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CONCOMITANT INJURIES OF ANTERIOR CRUCIATE LIGAMENT AND MENISCUS

UDRUŽENOST POVREDA PREDNJEG UKRŠTENOG LIGAMENTA I POVREDA MENISKUSA

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Summary

Introduction. The aim of this study was to determine the correlation between meniscal injuries with injuries of the anterior cruciate ligament, as well as risk factors for those associated injuries. **Material and Methods.** This study included 496 operated patients. Almost half of patients with meniscal injury were between the ages of 21 and 30 years. **Results.** Meniscal injuries were diagnosed in 187 patients (38%). These patients were significantly older than the patients without meniscal injury. Meniscal injuries were significantly more frequent in patients who played sports recreationally than in professional athletes. The patients with meniscal injury underwent surgery almost four months later than the patients with preserved menisci. Meniscal injuries occurred significantly more frequently by non – contact mechanism, as a result of landing and sudden changes of direction and rhythm of running. **Conclusion.** Male patients hurt the medial meniscus more often, “bucket handle” type of lesion being much more frequent than on the lateral meniscus. The increase of body mass index is exactly proportional to the increase in the incidence of meniscal injuries.

Key words: Anterior Cruciate Ligament; Knee Injuries; Anterior Cruciate Ligament Reconstruction; Menisci, Tibial; Risk Factors; Age Factors; Recreation; Sports; Body Mass Index

Introduction

Anterior cruciate ligament (ACL) injuries are commonly encountered in athlete population. According to the available epidemiological data in the United States, the annual incidence of ACL injuries is estimated to range from 100,000 to 250,000 injuries per year, and more than 70% of these injuries are suffered by the sports active population [1, 2]. In Vojvodina, which has about two million inhabitants, about 400 reconstructions of the ACL (2 reconstructions per 10,000 residents) are performed per year. As for the European countries, the most accurate data are those from Denmark, where during one year three injuries per 10,000 residents are recorded, with a higher frequency of occurrence among the athletes

Sažetak

Uvod. Cilj istraživanja bio je da utvrdimo povezanost povreda prednjeg ukrštenog ligamenta i povreda meniskusa, kao i faktore rizika za nastanak ovih udruženih povreda. **Materijal i metode.** Ispitivanu grupu činilo je 496 operisanih pacijenata sa povredom prednjeg ukrštenog ligamenta. Gotovo polovina pacijenata sa povredom meniskusa pripadala je starosnoj grupi između 21 i 30 godina. **Rezultati.** Povrede meniskusa su dijagnostikovane kod 187 pacijenata (38%). Pacijenti sa povredom meniskusa bili su statistički značajno stariji od pacijenata sa intaktnim meniskusima. Povrede meniskusa su se statistički značajno češće dešavale kod pacijenata koji se sportom bave rekreativno, nego kod profesionalnih sportista. Pacijenti sa povredom meniskusa su operisani gotovo četiri meseca kasnije u odnosu na pacijente sa očuvanim meniskusima. **Zaključak.** Udružene povrede prednjeg ukrštenog ligamenta i meniskusa najčešće nastaju nekontaktnim mehanizmom. Muškarci češće povređuju unutrašnji meniskus po tipu *bucket handle* nego na spoljašnjem meniskusu. Porast indeksa telesne mase upravo je srazmeran porastu incidencije udruženih povreda meniskusa.

Ključne reči: prednji ukršteni ligament; povrede kolena; rekonstrukcija prednjeg ukrštenog ligamenta; tibijalni meniskus; faktori rizika; faktori starosti; rekreacija; sport; indeks telesne mase

as well [3]. These data are very similar to the data from the United States, where it is estimated that injuries occur in one out of 3,000 people in the general population [1]. The reason for this epidemiological situation certainly lies in the fact that the number of participants in sports on the global level is constantly growing. Not only have sports activities become an important part of modern life, but also an increasing number of people go in for sports for relaxation and entertainment. The number of men and women who become members of fitness and various sports clubs is increasing [4]. All this supports the fact that a significant increase in injuries of ACL has been recorded in the past 10–15 years [5].

It is estimated that almost every second or third ACL injury goes with additional meniscus injury

Abbreviations

ACL – anterior cruciate ligament
 BMI – body mass index

[6–8]. In acute cases lateral meniscus is most frequently injured, while chronic lesions are connected most often with medial meniscus [6, 7]. Both menisci are the second most important structures of stability of a knee joint. ALC is the first one. Levy and al. [8] have proved that bilateral total meniscectomy does not influence the knee stability significantly if ACL is uninjured. If it is ruptured, most of ACL function is taken over by medial meniscus in order to limit the anterior tibial translation, thus providing stability and retaining the biomechanics of knee joint.

The aim of this study was to determine the correlation between meniscal and ACL injuries, as well as risk factors for meniscal injury in patients with ACL rupture.

Material and Methods

With the permission of the Ethics Committee of the Clinical Center of Vojvodina, a prospective study was conducted at the Department of Orthopedic Surgery and Traumatology. The study included 496 patients with ACL ruptures operated between January 2012 and December 2013. Data were gathered from the history of injury, operative protocols and register of ACL injuries kept at the Department.

Of the total number of operated patients, 401 (80.8%) were male, while 95 (19.2%) were female. The average age was 25.54 ± 7.69 years (minimum 13, maximum 57). The criterion for inclusion in the study was the diagnosed ACL rupture in the patients who had got injured during active participation in sports and recreation, in the performance of daily activities or in traffic accidents.

The results are presented in tables and graphs. Several independent variables were observed and subgroups were formed accordingly as a part of the study sample. The comparison was carried out between certain subgroups of patients by Student’s T-test, with marked statistical significance level of $p < 0.05$.

Results

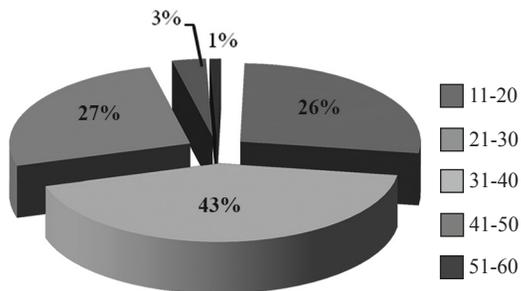
Out of 496 patients with ACL rupture, 309 (62.3%) had no rupture of menisci, while the remaining 187 (37.7%) were diagnosed with meniscal lesions.

The medial meniscal lesion was found in 101 cases (20.4%), and 56 patients (11.3%) had lateral meniscal rupture. Both menisci were injured in 30 patients (6%).

The average age of patients with intact menisci was 24.7 years, while the average age of the patients with a damaged meniscus or menisci was 27 years. A statistical significance ($p < 0.05$) was found by comparing these two values.

The patients were divided into five groups according to their age. Most patients with concomitant

meniscus and ACL injury were in the age group from 21 to 30 years (43.3%) (**Graph 1**).

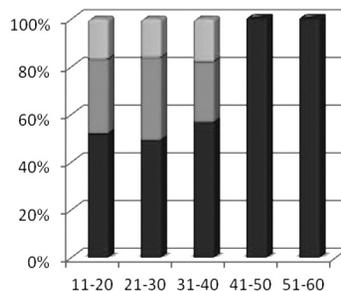


Graph 1. Age structure of the subjects with associated injuries

Grafikon 1. Starosna struktura ispitanika sa udruženim povredama

Comparing these associated injuries among different age groups, it was found that the patients aged between 31 and 40 years had associated medial meniscal injury significantly more often than the patients aged between 11 and 30 years ($p < 0.05$). A statistical significance was also found considering lateral meniscal lesions, which happened more frequently in the patients under 40 years of age ($p < 0.05$). Comparing the existence of associated ACL and medial or lateral meniscal ruptures within the age groups, the patients between 31 and 40 years and 41 and 50 years of age were found to be statistically significantly more likely to have ACL and medial meniscal injury ($p < 0.05$) (**Graph 2**).

Out of all subjects, 480 (96.8%) were active in sports, while 16 (3.2%) did not go in for sports ($p < 0.05$). In relation to sports activity, more subjects were engaged in recreational sports, i.e. 282 of them (58.75%), while 198 were professional athletes (41.25%). As for the patients with a meniscal lesion, 117 (62.6%) were engaged in recreational sports, 63 (33.7%) practiced



Graph 2. Meniscal injuries in relation to age structure
Grafikon 2. Povrede meniskusa u odnosu na starosnu strukturu

Table 1. Meniscal lesions depending on sport
Tabela 1. Lezije meniskusa u zavisnosti od vrste sporta

	Medial meniscus <i>Unutrašnji meniskus</i>	Lateral meniscus <i>Spoljašnji meniskus</i>	Both menisci <i>Oba meniskusa</i>	Both menisci intact <i>Intaktna oba</i>
Basketball/ <i>Košarka</i>	15.5%	15.5%	8.3%	60.7%
Soccer/ <i>Fudbal</i>	19.6%	10.4%	5%	65%
Volleyball/ <i>Odbojka</i>	33.3%	11.1%	5.6%	50%
Handball/ <i>Rukomet</i>	12.8%	10.6%	6.4%	70.2%
Martial arts/ <i>Borilačke veštine</i>	31.3%	12.5%	9.3%	46.9%
Skiing/ <i>Skijanje</i>	4%	4%	4%	88%
Am. Football/ <i>Ragbi</i>	25%	25%	0%	50%
Other/ <i>Drugi sport</i>	45%	5%	0%	50%
Non-athletes/ <i>Nesportisti</i>	27.3%	13.6%	13.6%	45.5%

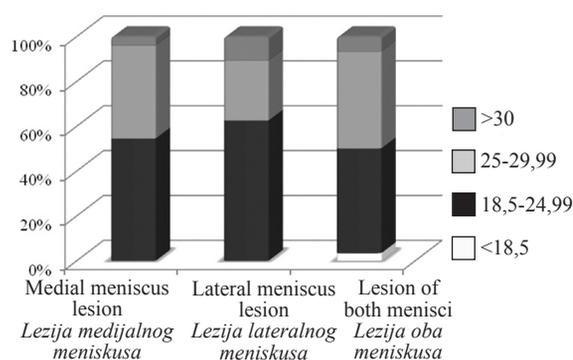
sports professionally, while 73.7%) were not active in any sport. A statistically significant difference ($p < 0.05$) was found by comparing the level of sports between the group of patients with meniscal injury and the group of patients with intact menisci.

Injuries of medial meniscus are often present among patients who are active in „other“ sports, such as: water polo, athletics, gymnastics, tennis. Lateral meniscal rupture occurred most often in the patients who were active in rugby or American football, while both meniscal injuries were found in the group of patients who were not engaged in any kind of sports activity. The highest percentage of intact menisci happened in those patients who had isolated ACL injury during skiing (**Table 1**).

Nutritional status of our patients was determined according to their anthropometric data – body height and weight. The patients were divided into four groups: normal weight ($18.5 \leq$ body mass index (BMI) < 25), malnourished (BMI < 18.5 kg/m²), overweight ($25 \leq$ BMI < 30) and obese (BMI > 30 kg/m²). Most of them had normal weight (62.1%), 32.3% of the patients were overweight, 4.6% of them were obese, whereas only 1% of the patients were malnourished.

A medial meniscal injury associated with ACL rupture was found more frequently in overweight patients than in those with normal weight ($p < 0.05$). A statistically significant difference between these two groups was observed ($p < 0.05$) when comparing the total number of medial and lateral meniscal injuries, and it was in favor of those patients who had a body mass index greater than 25 (**Graph 3**).

Three groups of patients were formed according to the time elapsed from the moment of ACL rupture to surgical intervention. The majority of patients (304, i.e. 61.2%) were operated within six months after injury. The ACL reconstruction was performed between 6 and 12 months after rupture in 144 cases (29.1%), while surgery was performed in 48 patients (9.7%) more than a year after the injury. The longer the period between getting injured and being operated, the higher was the number of associated meniscal injuries. As for the average time elapsed from getting injured and surgical intervention, there was

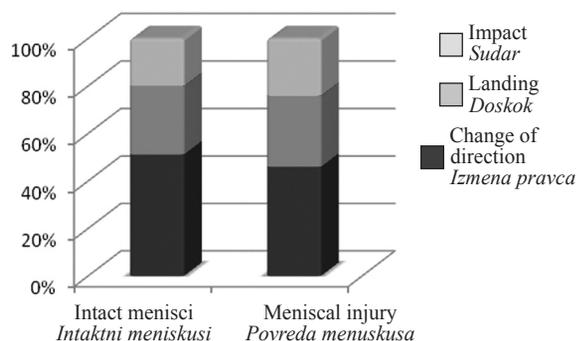


Graph 3. Meniscal lesions depending on BMI
Grafikon 3. Lezije meniskusa u odnosu na indeks telesne mase

also a statistically significant difference between the groups of patients with an injury of meniscus (on average after 10.75 months of delayed surgery) and those patients with an intact meniscus (operated on average 7 months after injury).

A sudden change of direction was the most common cause of injury. It happened in 244 subjects (49.2%); 145 patients (29.2%) were injured during landing, while in 107 patients (21.6%) injury occurred by contact mechanism and collision. There was a statistically significant difference ($p < 0.05$) when comparing the mechanisms of ACL injury between the group of patients with intact menisci and those diagnosed with meniscal lesion (**Graph 4**). The associated ACL and meniscal injury occurred significantly more often during non-contact injuries (changes in direction or landing) than in contact way (crash of opponent players) (75.8%: 24.2%).

The comparison of subjects regarding the localization of meniscal lesions revealed a statistical significance in relation with the body mass index between the patients with longitudinal medial meniscal rupture and those with intact medial meniscus ($p < 0.05$). Being overweight significantly increases the chances of associated injuries of ACL and posterior horn of lateral meniscus ($p < 0.05$) (**Graph 5**). On the other

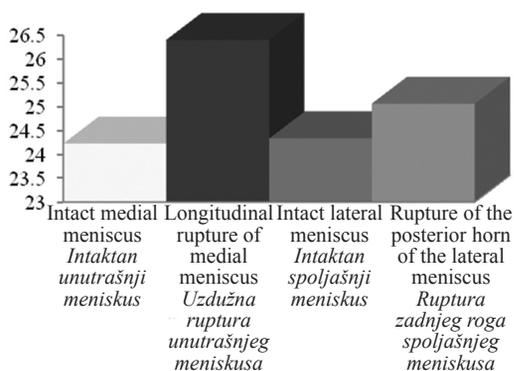


Graph 4. Meniscal lesions in relation to mechanism of ACL rupture

Grafikon 4. Lezije meniskusa u odnosu na mehanizam rupture prednjeg ukrštenog ligamenta

hand, the age of the participants had a statistically significant influence on the injury of the posterior horn of the medial meniscus, while not significantly affecting the localization of lateral meniscus lesions.

As for the concomitant ACL and meniscus injuries between men and women, there was no statistically significant difference ($p > 0.05$). However, male patients injured their medial meniscus more frequently than the lateral meniscus ($p < 0.05$). In male patients with associated injuries of ACL and meniscus, "bucket handle" meniscal lesion occurred also more often on the medial meniscus than on the lateral one ($p < 0.05$), while no significant difference was observed in women in this respect.



Graph 5. Average BMI among types of meniscal lesions
Grafikon 5. Prosečan indeks telesne mase među tipovima lezije meniskusa

Discussion

It has been thought for a long time that ACL reconstructions prevent degenerative changes in articular cartilage, which has not been confirmed by later studies [9]. However, they significantly affect the stability of the knee joint, reduce subsequent me-

niscal injuries, provide return to sports activities and improve the quality of life of patients [6, 9–11].

More than one-third of our patients (37.7%) with ruptured ACL had associated lesion of the meniscus. This finding is consistent with the literature [12–17], stating that a meniscus injury occurs in 35–79% of patients with ACL rupture.

Associated injuries are more common in men. In this study, 80% of patients were male. In other similar studies [19, 20] men are also more affected, the percentage ranging from 70 to 80%. A significantly higher proportion of the male population having this problem is attributed to the greater involvement of men in professional sports, especially in contact sports, where the forces acting on the knee joint are extremely strong. The results of this study show that there is no significant correlation between meniscal injuries and the sex of patients, in contrast to the results of a study conducted by the Kluczynski et al. [21], where it was found that male gender was correlated with significantly more frequent injuries, of both medial and lateral meniscus [16, 17, 19, 20]. Medial meniscal ruptures also dominated among our male patients.

The average age of the surveyed patients was 25.5 years (ranging between 13 and 57 years). The average age of patients with intact menisci was 24.7 years, while the patients with meniscus and ACL injury were 27 years old on average. The largest number of patients with meniscus lesion, almost half of the total, belongs to the population between 21 and 30 years of age [4, 14–17, 22].

Adequate preparation of all muscle groups and joints before any sports activity is a significant measure of injury prevention, especially among amateurs, who do not pay enough attention to this issue. Although Myklebust et al., as well Bjordal et al. [9, 23] found associated meniscus and ACL injuries more frequently in professional athletes; however, these injuries are more common in recreational athletes in our study sample. A possible reason for the frequent occurrence of meniscus lesions during professional career can be explained by competitive character and large number of rough starts, and strong wish to achieve better sports results [24]. On the other hand, our result is logical considering the fact that professional athletes are well prepared in full training and physically ready for extreme efforts. Besides, professional athletes are under constant control of club doctors and medical staff, so an ACL rupture is diagnosed early, it is monitored actively and treated to full recovery, thus reducing the occurrence of later complications, above all, meniscal injury.

Associated injuries occur more frequently by non-contact injury mechanism, such as landing or changes of direction, as well as by direct contact with other players. A multidisciplinary approach to non-contact knee injuries mostly speaks in favor of movements of the whole body that participate in the mechanism of injury [14, 25, 26]. The combination of anterior translation of tibia in relation to the fe-

mur and dynamic valgus position predict the injury, which may also include other joints of the lower extremities [25, 27].

The lateral meniscus usually gets injured in patients who have practiced contact sports such as rugby and American football. This result indicates an increase in the incidence of meniscal injuries in general, especially during practicing these sports, which is similar to the results of a study conducted by Chomiak et al. [28]. Medial meniscal tears occurred most often in our patients involved in "other sports" such as tennis, water polo, swimming, athletics and gymnastics. Besides water polo, other sports are non-contact, so we can conclude that the injuries of medial meniscus are largely associated with contactless mechanism of injury. These data correlate with data from the literature [14, 29]. Patients who are not engaged in any kind of sport activity are less exposed to injuries, such as ACL and meniscus [14, 29]. However, the simultaneous ruptures of both menisci and ACL are most frequent in this group of patients. The reason for such a result can be found in the fact that they are physically unfit and each provocative position of their knee joint can lead to lesions of some of its structures. However, a delayed diagnosis of ACL rupture is more frequent in those who do not go in for any sports than among athletes [14, 29]. ACL injury without meniscal lesions appeared most often in the patients who were injured while skiing, which globally carries a high risk for injury, although it is significantly more present in the Scandinavian countries and in United States [5, 9, 23, 30].

The dimensions of the body, such as height, weight, body fat content and body mass index were evaluated in several studies [31–34], suggesting that higher levels of body mass index may be a potential risk factor for non-contact injuries. Hypothetically, the higher value of body mass index may increase the force that is transmitted to the ligament apparatus of the knee joint and stabilizer muscles [35, 36]. Our results suggest that patients with a body mass index greater than 25 kg/m² have an associated medial meniscal tear significantly more often. Associated ACL injuries with ruptures of medial meniscus or tears of posterior horn of lateral meniscus are directly connected to obesity.

The injured knee joint requires timely and accurate diagnosis, which is a prerequisite for surgical intervention on time. Hagino et al. [6] registered the incidence of associated ACL and meniscus injuries in as many as 79.2% of cases, with a significant difference compared to our study because their patients had significantly more injuries of the lateral meniscus. In acute trauma, the incidence was lower (72.7% vs. 84.8% for the chronic ACL rupture). Regarding the locations of meniscal tears in acute trauma, the medial meniscus was injured only in 10.8% of cases, the lateral in 69.4% and 19.9% of patients had the rupture of both menisci. The situation was different in case of chronic injuries. In our study sample,

24.7% of patients had medial meniscus tears, 33.9% of them had lateral meniscus tears and 41.4% of patients had both ruptures [6]. The similarity between the results of our study and the above mentioned study is only in the conclusion that the lateral meniscal tear was commonly associated with an acute ACL injury, while medial meniscal tear with the chronic one.

Delay in ACL reconstruction is associated with more severe and painful meniscal and chondral injuries [18]. However, there are opposite opinions. Michalitsis et al. [13] believe that if ACL reconstruction is performed more than a year after the injury, there is a greater chance for serious cartilage damage, but without increasing the incidence of meniscal injuries. In our study, the average length of time elapsed between injury and surgical intervention in the patients with additional meniscal lesion was nearly 11 months, while in the patients with intact menisci it was significantly shorter (7 months). The results show that the percentage of intact meniscus decreases with time, while medial meniscus lesions and injuries of both menisci significantly increase. After ACL tearing, which is the most important stabilizer of the knee, other structures of the joint are overloaded by redistributing the forces, so there is a direct physical contact between the femoral condyle and meniscus. This results in degenerative damage of menisci and articular cartilage in the first place [13, 18, 37]. Lateral meniscal tear occurs more acutely, in a short period of time after ACL injury, while medial meniscus is most often injured if the period of time between the injury and surgical reconstruction of the ligament is longer [6, 36, 38–40]. Among the patients who underwent surgery within 6 months after injury, the percentage of medial meniscus rupture increases over the time while the percentage of lateral one stagnates, even decreases slightly. The reasons for these results could be due to the localization and anatomical characteristics of the menisci, as well as the relationship of medial and lateral meniscus with the anterior cruciate ligament, or different mechanisms of meniscus lesions [38].

Cerabona and Keene [41, 42] believe that the longitudinal rupture of medial meniscus is the most frequent injury associated with ACL injury. In our study sample, the most frequent location happens to be posterior horn tears of medial or lateral menisci. The patients with posterior horn tears of medial meniscus were on average four years older than the patients with intact meniscus. Among male patients, the longitudinal medial meniscal rupture occurs much more frequently than the rupture of lateral meniscus. In addition, incarcerated "bucket handle" type of rupture, which is a variant of the longitudinal rupture, occurs more frequently in medial meniscus in male patients. This result can be explained by different mechanisms of injuries, as well as by playing different sports at different sports surfaces [14, 25, 30].

One of the main drawbacks of this research is the intraoperative diagnosing of meniscal tears as well as the specific type and localization of rupture. Unfor-

tunately, although magnetic resonance imaging (MRI) can diagnose the localization of meniscal lesion with high certainty, this method is not available to all patients due to its high cost. The waiting lists in our public institutions are long and ligament apparatus injuries of the knee are not on the priority list of institutions. However, the value of this research is in its suggesting directions for future research, which could determine the temporal relationship with a specific type of meniscal lesions.

Conclusion

The meniscal injuries are associated with anterior cruciate ligament injuries to a very significant extent. They occur most often in sports activities, with no contact with opposing players. Concomitant injuries of anterior cruciate ligament and medial meniscus (posterior horn) frequently occur in obese men from the age group from 30 to 40, who are engaged in sports and in those who had their ligament reconstructed with a delay.

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