RECOVERY OF THE ACTIVE FLEXION OF THE KNEE JOINT AFTER „O’DONOGHUE’S TRIAD“

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Abstract
The publicly accessible information sources contain no research on the effectiveness of manual-soft tissue mobilization on the degree of movement of the knee joint of patients after O’Donoghue’s Triad. This has necessitated the development of an experimental physiotherapy program, which also includes manual-soft tissue mobilization by the method of J.C. Terrier. Patients have entered a moderately-protective phase. The control group received treatment with traditional model of physiotherapy. Variations have been observed in the degree of movement of the knee. The results show an average variation in the active flexion of the injured and the healthy leg in the first study of the control group - 39,3°±5,98°. After a ten-day physiotherapy, the variation is reduced to 18,8°±4,12°or the improvement is 20,5° (52,1%). The variation in the flexion of the healthy and the injured knee in the experimental group during the first day is 47,21°±4,003°. After a ten-day traditional physiotherapy, complemented with a manual-soft tissue mobilization by the method of J.C. Terrier, the injured knee recovers 82,05% of its mobility and the variation of the active flexion between the healthy and the surgically treated knee is reduced to 8,47°±2,708°. The P-values show that prior to the physiotherapy, the variations of the indicator in the control and the experimental group are statistically insignificant (P=0,317). The results of the final study, however, are significant (P=0,037), which comes to show that the experimental model of physiotherapy is a more effective method for knee recovery of patients who have undergone O’Donoghue’s Triad.

Keywords: knee, triad, manual-soft tissue mobilization, kinesitherapy

Introduction
The static and dynamic functional stability of the knee joint is provided by the capsular-ligament apparatus, which is the passive structure of the knee, and the condition of the muscles ensuring its active support. Therefore, the motive actions in the joint depend on the condition and strength of the indicated structures. With reference to this, one of the most severe and complex capsular-ligament injuries of the knee joint is the so-called “Unhappy Triad,” a combination of a rupture of the anterior cruciate ligament, the medial collateral ligament and the medial meniscus - “O’Donoghue’s Triad.”

In 1950, O’Donoghue draws the attention of the specialists towards the triad and recommends early surgical and rehabilitation intervention (FA, Barber,1992). Shelbourne and Nits, 1991, examine patients with compound injury to the anterior cruciate ligament and medial collateral ligament, who have undergone early rehabilitation of the anterior cruciate ligament. While reviewing thearthroscopic data from the rehabilitation surgery, the authors discover that the rupture of the ACL, with second degree injury to the medial collateral ligament is very often associated with injured lateral meniscus. Thus the name „Unhappy Triad“ – the compound injury to the ACL, medial collateral ligament and lateral meniscus. This serious injury is caused by highly dynamic and extreme valgus stress (contact without injury), or due to external forced rotation of the tibia in full extension of the knee joint, with the foot in a fixed position during both processes.

Methods

Hypothesis of the study
We assume that the inclusion of manual-soft tissue mobilization after the method of J. C. Terrier in the physiotherapy program of patients after the “O'Donoghue’s Triad”, during the moderately-protective period, will accelerate the recovery of the degree of movement of the knee joint.

Aim of the study
Examining the effectiveness of manual-soft tissue mobilization after the method of J. C. Terrier on the recovery of the joint mobility (active flexion) of patients’ knee joint after “O'Donoghue’s Triad.”

Tasks of the study
1. Determine the degree of joint mobility of the injured and the healthy knee of the patients prior to the physiotherapy treatment.
2. Examine the intensity of the healing process in the control and the experimental groups. The results that were obtained show that the average variation of the accumulated results, with the value of V=0.6% in the first study and increasing to 87, 3% during the procedures (during the second study).

Research methods
- Testing the condition and changes of the active flexion of the knee joint.
- Expert evaluation.
- Testing the effectiveness of two methods of kinesitherapy.
- Mathematical and statistical methods (variation analysis and an alternative method for testing hypotheses).

Organization of the study

Location of the study
The research was conducted at St. Sofia General Hospital in Sofia, Bulgaria.

Subjects
The research included 35 patients. All of the patients have signed a Statement of Informed Consent for participation in the research, which has been drafted in accordance with the ethical standards set forth in the Declaration of the World Medical Association in Helsinki in 1964, and revised in 2008. The research was conducted with the informed consent of the patients, which is documented by their signatures.

Description of the experiment
Tests were run on the active flexion of the patients' knee joint, which were followed by a ten-day traditional physiotherapy in the control group, whereas a manual-soft tissue mobilization by the method of J.C. Terrier (1996) was added as an element of the physiotherapy program in the experimental group. Tests were conducted in both groups after the completion of the course of physiotherapy.

Results
The empirical material collected from the first and the second tests of the control and the experimental group was subjected to careful statistical processing. Variation analysis was performed on the variations in the active flexion of the knee (in degrees) of the healthy and the injured leg - before and after the ten-day physiotherapy, with manual-soft tissue mobilization by the method of J. C. Terrier being added to the physiotherapy program in the experimental group.

In the control group
The results that were obtained show that the average variation in the active flexion of the injured and the healthy leg (in degrees) in the first test (which took place during the first day) of the control group was 39.3±5.98 degrees. It is reduced to 18.8±4.12 degrees as a result of the ten-day physiotherapy. In other words, the improvement of the active flexion of the injured knee is 20.5 degrees in absolute terms, and 52.1% - in relative terms. The values of the dispersion indicator are also very high, SD=23.93 in the first study and down to 16.48 degrees during the second (final) study. Table 1 shows that there is a high variation of the accumulated results, with the value of V=0.6% in the first study and increasing to 87, 3% during the procedures (during the second study). There is an increase in the individual variances of the indicator under investigation as the recovery process of the patients progresses. The representational error of the mean (m) of the knee’s active flexion in the control group during the first study is 5.98 degrees and remains relatively stable during the ten-day period of observation of the patients with values of 4.12 degrees.

In the experimental group
The results of the indicator in the experimental group show weaker starting values than those of the patients in the control group. The average variance of the active flexion of the knee in the healthy and the injured leg during the first day of the study was 47.21±4.003 degrees. Following pre-determined daily activities, which include traditional physiotherapy program and manual-soft tissue mobilization after the method of J. C. Terrier, the knee with a triad recovered its mobility by up to 8.47±2.708 degrees under the active flexion of the healthy leg. In absolute terms, the improvement is with 38.73 degrees, whereas its relative value is 82.05%. The results confirm the effectiveness of the manual-soft tissue mobilization, which requires that it should be an integral part of the physiotherapy programs of patients after a triad on...
the knee. In relation to the dispersion indicators, the results show $SD=17.45$ degrees in the first study, which decreases by 11.8 degrees as the procedures progress. On the other hand, the variability increases from $V_{m}=36.96$ in the first study to 139.3% in the final one. The tendency of increase of the individual variances in the recovery process of the knee is being observed in the control group as well. The representational error ($m_r$) is relatively low - 4.0 degrees prior to the beginning of the physiotherapy program in the experimental group and gets reduced to 2.7 degrees in the second study.

Table 1. Changes in the variations of the active flexion (in degrees) of patients' injured and healthy leg after “O'Donoghue's Triad”

<table>
<thead>
<tr>
<th>Variable (active flexion)</th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$X$ of the variance in the</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td>During</td>
<td>$X^m$</td>
</tr>
<tr>
<td>$X$</td>
<td>39.375</td>
<td>18.875</td>
</tr>
<tr>
<td>$SD$</td>
<td>23.936</td>
<td>16.48</td>
</tr>
<tr>
<td>$m_r$</td>
<td>5.984</td>
<td>4.11</td>
</tr>
<tr>
<td>$V_{m}$</td>
<td>60.789</td>
<td>87.31</td>
</tr>
<tr>
<td>$A$</td>
<td>0.184</td>
<td>1.012</td>
</tr>
<tr>
<td>$E$</td>
<td>0.816</td>
<td>1.016</td>
</tr>
</tbody>
</table>

Table 2. P-value according to Mann-Whitney

<table>
<thead>
<tr>
<th>Variable</th>
<th>$KG$-X1</th>
<th>$S1$</th>
<th>$EG$-X2</th>
<th>$S2$</th>
<th>$P$-value</th>
<th>$D = X_2 -$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st day</td>
<td>39.375</td>
<td>23.936</td>
<td>47.211</td>
<td>17.45</td>
<td>0.317</td>
<td>7.836</td>
</tr>
<tr>
<td>10th day</td>
<td>18.875</td>
<td>16.48</td>
<td>8.474</td>
<td>11.806</td>
<td>0.037</td>
<td>10.401</td>
</tr>
</tbody>
</table>

The low values of $m_r$ pre-determine little confidence interval of the average value in the general pool of patients with triad of the knee. The P-values show that prior to the physiotherapy treatment, the variance of the indicator in the control group and the experimental group are statistically insignificant. In the final study, however, they are significant and show that the experimental physiotherapy model by the method of J. C. Terrier is more effective for the recovery of patients’ knee after O'Donoghue's Triad.

Statistical significance of the variances
The Mann-Whitney null hypothesis criterion has been applied in order to establish the statistical significance of the variances in the active flexion of the injured and the healthy leg of the patients, with $A$ and $E$ having values outside the interval (-1, 1). Its margin of error is $\alpha = 0.05$.

Discussion and conclusion
The physiotherapy, which is applied with the aim of recovering the motor function of the knee, its active flexion, and the complete elimination of the limited mobility of the joints in cases of O'Donoghue's Triad", is directed towards neutralization of its hindering factors - such as reduced elasticity of the soft tissues, shortening and contractures of the corresponding to the injury muscles and capsular-ligament structures. In order to improve the joint mobility of the knee, the physiotherapist directs the attention towards the factors preventing the recovery process. This lies at the core of the choice of physiotherapy means like manual passive and active stretching, which is mechanical and positional, and its direction is opposite to the direction of the contraction. The muscle inhibition techniques with post isometric relaxation are very appropriate as well as the reciprocal inhibition and stretching. The efforts of the physiotherapist are focused on reducing the muscle tonicity and recovery of the muscle balance in the knee complex. An essential element in the physiotherapy applied in cases of O'Donoghue's Triad is the soft tissue mobilization. It is applied via direct manual impact on the contracted tissues, which improves the myo-articular laxity of the injured knee joint. In light of the study that was carried out and the accumulated results, we can conclude that:

a) The physiotherapy methodology, which includes manual-soft tissue mobilization after the method of Terrier, is effective in cases where we have O'Donoghue's Triad and significantly improves the knee joint mobility when compared to the traditional physiotherapy.

b) It is necessary to study and determine the reasons for the reduced degree of the joint mobility when developing the recovery program of patients as this will have impact on the choice of physiotherapy means.

c) The wide differences in the recovery process of the patients under observation indicate a marked individual intensity of the recovery, which requires differentiated approach towards the selection and prescription of the physiotherapy means.
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