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ORIGINAL STUDIES

The effectiveness of postoperative kinetic physical therapy in patients suffering from anterior cruciate ligament injuries

Eficiența tratamentului fizicalkinetic postoperator al leziunilor ligamentului încrucișat anterior

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Abstract

Background. Anterior cruciate ligament tears are the most frequently encountered ligament injuries in the knee, particularly in practitioners of sports where sudden changes of direction, frequent stops and sprints or landings on the feet are involved.

Aims. The present study aims to demonstrate the effectiveness of kinetic physical therapy upon performing ligamentoplasty on patients with anterior cruciate ligament (ACL) tears.

Methods. Thirty patients were admitted into hospital upon being diagnosed with ACL tears. They were divided into two groups, as follows: group E (G.E.), consisting of 15 patients submitted to ligamentoplasty using the Soft Tissue method, which involves the harvest of semitendinosus and gracilis tendons; and group C (G.C.), consisting of 15 patients submitted to ligamentoplasty using the Jones method, which involves the harvest of patellar tendon. Both groups were given a standard exercise program, as well as complementary techniques adapted to each individual and a hydrogymnastics program to carry out in the swimming pool. The outcomes at the end of day 1 and day 180 of therapy alike were evaluated using the following assessment methods: the pain VAS (visual analogue scale), joint and muscle testing of the knee and the Tegner Lysholm knee scoring scale.

Results. There were no major differences between the two groups of patients on day 1 of therapy, either demographically or statistically. Out of the 15 patients in group E, 13 resided in the urban area and 2 in the rural area, whereas out of the 15 patients in group C, the ratio was 12 to 3. Upon assessment using the pain VAS, the percentages were 7.35% and 7.53% in patients treated using semitendinosus and gracilis tendon grafts and patients treated using patellar tendon grafts, respectively. Thus, no significant differences between the two groups were noted on day 1 of therapy. The Lysholm scores were 3.73% and 3.46% in patients in group E and group C, respectively.

After a period of 90 days, the pain VAS assessment showed an increased percentage in patients treated using patellar tendon grafts. A statistical assessment was also performed (p=0.0019). According to the end and intermediate values obtained upon joint testing, patients treated using semitendinosus tendon grafts tended to have increased mobility as compared to those treated using patellar tendon grafts. The Lysholm scores revealed no notable differences between the two groups of patients (p=0.54).

Conclusions. The kinetotherapy programs and the personalised complementary techniques proved highly effective in both groups of patients, regardless of the type of ligamentoplasty performed.

Key words: ACL tear, physical kinetic therapy, ligamentoplasty

Rezumat

Premize. Ruptura ligamentului încrucișat anterior este cea mai frecventă leziune ligamentară a genunchiului. Lezarea acestui ligament apare frecvent la cei care practică un sport, ce presupune schimbări rapide de direcție, opriri și alergări repetate sau aterizări din săritură.

Obiective. Studiul are ca scop demonstrarea eficienței tratamentului fizicalkinetic, la pacienții care au suferit ruptura de ligament încrucișat anterior (LIA), reconstruit prin ligamentoplastie.

Metode. 30 de pacienți internați cu diagnosticul de ruptură de LIA care au fost repartizați în două loturi: lot E (L.E) -15 pacienți care au fost supuși ligamentoplastiei prin metoda Soft tissue cu tendon din mușchiul semitendinos și garcilis și lot C (L.C) -15 pacienți prin metoda Keneth Jones cu tendon rotulian. Ambele loturi au urmat același program de exerciții și tehnici

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complementare adaptate pentru fiecare pacient în parte, cât și hidrogimnastică la bazin. Pentru obiectivarea rezultatelor terapeutice, atât în prima zi de tratament (ziua 1) cât și în ultima zi de tratament (ziua 180), s-au folosit următoarele metode de evaluare: scala analog vizuală a durerii – VAS, bilanțul articular al genunchiului, bilanțul muscular al genunchiului și scorul funțional Tegner Lysholm pentru genunchi.

Rezultate. In prima zi de tratament nu au existat diferențe majore între cele două loturi atât din punct de vedere demografic cât și statistic. Lotul E a fost compus din 15 pacienți, dintre care 13 din mediul urban și 2 din mediul rural, iar lotul C a fost compus tot din 15 pacienți, dintre care 12 din mediul urban și 3 din mediul rural. Pe scala analog vizuală a durerii în prima zi am obținut un procent de 7,35 la cei cu autografă din tendonul semitendinos ți garcilis, iar la cei cu autografă din tendonul rotulian am obținut un procent de 7,53. Astfel, în prima zi nu au existat diferențe semnificative între cele două loturi. Scorul Lysholm în prima zi a înregistrat un procent de 3,73 la cei din lotul E, iar la cei din lotul C un procent de 3,46.

Scorul scalei VAS arată un procent crescut la 90 de zile la pacienții cu autografă din tendonul rotulian. Scala analog vizuală a durerii raportată la cele două loturi a fost evaluată și din punct de vedere statistic, astfel am obținut o valoare a lui $p = 0,0019$. Valorile finale și intermediare ale bilanțului articular exprimă o diferență care înclină spre o mobilitate mai bună a pacienților cu autografă din semitendinos. Scorul Lysholm nu prezintă diferențe notabile între cele două loturi ($p = 0,54$).

Concluzii. Programul kinetoterapeutic și tehnicile complementare individualizate au demonstrat a avea un rezultat notabil la ambele loturi de pacienți, indiferent de metoda de reconstrucție a ligamentului.

Cuvinte cheie: ruptură LIA, tratament fizicalkinetic, ligamentoplastie.

Introduction

Anterior cruciate ligament (ACL) tears are more frequently encountered in patients aged over 30 as a result of decreased endurance of ligaments due to aging (Albu et al., 2010).

The anatomic structure of the knee, on the other hand, causes the incidence rate of ACL tears to be eight times higher in women than in men. By comparison to internal femoral rotation, internal tibial rotation was associated with a higher risk of ACL tear, particularly in female athletes (Carter et al., 2016). ACL tears are most frequently encountered among practitioners of sports where sudden changes of direction, stops, rapid flexion-extension alternations, sprints or landings on the feet are involved (Acevedo et al., 2014).

The surgical treatment of ACL tears includes harvesting of patellar tendon autografts, hamstring grafts, quadriceps tendon grafts, patellar tendon allografts (harvested from corpses), Achilles tendon grafts or semitendinosus, gracilis or posterior tibial tendon grafts, among others (Schindler, 2012).

Enabling an anatomical approach to restore optimal functionality of the joints, patellar tendon autografts provide the most commonly used solution for ACL reconstruction purposes worldwide (Chee et al., 2016).

90-95% of patients submitted to ACL reconstruction using patellar tendon grafts are able to resume their sporting activities at the end of the rehabilitation period. Patellar tendon autografts are made of tibial and patellar bone fragments and the middle third of patellar tendons (Predescu, 2013).

The semitendinosus tendon, located on the inner side of the knee, is also used for ACL reconstruction autografts (Antonescu et al., 2008), sometimes in association with the gracilis tendon. The gracilis tendon is located just below the knee, also on the inner side. According to users, there are a number of advantages to the use of semitendinosus tendon autografts as opposed to that of patellar tendon autografts, including smaller amounts of pain after surgery, smaller incisions or shorter rehabilitation periods (Setuain et al., 2016).

According to the latest studies, upon the occurrence of ACL tears, the disrupted biomechanics of the knee and forces acting on it may cause secondary injuries of the meniscus and cartilage located in the lateral compartment within a maximum period of five years. Therefore, full ACL tears require surgical treatment, particularly in active patients and athletes (Flosadottir et al., 2016).

Also, it has been demonstrated that ligamentoplasty lowers the risk of falling in patients suffering from ACL injuries by ensuring increased knee stability and mobility (Gokalp et al., 2016).

The rehabilitation program plays an essential role in the context of the majority of patients submitted to ligamentoplasty being young, active or even athletes. Thus, correlation between the orthopaedic surgical solutions and the rehabilitation solutions used enables a faster socio-professional integration of patients, while also enabling athletes to perform at competition level after shorter periods of time (Andriolo et al., 2015).

ACL injuries are among the most devastating and common injuries of the knee. At present, surgical reconstruction provides the standard treatment solution for patients suffering from ACL injuries (Kiapour &Murray, 2014).

Hypothesis

A complex knee joint rehabilitation program is required upon the execution of ligamentoplasty using either semitendinosus tendon autografts or patellar tendon autografts.

The present study aims to demonstrate the effectiveness of kinetic physical therapy upon performing ligamentoplasty in patients with anterior cruciate ligament (ACL) tears by comparing their preoperative and postoperative conditions throughout their treatment (from day 1 to day 180 of therapy).

Methods

The research was approved by The Ethics Committee of "Iuliu Haţieganu" University of Medicine and Pharmacy, Cluj-Napoca.

Research protocol

a) Time and place of research

The research was conducted on patients admitted to

hospital, diagnosed with ACL tears and treated using the Jones (bone-tendon-bone) method, which involves the harvest of patellar tendon, and the Soft Tissue method, which involves the harvest of semitendinosus and gracilis tendons, in the Rehabilitation Hospital in Cluj-Napoca, as well as in the Ambulatory Care Service for Athletes, between August 2015 and August 2016.

b) Subjects and groups of subjects

The research was conducted on a number of 30 subjects. They were divided into two groups, as follows: E group (EG), consisting of 15 patients submitted to ligamentoplasty using the Soft Tissue method, which involves the harvest of semitendinosus and gracilis tendons (9 men and 6 women; 13 residing in urban areas and 2 in rural areas); and C group (CG), consisting of 15 patients submitted to ligamentoplasty using the Jones method, which involves the harvest of patellar tendon (10 men and 5 women; 12 residing in urban areas and 3 in rural areas). The mean age range was 30-35 years.

The subjects were selected from a pool of patients aged 20 to 45 years, competing athletes and patients who had been previously submitted to surgical reconstruction after being diagnosed with an ACL tear. Potential subjects unable to carry out the rehabilitation program for whatever reasons or unwilling to cooperate were excluded (Table I).

c) Assessment methods

Clinical examination:

- Anamnesis
- Inspection and palpation of the affected area
- Full physical examination
- Ligament stability testing
- Active stability testing

Paraclinical examination & additional information to confirm the diagnosis:

- Radiological examination (anterior, posterior, lateral)
- MRI (magnetic resonance imaging)
- Arthroscopy or examination under anaesthesia

The pain VAS - a scale from 0 to 10 used to measure the intensity of perceived pain, where 0 is non-existent pain and 10 is a maximum, unbearable level of pain.

Joint testing of the knee - conducted using a hand-operated goniometer both actively and passively; active mobility relies on the subject's neuromotor function, thus threatening to alter their performance.

Muscle testing of the knee - conducted based on the rating system introduced by the National Foundation for Infantile Paralysis in 1940, which uses values ranging from 0 to 5 or percentages to measure muscle strength (Pop et al., 2016).

The Tegner Lysholm knee scoring scale - a scale using different ratings and scores to assess the following 8 distinct aspects: limping, use of aid equipment, joint blockage, instability, pain, tumefaction, stair climbing, execution of squats.

d) Statistical analysis

The statistical analysis focused on potential statistically significant differences between the mean scores registered before and after therapy. The data was collected and analysed using Microsoft Excel 2007. Group 1 was assessed using the Descriptive Statistics tool under Data

Table I

The rehabilitation program for patients submitted to surgical reconstruction after being diagnosed with an ACL tear

Exercises	Objectives	Description
A. Immediate postoperative phase - week 1	- to facilitate blood flow - to prevent pain and tumefaction - to prevent hypotrophy - to prevent and control hemarthrosis and hydrarthrosis	- dorsal decubitus position with knees semi-flexed fixed in the orthosis, ankles and feet exposed - antideclive position of the affected lower limb - dorsal decubitus position with ankle resting on a pad - kneecap mobilisation in all directions by physiotherapist - passive flexion at 30 degrees using kinetic apparatus
B. Maximum protection phase - weeks 2-8	- to maintain full extension - to achieve passive flexion at 100 degrees & active flexion at 70-80 degrees - to strengthen the hip muscles - to restore proprioceptive sensitivity	- movement of lower limb forwards and backwards from lateral decubitus position - 15 reps - abduction and adduction exercises in lateral decubitus position - 15 reps - riding a static ergonomic bike - lifting of lower limb at 40 degrees while leaning on elbows in lateral decubitus position, knee stretched & writing the alphabet using foot - 4 reps x 1 min
C. Moderate protection phase - weeks 9-12	- to improve the strength and endurance of the quadriceps muscle (90%) - to fully restore stability - to improve proprioceptive sensitivity - to improve the range of motion	- triple flexion in dorsal decubitus position, against resistance from physiotherapist - four-point kneeling position: pelvis to the heels and back - walking on treadmill at progressive speed - diagonal walking, side shuffles - hopping
D. Minimum protection phase - weeks 13-14	- to fully restore mobility - to achieve full rehabilitation of the quadriceps muscle - to re-enable performance at maximum effort levels - to enable squatting at 45-90 degrees - to facilitate professional reintegration into training	- sprinting over short distances with gradual increases in distance and speed - full lunges - squats, weights on shoulders - presses
E. Final rehabilitation phase - weeks 15-16	- to improve strength and prevent hypertrophy in muscles of the lower limb	- application of excitomotor currents - neuromuscular facilitation techniques - static contractions - isometric contractions at 50% of full capacity with knee in extension, against resistance

Analysis. The T test was applied to each scale to compare the mean scores for paired samples. The reference value was set at $p<0.05$. The results were expressed using bar charts.

The hydrogymnastics program for knee rehabilitation following ligamentoplasty

The hydrogymnastics program was carried out in a swimming pool filled up to shoulder height, with water heated at 35 degrees Celsius. The exercises were adjusted depending on each patient's condition. They included various types of water walking or orthostatic exercises against the rail, among others.

Walking exercises:

- On tiptoes, hands at the back of the head.
- On heels, hands at the back.
- Lunges, hands on the hip.
- Double step walking.
- High jump walking.

Exercises:

- Stance: Face to the rail, hands on the rail. Exercise: Rising on tiptoes.
- Stance: Face to the rail, hands on the rail. Exercise: Pawing.
- Stance: Right shoulder against the rail, right hand on the rail. Exercise: Abduction and adduction movements.
- Stance: Initial stance, back to the wall, hanging by the rail. Exercise: Scissor exercises, forwards, knees in extension.
- Stance: Initial stance, back to the wall, hanging by the rail. Exercise: Pedalling.

Results

The results are shown in Figures 1-4.

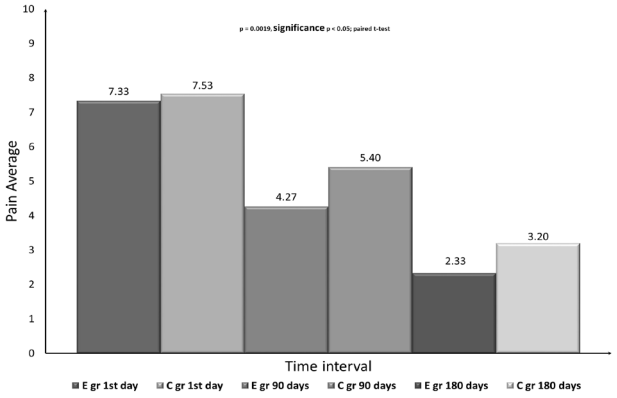

Fig. 1 – VAS pain assessment in patients in groups E and C

During the first few days, the assessment of VAS for pain showed an increasing percentage in both groups due to knee injury. On reassessment at the end of the study, pain intensity decreased. The difference between the two groups was due to local trauma from grafting. About 10-12% of patients with patellar tendon allograft experienced pain in the anterior compartment of the knee.

The results of the range of motion evaluation showed that reconstruction of the ligament with patellar tendon autograft tends to weaken the knee extensor mechanism and thus, recovery is more difficult.

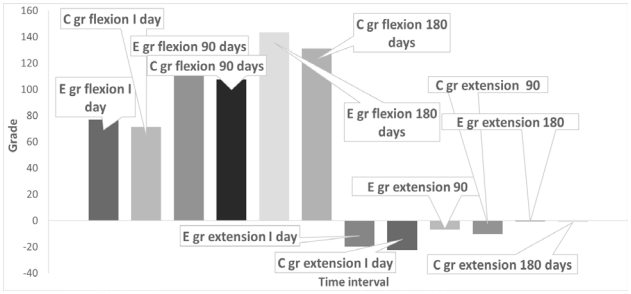

Fig. 2 – Joint testing of the knee in patients in groups E and C.

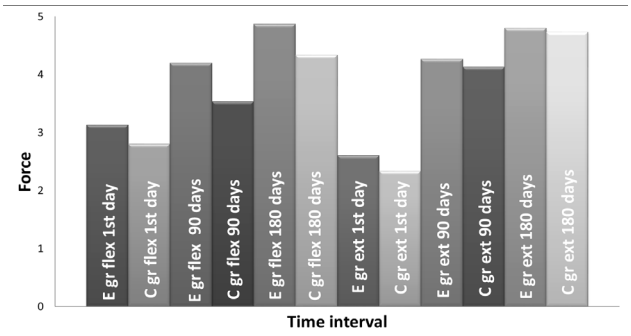

Fig. 3 – Muscle testing of the knee in patients in groups E and C.

The patients who underwent a semitendinosus tendon allograft had the highest muscular testing score due to lower levels of pain and sex differences.

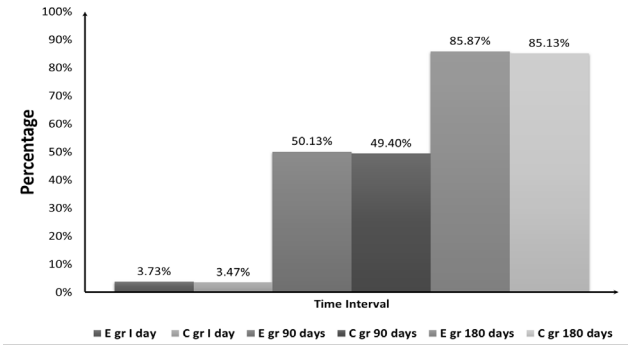

Fig. 4 – Tegner Lysholm knee scoring in patients in groups E and C

The evaluation of the Lysholm Score – 7 criteria showed a low score in the first days, which represents a limitation of social activities. This result highlights the recovery of patients in both groups, which eventually reached a score of 85%, representing a satisfactory recovery.

Discussions

The study contradicts the hypotheses formulated in the literature, according to which women are more susceptible to presenting with ACL tears than men due to their anatomical structure, by revealing a 70% higher incidence rate in men.

Scientific studies have shown that surgical reconstruction does not ensure optimal muscle functionality; reduced muscle functionality causes the development of

Table II
Comparative data on the effectiveness of kinetic physical therapy in patients in groups E and C.

Parameters	Group E			Group C			p* (group E vs group C) Significance p<0.05; paired t-test
	Day 1	Day 90	Day 180	Day 1	Day 90	Day 180	
Pain VAS (0-10)	7.33	4.47	2.33	7.53	5.40	3.2	p=0.0019
Joint testing	77.6	Flexion 111.86	143.6	71.33	Flexion 107.6	131	p=0.04 (flexion on day180)
	-19.87	Extension -6.87	-0.67	-22.47	Extension -10.33	-1.13	
Muscle testing	3.13	Flexion 4.2	4.86	2.8	Flexion 3.53	4.33	p=0.009 (flexion on day 180)
	2.6	Extension 4.26	4.8	2.33	Extension 4.13	4.73	p=0.33 (extension on day 180)
Tegner Lysholm score	3.73	50.13	85.86	3.46	48.73	85.13	p=0.54

gonarthrosis (Ageberg et al., 2008).

Basketball and football stand out as the top most physically demanding sports due to the frequent changes of direction and complexity of lower limb movements involved. They are contact sports that require frequent pivoting and changes of direction in association with a varied range of jumps, spins and strains on the knee.

After 90 days of therapy, the VAS pain assessment revealed a higher level of pain in patients with patellar tendon autografts, which play an important role in improving stability and thus are exposed to stress during the entire treatment period. The results obtained by VAS pain testing were also analysed from a statistical point of view, the average value being calculated at p=0/0019 (p<0.05) (Fig. 1).

The end and intermediate values obtained by joint testing suggest a higher level of mobility in patients with semitendinosus tendon grafts, as reflected by reduced pain at the back of the kneecap and stiffness following surgery (Fig. 2).

However, the results obtained by muscle testing did not indicate any significant differences between the two groups of patients, mainly due to gender related reasons (Fig. 3).

Lysholm scores also indicated no significant differences between the two groups of patients and therefore, similar socio-professional reintegration indices (Fig. 4).

The outcomes of the present research confirm the possibility for timely rehabilitation and socio-professional reintegration of patients following ligamentoplasty (Groot, 2017).

Lysholm scores were also analysed from a statistical point of view, the mean score being calculated at p=0.54, which confirms the differences between the two groups of patients as statistically insignificant (Table II).

Conclusions

1. Within the study, the incidence of ACL tears was higher in men as main subjects of intense physical activity and practitioners of extreme sports, as well as high-risk competitive sports. The same approach served as a basis for the treatment protocol designed to be applied to both male and female patients for a period of up to six weeks.

2. Specialised monitoring of the patients was carried out over the treatment period to assess their progress and prevent monotony or a potential lack of concentration. Most of the exercises included in the treatment program can be executed individually, without specialised monitoring being required. I believe that significant outcomes can be achieved under close monitoring by qualified members of staff, who can make adjustments to the treatment plan if necessary.

3. The kinetic physical therapy program and the personalised complementary techniques proved effective in both groups of patients, irrespective of the type of ligamentoplasty performed.

4. Unlike other studies focusing on the differences between the two ACL reconstruction methods, the present study indicated similar outcomes in both patients treated using semintendinosus and gracilis tendon autografts and those treated using patellar tendon grafts, slightly more favourable in the former group of patients.

Conflicts of interest

Nothing to declare

Acknowledgments

The present paper is based on the outcomes discussed in the first author's final thesis, which was presented at "Iuliu Haţieganu" University of Medicine and Pharmacy, Cluj-Napoca.

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