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CONSERVATIVE TREATMENT FOR PARTIAL RUPTURE OF POSTERIOR CRUCIATE LIGAMENT-CASE STUDY

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Abstract

High grade tear of the posterior cruciate ligament (PCL) is a serious condition in performance sport that requires first-line conservative treatment based on specialized rehabilitation. The study in question is a case report that analyzed the effects of conservative treatment for partial PCL tear in a 21-year-old performance handball player. The recovery plan consisted of kinesiotherapeutic exercises, hydrokinetotherapy and exercises in the fitness room, which were staged and dosed according to the athlete's potential.The measurements and scales used during the recovery confirmed the effectiveness of the recovery plan applied and the athlete returned to the field after 3 months of rest. The athlete's low degree of posterior translation and high muscle tone contributed significantly to his quick return to the field. This study indicates the need for a conservative protocol to optimize recovery time and reduce the risk of recurrence of partial PCL tear.

Introduction

The need for spectacularity increased the dynamics of the handball game and the toughness of this sport. In addition to these, aspects such as the overexertion imposed by achieving competitive goals, the lack of recovery time due to the busy competitive calendar, the athlete's lack of dicipline and his disordered schedule can also be considered as causes of these injuries.

Isolated rupture of the posterior cruciate ligament is one of the rarest injuries of the knee ligament system, with a low incidence[1], [2].

According to the authors, the most common mechanism of trauma to the posterior cruciate ligament are due to direct blows to the flexed knee and is specific to traffic accidents and sports injuries [3], [4], [5].

This trauma is also common in contact sports or in those with very high dynamics that involve technical elements resulting in direct falls on the front of the knee, with the ankle in plantar flexion [6], as in the case of our athlete.

The specialized literature reports good subjective results in the case of conservative treatment after PCL injury, the efficiency of recovery is a result of the degree of ligament injury and recovery management, however knee arthrosis would be a secondary consequence of this treatment[7].

Based on the results of a study from 2023, we find that posterior cruciate ligament reconstruction within 3 weeks of injury is more favorable for knee joint recovery. Since the posterior cruciate ligament plays an important role in the stability of the joint, it's rupture will affect this stability, thus accelerating the deterioration of the meniscus and articular cartilage. Through surgery, authors Jin Xiaoyun and Xu Yuping state that the quality of life of patients can be improved, thus being a safe procedure [8].

Surgical treatment is recommended for isolated PCL ligament tears, due to stronger grafts, safer fixation methods, rehabilitation programs that promote early Range Of Motion (ROM), and recent advances in surgery [9]. Surgical treatment is indicated when tibial translation is >12 mm or when other ligamentous and meniscal tears are associated[10]. In the case of PCL reconstruction with artificial graft, satisfactory long-term results have been reported, as being a valid alternative [11].

Conservative treatment is indicated if the ligament injury is grade 1 or 2 with a tibial translation between 8-12 mm, or grade 3 with mild symptoms and the need to integrate activity with minimal stress [10]. Conservative rehabilitation includes physical therapy divided into stages. In the first stage, lying down exercises are recommended, at 90° flexion for the first two weeks and avoiding translation of the tibia. The goals focused on the strengthening on the extensor mechanism of the knee and progressive weight bearing. The second stage lasts 4-6 weeks and emphasizes full ROM and muscle-strengthening exercises. In the following stages, progressive loading exercises are recommended, which aim to regain strength, endurance and agility [12].

A conservative protocol applied to patients with grade 1 and 2 tears suggests the use of a mobile orthosis between 0° and 60° flexion for the first 4 weeks, and exercises focused on stretching the hamstrings and gastrocnemius, respectively strengthening the quadriceps. Phase II lasted 12 weeks and allowed full weight bearing, performing closed kinematic chain exercises and proprioceptive exercises. The last phase which includes the 5th and 6th months had the purpose of: re-introducing the patient back into thier sports discipline through proprioceptive exercises and techniques specific to the practiced sport. Athletes with initial laxity >10 mm required PCL reconstruction after failure of conservative treatment [13].

The aim of this study is to comprehensively present the conservative treatment of high-grade rupture of the posterior cruciate ligament, in the case of an

athlete, a performance handball player, who occupies the pivot position in the field. Although we cannot consider our intervention to serve as a recovery protocol for posterior cruciate ligament injuries, we aim to contribute to the scientific community regarding the techniques and methods of physical therapy that can be used in the recovery of this injury and how to stage the recovery program based on specific goals.

Material-method

This paper is a case study, conducted over 3 months, in which we aimed to analyze the effects of the conservative approach, throughout the recovery period, of posterior cruciate ligament rupture.

From the medical history we were able to learn the following about the athlete: age 21 years, weight 115 kg, height 205 cm, right upper limb being the dominant one, occupying the pivot position in the team, the trauma being located at the left knee level. At the same time, the athlete presents genu valgum of 10° bilateral, of physiological nature.

The mechanism of rupture was direct, through contact between the knee and the surface of the handball court. The injury occurred during an official handball match when the athlete received the ball in attack, having the opportunity to throw at the goal, he jumped, was unbalanced by the opponent, and upon landing he fell with the knee in 90° flexion, this increasing under the weight of his own body. The contact surface of the lower limb with the ground was manifested by the anterior surface of the calf, the ankle being in plantar flexion.

Following the trauma, the athlete underwent an MRI scan that established an irregular and interrupted appearance in the medial third of the PCL, being diagnosed with a high-grade ligament tear. Following the consultation of the orthopedic doctor and the team of physiotherapists, it was decided to have a 3-month period of rest from sports and to initiate specialized recovery as soon as possible. Conservative treatment consisted of: the PRICE method, physiotherapy, hydrokinetotherapy and strength exercises performed in the gym.

It is important to note that following medical investigations, the athlete in question was diagnosed with grade II degeneration of the lateral meniscus, gonarthrosis changes in the lateral compartment, and hydrarthrosis.

The evolution of the treatment was monitored using scales and measurements, performed comparatively at the level of both lower limbs, these being applied at the beginning, middle and end of the recovery program. The scales used were VAS (Visual Analog Scale) to assess the pain parameter, QoL (Quality of Life) to assess the patient's quality of life and the KOOS (Knee injury and Osteoarthritis Outcome Score) and TegnerLysholm scales to assess the functionality of the knee [14], [15], [16], [17]. To measure the joint balance we used the goniometric method,

the perimeters were measured with a metric tape, and to assess the muscle strength the MRC scale was used [18].

The initial and final results were compared to quantify the athlete's progress during the recovery period. The reference value represents the measurements taken on the healthy lower limb to monitor functional differences and muscle parameters that need to be balanced.

Hypotheses:

- the implementation of conservative treatment in the case of partial rupture of the posterior cruciate ligament produces satisfactory functional results;
- fast integration of the athlete into an individualized recovery plan contributes significantly to the recovery of the posterior cruciate ligament injury and to the reduction of the return time to the field;
- recovery techniques such as: physiotherapy, hydrokinetotherapy, the PRICE method have a positive influence in the conservative treatment of this injury.

Table 1. Recovery plan

OPERATIONAOBJECTIVES:	OBSERVATIONS
Stage 1 (Week 1) Immobilization period. OBJECTIVES: -Reduce pain and inflammation; -Preserve function; -Promote healing of injured tissues;	Following clinical analysis and paraclinical tests, the medical team established a one-week rest period to promote consolidation of the injured ligament. To support consolidation, a mobile orthosis was applied to maintain knee stability, and the patient was transferred using a subaxillary cane. The indications from the medical team were as follows: -avoid knee flexion above 90 degrees to reduce posterior tibial translation; -use of a mobile orthosis and decrease pressure on the knee; -reduce pain and inflammation by administering local and oral anti-inflammatories; -initiating conservative treatment as soon as possible; To reduce pain and inflammation, the PRICE technique was chosen, which involved: protection, rest, cryotherapy, compression, and elevation of the lower limb. The physiotherapy exercises targeted the healthy limb but also the other joints that were not traumatized. Exercises such as: -active mobilizations of the ankles in all planes; -isometric contractions of the anterior thigh chain (quadriceps complex); -passive mobilizations of the affected knee up to a maximum of 90 degrees of flexion, to prevent fibrosis of the joint capsule and to maintain joint mobility; -active free and resistance exercises on the healthy lower limb using elastic bands (Thera-Band); -upper body exercises to prevent physical deconditioning. The athlete received instructions on how to use the orthopedic cane while walking, how to use cryotherapy, a balanced lifestyle and the absolute contraindications of this stage, such as: avoiding knee flexion above 90 degrees, avoiding posterior tibial translation.

Stage 2 (Weeks 2-3) Recovery of joint mobility. OBJECTIVES: -Increase joint range of motion; -Control pain and inflammation -Combat muscle atrophy; -Prevention of complications.	At this stage, the mobile orthosis was abandoned, and new mobility exercises were implemented at the level of the injured knee. In order to favor the adaptation of the newly formed collagen fibers, active exercises were added that stimulate the hamstring complex without causing ligament laxity. At the same time, emphasis was placed on strengthening the quadriceps as a complementary means of stability, taking over part of the load initially borne by the PCL. The exercises used had as main objectives the progressive achievement of knee flexion and quadriceps strengthening, being performed mainly from supine position. The key exercises performed in this stage were: -active exercises with ankle resistance on all anatomical planes; -from supine position, triple flexion was performed on the lower limbs to the limit of pain, initially obtaining 90 degrees of flexion at the knees, progressing towards the final phase with increasing mobility; -from supine position, isotonic extension exercises were performed at the knees with action on the extensor mechanism; -combined isotonic, isometric exercises, which targeted the anterior thigh chain, performed from supine position such as: triple flexion with isometric return at the quadriceps, maintained for 5-7 seconds; -from orthostatism, calf flexion on the thigh was performed, using gravity to minimize posterior translation; - towards the end of week 4, the exercises were also performed from the supine position, but as an element of progression, resistance against gravity was opted for, the exercises being performed without contact of the lower limbs with the ground. -resistance exercises were an integral part of the next stage that promotes the complete achievement of ROM and the increase in muscle strength.
Stage 3 (Weeks 4-7) Muscle Strength Management OBJECTIVES: -Increase muscle strength -Improve coordination; -Improve dynamic stability; -Prevention of complications;	Stage 3 lasted approximately 4 weeks, 3 training sessions were performed, which included: initial physiotherapy exercises combined with hydrokinetiotherapy, and towards the end, the athlete began closed kinematic chain exercises performed in the fitness room. The physiotherapy exercises were continued from the previous stage and adapted according to the new potential obtained by the athlete, through the opposing resistance from the therapist, the elastic bands, but also the exercises performed with one's own weight. Some of the exercises used were: -from supine position, triple flexion of the lower limb is performed with resistance, the elastic band fixed to the dorsal surface of the foot; -from prone position, knee flexion is performed with resistance, the elastic band fixed to the ankle; -from sitting, with the knee extended, the ankle in dorsal flexion, adduction and abduction are performed with resistance, the elastic band fixed to the foot. In this stage, the squat exercises were integrated, initially starting from 90 degrees of flexion increasing towards maximum mobility towards the end of the stage. Hydrokinetotherapy was introduced from this stage and was composed of types of walking, maximizing mobility, with a muscular stimulus evenly distributed on the joints and muscles involved in movement. The exercises performed in the pool were the following: -biomechanics of walking divided into its phases; -walking with ankle play; -walking with knees to the chest; -walking with the calf swinging back;

	-walking with added step; -cross walk; -lunge walk; -walking backwards; -walking with the knee extended; -walking on tip toes (controlled ankle extension); Each distance of the pool was covered with a different type of walk, and the return to the start was done by walking normally. The intensity of the execution increased by 10% with each series. The training in the fitness room aimed at the uniform development of the lower body muscles, being adapted according to the biomechanical requirements of the sport practiced. Knee flexions to the block were avoided, in a closed kinematic chain, in order not to overload the ligament that is being consolidated and, respectively, in order not to cause the posterior translation of the tibia that would determine a high joint laxity. The exercises were performed progressively, without pain, in 3 series of 14-16 repetitions each, remembering the following: -bicycle 5-7 min moderate speed -Bulgarian lunges -Romanian deadlifts -knee extensions to the block for quadriceps -free squats, subsequently with progressive loading; - calf raises on the machine/calf raises under the smith bar The athlete performed 3 fitness workouts per week combining isotonic exercises with passive stretching and massage to facilitate recovery after exercise.
Stage 4 (Weeks 8-12) Socio-professional reintegration OBJECTIVES: -Maximizing muscle strength; -Increasing proprioception; -Preventing relapse; -Readaptation and training for exertion;	In the first week of stage 4, walking and running exercises were introduced, which aimed to improve coordination and balance, exercises on the BOSU ball, agility exercises performed on the agility ladder. Furthermore, we used proprioceptive exercises to improve the perception of the body in space, providing the athlete with a higher degree of confidence as a result of the direct action on the prevention of traumatic relapses. The exercises in the fitness room were continued from the previous stage, progressing towards a higher neuromuscular stimulus, which ensured the maximization of muscle strength and tone. During the recovery in the water, we introduced exercises from the running school, plyometric exercises that were later transferred to the physiotherapy room. The plyometric exercises respected the principle of progressivity and regression, being composed of: -simple jumps in place; -jumps on one leg; -changes of direction followed by jumps; -jumps on the stepper; In the end, we opted for circuit-type exercises that combine: changes of direction, accelerations, decelerations, plyometrics, pivots and throws at the goal to readapt the athlete to the effort To significantly reduce the occurrence of relapse, the athlete performed jumps from the edge of the semicircle and landing exercises on a mat, respectively on the leg in recovery, to form defense automatisms and to increase his confidence.

Results

As mentioned in the Material and Methods chapter, the results obtained from the scales and measurement methods used are presented in table form, the initial ones were performed in the first week after the injury, and the final ones at the end of the recovery program.

The testing was performed on both lower limbs, thus allowing the results obtained to be compared.

Table 2. Initial and final measurements

Measurments		Initial value	Final value	Reference value (healthy limb)
Joint balance-Flexion		115 º	140º	140 º
Knee flexum		5º	0º	0º
Thigh perimeter		57 cm	59 cm	58 cm
Calf perimeter		42 cm	43 cm	42 cm
Knee perimeter		43,5 cm	43 cm	43 cm
MRC-Flexion		F4	F5	F5
MRC-Extension		F4+	F5	F5
VAS scale		7	1	0
QOL scale		88	98	112
TEGNER LYSHOLM scale		70	94	100
KOOS scale	Symptoms. Stiffness (ankylosis)	43	89	100
	Pain	56	86	100
	Daily activity	49	93	100
	Sports and recreational activities	20	90	100
	Quality of life	38	93	100

Table 2 shows the measurements taken at the beginning and end of the rehabilitation program, as well as the results of the applied scales.

Knee joint mobility is shown in Table 2. Initial measurements recorded reduced mobility in flexion of the affected limb, due to pain limitation. In the case of extension, on the injured limb, we measured a flexion of 5°. The final results show a significant improvement in flexion, reaching the same value as in the healthy limb. In extension, flexion was reduced, the final value being 0°.

The analysis of the muscle balance on the flexion movement shows us, following the initial assessment, a loss of muscle strength up to F3, which will be regained to the maximum value, at the end of the recovery program. Regarding the extension movement, the loss of muscle strength was very slightly lower than the final value.

Also in Table 2 are represented the perimeters measured at the level of the thighs, calves, and knees. To measure them, a tape measure was used, positioned at the following points: 15 cm up from the upper edge of the patella for the thigh, 15 cm down from the tip of the patella for the calf and right at the knee joint. Due to the immobilization performed at the beginning of the recovery program, muscle tone decreased. The initial value of the knee perimeter was 0.5° higher than the final value due to the inflammation present in the respective area. By analyzing the final values compared to the reference ones, we can observe the increase in muscle tone at the level of the affected lower limb, thus reaching normal values.

Table 2 presents the values recorded by the scales used in the athlete's evaluation. With their help, significant improvements can be observed following the recovery program.

Knee function was assessed using the KOOS and TegnerLysholm scales. The KOOS scale is divided into several sections, allowing for the analysis of several characteristics such as: symptoms and stiffness, pain, sports and recreational activities, and quality of life. After analyzing the data obtained, we can observe a significant increase in the results, with the final values being much closer to the reference values, compared to the initial ones, less so in the case of the quality of life parameter. The results of the TegnerLysholm scale had an obvious increase, starting from the "satisfactory" score and reaching the "excellent" score.

The QoL scale (quality of life) did not have major differences between the initial and final values, the athlete's daily activities not being greatly affected by the trauma suffered.

The VAS (Visual Analog Scale) scale monitored the pain parameter throughout the recovery program and if the score recorded at the initial assessment was 7 in intensity, at the final assessment it decreased to 1.

Discussions

The conservative treatment in the case of partial rupture of the posterior cruciate ligament in the athlete in question was a real success, according to the measurements and scales used initially and finally. Socio-professional reinsertion was achieved after approximately 3 months, being the consequence of a minimal posterior translation and a staged and individualized recovery plan according to the requirements of the sport practiced but also dosed according to the potential presented by the athlete.

Although the clinical examination reported a high degree of ligament rupture, combined with post-traumatic osteoarthritis, the athlete had low posterior tibial translation, tested manually using the posterior drawer test, which contributed to his rapid return to the field. This apparent stability may be due to high muscle tone, low local edema, and the other stabilizing structures of the knee that were not affected.

The first recovery phase provided the substrate necessary for the production of type III collagen fibers, acting through rest, passive mobilizations to stimulate the synovial fluid and to maintain mobility at the joint level. Due to its posterior insertion, its oblique positioning and its function of limiting posterior translation, the posterior cruciate ligament is easily activated in daily activities such as: walking, climbing stairs, activities with knees flexed above 90 degrees [19]. This fact required additional protection of the ligament by using a mobile orthosis locked up to 90 degrees of flexion and the use of an orthopedic cane. A key point of this phase is the rest period combined with early strengthening of the quadriceps to limit muscle atrophy, ensuring long-term knee stability[20]. The presence of pain and inflammation signaled the beginning of the inflammatory period, being modulated by cryotherapy and the PRICE method, which induced the desired effect[21].

The second stage of recovery continued with protecting the injured ligament, by avoiding resistance exercises that required the hamstring complex, with an emphasis on increasing joint mobility. The exercises mainly targeted the anterior thigh chain, being performed predominantly from the supine position to promote stability. The orthosis and the orthopedic cane were abandoned, moving towards gait re-education and avoiding activities that could require the knee. The key points of this stage were the mobility exercises used, active resistance mobilizations for the quadriceps and the avoidance of posterior translation, which induced satisfactory results at the end of this stage.

The third recovery stage was based on increasing muscle strength, using, as mentioned in table 1, 3 different trainings. The exercises performed within the hydrokinetotherapy reduced joint stress due to the buoyancy force, improving joint mobility but also muscle strength in all lower compartments. In addition to these benefits, we trained proprioception and balance, acting positively on the athlete's psyche. The training in the physiotherapy room was mainly performed with the opposing resistance of the body weight and with the help of Thera-Band, combining elements of strength while increasing mobility. The training in the fitness room

aimed to improve the strength potential at the lower level, initially protecting the block flexion exercises to avoid excessive stress on the PCL. However, we initially opted for exercises such as: Romanian deadlifts, which stimulate the hamstring complex concentrically and eccentrically, promoting stability and progressive loading. The selected exercises had the role of uniformly developing muscle strength in the lower limbs, working progressively with weights that reached 60% of 1RM. Initially, we avoided explosive movements, but emphasized the mind-muscle connection and movement control. Towards the end of this phase, the pool exercises were transferred to the physiotherapy room and the exercises in the fitness room were maximized to contribute to the remodeling phase of the ligament and the organization of type I collagen fibers. According to the literature, this process of remodeling and maturation of the newly formed ligament takes months to years[22].

The last stage of recovery introduced the athlete to the training circuit of skills such as: coordination, speed, agility. Static exercises were transformed into dynamic exercises by transferring motor control and strength to ensure the necessary framework for the athlete's safe return to the field. Plyometric exercises improved neuromuscular coordination, increased explosive strength, actively participating in the re-adaptation to the practiced sport, which involves a majority of actions completed by jumping. Moreover, the exercises performed in the form of a motor route combined sprint elements with changes of direction, pivots, balance and throws at the goal to re-adapt to training. Although we also performed prevention exercises such as: landings on the semicircle that resembled the mechanism of injury (being adapted to minimize the recurrence of the injury), we cannot truly support a decrease in the occurrence of relapse, being a trauma produced by direct contact. However, a genetic predisposition to non-contact cruciate ligament rupture has been observed, which may be investigated in future studies[23], [24].

The final results presented in the previous section show a positive functional trend through decreased pain, increased quality of life and increased physical performance. The perimeters evaluated initially and at the end show similar muscle tone, which may indicate a restoration of strength on the affected limb. However, we must consider the need for a dynamometric test to accurately establish the differences in strength on the hamstring and quadriceps on both lower limbs, which was not achieved in the present study[25].

The scales used to monitor the patient's progress are tested and validated by the scientific community, these tools are indispensable for the recovery team because they can be repeated as often as the situation requires and give an overview of the athlete's condition. The initial assessment reported a functional deficit on the injured limb with a high degree of pain and a slightly altered quality of life of the athlete according to table 2. Following the application of the conservative treatment, the pain was significantly reduced, the quality of life was improved, and the specific

KOOS scale for the assessment of symptoms and function recorded satisfactory scores.

This case study may raise hypotheses regarding the recovery times of partial posterior cruciate ligament ruptures in competitive athletes, requiring a detailed analysis of all factors involved in recovery, depending on the particularities of each trauma. The small number of studies in the specialized literature regarding the conservative treatment of this pathology limits the application of a universally valid recovery protocol and diminishes the number of meta-analyses on this topic, having a negative impact on a gold standard.

Conclusions

Conservative management of high-grade posterior cruciate ligament injury has very good functional results only if the applied physiotherapy program is individualized and the athlete is included early in the recovery program.

The physiotherapy program has demonstrated effectiveness in increasing the athlete's functional parameters due to its staging, thus contributing to reducing the time needed to return to the field.

The application of recovery techniques such as the PRICE method, physiotherapy and hydrokinetotherapy had a positive influence on the improvement of inflammatory symptoms, the increase in joint amplitude and the regaining of muscle strength.

Following this study, we conclude that the existence of a posterior cruciate ligament injury recovery protocol is increasingly necessary, the program developed by us demonstrating that it has beneficial effects both on the previously mentioned parameters and on the increase in the quality of life.

In conclusion, due to the conservative techniques applied in the case of the athlete with a partial injury of the posterior cruciate ligament, his return to sports activity occurred in a relatively short time, but it is necessary to mention that in addition to our contribution, the subject should not neglect the recommended prevention program.

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