fizjoterapia polska
nr 4/2015 (15)

Charakterystyka więzadła przedniobocznego stawu kolanowego oraz jego korelacja z urazami więzadła krzyżowego przedniego u sportowców

Characteristic of the anterolateral ligament of the knee and its correlation with trauma of the anterior cruciate ligament in athletes

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Streszczenie:

Urazy więzadła krzyżowego przedniego (ACL) są najczęstszymi urazami stawu kolanowego u sportowców. Diagnozujemy je specyficznymi testami klinicznymi – test Lachmana, szuflady przedniej, pivot-shift oraz dodatkowymi badaniami obrazowymi. Formą leczenia jest rekonstrukcja więzadła z pobranego przeszczepu mięśniowego. Po leczeniu wciąż pojawia się problem z niestabilnością rotacyjną. Tylko 60% sportowców wraca do formy sprzed urazu. Ma to związek z więzadłem przedniobocznym stawu kolanowego (ALL). Jest to więzadło występujące u ok. 95% populacji. Znajduje się na przedniobocznej stronie stawu kolanowego łącząc kość udową z kością piszczelową. Odpowiada za stabilność rotacyjną kolana, szczególnie przy zgiętym kolanie (30-90o), wspomaga funkcję więzadła ACL. Uszkodzenia ALL, które mogą być bezobjawowe, mogą prognozować następowe zerwanie ACL. Natomiast przy zerwaniach więzadła ACL prawie zawsze jest uszkodzone więzadło ALL. Zerwania i uszkodzenia więzadła ALL wykazują związek ze złamaniami Segonda. Niewykryte uszkodzenia ALL powodują niepowodzenia leczenia urazów więzadła krzyżowego przedniego. Należy zastanowić się czy przy współistniejących urazach ACL i ALL wystarczyłoby leczenie zachowawcze uszkodzonego więzadła ALL, aby leczenie i rehabilitacja zakończyły się sukcesem, czy konieczna jest również rekonstrukcja więzadła ALL. Celem publikacji jest zwrócenie uwagi na powszechny problem urazów stawu kolanowego u sportowców i sposób ich leczenia, które doprowadzą do pełnego wyzdrowienia zawodnika oraz jego szybszy powrót do gry.

Słowa kluczowe:

staw kolanowy, więzadło przednioboczne kolana, więzadło krzyżowe przednie, charakterystyka, uraz

Abstract

Traumas of the anterior cruciate ligament (ACL) are the most common injuries of a knee joint in athletes. We diagnose them by specific clinical tests – Lachman test, anterior drawer test, pivot-shift test and additional imaging studies. Form of the treatment is to reconstruct the ligament with a graft taken muscle. After treatment, there is still a problem with the rotational instability. Only 60% of the athletes returned to pre-injury form. This is due to anterolateral ligament (ALL) of knee. It is a ligament that occurs in approximately 95% of the population. It's located on the anterolateral side of the knee joint which connects the femur with the tibia bone, it is responsible for rotational stability of the knee, especially when bent knee (30-90o) and it`s supports the function of the ACL. ALL trauma that may be asymptomatic, they can imply subsequently breaking of the ACL. However, when ACL is ruptured, almost always the ALL is damaged too. Ruptures and damages of ALL have a connection with Segond fractures. Undetected damage of ALL causes treatment failure of the anterior cruciate ligament injuries. It should be taken into consideration that with concomitant ACL and ALL injuries conservative treatment of damaged ALL is enough for treatment and rehabilitation success or if reconstruction of the ALL also necessary. The aim of the study is to highlight the widespread problem of knee injuries in athletes and how they should be treated so it will lead to full recovery of the competitor and his/her faster return to the game.

Key words:

knee joint, anterolateral ligament of the knee, anterior cruciate ligament, characteristic, trauma

Introduction

Anterior Cruciate Ligament (ACL) is one of the four major ligaments of the knee joint. Its primary function is to stabilize the joint. It prevents the excessive extension of the tibia to the front of the femur and, more importantly, protects against the anterolateral rotational knee instability (AP). This is particularly important to the athletes involved in the sports, where there are sudden changes of the direction of movement, and thus frequent changes of the knee joint position, which includes such contact disciplines like, among others, football and basketball. The anterior cruciate ligament rupture is the most common knee ligaments injury (among sportsmen up to 70%) [1], and it is usually due to a non-contact trauma [2]. Usually it occurs as a result of one of the two mechanisms (3):

• rotation – with a stabilized foot; sudden twist of the body, especially with a bent knee, brings about the excessive tension of the ligament and causes its damage (this may take place, for example. during skiing, when the foot is immobilized by the ski shoe),

• over straightening – a blow to the tibia, with the knee straight (e.g., sliding tackle in a game of football).

Repeated subluxations may result in a damage to the meniscus and the articular cartilage, causing the development of degenerative changes in the knee. Often, along with the damage of the anterior cruciate ligament, there are other intra-articular damages present (damages of tibial collateral ligament and medial meniscus). The phenomenon is being called the unhappy triad or O`Donoghue`s triad [4, 5]. The ACL damage causes characteristic symptoms, which confirm the injury diagnosis. The symptoms are: pain (in the initial phase of injury), giving way of the knee, decreased range of motion - especially straightening, the widespread moderate hypersensitivity to pressure and swelling [6]. For the palpation examination and diagnosis, we use the specific knee joint tests. The most important of those, are [4, 7]:

• Lachman test – test for stability; with the ACL injuries there occurs the displacement of tibia in relation to femur, and the movement seems “soft” towards its end. If the thrust is “hard”, it proves the preserved integrity of the ligament;

• anterior drawer test – test for stability; evaluation of the anteromedial or the anterolateral instability;

• Test pivot-shift test (Galway test [8]) – if the ACL is damaged, the tibial subluxation occurs in bending and straightening. Here the diagnosis can be confirmed by the patient, who in any sports activity suffers from the typical knee instability symptom, the giving way knee – it is this symptom, that we bring about in the pivot-shift test.

A form of treatment applied to athletes is the anterior cruciate ligament reconstruction (ACLR). Most commonly, the reconstruction is done in one of the two surgical techniques, depending on the selected type of transplantation:

• STG method – transplanted is a part of the semitendinosus and gracilis muscles,
• BPTB (BTB) method – a transplant of a part of the patellar tendon (Bone-Patellar Tendon-Bone).
The results of this form of therapy show, that after the surgery, the anterolateral instability (AP) can be well under control – the Lachman test comes out negative. Still there occurs the problem with the rotational instability [9] – the pivot-shift test is difficult to interpret and has not been standardized [10]. On the one hand it is the most specific test for the rotation and it does correlate best with the functional instability. On the other hand, some patients without the ACL ligament do not show the pivot-shift [11], while others, after the ACLR, have the positive pivot shift test result. Only some 60% of athletes, after the successful ACL reconstruction and rehabilitation process, regain their full fitness from the time before the injury, the remaining suffer from the typical knee giving way symptom, accompanying their increased physical activity [10]. It is also quite puzzling, why many patients in the first hours after the anterior cruciate ligament reconstruction surgery, report pain in the anterolateral line of the knee joint and in the proximal part of the tibia. Some new answers come from the two Belgian physicians: S. Claes and J. Bellemans, who describe the anterior crucial ligament, which location corresponds to the areas of pain reported by the patients.

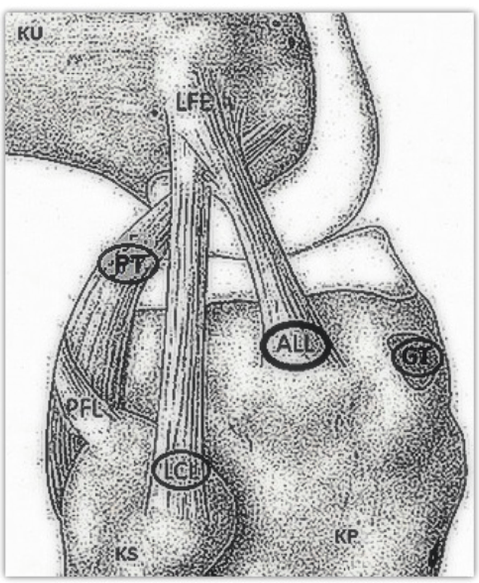
Etiology

The research has began with the basic question – is there any additional structure that affects the rotational stability of a knee, which, if damaged, could cause the failure of the reconstruction method and the pain occurring after the surgery. The studies have led to the analysis of the descriptions of the structure discovered by the French surgeon, P. Segond, in 1879 [12]. In his work he described the avulsion of a small portion of the lateral tibial plateau, caused by the excessive tension of the menisci tibial ligament, caused by the forced internal rotation of the knee [12, 13]. The presence of this Segond fracture (as it has been called), in 90% of cases means the ACL rupture (is pathognomonic for the anterior cruciate ligament rupture) [13, 14, 15]. The fracture occurs in the vicinity of the lower-lateral part of the knee joint capsule, above and behind the Gerdy's tubercle. Also in this this area, the French physician described the "pearly, tough, fibrous band of tissue", which was clearly visible and showed the maximum tension during the forced internal rotation of the knee. This band has been named the anterolateral ligament (ALL), successively by Vieira (2007) [16] and Vincent (2012) [17]. The presence of this additional structure has also been mentioned by J. Hughston (1976), in his work about the patterns and types of the rotational instability of a knee [18, 19]. He described "the middle one-third of the lateral capsular ligament", closely connected to

the meniscus and divided into the menisci femoral and menisci tibial parts [19]. According to him, the capsular ligament is strongly supported by the iliotibial band, which is located on top of the ligament. This was to play an important role in the anterolateral instability of a knee. To study this phenomenon he has developed the (Hughston) Jerk Test [4]. His theory, however, proved not to be entirely correct. And since the advent of arthroscopy it is being considered outdated [20]. 134 years have passed from the first description of the structure made by Segond, and doctors Claes and Bellemans, on the basis of their own research, finally analyzed and characterized the ligament, which took the name of the anterolateral ligament [21].

Characteristics

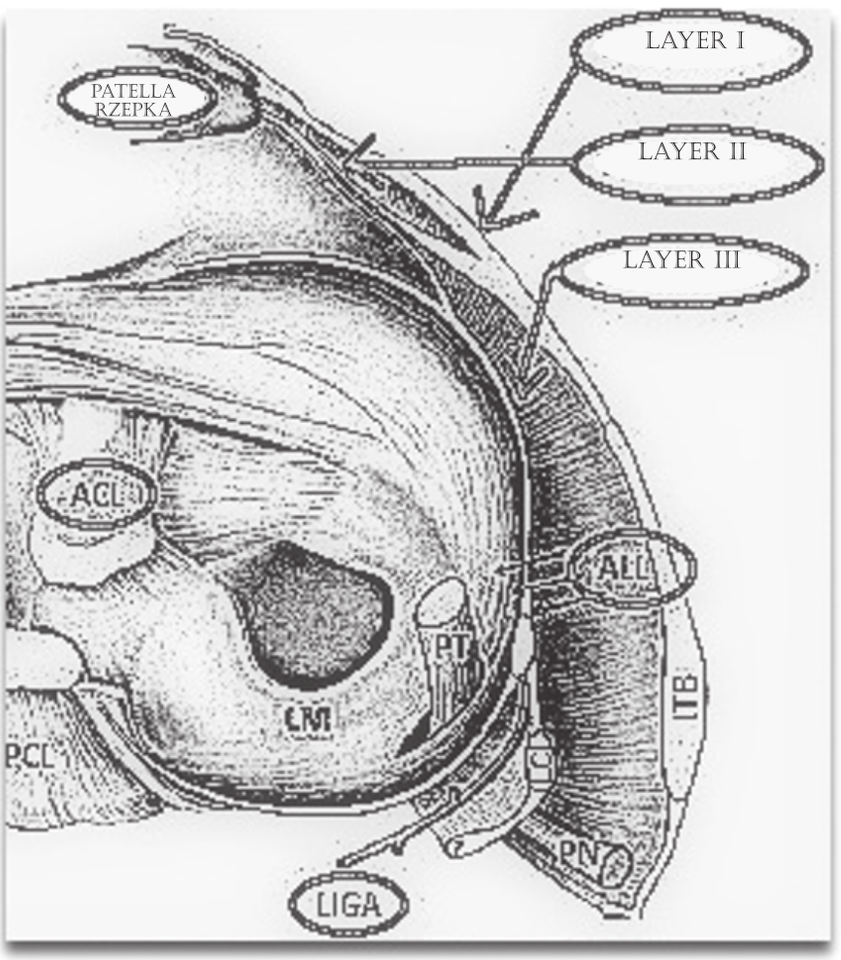
The anterolateral ligament of a knee (ALL), which is present in approx. 95% of the population [9, 17, 21, 22], is a separate ligament structure, located on the anterolateral side of a knee joint, and it connects the femur and the tibia bones [23, 24]. The main insertion of the ligament is located on the femur lateral epicondyle eminence, in front of the lateral collateral ligament (LCL) and proximally, and in the back of the popliteus (PT) muscle tendon insertion. The rear fibers of the initial ALL insertion are mixed with the initial insertion of the LCL [21, 22]. The ALL fibers are positioned on the surface [21]. They are not connected though, to the joint capsule of a knee [22, 24] (Fig.1).



KU – femoral bone;
KP – tibia bone;
KS – fibula bone;
ALL – anterolateral ligament;
LCL – lateral collateral ligament;
GT – Gerdy's tubercle;
LFE – lateral femoral epicondyle;
PFL – popliteo-fibular ligament;
PT – popliteus tendon

Fig. 1 Anatomic drawing of the the ALL on the lateral aspect of the human knee; knee in 90° of flexion

Because of such a spatial arrangement, and because the LCL and ALL are both a part of the deep layer (III) and they are partially connected with the fibers of the initial insertion, the two structures can be called the lateral collateral ligament complex (LCLC) [25, 26, 27] . Between the ALL and the lateral meniscus edge, in line with the joint, there is the inferior lateral genicular artery (LIGA) – a branch of the popliteal artery (Fig. 2).



ALL – anterolateral ligament;
ACL – anterior cruciate ligament;
ITB – iliotibial band;
LCL – lateral collateral ligament;
LIGA – lateral inferior geniculate artery;
PN – peroneal nerve;
PT – popliteus tendon;
LM – lateral meniscus;
PCL – posterior cruciate ligament;

Fig. 2 Anatomic drawing of a right knee

The more distally located ALL insertion is placed at the closer end of the tibia, and so it creates a thick fold of the joint capsule insertion. The end insertion is located to the rear of the Gerdy's tubercle (GT; situated on the anterolateral side of the lateral condyle of the tibia, the insertion spot of the iliotibial band), it is not connected with the iliotibial band (ITB) fibers [21]. The average length of the ligament is 38.5mm in extension, and 41.5mm in inflection of 90º. The width of the ALL ranges from 4mm to 7mm, depending on the place of insertion, and its average thickness is 1.2mm [21].

In terms of its histological composition, the anterolateral ligament is build of bands of the dense regular tissue [9] (fibrous connective tissue), surrounded by the loose synovial

fluid. This ligament tissue consists of the tightly packed fibers, a small amount of the ground substance and a small number of cells. Under a microscope, we can see the orderly arrangement of parallel bundles of the collagen fibers, type I, with a wavy course, sunken in a small amount of the ground substance. The tissue also has some elastin fibers, which provide for the good flexibility of the ALL ligament [17, 29, 30], as well as the numerous cells of the proprioceptive innervation, which are relevant for the biomechanics of a knee joint. [23,24]

Biomechanics

All researchers agree that the anterolateral ligament is responsible for the stability of the knee joint. At the beginning, it seemed to have the same function as the anterior cruciate ligament (ACL), that is protection against too much of a rotation of the joint. Today, we are already certain, that the ALL supports the ACL operation, but its function in the joint is not completely identical.

The starting point to fully understand the ligament function, has been the observation of the rotational instability of the knee after the successful ACL reconstruction surgery. It has turned out that in the cases of the ACL rupture, more often than not the ALL is damaged as well. And it is this ligament, that causes the instability of the knee after the surgery. It is believed, that ALL helps to reduce the forward movements and the lateral rotation of the tibia in relation to the femur. With the stabilization function not working (rupture or damage) the instability symptoms appear. Fro this it follows, that the ALL most likely acts as the internal rotation stabilizer, when the knee is bent at an angle of 30 to 90° [28, 31]. In this position the ACL does not have similar function. This fact seems to be confirmed by the occurrence, that the rupture of the ALL alone causes the pivot-shift of the 3rd degree in the knee joints with or without the damaged ACL [10, 20, 31]. The ACL ruptures are more common in persons engaged in sport disciplines, in which there are frequent changes of the direction of the movement (skiing, netball, basketball, football, beach volleyball, beach soccer, rugby, baseball or hockey). Some of these injuries are related to the asymptomatic damage of the ALL. The recent studies of the Journal of Athletic Training show, that this is occurring due to the fact that the athletes are more likely to land with their knees bent inwards (wrong motor pattern.) Interestingly, the ruptures of both, ACL and ALL, occur four times more frequently in women than in men. This is associated with the anatomy differences between women and men, and with the fact that women produce more estrogen hormones. The ALL damages may be asymptomatic, and can therefore cause failures in treatment of other ligaments of a knee. The ALL injuries we usually detect after the ACLR surgery – ca 50%. What's interesting, almost 80% of the ALL lesions are related to the ACL damage [10, 20]. It has turned out, that the ALL damages are also associated with the Segond fracture, primarily due to the ligament location and the direction of the avulsion force [13,

26]. The conclusion is, that the Segond fracture should not only be regarded as the pathognomonic symptom of the ACL damages, but it should also indicate the possibility of both pathological changes and injuries of the ALL [22, 28, 32, 34].

Imaging examinations

It has been demonstrated that the anterior cruciate ligament (ACL) injuries are often accompanied by the anterolateral ligament lesions (ALL). Knowledge of the above relation is important for the subsequent convalescence process. In order to treat these lesions properly, they need to be made visible in the procedures of the imaging diagnostics. One should also be able to distinguish the normal state and the pathological changes.

The basic examination showing the pathological changes in ligaments is the magnetic resonance imaging (MRI). In the study conducted by Dr S. Claes (2014), in 78.8% of the radiological images the pathological changes in the ALL are shown. 77.8% of the lesions were located in the the distal part of ligaments [28]. For the purpose of this study, the ligaments have been considered incorrect in the case of the actual ligament rupture (no continuity in all of the fibers). The injury has been defined as proximal in the condition, that the damage has been located in the area from the epicondyle of the femur to the menisci femoral part of the ALL (21). The changes located from the level of meniscus to the ligament insertion into the tibia bone, are being defined as distal. And the bone breaking away with the piece of ligament at the level of the tibia bone has been categorized as the Segond fracture. In other tests, depending on the method applied, there have been shown from 11% to 98% of the ligament. [35, 36] Almost 80% of the ALL pathology cases reported occurred together with the damage (often the total rupture) of the anterior cruciate ligament (ACL) [28, 34]. The medical ultrasound examination may also be applied, the ALL is most visible here with the knee bent at the angle of 90° and with the slight internal rotation – the ligament is well strained then. The advantage of this examination method is its dynamics and the changes, which we can observe [37].

Conclusions

It needs to be considered, how does the anatomical position of the ALL affect the structures in the surrounding area, and how do those structures affect at the ALL. The anterolateral ligament injury may play a role in causing the lateral meniscus lesions, even if there are no ACL damages shown. Especially in the case of the rupture of the peripheral meniscus edge. [9] The LCL sprain may cause changes or damages to the ALL, due to the shared course of the fiber bands in the initial insertion of the ALL . Proximity of the inferior lateral genicular artery (LIGA), can also be important in view of the bilateral interactions and injuries, as well as for the subsequent treatment and rehabilitation.

It is worth noting, that there is a correlation between the prior ALL pathology and the posterior ACL injuries. Having in mind this correlation, it would be appropriate to consider the methods

of treatment (including the conservative treatment), which after the early detection of the ALL pathology would help to avoid the posterior ACL injury, as well as the surgery, by healing up the damaged ALL. An important procedure assisting the diagnosis would be the arthroscopy, during which the ALL can be made visible – depending on its status, the appropriate therapy and treatment may be applied [38].

The key question to ask would be whether after the damage of the ACL and the reconstruction surgery of ACL and ALL, more athletes will return to their full physical fitness, like at the time before the injury, and whether the give way knee symptom will not occur during the physical activities [38, 39]. It would be also important, if the subsequent rehabilitation, the strengthening of the extensor and flexor muscles, will prevent further damages of the ALL, and consequently the posterior ACL injuries, which would amount to the faster come back of the athlete to the full training and to participation in the game [40, 41].

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