
CHANGES IN THE FUNCTIONAL STATUS OF THE KNEE IN PATIENTS WITH THE "UNHAPPY TRIAD"

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Abstract: The "Unhappy Triad" or "O'Donoghue's Triad" is one of the most severe multiligamentous sports injuries that involves a tear of the ACL, MCL and medial meniscus of the knee. Recovery after surgical treatment is between 6 and 12 months, and many athletes after this injury do not return to their sports activities. Purpose: to follow the functional state of the knee complex in patients after surgical treatment of the "Unhappy Triad", before and after 10 days of kinesitherapy in the moderately protective period. Methodology: 70 patients after surgical treatment of the "Unhappy Triad" were studied, 32 were assigned to a control group (CG) and 38 to an experimental group (EG). In all patients, the treatment of the MCL rupture was conservative (30 days of knee immobilization) with subsequent surgery that included partial meniscectomy and ACL reconstruction using the BPTB method. A traditional model of kinesitherapy was applied in the CG, and in the EG the following were applied: instrumentally assisted soft tissue mobilization - Ergon® IASTM Technique, kinesio tape, post-isometric relaxation, stretching, proprioceptive training, locomotor training, analytical exercises and aquatherapy for 10 days. To monitor changes in the functional state of the knee, a functional scale for complex assessment according to D. Seligson was applied, before and after 10 days of kinesitherapy. Results: the initial average cumulative assessment of the functional state of the damaged knee in CG before kinesitherapy was 4.688, and in EG it was similar – 5.105. The values indicate a severe functional state on the first day of the study. After 10 days of kinesitherapy there was a significant improvement in results in both groups. In absolute values, the functional state of the knee in CG increased by 5.37, and in relative values by 114.67%, in EG it increased by 7.9 or the improvement was by 155.66%. As a result, the final mean cumulative score of patients in the control group was 10.06 and in the experimental group it was 13.05. The testing of the hypotheses for the significance of the differences of the variable in the two groups shows that $P > 0.05$ on the first day of the study, from which it follows that the groups are the same in terms of the studied indicator, and on the tenth day $P < 0.05$, which proves the existence of a statistically significant difference in the average values of the indicator in favor of EG. Conclusions: The applied model of kinesitherapy in the experimental group is more effective and contributes to a more significant complex restoration of the functional state of the knee joint of the patients, compared to the traditional model of kinesitherapy in the control group.

Keywords: O'Donoghue's triad, Unfortunate triad, knee surgery, ACL, MCL, kinesitherapy

1. INTRODUCTION

The combination of multiligamentous knee injury: anterior cruciate ligament (ACL), medial collateral ligament (MCL), and medial meniscus (MM) has been known to orthopedic surgeons since 1936. For the first time in 1950, O'Donoghue used the term "Unhappy triad" to describe this condition, hence also known as "O'Donoghue's Triad" (Hoveidaei et al., 2023).

For this severe injury, surgery is performed and includes ACL reconstruction with autograft, partial meniscectomy of the medial meniscus. Treatment of the MCL rupture, if it is a grade I or II injury (this type of injury is characteristic of the triad) is treated conservatively, by immobilizing the knee for 30 days before surgery. At the III degree of MCL damage, at the discretion of the orthopedic surgeon, it can be both conservative or operative. But in a grade III MCL lesion, a lateral rather than a medial meniscal lesion is more commonly seen with a combination of a chondral tissue lesion, which goes beyond the classic O'Donoghue Triad.

After surgical treatment, main symptoms such as: edema, pain, cicatrix, limited range of motion, reduced myoarticular laxity, reflex muscle inhibition, dynamic instability, muscle hypotrophy, myo-articular contractures, muscle imbalance, impaired proprioception and muscle control, claudication with pathological gait and others (Gramatikova, 2021).

The capsuloligamentous structures, which are the passive static stabilizers of the knee, are restored immediately after the arthroscopy and reconstruction, in clinical tests the knee is statically stable. Dynamic joint stability, which is in dysfunction, is provided by the muscles around the knee complex (Gramatikova, 2021). To restore the dynamic

stability and motor function of the knee, kinesitherapy programs include specialized means to improve the dynamic, static and strength endurance of the periarticular muscles.

Intense contact sports involving sudden explosive changes in the direction of movements, such as alpine skiing, football, martial arts, rugby and others are at particular risk of injuries involving the three components of the knee joint (Reer et al., 2001; Gramatikova, 2021). Researchers Fomin et al., 2020, followed patients with the "Unhappy Triad" for 6 months and found that only 17% of them returned to their pre-injury sports activity.

The reasons for this, according to the authors, is that at the end of the rehabilitation, the function of the knee is still incomplete, as a result of the trauma and prolonged hypo and adynamia, fear of a new injury, uncertainty in the knee, are the reasons why 83% of patients do not return to their physical activity before the trauma, which is a very high and negative percentage (Fomin et al., 2020; Gramatikova, 2021).

Knee joint injuries are still the most common anatomical site of injury, accounting for about one third of all injuries in amateur alpine skiers (Posch et al., 2021).

Scientific research approves and updates kinesitherapy with innovative methods in order to increase and improve the functional state of patients (Valchev et al., 2024; Subeva et al., 2023; Avramova et al., 2023; Filipova, 2023; Mitova, et al., 2021; Zlatkov et al., 2021).

Prevention and rehabilitation protocols for lower extremity injuries should continue to be a priority, as over the past 4 National Football League seasons examined, injury rates have not decreased (Mack et al., 2020).

The indicated relative proportion of the Unhappy Triad is high and its reduction depends on rehabilitation, high and innovative competences of physiotherapists, availability of up-to-date data on the epidemiology of "O'Donoghue's Triad" for injury prevention. One of the most severe and difficult to treat, restore and study injuries, which studies are rare in research practice (Gramatikova, 2024).

2. MATERIALS AND METHODS

Цел на изследването: Aim of the study: to track the functional state of the knee complex in patients after surgical treatment of the "Unhappy Triad", before and after 10 days of kinesitherapy in the moderately protective period.

Study methodology: 70 patients (62 men and 8 women) were studied, after surgical treatment of the "Unhappy Triad", distributed 32 in (CG) and 38 in (EG). The O'Donoghue's triad is a sports injury as 91.52% were athletes out of all 70 individuals examined (Gramatikova, 2024).

In all patients, the treatment of the MCL rupture was conservative (30 days of knee immobilization) with subsequent surgery that included a partial meniscectomy of the medial meniscus and ACL reconstruction with bone-patellar tendon-bone (BPTB) autograft. Patients with total meniscectomy or meniscal suture were not included in the study because the loading protocol for the injured lower extremity was different.

Functional scale for complex assessment: to track changes in the functional state of the knee, a functional scale for complex assessment according to D. Seligson (1980) was applied, before and after 10 days of kinesitherapy. The functional scale includes different categories of questions: is there pain, how intense is it, when does it occur; whether there is myoarticular stability or not, how severe it is; is there stiffness or not; presence and occurrence of edema; is there a full range of motion or is limited flexion, limited extension, or both present; functional activity - assesses the rebound ability of the injured leg.

Each answer on the scale has certain points. The maximum score is 20 and the minimum score is 0. Scores 19 and 20 are considered an excellent score, scores 15 to 19 a good score. A score below 15 interprets a risk in sports activity and a risk of developing chronic joint instability of the knee. The evaluation scale was applied for the purpose of comparative analysis of the patients' functional capabilities before and after 10 days of kinesitherapy and comparison between the two groups of patients - control and experimental.

Methodology of kinesitherapy: Kinesitherapy in CG and EG begins immediately after the end of walking with aids - the end of the 4th week. According to the protocol of orthopedic surgeons in Bulgaria (it is more conservative), patients with this nosology use 2 crutches for walking within 3 weeks, and in the 4th week they use one crutch. Kinesitherapy is applied every day, for 2 weeks or 10 days, during the 5th and 6th postoperative week. Western protocols are much more aggressive and some of the means of kinesitherapy are applied earlier, but we comply with the requirements and recommendations of our doctors.

In CG, a 10-day traditional model of kinesitherapy was applied.

In EG, an experimental methodology of kinesitherapy has been approved, which includes the following means:

- **Kinesio tape** - to reduce pain and swelling, apply 2 crossed fan-type tapes - W in the ventral, medial and lateral areas of the knee; 1 application I – joint-stabilizing technique along the knee joint; for cicatrix, type I applications are applied - correction technique; kinesio tape is applied on the days when the Ergon techniques are not applied.

- **Instrument assisted soft tissue mobilization (IASTM) - Ergon@Technique**, applied over 3 days. The cicatrix is treated for elasticity, mobility and to prevent the growth of fibrosis. Shortened, hyperextended muscles with existing contractures that limit the range of motion (flexion, extension, or both) in the knee joint are treated. The techniques also reduce swelling and pain, improve elasticity and mobility of soft tissues and cicatrix, and restore range of motion in the knee joint.
- **Muscle-inhibitory techniques** (post-isometric relaxation, reciprocal inhibition and stretching) to reduce muscle hypertonus and restore joint mobility.
- **Progressive proprioceptive training**, includes the means: elastic bands (with different resistance), fitball, balance board (different types - two-axis, one-axis, air, relief), multi-active stones, trampoline. The workout progresses from lighter resistance on the elastic bands, to heavier; from a more stable support to a more unstable one with the inclusion of body and limb movements, a particularly important part of restoring dynamic stability in the knee; exercises progress from closed to open kinematic chain; some exercises are performed with eyes open and later with eyes closed. Proprioceptive training supports complex functional recovery, muscle control, proprioception, balance, equilibrium and locomotor skills of patients.
- **Locomotor training** is carried out entirely on a treadmill, which restores not only locomotion by eliminating claudication, but also improves proprioception and dynamic joint stability and returns the patient's security, as the feeling of giving way to the knee disappears. It supports the complex functional recovery of the knee complex.
- **Analytical exercises** to restore the strength and power endurance of the muscles of the knee complex, suppressed by reciprocal muscle inhibition. It helps in the complex functional recovery of the damaged knee.
- **Aquatherapy** for complex functional restoration of the damaged knee joint. Aquatherapy is an excellent adjunct to kinesitherapy, helping to restore joint range of motion, reduce swelling and pain, reduce muscle hypertonus, improve muscle strength and endurance.

3. RESULTS

From Fig. 1, it can be seen that the baseline mean cumulative functional status score of the injured knee after surgical treatment of the "Unhappy Triad" in the moderate-protective period in the CG on the first day was 4.688. The average cumulative grade in the first study in EG is similar, it is 5.105. Low values indicate severe functional status of patients from both groups, on the first day of the study (before starting kinesitherapy).

Table 1 Mean cumulative scores of functional status of the knee joint before and after kinesitherapy

Indication	Control group				Experimental group			
	On the 1st day	On the Xth day	D	D%	On the 1st day	On the Xth day	D	D%
\bar{X}	4,688	10,063	5,375	114,667	5,105	13,053	7,947	155,668
SD	3,807	3,255			2,747	3,153		
m_x	0,952	0,814			0,630	0,723		
$V\%$	81,223	32,349			53,799	24,156		
A	0,557	0,891			0,237	0,065		
E	-0,126	1,174			-0,238	-0,180		

Source: Gramatikova M., 2024

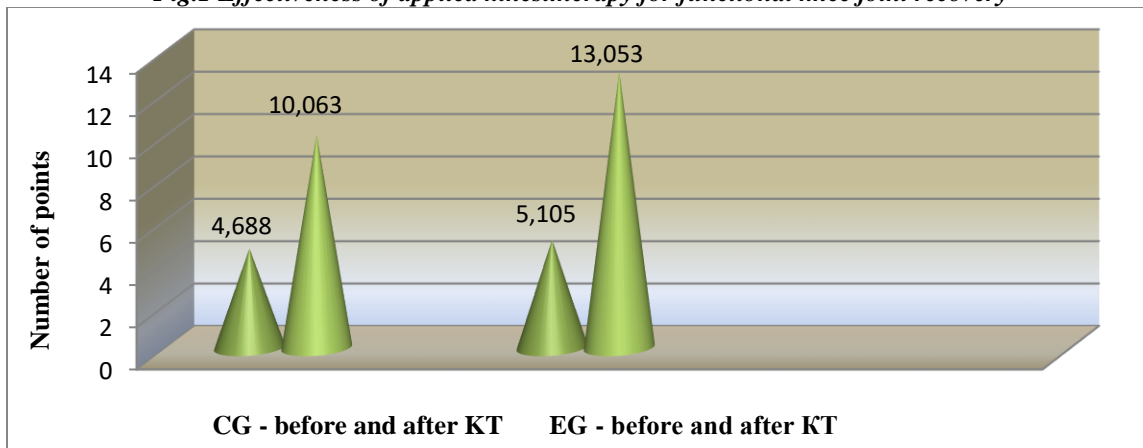
However, no statistically significant difference was found with the baseline result in the control group in the first study. Table 2 shows that the P-values (by Student) of the variable on the first day is 0.709 or $P > 0.05$, with a significance level of $\alpha = 0.05$. This shows that the two studied groups CG and EG are the same regarding the variable at the beginning of the study.

As a result of 10 days of applied kinesitherapy, a significant improvement in results was achieved in both groups. The improvement in the assessment (in absolute values) of the functional state of the knee in the control group was 5.37, and in relative values by 114.67%, which speaks of the effectiveness of the classic, traditional model of kinesitherapy applied in the control group.

The evaluation of the functional state of the knee joint of the patients after kinesitherapy in the experimental group (on the tenth day) increased by 7.9 or the improvement was 155.66%. As a result, the final mean cumulative score of patients in the control group was 10.06 and in the experimental group it was 13.05.

Regarding the variability of the patients' results, as can be seen from Table 1, V%=81.22 in the first examination in the control group and decreased to 32.35% in the tenth day. The variability is similar in the experimental group, with V% from 53.8% on the first day, decreasing to 24.2% on the tenth day.

Fig.1 Effectiveness of applied kinesitherapy for functional knee joint recovery



Source: Gramatikova M., 2024

The testing of the hypotheses for the significance of the differences of the variable in the two groups shows that $P > 0.05$ on the first day of the study, from which it follows that the groups are the same in terms of the studied indicator, and on the tenth day $P < 0.05$, which proves the existence of a statistically significant difference in the mean values of the indicator in favor of the experimental group.

Table 2. P-values (by Student's t-test)

Variable	CG-X1	S1	EG-X2	S2	D = X2 - X1		D%
					P- value	B - absolute value	
1 day	4,688	3,807	5,105	2,747	0,709	0,418	8,913
10 day	10,063	3,255	13,053	3,153	0,010	2,990	29,715

Source: Gramatikova M., 2024

Therefore, the applied model of kinesitherapy in the experimental group is more effective and contributes to a more substantial complex and functional recovery of the knee joint of patients after surgical treatment of the "Unhappy Triad" in the moderate-protective period, compared to the traditional model of applied kinesitherapy in a control group.

4. DISCUSSIONS

The developed and approved experimental model of kinesitherapy for restoring the functional state of the knee after surgical treatment of the "Unhappy Triad" is aimed at reducing its limiting pathofactors such as pain, edema, fibrosing and inelastic cicatrix, loss of myo-articular laxity, muscle imbalance, reciprocal muscle inhibition, impaired proprioception, dynamic instability and others, leads to better recovery of arthrokinematics, dynamic stability, proprioception and other aspects of the healing process of the knee area.

Therefore, to restore the functional abilities of the knee joint, the kinesitherapist directs his attention to the causes and pathofactors of their limitation, which are the basis of the selection of experimental means of kinesitherapy,

such as instrumentally assisted soft tissue mobilization (to restore muscle laxity and elasticity of the cicatrix), kinesio taping - to reduce swelling and pain, restore proprioception and dynamic stability by applying proprioceptive and locomotor training.

Muscle-inhibitory techniques (post-isometric relaxation or reciprocal inhibition, stretching) are applied to the hyperexact, shortened or contracted muscles, and the task of the kinesiotherapist is to reduce the increased muscle tone and restore the normal elasticity and tension of these muscles. Proprioceptive training restores proprioception, muscle control, static and dynamic myo-articular stability, balance and equilibrium, and more.

For the complex improvement of the functionality of the damaged knee joint, aquatherapy is an excellent additional means of kinesiotherapy, helping to restore the range of motion of the joint, reduce swelling and pain, improve muscle strength and endurance.

5. CONCLUSIONS

The analysis of the results of this study statistically prove that the applied model of kinesiotherapy in the experimental group is more effective and contributes to a more substantial complex and functional recovery of the knee joint of patients after surgical treatment of the "Unhappy Triad" in the moderate-protective period, compared to the traditional model of kinesiotherapy applied in a control group.

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