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DOCTORAL DISSERTATION ABSTRACT

EFFECTS OF THE KINETOTHERAPY APPLICATION IN INTEGRATIVE SYSTEM UPON THE QUALITY OF LIFE OF THE PERSONS WITH LESIONS OF THE ANTERIOR CRUCIATE LIGAMENT

GJORGJI NEDELKOSKI

SCIENTIFIC COORDINATOR

PROF. DORINA ORŢĂNESCU PhD

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The doctoral dissertation is structured in three parts.

1st PART, called *THEORETICAL SUBSTANTIATION ON THE PROBLEMS OF THE RESEARCH* approaches aspects such as: notions of anatomy and biomechanics of the knee and instability, motor control, quality of life, general notions of recovery-evaluation- appreciation.

Numerous specialists in the field share the opinion that the recovery of lesions of the knee that involves the anterior cruciate ligament (ACL) is a controversial

problem. This work describes the tension in the normal and reconstructed ligament during a series of active and passive tests of flection of the knee, with and without varus, valgus and axial rotational torque from the tibia. The tension level in the anterior cruciate ligament of the human knee has been significantly different according to the way the flexion angle of the knee was passively changed or to the simulated contraction of the quadriceps.

The skeleton of the knee is represented by: the lower extremity of the femur; the upper extremities of the tibia and of the fibula; patella.

The lower extremity of the femur – the distal epiphysis of the femur – is voluminous, showing two prominences called condyle - medial condyle and lateral condyle. In the anterior part of the epiphysis there is an articular surface for patella, which is called trochlea of femur. **The upper extremities** of tibia and fibula – the proximal tibial epiphysis – are slightly posterior curved, has a quadrangular shape, with transversely directed large axis. **The posterior facet of patella**. Patella is a short bone, located on the anterior surface of the knee. The posterior surface of patella agrees with the patellar surface of femur. It is divided in two articular surfaces by a vertical peak, which agrees with the ditch of femoral trochlea. The two surfaces are uneven: the lateral one is extended and concave and the medial is plane or slightly transversely concave.

Intra-articular menisci are two fibrocartilages developed at the periphery of each tibial articular fossa, they contributing to a better consistency between the articular surfaces, an „O" shaped external meniscus and a „C" shaped internal meniscus, and triangular shaped in cross-section. The menisci are inserted by two extremities (anterior and posterior) in the respective intercondyloid area. The transverse ligament of the knee unites the anterior extremities of the two menisci. The menisci are not strictly cartilaginous, hence they possess elasticity and deformability higher than an ordinary cartilage (Baciu, 1981).

The anterior cruciate ligament is inserted in the anterior intercondyloid area, has an inclined course, inserting ascendant and laterally on the medial facet of the external femoral condyle. ACL is a complex structure which direction, reconstruction and biology are directly related to the bearing function of the knee, while the complexity of its structure and architecture ensures the mobility of the knee as static stabilizer. The **macroscopic anatomy** – ACL is a strip consisting of fibers of conjunctive tissue which links the femur and the tibia. Proximal, ACL is inserted at the level of a fossa on the medial facet of the external femoral condyle. The femoral insertion area has 14 -24 mm in diameter and it is nearby the „over the top" area (Brotzman, Kevin and Wilk, 2003).

The spatial orientation – ACL is anterior, medial and distal directed between the femur and tibia. It is twisted around its longitudinal axis, towards outside, this spirality being in fact the result of the location of its bone insertions. The orientation of the femoral insertion of ACL during flexion and extension is responsible of the tension of the ligament during the movement.

The femoral insertion of the ACL is not made in one bundle, but by several individual bundles, which deploy in the shape of fan. In the structure of the ligament, these bundles are grouped in: antero-medial group and postero-lateral group. When the knee is in extension, the postero-lateral group is extended and the antero-medial group is moderately relaxed.

Microscopic anatomy – ACL consists of multiple bundles of 20 mm width collagen fibers. These are grouped at their turn in bundles with 20-40 mm width. The femoral and tibial insertion of the ACL is made by the interpenetration of collagen fibers with those of the cortical bone. A transition area represented by the frbrocartilage mediates the sudden path from the flexible ligament tissue to the rigid bone. This change in the microstructure, from ligament to bone, allows as it seems, a gradual change of the rigidity and prevents the concentrations of the pressure forces at the level of insertion areas.

Histology – ACL consists of fibroblasts surrounded by an extracellular matrix containing water, macromolecules of collagen (mainly type 1 collagen) and other substances. The collagen –main component of the ACL, is representing 75% of the dried structure of the ligament. The elastine –although ACL contains a small quantity of elastine, this molecule is very important for extracellular matrix organizing and function. The elastine contributes to the resistance and elasticity of the ACL. Proteoglycans – represents only 1% of the ACL dry weight. They have an important role in extracellular matrix organizing. Water– represents 60% or more than the total weight of the ligament.

Innervations of the ACL –in the structure of the ACL nervous fibers and receivers have been dicovered that are usually placed all along blood vessels forming vascular-nervous bundles. Four types of morphologically distinctive nervous terminations have been emphasized: two types of Ruffini corpuscle; Pacinian corpuscles; free nerve ending.

2nd PART of the doctoral dissertation, PRELIMINARY ***RESEARCHES ON THERAPEUTICAL APPROACH OF THE RECOVERY BY EARLY TRAINING PROGRAMMES OF THE OPERATED KNEE BY LIGAMENT PLASTICS***, is a pilot research aiming at verifying the logistics and the research

tool. This research represents a general rehearsal of the research itself and consisted of emphasizing the role of kinetotherapy in early re-education of the propriception in the ligament plastics of the knee.

The synthesis of the specialty literature has been based on the analysis of the studies published in scientific databases such as: PubMed, Google Scholar and MedLine. The majority of the recent studies emphasized that the recovery after anterior cruciate ligament should consider the control of the level of pain and postoperator inflammation, the muscles hardening which stabilizes the knee, the hip and the trunk, the consolidation of the neuromuscular control, all these by a gradual progress in carrying on the functional activities needed to return to the everyday activity.

Stages of the Experimental Research:

1. Choosing variables. This stage follows immediately after the stage of establishing the problem that is intended to be submitted to the experiment. Choosing variables is carried out depending on the hypotheses of the research.

2. Establishing the experimental situation. Depending on the variables of the chosen experimental plan, I made the option to achieve the experiment on field, within the ***KINETO MEDICAL HEALTH*** recovery private practice.

3. Establishing the subjects in experimental groups and control groups. In order to satisfy the requirements of the internal, and also external control, it was preceded very rigorously in establishing the subjects, which participated in the experiment.

4. Experimental data processing. Values have been obtained by measuring variables which were statistically processed, establishing the frequency, the average values, calculating the dispersion, the correlation coefficients and their significance.

Hypothesis of the preliminary research: *Significant differences may be obtained in the recovery of the lesions of anterior cruciate ligament, by applying a correct and iterated recovery protocol, with a correct and early approach on the proprioceptive reeducation.*

Subjects of Preliminary Research. Subjects have been registered with age between 26 and 40, masculine gender, with diagnosis: anterior cruciate ligament lesions solved by ligament plastics, 2 at the right knee and 3 at the left knee. The subjects have participated in recovery programs with period's comprised between 6 and 8 weeks.

Evaluation Methods and Tests:

- *Evaluation of the Proprioception* – has been carried out by *SMART Balance Master*® apparatus, which achieves both the objective evaluation as well as the reeducation of the sensitive and willing motor control of the balance with visual feedback on a stable or instable support surface and a stable or dynamic visual framework [1].
  - *Sensory Organization Test* (SOT)
  - *Limits of stability* – (LOS)
  - *Rhythmic Weight Shift* – (RWS)
  - *Weight Bearing Squat* – (wbs)
  - *Unilateral stance* – (us)

Analysis and interpretation of the results:

☐ It has been found out that anterior cruciate ligament lesions are more frequent in case of left knee in the case of the patients included in this study.

☐ The balance score which quantifies the balance or the postural stability of the weight center, is better in case of young subjects compared to older subjects, no major standard deviations has been registered compared to the average, in case of patients with right anterior cruciate ligament, nor in case of the patients with left anterior cruciate ligament.

☐ In case of the stability limit for the reaction time, the patients with right ACL, have a better reaction time in sagital plan than the patients with left anterior cruciate ligament. Low movement speeds indicates deficits of the high level of the central nervous system, the subjects of the present study, show no movement speeds of the low center of mass. It has been found out that the movement speed of the compound mass is higher at the patients with left anterior cruciate ligament (6.9 sec, respectively 5.8 sec.), towards the patients with right ACL (4 sec, respectively 5.3 sec.). As concerns the results of the trips until the final point or maximum movements, indicators of certain abnormalities of the control motor, differences depending on the lesion of the anterior cruciate ligament (higher values of the standard deviation, 13.55-12.66 right and 9.16-11.41 left) may be observed.

☐ For the rhythmic movement of the center of mass, the slow, moderate, fast control of mass, the data emphasize the following aspects: the lowest deviation compared to the data sequence is registered on the left/right –slow (2.95%), while highest deviation compared to the average is observed on front/back – slow

[1] www.neuro.com. Accessed on 20.12.2012

(11.08%), fact that emphasizes existing adjustment problems to the changes intervened.

☐ As concerns the genuflections, the processed data show a standard deviation with identical values on the left and on the right. The subjects who show orthopedic nature lesions of the lower extremities may show an even distribution of the weight in orthostatic stance, but they will transfer a major part of the weight on the non-affected side during the most requiring genuflection positions. The results emphasize the fact that the subjects with lesions of left anterior cruciate ligament transfer the weight on the right side during genuflection, while the subjects with lesion of right anterior cruciate ligament transfer the weight on the left side during genuflection. The majority of subjects show a difference higher than 7% between left and right; this fact is due to lesions of the anterior cruciate ligament.

☐ The unilateral support, for the average balance speed emphasizes a trend that the stability is more performing on the non affected part, so that the patients with lesions on the right side have a better stability on the left sideb and the patients with lesions on the left side have a better stability on the right side.

Conclusions of the preliminary study

✓ The results of the preliminary study are in line with the studies from the specialty literature (Kruse, Gray, and Wright, 2012), published in the data bases and analyzed within the present study and emphasize the fact that the modern recovery methods that include reeducation means of the proprioception, after reconstruction of the anterior cruciate ligament are superior to the classical recovery methods that are based, generally, on achieving the objectives targeting the increase of the movement amplitude and muscular toning up.

✓ The results of the preliminary study entitle us to support the fact that the recovery programs used in this stage of the research have significant results in the recovery of the anterior cruciate ligament and as such the basic research may be started, on a higher sample of subjects and within involvements upon the quality of life of the patients diagnosed with anterior cruciate ligament**.**

3rd PART. *PERSONAL CONTRIBUTIONS ON THE EFFECTS OF THE KINETOTHERAPY APPLICATION IN INTEGRATIVE SYSTEM UPON THE QUALITY OF LIFE OF THE PERSONS WITH LESIONS OF THE ANTERIOR CRUCIATE LIGAMENT*.

Goal of the Research

Derives from its title and consists in obtaining significant results in the recovery of patients diagnosed with lesions of the anterior cruciate ligament, solved by ligament plastics, by creating and applying early complex recovery and reeducation proprioceptive programs, with major impact upon the quality of life.

Subjects of the Research

The research achieved a number of 11 subjects, with age comprised between 30 and 40 years.

Place of carrying on the research. The recovery programs have been carried out within the „KINETO MEDICAL HEALTH" private medical recovery practice, equipped with modern apparatus and means needed for this purpose. The evaluation of the subjects has been made in „***OTOMED***" medical private practice with ***SMART Balance Master*** equipment.

Hypotheses of the Research

1. Establishing the level of post-operator recovery of the patients with anterior cruciate ligament by periodical and linear evaluation, using modern evaluation methods, may have significant influences in the recovery process.

2. Achieving diagnoses on the level of proprioception of the affected inferior member as well as on the non-affected one may be a significant indicator in the recovery process of the patients with lesions of anterior cruciate ligament solved by ligament plastics.

3. If during the recovery process of the patients diagnosed with lesions of the anterior cruciate ligament, solved by ligament plastics, an early proprioceptive reeducation protocol is applied, then significant changes on the patients' quality of life may be obtained and implicitly early return to the everyday activities.

Conclusion of the Research

☐ Processing the results of the research emphasized the fact that the periods when the post operator evaluation has been performed increased linearly depending on the stage of recovery.

☐ Statical analysis of the results emphasized the fact that applying the recovery protocol proposed in this study, had as result a linear evolution, as concerns the movement amplitude of the knee on active extension, active flections, passive flections movement, statistically significant depending on the recovery period. The evolution of the passive extension was not linear, but despite this, at the end of the recovery period optimum functional values are reached.

☐ The evolution of the muscular force during the period of recovery has been indirectly evaluated, by evaluating the muscular relief by the perimeter of the thighs. The average of the differences of the perimeters of the thighs between the healthy inferior member and the affected inferior member drops significantly from statistical viewpoint (p=0,0001), so that in the week 24-28 the perimeters of the two thighs (left, right) have the same value.

☐ Pain represents an important symptom in this pathology. The results of the research emphasize the fact that pain had a linear involution, which ensured the patients the needed comfort to carry out the kinetotherapy programs, the pain disappears between week 15-18 at all patients, with statistically significant average values, p=0,0001. The obtained data have confirmed the work hypothesis number 1.

☐ Evaluation of proprioception has been carried out with SMART Balance Master system and started the Sensory Organization Test –the Balance Score. In the first part of the test the results of the balance score were analyses, the subjects show no incapacity of using efficiently individual sensory systems or not matching adaptive responses, resulting the correct use of sensory information (senses).

☐ The Sensory Organization Test – The Sensory Analysis, in case of this test the compensatory (abnormal) methods are objectively identified, where the subject uses the three sensory systems contributing to the achievement of postural control: proprioceptive; visual; vestibular. As consequence of the results of the research subjects, it has been found out that there are no statistically significant differences at either of the evaluated scores, or in case of comparison analysis between the subjects within left ACL group or right ACL group, and also either between the subjects of the two groups, the scores vary, but they are not statistically significant.

☐ In case of the movement speed, the recovery speed in case of forward movements is higher than in case of backward movements, this fact is due to the visual control. As concerns the data on lateral stability (left/right), the recovery speeds are also higher than in case of antero/posterior movements. As concerns the control of direction, small differences statistically not significant between the subjects of the two groups are emphasized for the control fore ward/left.

☐ The Test – Rhythmic weight shift (RWS), measures the ability of the patient to move rhythmically the weight shift (WS) from left to right (lateral) and from forward to backward (anterior-posterior) between 2 targets, with 3 speeds: slow, medium and fast. The measured parameters are the movement speed of the WS on the axis (willing) and the control of direction. For each of the 3 speeds, the subjects

reach the rhythm imposed by the speed and covering the entire distance between the specified limits of the movement.

☐ The Test – Weight bearing squat (% from the body weight), in orthostatic stance, the biggest part of the body weight is supported by the skeletal system, a relatively low charge being supported by the articulations of the knees, and hips. There are no statistically significant differences between the subjects of the two groups (left ACL and right ACL), but there are statistically significant differences between the inferior member affected and the one non-affected, depending on the degree of flections in the articulation of the knee.

☐ The Test - Unilateral Stance measured the stance balance speed. No statistically significant differences between groups with left/right ACL, or between the left inferior member and the right inferior member are emphasized. The results confirm the research hypothesis number 2.

☐ The statistical analysis of Barthel scale (Barthel ADL Index), obtained in the two evaluation moments (initial- before recovery and final- after recovery) of the quality of life, emphasizes a statistically significant difference for the majority of items (<0.00001), items that may suffer changes of the score depending on the operational degree of the knee.

☐ According to the total score of Barthel scale (Barthel ADL Index) (<0.00001), as well as of the results obtained in this research, the research hypothesis number 3 is confirmed.

☐ The results obtained as consequence of the present study allow us to assert that the protocol made and applied represents an original and valuable contribution we bring in this research. The proposed recovery protocol offers an alternative in achieving higher results during the recovery process in lesions of anterior cruciate ligament solved with ligament plastics.