Original papers

Medical Ultrasonography
2009, Vol. 11, no. 4, 13-16

The ultrasonographic evaluation of the posterior cruciate ligament length before and after training in patients with posterior knee instability – preliminary report

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Abstract

Summary: The posterior cruciate ligament (PCL) has an important role in stabilization and kinematics of knee. **The aim** of this study is to evaluate by ultrasonography the changes in length of the PCL during the rehabilitation programs in patients with posterior instable knees treated conservatively. **Material and method:** Ultrasonographic examination was performed in 16 patients with unilateral posterior knee instability treated by conservative therapy. The length of the PCL was measured. The control group was represented by the normal contralateral knee (group A). The patients were evaluated before starting the treatment (group B), after a month (group C), and after 6 months (group D) of rehabilitation therapy. **Results:** The average length of the PCL was 39.87± 6.1 mm in group A, 46.8±7.9 mm in group B, 43.9± 7.5 mm in group C, and 40.36±6.2 mm in group D. There were significant differences of the PCL length between group A and group B ($p<0.01$), group A and group D ($p<0.01$) and between group B and group D ($p<0.05$). No statistical difference was found between group C and group D ($p>0.05$). Stability of knee was in correlation with decrease of PLC measured size. **Conclusion:** The most important period for ligament recovery is the first month of therapy. Ultrasonography can be used for the evaluation of the effects of rehabilitation therapy.

Key words: ultrasonography, posterior cruciate ligament, rehabilitation therapy.

Rezumat

Ligamentul încrucisat posterior (LIP) are un important rol în stabilitatea şi mobilitatea genunchiului. **Scopul** studiului a fost de a evalua ecografic modificările în lungimea LIP apărute în cursul programului de recuperare a pacienţilor cu genunchi instabil posterior trataţi conservativ. **Material şi metodă:** S-au evaluat ecografic 16 pacienti cu genunchi posterior instabil trataţi conservativ. S-a măsurat lungimea LIP. Grupul de control a fost constituit din genunchiul contralateral sănătos (grup A). Pacienţii au fost evaluaţi înaintea iniţierii terapiei de reabilitare (grup B), după o lună de terapie (grup C) şi după 6 luni de terapie (grup D). **Rezultate:** Lungimea medie a LIP a fost de 39,87± 6,1 mm în grupul A, 46,8±7,9 mm în grupul B, 43,9± 7,5 mm în grupul C şi 40.36±6.2 mm în grupul D. S-au decelat diferenţe semnificative statistic între grupul A şi B ($p<0,01$), între grupul A şi D ($p<0,01$) şi între grupul B şi D ($p<0,05$). Nu au fost diferenţe semnificative statistic între grupul C şi D ($p>0,05$). Stabilşitatea genunchiului s+a corelat cu scăderea lungimii LIP. **Concluzii:** Cea mai importantă perioadă în recuperarea LIP este prima lună de terapie. Ecigrafia poate fi folosită pentru evaluarea efectelor terapiei recuperatorii.

Cuvinte cheie: ecografie, ligament încrucişat posterior, terapie de reabilitare

Introduction

The posterior cruciate ligament (PCL), the strongest ligament of the knee, is the primary restraint against posterior subluxation of the tibia [1] acting as an important stabilizer of the knee. PCL (together with meniscofemo-

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ral ligaments) is located at the medial edge of the posterolateral corner of the knee and provide static stability to the posterior translation of the tibia [2]. The PCL has a larger anterolateral and a smaller posterolateral bundle. The first bundle is tight in flexion and the second bundle in extension [3]. The PLC also stabilizes the knee against excess varus and valgus angulations. Biomechanical studies revealed a strong functional interaction between the PCL and the other posterolateral structures of knee in stabilization and kinematics of the knee [4].

Clinical diagnosis in PCL lesions may be difficult, particularly in the acute phase, or may underestimate the extent of the lesions. Arthroscopy permits direct visualization of the PCL and is considered the diagnostic standard. Being an invasive procedure it is rarely used only for diagnostic purpose. Computer tomography (CT) and magnetic resonance imaging (MRI) play a key role in evaluation PCL lesions, traumatic or degenerative. MRI is known to be as useful as arthroscopy but is expensive. Ultrasonography (US) became in the last decade a more and more frequently used technique for PCL evaluation, proving to be an inexpensive, noninvasive and non-time consuming examination. It was proved that US, especially high-resolution US, is a reliable technique for studying the PCL and for detecting PCL injuries [1,5,6,7].

The treatment of posterolateral corner of the knee injuries depend on a variety of factors: complexity of trauma, grading of injury, associated lesions of anatomical structures, etc. The decision for surgical or conservative treatment of the lesion should be taken after a careful analysis of the clinical situation and the imaging investigations reports [8,9] .

The bracing or the bed rest after a joint trauma may induce muscle atrophy and impairment of contraction. The bed rest also results in a decrease in the stiffness of tendon structures with a reduction of the muscle strength and volume. The effects of prolonged inactivity would bring an electromechanical delay (time lag between the onset of the electrical activity and tension development in skeletal muscle) and a rate of torque development [10].

Considering these findings it is likely that a normal, non-tear PCL could have the same alteration after a non-surgical treated trauma in the posterolateral corner of the knee. The aim of our study was to evaluate the changes of PCL length before and after exercise treatment (quadriceps muscle rehabilitation) in patients with posterior knee instability

Material and method

We performed the ultrasonographic examination in 16 patients (2 women, 14 men; age range 21-35 years: mean age 29.6 years). All patients had professional overuse of the knees and an anterior unilateral knee trauma. Clinical examination revealed the presence of unilateral posterior knee instability (positive clinical test for posterior knee instability- dynamic posterior and pivot shift test by Jacob), but at MRI a PCL tear or other knee pathology with surgical indication was excluded. The symptomatology of the patients was explained by the presence of various lesions of the posterolateral corner of the knee, with indication for rehabilitation program. To demonstrate the normal appearance of the normal PCL, the control group was represented by the healthy knee of every patient- group A (none with previous trauma or degenerative knee lesions). The patients were evaluated before starting the treatment (group B), after a month (group C) and after 6 months (group D) of rehabilitation therapy. To be sure of the correctness and the continuity of the rehabilitation exercises, the electrodiagnostic with galvanic current of the rectus femoris strength was performed.

Ultrasonography was performed by using a 7.5 MHz linear-array transducer (Aloka SSD1000). Examinations were performed with the subject lying prone and the knee extended in a neutral position. The longitudinal profile of the PCL was obtained by using the technique described by Cho *et al* [5]. The transducer was longitudinally positioned at the site of the distal attachment of the PCL, in the posterior intercondylar area of the proximal tibia. The proximal corner of the transducer was pushed down in a "heel-to-toe" maneuver and was tilted slightly to achieve a plane parallel to the long axis of the ligament. The PCL was identified as a hypoechoic, crescentic structure with fibrillar pattern, easily distinguished from the hyperechoic fat. The length of the PCL was measured using sonographic units calipers. One caliper was positioned at the distal insertion of the PCL on the tibial spine, and the other on the superficial plane of the proximal insertion (fig 1).

Statistics: Measurements were reported as values ± standard deviation (SD). A Chi Square test was used and the level of significance was established at $p<0.05$.

Results:

The measurement of the PCL length and thickness was possible in every knee (healthy or instable). The length of the PCL in the four groups and the average values ± SD are shown in table I. There were significant differences between group A and group B ($p<0.01$), group A and group D ($p<0.01$) and between group B and group D ($p<0.05$). No statistical difference was found between group C and group D ($p>0.05$).

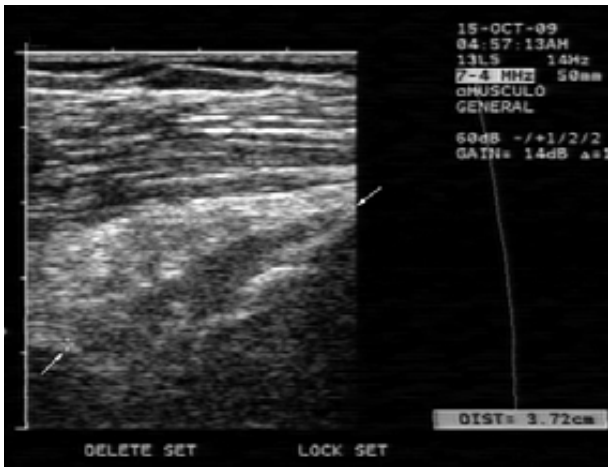


Fig 1. The ultrasonographic aspect of a normal PCL, longitudianla view. For measurement one caliper was positioned at the distal insertion of the PCL on the tibial spine, and the other in the superficial plane of the proximal insertion (arrows).

Tab.1. The length of PCL (in mm) in four groups

Group A ***(healthy knees)***	**Group B** ***(instable knee before treatment)***	**Group C** ***(instable knee after 1 month of rehabilitation)***	**Group D** ***(instable knee after 6 months of rehabilitation)***
38	41	41	34
51	51	49	45
38	41	41	35
30	39.8	39	38
40	48	40	45
30	30	26.5	28
40	47	48	46
39	42	38	39
43	47.6	47	45
43.4	47.6	48.3	40
35	38	48,3	40
45.1	47	38	38
41.5	41	46	42
51	56	50.8	52
39	41	45	34
34	41	44	36.8
Average 39.87± 6.1	Average 46.8±7.9	Average 43.9± 7.5	Average 40.36±6.2

Discussion

The use of the ultrasonography for the evaluation and the follow-up of the morphological changes in ligaments, muscles, and tendons during the rehabilitation program has proved to be useful for the assessment of the effects of treatment. It had been demonstrated that bed-rest results in decrease in the stiffness of tendon structures with a reduction of muscle strength and volume [10,11] and that dynamic training during bed rest can prevent deterioration of these structures [12]. One of the causes of the inefficient rehabilitation therapy is the lack of correctness and continuity of the rehabilitation exercises. That is why we decide to measure muscle rectus femoris strength by electrodiagnostic with galvanic current. In these conditions, to have a precise and objective method for evaluating the changes of the aspect and dimension of the ligament could be of high value for the clinician.

The ultrasonographic evaluation of the PCL and also of the posterolateral corner of the knee could be difficult due to the anatomical variations of these structures [2,8]. It requires solid anatomical knowledge, a precise ultrasonographic technique and a good experience in musculoskeletal ultrasonography.

We found in 13 of the 16 patients a larger value of the PCL in the instable knee compared with the healthy knee. Despite that all these PCLs were not torn at MRI, we interpreted the higher length of the PCL as a result of the trauma. The differences were statistically significant. In evolution, after 6 month of rehabilitation the length of PCL decreased in all but one case. The variations between the values obtained after 1 month and after 6 months of treatment showed no statistical significance. It seems that the rehabilitation program should be done more carefully in the first month, this being the most important period for ligament recovery. It is difficult to explain the differences between the normal ligament and the PCL after 6 month of therapy. It is possible that this ligament needs more time for full recovery. More studies are needed to evaluate this aspect. We can assume that the stability of knee was in correlation with decrease of PCL length.

We can not compare our results with those of the literature because all the authors measured only the thickness of the PCL [1,5,6,7]. The general opinion is that the proximal half of the PCL is too deep to be depicted, so all the authors measured the thickness of the PCL at the distal insertion (at the tibial spine level or at 1 cm before insertion). They generally consider that a PCL over 10 mm thickness must be consider abnormal. We did not have difficulties in measuring the PCL length, maybe because all of our patients were relatively young and non-obese persons.

This is in fact the main limitation of the study - a small number of cases, without anatomical or MRI comparison. More studies are needed to assess the normal and pathological length of the PCL, especially because there are numerous and important interindividual and interracial variations.

In conclusion ultrasonography can be used for the evaluation of the normal and pathologic PCL. The measurement of the length of the PCL during the rehabilitation program proved the elasticity of ligament and its capacity for recovery during a non operative treatment.

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