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# The Effect of a Rehabilitation Program Using a TENS Device on Thigh Muscle Atrophy in Football Players with Anterior Cruciate Ligament (ACL) Tears After Surgical Intervention

**Sabhan Younis Sultan Mahdi Alhiali**
Sabhan.alhayali83@uomosul.edu.iq
College of Physical Education and Sport Science/ University of Mosul

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***Correspondence:***
Sabhan Younis Sultan Mahdi Alhiali
Sabhan.alhayali83@uomosul.edu.iq

**Abstract**
The study aimed to develop a rehabilitation program using the Transcutaneous Electrical Nerve Stimulation (TENS) device along with rehabilitation exercises for individuals with anterior cruciate ligament (ACL) tears following surgical intervention. The researcher used the experimental method with a one-group design involving pre-and post-tests. The study population was intentionally selected and consisted of five individuals with ACL tears who were undergoing treatment at the Mosul Centre for Rehabilitation and Physical Therapy in Mosul over six months. Scientific principles regarding exercise intensity were taken into consideration, and the statistical results were analyzed. The program was applied to the study sample, and exercises were consistently accompanied by the use of a muscle stimulation device.

The researcher reached the following conclusions:
The results showed statistically significant differences between the pre- and post-tests for the experimental group, in favor of the post-test results, indicating successful rehabilitation of ACL-injured individuals. There was a noticeable increase in the range of motion (ROM) of the knee joint, which had been limited due to the injury. Additionally, participants reported a decrease in pain levels, which suggests that the therapeutic exercises were effective.

The researcher recommends the use of the TENS device by physical therapy departments in sports medicine centers due to its effectiveness in improving the strength of muscles acting on the knee joint.

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# أثر برنامج تأهيلي باستخدام جهاز ( TENS) الضمور عضلات الفخذ لاعبي كرة القدم المصابين بقطع الرباط الصليبي الأمامي بعد التدخل الجراحي

**سبهان يونس سلطان مهدي الحيالي** كلية التربية البدنية وعلوم الرياضة / جامعة الموصل
*alhayali83@uomosul.edu.iq*

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**الملخص**

هدفت الدراسة الى اعداد برنامج تأهيلي باستخدام جهاز التحفيز الكهربائي (TENS) مع التمارين التأهيلية للمصابين بقطع الرباط الصليبي الامامي بعد التدخل الجراحي .استخدم الباحث المنهج التجريبي ذو المجموعة الواحدة ذات الاختبارين القبلي والبعدي ، وتم اختيار مجتمع البحث بالطريقة العمدية اذ تكونت العينة من (5) مصابين بقطع بالرباط الصليبي الامامي الذين يراجعون ( مركز الموصل التأهيل والعلاج الطبيعي) في الموصل ، لمدة (6 ) أشهر وتم مراعاة الاسس العلمية في درجات الشدد وتم معالجة النتائج الإحصائية وقد تم تطبيق على العينة البحث والتثبيت لاستخدام التمارين التأهيلية مرفق بجهاز التحفيز العضلات . **وتوصل الباحث الى استنتاجات الآتية:** أظهرت النتائج وجود فروق معنوية بين الاختبارات القلبية والبعدي للمجموعة التجريبية ولصالح الاختبارات البعدية لإفراد عينة البحث في تأهيل المصابين بإصابة الرباط الصليبي ، وكانت هنالك زيادة واضحة في المدى الحركي المفصل الركبة بعد تحدده جراء الاصابة ، كما انخفض الشعور درجة الألم لدى عينة البحث وهذا يدل على أن المصابين قد حققوا نتائج في التمارين العلاجية ، **ويوصي الباحث** استخدام جهاز التحفيز الكهربائي من قبل أقسام العلاج الطبيعي في المراكز الطب الرياضي لما لهما من فعالية في تحسين قوة العضلات العاملة على المفصل الركبة .

**الكلمات المفتاحية :** البرامج التأهيلية العضلات ، جهاز التحفيز الكهربائي **(TENS )** ، المدى الحركي، التمارين العلاجية.

## Introduction

In the field of sports, injuries are numerous and varied, differing from one sport to another. Due to the athlete's continuous participation in competitions, they are exposed to injuries of various types and degrees, whether in bones, joints, ligaments, or muscles. This can lead to the athlete being deprived of practicing sports for long periods, which may negatively affect their physical and skill levels. Appropriate rehabilitation following an injury is one of the main reasons for restoring the injured area to its full function, which consequently allows the athlete to return early to practicing their sport in good form (Abu Al-Ala, Ahmed 2003, 35).

Sports injuries are an obstacle that affects the musculoskeletal system, including bones. Joints. Muscles. Nerves, which cause a hindrance to the dynamic development of the athletic level and prevent continuity in training performance, friendly participation, and official competitions. Often, injuries occur suddenly, making it extremely difficult to predict their location and timing. This is a pathological condition (Ahmed Hassan, 4, 2013).

The knee joint is considered one of the most complex joints in the human body and is also one of the most prone to injury. Anterior cruciate ligament (ACL) injuries often require surgery using arthroscopy, which involves reconstructing the damaged ligament with a new ligament from the patient's own body or with an artificial ligament.Hassan Mohammed Al-Nawasra, 2009, 24).

The anterior cruciate ligament injury is one of the most common injuries to the knee and has a significant impact on the knee's functional performance during daily activities. As for treatment, surgical intervention using arthroscopy is considered one of the most suitable and widely used methods. Following that, the phase of physical rehabilitation and therapy is crucial for recovery after the surgical intervention, typically involving a rehabilitation program that lasts for six months and may extend up to a year. Arvidsson 131,124,2004).

The primary goal of rehabilitating the knee joint after surgical intervention is to restore the range of motion of the joint and the muscles, which include a group of thigh and calf muscles. The design of the rehabilitation program is based on strengthening those muscles. (Mu'taz Billah Hassanein, 1992, p. 20).

**Research problem**

After the follow-up, the researcher noticed that there are many injuries affecting athletes, leading some of them to permanently distance themselves from the fields. Additionally, there are few effective rehabilitation programs, and the use of the TENS device for rehabilitating knee joint injuries, particularly after surgery for anterior cruciate ligament tears, is rare. Therefore, the researcher deemed it necessary to address this issue by developing rehabilitation programs based on modern scientific principles in the field of knee joint rehabilitation following injury, using the TENS device alongside motor and rehabilitative exercises. Through the current study, the researcher

reviewed previous studies and research on this topic, revealing that there is little interest in research addressing the TENS device for treating atrophy of the thigh and calf muscles.

**Purpose:**

1. Identifying the impact of the rehabilitation program using the TENS device on thigh muscle atrophy in patients with anterior cruciate ligament tears after surgical intervention, aimed at improving the circumference of the thigh and calf muscles and the muscular strength of the flexor and extensor muscles in the knee joint.

2. Identifying the impact of the rehabilitation program using therapeutic exercises to improve the range of motion of the knee joint during movement (flexion - extension).
3. Identifying the impact of the rehabilitation program on improving the level of pain perception in patients with knee joint injuries.

**Hypothesis:**

1. There are statistically significant differences between the measurements (pre-test and post-test) in favor of the post-test measurement for the circumference of the thigh and calf muscles (muscle strength).
2. There are statistically significant differences between the measurements (pre-test and post-test) in favor of the post-test measurement and balance (range of motion).
3. There are statistically significant differences between the two measurements (pre-test and post-test) in favor of (the perception of pain level) around the knee joint.
4.

**Methods:**

The research community consisted of five players from the Rabia Football Club in Mosul who suffered from anterior cruciate ligament tears after undergoing surgery. They were selected through a deliberate method and rehabilitate. The researcher used the experimental method to suit the nature and

problem of the study. At the Adam Medical Consulting Complex in the Mosul Center for Rehabilitation and Physical Therapy.

The researcher presented the exercises prepared in the rehabilitation program to a group of specialists and experts in the fields of medicine, sports rehabilitation, physical therapy, and sports training, taking their feedback into account. The program included specific exercises in addition to the TENS stimulation device. The goal of the rehabilitation exercises is to strengthen the ligaments and tendons of the working muscles around the knee joint. The exercises were implemented in a progressive manner, with intensity levels increasing from the first week to the twenty-fourth week, according to the rehabilitation program. The initial intensity of the rehabilitation units varied based on the percentage of intensity in performing the exercises, which is measured as a percentage of the maximum strength of the healthy leg for each individual with an injury. The vocabulary of the main experiment has begun to be applied in the rehabilitation program for the experimental group of the research. For a duration of 24 weeks, with 3 rehabilitation sessions per week, which amounts to a total of 72 rehabilitation sessions for the injured. From a lying position on the ground, bend the uninjured knee and place a rolled-up pillow under the knee.

We contract the front thigh muscles and then push back towards the cushion towards the ground, holding steady. In the lying position, place a rolled towel or a small pillow under the joint of the injured knee, and the weight is tied above the ankle joint. The height of the pillow should be between 15 to 20 cm. We raise the injured leg 30-45 cm higher, hold it for 3 seconds, then slowly lower it back down and take a rest. In the side-lying position opposite the injured leg, bend the knee and place the foot behind the injured leg on the ground.

Strengthening the front and back thigh muscles using the muscle stimulation device for tennis, placing electrodes around the muscle with electrodes 2(A) and then electrodes 2(B) around the thigh muscle. Each electrode is placed on the front muscle and the second electrode on the back muscle for a duration of 10 minutes. Stimulation is applied before starting the exercises in each session. After the completion of the rehabilitation program prepared for the research sample, which consisted of (5) injured individuals, the post-tests were conducted. At exactly 4 PM at the Mosul Rehabilitation and Physical Therapy Clinic, in the same location and under the same conditions as the tests and procedures conducted by the researcher.

**Method of performance:**

The performance description involves the injured person lying on the medical bed with their legs elevated. A question is directed to the patient through visual measurement to determine the pain level on a scale from 0 to 10, identifying the highest and lowest degrees. The degree is determined after completing the examination and asking questions to the patient, who responds regarding their pain level (VAS) according to the prepared form for this purpose, providing a reference number for the severity of pain or its absence. (Cynthia C.) Norlina, 2009).

The device (goniometer), a medical bed for lying down, registration form for measurement description: The therapist stands next to the laboratory while the patient is lying on the medical bed. Then, we ask the injured person to bend the affected knee inward to the maximum degree, where the measurement is taken using the fixed arm and the movable arm, which indicates the range of motion of the joint. The measurement is recorded in a single attempt and is taken in angular degrees.

The researcher identified the midpoint of the patella and 8 inches above the patella.

The measurement point was determined on the femur, which is considered the area where muscle development occurs the most, and it is carried out.

The researcher wrapped the tape around the thigh muscles and recorded the measurement reading, and a point was determined.

The measurement (8 inches) comes after reviewing previous studies related to the use of this method for measurement. Circumference of the thigh. Mr. Ahmed Nasr El-Din, 2003, p. 65

**Statistical methods:**

The researcher used the statistics package for the mean and standard deviation to process the data statistically. The T-test was used to calculate the mean, and the T-test was used to assess the differences between the pre-test and post-test measurements for the single experimental group, where statistical comparisons were conducted.

| Statistical treatments The variables | The arithmetic mean. | The mediator. | Deviation | The coefficient of torsion |
|---|---|---|---|---|
| Age (in years) | 20.741 | 20.51 | 3.220 | 0.833 |
| Height (cm) | 168.081 | 173.001 | 30622 | 0.010 |
| Weight (kg) | 65.490 | 73.150 | 1.257 | 1.195 |

**Result:**

**Table number (1) shows the homogeneity of the research sample selected.**

**Presentation and discussion of the pre-test and post-test results, as shown in Table No. (2):**
**The arithmetic mean and standard deviations of the pre-tests and post-tests for the research group.**

| Research variables | Degree of measurement | The arithmetic mean | | Standard deviation | The calculated value. | Level of significance | The significance of differences. |
|---|---|---|---|---|---|---|---|
| Range of motion test for the knee joint in the (extension) position. | Before me | Degree | 163.6 | 1.304 | 2.213 | 0.02 | moral |
| | After me | Degree | 170.3 | 0.830 | | | |
| Range of motion test for the knee joint in the (flexion) position. | Before me | Degree | 121.2 | 1.321 | 19.212 | 0.000 | Spiritual |
| | After me | Degree | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | 133 | 1.532 | | | |
| Degree of pain | Before me | Scale | 6.657 | 0.809 | 12.543 | 0.02 | Spiritual |
| | After me | Scale | 2.830 | 0.705 | | | |
| For muscle strength. | Before me | Newton meter | 23.3 | 33.8 | 10.5 | 4.53 | The calculated value of t. quadriceps muscles |
| | After me | Newton meter | 27.3 | 38.1 | 10.8 | 5.32 | |

Discussion of the results:

By reviewing Table (2), we notice the significance of the differences in favor of the post-test for the research group regarding the range of motion, which has increased compared to the pre-test. This is attributed to the fact that the forced movement of the joint stimulates the muscles that move and support it, namely the semitendinosus, biceps,

semimembranosus, gracilis, and sartorius muscles during the flexion of the joint. As for... In the case of stretching, the muscles (rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius) are activated (Hassan Muhammad Al-Nawasra, 2009). These movements keep the muscles active, even though the positive movements are minimal; however, they send nerve signals for relaxation and contraction. These movements themselves are considered athletic actions that activate the muscle fibers, which is evident in the external appearance of the muscle, as confirmed by (Tariq Muhammad Sadiq, 2000, p. 116). "The rehabilitation program has a significant and positive impact on increasing the circumference of the thigh muscles in the affected limb, which means enhancing the strength of the muscle groups that contribute to improving the functional efficiency of the joint and bringing it as close as possible to its natural state .

**Findings and Discussion**

." The rehabilitation exercise program implemented by the researcher, which included all its exercises, has increased the elasticity of the muscles working on the knee joint, reflecting an improvement in the range of motion angles of the knee joint. As Hamill (2009, p. 185) confirms, "an increase in the range of motion means an improvement in the elasticity of the muscles and the ligaments surrounding the joint, as well as an enhancement in neuromuscular function in controlling the sensors responsible for providing sensory information to the brain about this range." Through discussing the results of the measurements of the knee joint angles, we can confirm the achievement of the research hypotheses and objectives. Flexibility is one of the most important aspects that a physical therapist should focus on improving, especially for the injured joint, as it plays a role in the healing process. It is noted that...(2019). Svensson, M., Lind, V. (It plays an active role in delaying the onset of fatigue and reducing the likelihood of muscle contraction, contributing to recovery, and alleviating muscle pain.) The researcher relied on the introduction of the TENS stimulation device, which improves muscle strength and helps restore the muscle to its previous state. The stimulation device increases the number of muscle fibers and reduces muscle atrophy after undergoing surgery on the cruciate ligament, thereby enhancing the patient's ability to walk afterward and speeding up recovery during therapy sessions. It also reduces pain levels, positively impacting the performance of the program and the emergence of results, as there is a clear decrease in pain levels among the sample individuals and an opportunity for recovery, allowing the injured part to return to a level of healing that enables work and the resumption of daily activities as they did before.

**Result:**

The therapeutic methods have achieved positive results in rehabilitating those with cruciate ligament injuries, showing a clear increase in the flexibility of the knee joint after being restricted due to the injury, as well as a decrease in the level of pain among the research sample. This indicates that the injured individuals have achieved results in therapeutic exercises and improvements in physical variables such as muscular strength and the range of motion of the knee joint.

**Discussion:**

It improves muscle strength and recovery to its previous state. The stimulation device increases the number of muscle fibers and reduces muscle

atrophy after undergoing surgery for the cruciate ligament, which enhances the patient's ability to walk afterward and speeds up recovery during therapy sessions. It also reduces the level of pain, positively impacting the program's performance and the appearance of results, as there is a noticeable decrease in pain levels among the sample individuals and an opportunity for healing, allowing the injured part to return to a level of recovery that enables work and the resumption of daily activities.

## Recommendations:

Depending on this study results, the researcher reached the following recommendations:

1. The researcher recommends ensuring the use of the therapeutic methods employed in the study. To prioritize and expedite the treatment and appropriate rehabilitation for the injured as quickly as possible after the onset of pain or the feeling of injury.

2. The use of exercises that are based on the principle of flexibility and mobility, which are generally recommended by doctors, is easy to apply at home and in the gym.

3. The club recommends paying attention to the training aspect of the knee's auxiliary muscles and strengthening them to avoid such injuries.

## Conclusion:

In the use of the stimulation device by the physical therapy departments at the specialized center for rehabilitating athletes with knee joint injuries, due to its effectiveness in improving the range of motion angles of the knee joint.

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