions. Analytical exercises for the kinetic chain were implemented in the physiotherapeutic programme. The functional research methods were applied as follows:

- range of motion in the knee joint;
- manual muscle testing;
- static and dynamic balance tests, and posture control test [5].

The test consists of two portions:

**The static portion** includes three positions with increasing levels of difficulty. In case of loss of balance and postural disturbance, the test has to be terminated. The duration is measured in seconds.

- *position one* - standing on the operated lower extremity as the other steps in front of the toes of the standing extremity; eyes are closed; maintain position;

- *position two* - standing on the operated lower extremity as the other bends at the hip and knee joints with its sole in front of the knee of the standing extremity; eyes are closed; maintain position;

- *position three* - standing on the operated lower extremity with hands placed at a 90° angle and torso bent forward at a 90° angle as the free lower extremity lifts to a 90° angle - balance position; eyes are closed; maintain position.

**The dynamic portion** requires two patches of 150 cm to be attached to the floor perpendicularly (crosswise) and two more between them at 45°. Thus 4 beams appear to the left and 4 to the right. Measuring the length of the free lower extremity, removing 2/3 of the length and projecting it on each beam. The patient steps with the operated lower limb in the middle, and the other extremity steps beside it without taking any weight from the body. By signal from the therapist, the patient touches the 4 beams with their free lower extremity (the first in the front and the other three to the side towards the non-operated extremity). The duration of the test is 5 sec. Touching the 4 beams gives 4 points (1 point per beam). If a beam is not touched, the evaluation is reduced by 1 point.

The programme includes physiotherapy analytical exercises for the muscle agonists, antagonists and stabiliz-

ers of the three kinetic chains of the lower extremity. Before the test for evaluation of static, dynamic balance and postural control, the range of motion in the knee joint was measured - S: 0-0-135°, and the MMT was conducted - 5. Despite the good performance, the test scores are lower than those of 20 healthy men at the age of 20-30. One finding is that restoring muscle balance is only one of the requirements for the implementation of sensorimotor exercises stimulation.

The physiotherapy means included in this treatment are: position training; cryotherapy (ice gel); therapeutic massage; isometric exercises; active exercises for the unaffected extremity; triple flexion with heel sliding; lifting of the operated lower extremity in all directions without removal of the brace; isometric training for the quadriceps femoris muscle at 80°-70°-60°; flexion and extension of the knee joint (passive with the help of gravity, against gravity); half-squats (10°-20°-30° to 45°); exercises from a position with terminal extension in the knee joint; stretching of shortened muscles; exercises to facilitate the contractions of the quadriceps femoris muscle; long time sitting; sitting and standing; stair exercises; exercises from a lying position - press; exercises to restore the strength of the quadriceps femoris muscle; squats; standing up against resistance (elastic band, weight, etc.); endurance exercises for the quadriceps femoris muscle; isometric exercises; analytical exercises for the muscles of the lower back, the back of the thigh and the gluteal muscles. No purposeful exercises for sensorimotor stimulation were performed. The patient was informed about the tests and performed them in advance [6].

## RESULTS AND DISCUSSION

At the end of the treatment, the results are the following:

1. Range of motion in the knee joint S:0-0-135°.
2. Manual muscle testing:
  - m. triceps surae - 5;
  - m. quadriceps femoris - 5;
  - m. gluteus maximus - 5;
  - m. vastus medialis - 4+.
3. Test for static, dynamic balance and postural control [7]:

- **static portion** - the results are compared with the results of 20 healthy men at the age of 20-30 years (table 1)

**Table 1.** Comparison of the results from the static test portion (in seconds) among healthy and operated men.

Position	n	$\bar{X}_1$	n	$\bar{X}_2$	n	$\bar{X}_1 - \bar{X}_2$
First	15	31,15	20	27,05	35	4,1
Second	15	21,65	20	17,15	35	5,5
Third	15	10,95	20	5,60	35	3,35

$\bar{X}_1$  - healthy men,  $\bar{X}_2$  - median values obtained from the test of 15 patients with ACL reconstruction.

The results from the static portion of the test show a deviation in the static posture control values. This requires the inclusion of specific sensorimotor exercises along with the others. The inclusion of additional exercises in the physiotherapeutic programme limits the disturbed mechanoreception in the central nervous system and cerebral cortex and helps its recovery. Sensorimotor stimulation applied in home conditions showed good results that were close to those of the healthy control group. The presented results in table 1 testify for the positive influence on the postural control of patients after anterior cruciate ligament reconstruction [8].

- **dynamic portion** (table 2)

**Table 2.** Comparison of the results from the dynamic test portion.

n	$\bar{X}_1$	Standard	Difference
15	2,95	4	1,05

$\bar{X}_1$  – study results of 15 patients compared to the 4-point standard.

The deviation is 1/4 points from the standard. This requires the application of specific sensorimotor exercises in combination with other special and general strengthening exercises. The small deviation from the standard values of the examined individuals after surgical treatment of the anterior cruciate ligament, in comparison with healthy individuals in the dynamic portion of the test for static and dynamic balance, as well as postural control, shows a positive influence of the sensorimotor practice. The results show that the sensorimotor stimulation must continue in order to maintain and improve postural control.

## CONCLUSION

From the performed observation and the obtained results, compared to those of 20 healthy men, the following conclusion has been drawn: the analytical exercises for the lower extremity lead to the overcoming of dysfunctions and increased stability of the extremity. Analytical exercises lead to the overcoming of muscle imbalance and to the improvement of static, dynamic balance and postural control, but are an insufficient sensorimotor stimulus for automatic postural control. The physiotherapy programme should include sensory stimulation exercises tailored for the strengthening of the weakened muscles and should contribute to the overcoming of muscle imbalance.

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