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THE EFFECTS OF AGE AND GENDER ON THE QUALITY OF LIFE AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

UTICAJ ŽIVOTNE DOBI I POLA NA KVALITET ŽIVOTA NAKON REKONSTRUKCIJE PREDNJEG UKRŠTENOG LIGAMENTA

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Summary

Introduction. The aim of the study was to determine whether there is was statistically significant difference in patients of different age and gender regarding quality of life and causes of postoperative knee instability after anterior cruciate ligament reconstruction. **Material and Methods.** The study included 776 subjects, aged 15 to 59 (average age 27 years), who we divided into groups by age and gender. All volunteered to complete the Knee injury and Osteoarthritis Outcome Score questionnaire. We examined the postoperative instability using clinical tests in order to determine its causes and incidence among the groups of patients. **Results and Discussion.** The average values related to pain during sports activities were the highest in the youngest group of patients, up to 18 years of age (81 points). Postoperative instability was reported by 27 patients (3.5%), more frequently by males. Among the causes of instability, the most common was a new sports injury, in 11 cases (40%), and inappropriate tunnel positioning in 7 (26%). The highest incidence of postoperative instability was found in the youngest group of patients, under the age of 18 years, (5%), and no such cases were found in patients aged over 41 years. **Conclusion.** There was no statistically significant correlation between the quality of life of younger and older patients after anterior cruciate ligament reconstruction, but there were differences in individual segments of the questionnaire. Postoperative instability was not common, but it was more common in males and in the youngest examinees. Inappropriate tunnel positioning and new sport injuries were the most common reasons for dissatisfaction after the primary surgery.

Key words: Anterior Cruciate Ligament Reconstruction; Quality of Life; Recovery of Function; Joint Instability; Age Factors; Sex Factors; Surveys and Questionnaires; Postoperative Complications; Reoperation; Athletes

Introduction

Sports activities improve the overall health, both physical and mental. However, the negative aspects of sports are sports injuries that may result in early termination of sports careers and a lower general quality of life (QOL) in athletes. The issue of the QOL in the modern society is complex and includes multiple fac-

Sažetak

Uvod. Cilj studije je da se utvrdi da li postoji statistički značajna razlika u kvalitetu života kod pacijenata različitog životnog doba i pola i da se analiziraju uzroci postoperativne nestabilnosti kolena, nakon rekonstrukcije prednjeg ukrštenog ligamenta. **Materijal i metode.** Ispitivanje je obuhvatilo 776 ispitanika starosti od 15 do 59 godina (prosečno 27), koje smo podelili u grupe prema životnom dobu i polu. Svi su dobrovoljno popunili *Knee injury and Osteoarthritis Outcome Score* upitnik. Postoperativnu nestabilnost objektivizirali smo kliničkim testovima i utvrdili njene uzroke i učestalost među grupama pacijenata. **Rezultati i diskusija.** Prosečne vrednosti upitnika u vezi sa tegobama tokom sportskih aktivnosti bile su najbolje u najmlađoj populaciji uzorka, do 18 godina starosti (81 poen). Postoperativnu nestabilnost smo zabeležili kod 27 pacijenata (3,5%), učestaliju kod muškog pola. Među uzrocima nestabilnosti, najčešća je bila nova sportska trauma, u 11 slučajeva (40%) i neadekvatan položaj tunela kod sedam (26%). Najmlađa starosna grupa, ispod 18 godina, imala je najviše postoperativnih nestabilnosti (5%), a nismo zabeležili nijedan takav slučaj kod pacijenata starijih od 41 godine. **Zaključak.** Ne postoji statistički značajna korelacija kvaliteta života pacijenata mlađeg i starijeg životnog doba, nakon rekonstrukcije prednjeg ukrštenog ligamenta, ali postoje razlike u pojedinim segmentima upitnika. Postoperativna nestabilnost nije česta, ali je učestalija kod muškog pola i u najmlađim starosnim grupama. Nezadovoljavajući položaj kalema i nova trauma predstavljaju najčešće razloge nezadovoljstva nakon primarne operacije.

Ključne reči: rekonstrukcija prednjeg ukrštenog ligamenta, kvalitet života, dob, pol, artroskopija, upitnici, nestabilnost, revizija, operacija

tors [1]; in recent decades, there has been a growing trend of knee joint sports injuries [1–7]. Sports-related injuries affect the adolescents, because elite sports demand early involvement of children in frequent and intense training process, but they also affect the increasingly active older population, because recreational sports may lead to joint degeneration [1, 4, 7].

Abbreviations

QOL	– quality of life
ACL	– anterior cruciate ligament
OA	– osteoarthritis
KOOS	– Knee injury and Osteoarthritis Outcome Score
ADL	– activities of daily living

The incidence of anterior cruciate ligament (ACL) injury in children and adolescents is constantly increasing, especially in those involved in competitive sports [2, 3, 5]. There is also an increasing number of reported injuries and ACL ruptures in children under 15 years of age [2, 3, 5]. Although it is well documented that postoperative instability is more common in adolescent girls and that women have a significantly higher risk of ACL injury [2–5], the dilemmas remain: why are men more prevalent in study samples; why does not ACL reconstruction prevent the development of arthrosis, as it provides stability of the knee joint and helps to restore proprioception; and when is the right time to return to sports activities. It is also not clear why active athletes have a higher incidence of postoperative complications, such as infections, than recreational athletes [8, 9]. Contemporary dilemmas are also related to the development of surgical techniques, especially in terms of whether additional anterolateral ligament reconstruction contributes to better stability [9] and if tibial osteotomy reduces the risk of arthrosis and rerupture [10].

The purpose of the ACL surgical reconstruction is not only to restore the knee joint function, but also to provide optimal QOL. Today, self-perceived health is considered as a reliable estimate of one's health [11].

The aim of this study was to determine the effects of age and gender on the QOL of patients after ACL reconstruction, as well as to analyze the causes of postoperative instability in our sample.

Material and Methods

A retrospective-prospective study was conducted at the Clinic of Orthopedic Surgery and Traumatology, Clinical Center of Vojvodina, with the prior approval of the Ethics Committee. The research included 776 patients with ACL injury who were surgically treated between March 2013 and January 2018. The sample included 626 male (80.7%) and 150 female (19.3%) patients (Table 1), aged from 15 to 59, average age 26.84 (SD = 7.90), who were divided into several age groups. The first group included 61 patients up to 18 years of age (7.9% of the sample), the second group from 18 to 25 years, 335 subjects (43.2%), the third group from 26 to 30 years, 153 patients (19.7%), the

fourth group from 31 to 40 years, 175 (22.6%), and the fifth group of 52 patients aged 41 and over (Table 2).

Most of the sample included recreational athletes, 434 (56%), followed by professional athletes 303 (39%), and finally non-athletes, 39 (5%). In relation to sports activity: 337 (43%) of the respondents were amateur athletes; 157 (20%) were at the regional, 156 (20%) at the republic, 91 (12%) at international level, and only 35 (5%) were non-athletes. The highest percentage of patients suffered injuries during sports activities (728 i.e. 95%), due to falls 24 subjects (3%), and in 14 subjects (2%) the injury occurred as a result of traffic accident.

Patients who signed a written consent to participate in the study were sent the Knee injury and Osteoarthritis Outcome Score (KOOS) questionnaire [12]. In addition to data on patients' postoperative QOL, general data were collected on the etiology of the injury, if they were professional or recreational athletes, as well as about their daily activities and potential knee instability. Data capture for each patient included the following parameters: gender and age distribution, cause of injury, type and level of sports activity, laterality, associated injuries, time elapsed: from injury to diagnosis, from injury to surgery, postoperative values of all 5 segments of the KOOS questionnaire, including symptoms, pain, activities of daily living (ADL), sports-related questions and QOL. The KOOS questionnaire is available, free of charge, on the Internet [12], translated from English and adapted to research. The questionnaire consists of 5 sections, which are scored separately. All items have 5 possible responses (Likert scale) with a score range from 0 to 4. The total score for each subscale ranges from 0 to 100 points, where 0 means severe problems, and 100 indicates problem-free functioning.

Two years after surgery, on average, the patients were invited for a final clinical examination, when X-ray checks were made of the operated knee joints. The postoperative instability was determined using Lachman and pivot shift tests. Control radiographs determined the position of the bone tunnels, containing graft fixed with interference screws. The correct position on profile X-rays was considered if the tunnels were located in the posterior quarter of the Blumensaat's line of the femur (at the ACL's footprint site) and if they were 65 ± 10 degrees in relation to the tibial plateau [13].

We have identified the causes of instability in gender and age groups and analyzed their incidence. The results of reoperations are also presented, revision arthroscopic ACL reconstructions (with bone–patellar tendon–bone graft, harvested from the opposite leg and fixed by interference screws), and in the end we analyzed return to sports activities after reoperations.

Table 1. Sex distribution and activities of daily living scores
Tabela 1. Polna struktura i skor "aktivnosti dnevnog života"

	N/Broj	Average/Prosek	SD/Standardna devijacija	Min./Min.	Max./Maks.
Male/Muško	626	93.2947	8.17541	32.50	100.00
Female/Žensko	150	94.6000	6.89129	57.50	100.00
Total/Ukupno	776	93.5470	7.95597	32.50	100.00

Table 2. Age groups distribution and sport and recreation scores**Tabela 2.** Vrednosti skora "sport i rekreacija" i slučajevi nestabilnosti među starosnim grupama

Age/Uzrast	N/Broj	Average/Prosek	SD/Stand. dev.	Instability/Nestabilnost	Percentage/Procenat
≤ 18	61	80.74	16.42	3	4.9
18-25	335	79.10	19.96	12	3.6
26-30	153	74.42	21.12	6	3.9
31-40	175	70.87	23.40	6	3.4
41 ≥	52	74.00	22.30	0	0
Total/Ukupno	776	76.11	21.17	27	3.5%

The study excluded subjects who were not volunteers, those who filled out the KOOS questionnaire incompletely, and those who have not responded to the final examination, which included clinical tests and radiographic evaluation of the position of the bone tunnels in the femur and tibia.

Statistical Package for Social Sciences (SPSS 21) software was used for statistical data processing. Numerical features were presented using mean values (arithmetic mean) and measure of variability (range of values, standard deviation), and attributive features using frequencies and percentages. The comparison of numerical values between the two groups was performed using the nonparametric Mann-Whitney test, while the nonparametric Kruskal-Wallis test was used to compare values between the data of three or more groups. The test of the correlation between the two characteristics was performed using Pearson's correlation coefficient. The $p < 0.05$ was considered statistically significant. The results are presented in tables and graphs.

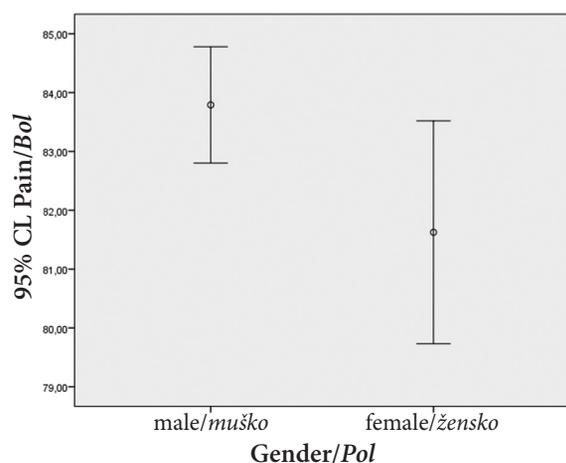
Results

No statistically significant difference was found between the genders on the Symptoms subscale (Mann-Whitney test; $U = 43454.500$; $p = 0.151$) and

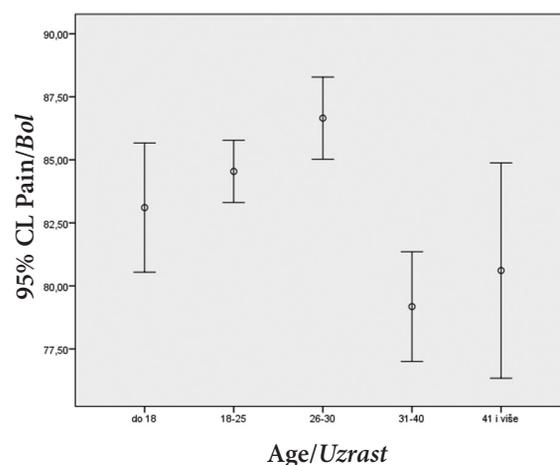
difficulties with knee movement, crepitus, swelling and joint stability.

However, there was a statistically significant difference between age categories on the Symptoms subscale (Kruskal-Wallis test; $H = 12.503$; $p = 0.014$). Subjects aged 18–25 years and 26–30 had statistically significantly lower scores than those aged 31–40 years (Mann-Whitney test; $U = 25346.500$; $p = 0.011$; $U = 11501.500$; $p = 0.026$). Respondents aged 31–40, had statistically significantly higher scores than those aged 41 and over (Mann-Whitney test; $U = 3303.000$; $p = 0.002$).

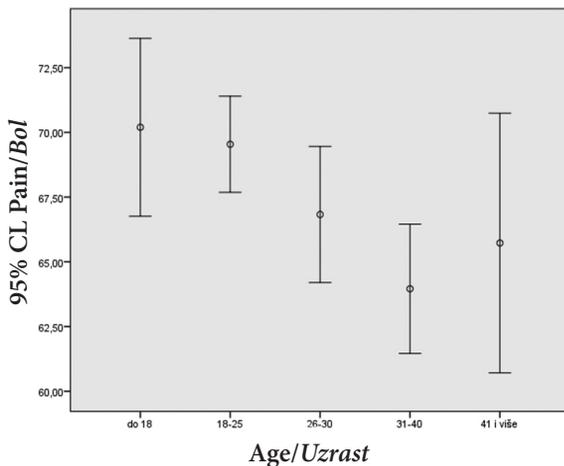
Men showed a statistically significantly higher scores on the Pain subscale and tolerated pain better than women (Mann-Whitney test; $U = 40458.500$; $p = 0.008$) (**Graph 1**). There was also a statistically significant difference between the age categories on the Pain subscale (Kruskal-Wallis test; $H = 44.499$; $p = 0.000$) (**Graph 2**). Subjects aged up to 18 years and subjects aged 18–25 had a statistically significantly lower scores than those aged 26–30 (Mann-Whitney test; $U = 3494.500$; $p = 0.004$ and $U = 22653.500$; $p = 0.039$). Respondents aged 18–25 years and 26–30 years had a statistically significantly higher scores than those aged 31–40 years (Mann-Whitney test; $U = 21327.500$; $p = 0.000$ and $U = 8159.500$; $p = 0.000$). Respondents aged 26–30 years had a statistically significantly higher scores than



Graph 1. Sex distribution and the total pain subscale scores
Grafikon 1. Ukupne vrednosti podskale "bol" prema polnoj strukturi



Graph 2. Age distribution and the total pain subscale scores
Grafikon 2. Ukupne vrednosti podskale "bol" prema starosnoj strukturi



Grafikon 3. Age groups distribution and quality of life scores
Grafikon 3. Kvalitet života među uzrasnim kategorijama

those aged 41 years and over (Mann-Whitney test; $U = 2891.500$; $p = 0.003$) (**Graph 2**).

We found that women had a statistically significantly higher scores in ADL than men (Mann-Whitney test; $U = 42193.000$; $p = 0.049$) (**Table 1**), but there were no statistically significant differences in the scores of ADL between age groups (Kruskal-Wallis test; $H = 9.178$; $p = 0.057$).

There was no statistically significant difference in the scores of the Sport/Recreation subscale between males and females (Mann-Whitney test; $U = 43841.500$; $p = 0.207$), but a significant difference was found between the age groups (Kruskal-Wallis test; $H = 18.934$; $p = 0.001$) (**Table 2**). The average values related to difficulties during jumps, squats, take off, sprints, landing and gym exercises, related to training and competitions were the best in the youngest group, up to 18 years of age (81 points) and they were better than in groups 18–25 years (79), 26–30 and over 41 (both 74), whereas patients in the fourth decade of life had the worst results (71 points).

Subjects under the age of 18 years had statistically significantly better scores than those aged 31–40 (Mann-Whitney test; $U = 4160.500$; $p = 0.010$). Those aged 18–25 had statistically significantly better scores than those aged 26–30 (Mann-Whitney test; $U = 21591.000$; $p = 0.005$), and subjects aged 18–25 years had statistically significantly better scores than those aged 31–40 years (Mann-Whitney test; $U = 23616.500$; $p = 0.000$).

In regard to the QOL subscale, females had statistically significantly higher scores than males (Mann-Whitney test; $U = 40480.500$; $p = 0.009$). There was a statistically significant difference in QOL scores between different age categories (Kruskal-Wallis test; $H = 15.934$; $p = 0.003$) (**Graph 3**). The results showed that subjects under the age of 18 years and between 18 and 25 years had a statistically significantly higher QOL scores than those aged 31–40 (Mann-Whitney test; $U = 4182.000$; $p = 0.012$; $U = 23471.000$; $p = 0.000$).

By analyzing the scores between 5 age groups in each subscale of the KOOS questionnaire, we observed a statistically significant correlation where predominantly younger respondents showed higher scores, except in the subscale ADL.

However, the overall correlation of age in the total number of respondents (not by age groups) and the obtained scores, we found that age statistically significantly correlated with the following scores: Pain (Pearson's correlation; $r = -0.129$; $p = 0.000$); Sport/Recreation ($R = -0.143$; $p = 0.000$) and QOL ($r = -0.122$; $p = 0.000$). Nevertheless, the statistically significant correlations were very small ($r < 0.3$), so no significant association between age and scores was established. The other two subscale scores showed no statistically significant correlation; Symptoms ($r = -0.032$; $p = 0.380$) and ADL ($r = -0.024$; $p = 0.498$) scores showed that there was no statistically significant correlation in the QOL of younger and older patients.

Postoperative instability was observed in 27 patients out of 776 (3.5%). In the total sample of primary ACL reconstruction there were more men 662 (81%) than women (19%), and the repeat instability was more frequent in males, because out of the 27 patients, 24 were men (88.9%) and only 3 women (11.1%).

Among the causes of postoperative instability, the most common were new sports injuries, in 11 cases (40.1%) and inadequate tunnel positioning in 7 (26.0%). Premature return to competition was the cause of instability only in the youngest groups, under 25 years of age, because three of these young athletes returned to competing too early (3–6 months after surgery, against the doctor's orders). A deep infection was the cause of one case of postoperative instability and the graft was replaced by another. In five cases the causes remained unknown (correct tunnel positioning, no other postoperative complications, no new trauma, and returned to competition in the prescribed 6–9 months after the primary surgery).

The highest incidence of postoperative instability was found in the youngest age group under the age of 18 years (4.9%) and there were no such cases in older patients over 41 years (**Table 2**).

Reoperations were performed in all cases with new sports injuries, all too anteriorly placed femoral tunnels (technically the best for reoperation) and in one case of infection. Out of 27 cases with postoperative instability, 19 underwent reoperation. So, out of a total of 776 patients, revision surgery was performed in 19 patients (2.5%). Eleven athletes have returned to sports activities (57.9%).

Discussion

According to various studies, the annual incidence of ACL injury in the general population varies between 0.01 and 0.08% [14–16], but the incidence is significantly higher among the population engaging in sports (1.5–1.7%) [5, 14, 16]. These injuries are generally more common in the male population [17–24], as was also the case in our sample, which included four times more males than females. The average age

of our patients was 26.8 years, which is consistent with other studies [17–24]. In our study, the biggest group included patients aged between 18 and 25 years, and that is the age when ACL injuries are most common [17–24]. The incidence of ACL injury has also increased in females, especially those younger than 20 and over 40 years of age [1, 5]. By analyzing ACL reconstructions in American high school basketball players, as many as 61% were girls and 39% were boys [25]. However, in the same group, after high school graduation (> 23 years), young men experienced ACL almost 7 times more frequently [25].

The incidence of ACL injury has led to the need to determine risk factors, causes of injury, and to develop preventive measures, in order to reduce the incidence of injuries. The risk factors are divided into internal and external, as well as to variable and invariable [26], so preventive measures are mainly aimed at correcting variable conditions in non-contact ACL sports injuries [27]. External factors include the characteristics (quality) of the playing surface, weather characteristics, type of sports footwear, and shoe-surface interaction [26, 28]. There is evidence that ACL injuries on natural grass are more frequent in dry conditions than wet field injuries [29], and that it is safer to play soccer on natural grass than on artificial ground [26]. Footwear may also be a potential risk factor, because it modulates foot fixation during the sport activity [30]. Due to the absence of surface friction, there are virtually no ACL injuries among hockey players, skaters, and ballerinas [20, 22, 23].

Internal factors are divided into anatomical, hormonal, neuromuscular, and genetic [25]. The most frequently studied anatomical factors are obesity, muscular contraction and specificities of the anatomical body structure [26, 28]. Women have, on average, a larger Q angle, a wider pelvis, a narrower intercondylar notch of the femur, lower leg muscle strength, increased knee valgus and more elastic ligaments, due to hormonal effects [5, 16, 25–29, 31]. The aggressive contraction of the thigh muscle in the slightly bent knee is also considered to be an important internal factor, especially in non-contact ACL injuries, as it leads to significant anterior tibial movement [32]. Increased posterior tibial slope angle over 10 degrees can also be a risk factor for ACL injury [10]. Because of this, by comparing genders at the same elite-level of sports, female basketball players have a 3.5 times increased risk of ACL injury than male basketball players, while female soccer players have 2.67 times more chance for ACL injury than male soccer players [33]. In our sample, the female patients showed a better QOL on average than male, since they are more engaged in the ADL after surgery, although postoperative pain is on average better tolerated by male subjects.

There are numerous disagreements about the impact of these isolated factors, but in our earlier study [23], we concluded that ACL injury in 450 operated patients was not significantly influenced by footwear type, warming, genetic predisposition, and daily therapy. Injuries occurred more frequently at competitions, at the end of matches, due to a landing or change of

direction, without contact with other competitors, on dry terrain, in insufficiently prepared athletes [23].

The incidence of ACL injury in children and adolescents among the total injuries is not high (up to 3%) but is constantly increasing, especially in those involved in competitive sports [34]. In the Australian population, an increasing number of registered ACL ruptures are reported in children under the age of 15 years, and most commonly, in the period after five years or more, recurrent or contralateral ACL ruptures occur [34]. Recent studies have shown that the overall standard ACL re-injury rate is 21%, of which 10% are injuries on the ipsilateral side in individuals younger than 25 years [34]. Patients under 20 years of age were found to have an 8.7–14.3% higher risk of ACL re-reconstruction, as early as 6 months after the primary reconstruction [35, 36]. Despite this risk, the younger patients in our sample are more satisfied with their postoperative sports performance than the older patients.

The athletes who return to high-risk sports at a professional level, which involve rapid changes of direction and pivoting (soccer, basketball, handball, American football, skiing), especially those younger (under 25 years), have a significantly higher risk of recurrent ACL rupture. Among all ACL reconstructions, only 7% of operated patients experience reruptures, while among professional athletes younger than 25 years, as many as 23% [37]. Contact sports are more likely to cause injuries in the younger population (< 39 years), while alpine skiing and other non-specific activities are the cause of injury at older age (> 40 years) [38]. Korean authors [38] recommend ACL reconstructions even in patients older than 50 years, especially in case of a major functional impairment. Although their values of functional scoring scales are lower, older patients have similar results in knee stability and ligament strength relative to younger patients [40]. Thus, in our sample, patients in the fourth decade of life tolerated postoperative symptoms better than younger patients.

Revision surgery after ACL reconstruction is no longer a rarity. Reruptures, after primary reconstruction, occur in 1–13% of cases [2–8, 16, 20]. We registered 3.5% of them. Comparing the results of ACL reconstruction between adolescents and those over 20 years of age, better functional results were observed in adolescents after returning to sports after 8 months, but after 12 months after surgery, the difference was not significant [2]. However, due to the early return of adolescents to competitive sports, they were at 30% higher risk of revision surgery, as soon as two years after the primary reconstruction [2–4]. We concluded the same. The causes were adolescent age, inadequate muscle strength (below 90% of strength of the operated in relation to the healthy leg) and premature return to competition, which may need to be delayed for at least 9 months after surgery [2–7]. Individuals with a predicting factor engaged in professional sport are three times more likely to undergo revision surgery during adolescence [4]. Comparing female soccer players with ACL injury and uninjured players from the same football team, it was concluded that female play-

ers with ACL reconstruction had almost 5 times higher rates of new ACL injuries and 2–4 times higher risk of other new knee injuries [5].

In our study, postoperative instability was more common in males, because 24 of the 27 patients were male (89%), and only 3 female (11%). Other authors have also had more male patients in the sample of revision surgery [2–4, 20]. Although ACL revisions provide better knee stability, the results of the KOOS questionnaire after revision are significantly worse than results after the primary surgery [35, 36]. It is a similar case when it comes to returning to sports activities; only 58% of athletes successfully return to competitions after ACL revisions and 53% after bilateral ACL reconstructions [40].

The orthopedic surgeons are most commonly asked on the time their patients can go back to training. The assessment is individual and there is no consensus. Return to the previous competitive level occurs in 65–88% of operated patients [15–21]. The majority of authors today suggest granting return to sporting activities 9 to 12 months after surgery [2–7]. Others, like us, if there are no complications allow athletes to return to training 6 to 9 months after surgery [19–21, 41]. There are also those who claim that it takes more than 12 months to safely regain knee stability [42–44]. Our operated patients returned to sports competitions (matches) in 75% of cases, 8 months after ACL reconstruction on average, unless serious complications occurred (such as rerupture, deep infection [8], cyclops lesion [46]), when adequate muscle strength was achieved (at least 90% the strength compared to the uninjured leg) [22].

Premature return to competition was recorded only in the youngest groups of our sample, under the age of 25 years, because some of these young athletes competed 3–6 months after surgery, although they were aware of the possible consequences. Among the causes of postoperative instability in our sample, the most common were new sports injuries and inadequate tunnel positioning (66% of revision cases). Milankov et al. [20] also concluded that an unsatisfactory position of the bone tunnels and new trauma are the most common causes of post-operative knee instability, and that the mean Lysholm score after reoperation was only 88 points (65–90), which is a much poorer result in comparison to primary reconstruction, ranging from 92 to 98 points, according to various studies [8, 19, 21]. In our study, there were cases where causes of postoperative knee instability remained unknown, especially in patients with correct tunnel positioning, who had no postoperative complications, no new trauma, and returned to competition in the prescribed 6–9 months after the primary surgery.

Less than 50% of all athletes achieve the same level of sports performance after the revision surgery [45]. Milankov et al. [20] had slightly better results of reoperations, as only 18% of patients stopped training. Of our 19 patients who had revision surgery, only 58% returned to sports activities, which is a significantly worse result compared with the primary ACL reconstruction (60–81%) [8, 19, 21]. Our

eight surveyed athletes explained their ending of sports career by waiting too long for two operations, long-term rehabilitation, dissatisfaction with the results of reoperation, inability to regain muscle strength, athletic form and place in the team, as well as changing their lifestyle (age for starting a family).

Investigating the impact of gender on QOL in 16,930 people with ACL injury showed that female patients had worse preoperative and two-year postoperative KOOS scores than men [4]. Also, women are more likely to experience recurrent ACL injury than men and find it more difficult to return to the level of sports performance they had before surgery compared to men of the same age and same level of performance [36]. In contrast, there are studies, including ours, that found that overall QOL, 1–2 years after ACL reconstruction, did not differ between the sexes [19].

In order to understand the pathomechanisms of ACL injury and offer effective prevention programs, understanding the biomechanics of movement during activity is necessary [46]. It is postulated that flexion, adduction, internal hip rotation, knee valgus position, anterior translation, and external rotation of the tibia may put ACL at increased risk for rupture [29, 30, 47]. It is called a “no return” position [46]. Video analysis of ACL sports injuries concluded that they occur most often without contact with other players, on jump or step when the athlete’s knee is flexed less than 30°, with increased valgus and internal rotation of the tibia, and at the time of injury women presented with significantly higher values of these angles than men [47]. In order to prevent knee injury, especially ACL, identification of athletes at-risk may be the first step before the creation and implementation of specific training programs aimed at modifying identified risk factors, reducing injury rates, and preventing osteoarthritis [41–44, 48]. Plyometric exercise, balance training, core stabilization and neuromuscular controls have been shown to play a role in the prevention of injury [46]. These workouts lead to a decrease in knee valgus and increase knee flexion during landings, reducing sudden changes in direction of movement and jumping. Training designed in this way should be applied 2 to 3 times per week, for at least one month, to achieve expected kinematic changes [49]. The annual incidence of ACL injuries is most common among professional athletes, where it is 0.15–3.7% [14, 15]. So, if in one major sports association, with about 300 professional athletes of all categories, only 1% of members are injured annually, three athletes have ACL injury during a season. There is evidence that by implementing adequate preventive training, as many as two injuries may be avoided [49]. Such preventive training may significantly (67–84%) reduce non-contact injuries, especially among female soccer players [6, 46, 49, 50].

The disadvantages of this study are related to the subjective judgment of patients on their own health, which may not always be valid, because patients often try to “please” the physicians, social and family expectations, or may be hypochondriacs [51]. Therefore, clinical evaluation and the patient’s personal assessment of health and QOL often do not correlate

[51]. In order to have a complete picture of how the injury affects all spheres of life, additional objectification of the patient's QOL is required, using measurement instruments. Also, given the risk of degenerative changes, it may be helpful to perform X-rays or second look arthroscopy 10–20 years after the primary operation, which could also be a task for some other researches in the future. Already mentioned unknown causes of postoperative instability of patients who had correct tunnel positioning, no other postoperative complications, no new traumas and who returned to training at a proper time, are challenges for future researches, because if we find all the causes, we will know how to treat them.

Conclusion

There is generally no statistically significant correlation between the quality of life of younger and older patients after anterior cruciate ligament reconstruction, but there are differences in some segments of the questionnaire.

Women have a better quality of life concerning activities of daily living than men, because they are more engaged with them after surgery. Patients in the fourth decade of life tolerate postoperative symptoms better than younger ones. Generally, postoperative pain is better tolerated by men than women. Younger patients, over the age of 25 years, are more satisfied with their participation in sports activities than older patients. Postoperative instability was not common and it was found in 3.5% of cases, predominantly in males. It is generally more common in the youngest patients, under the age of 25 years, and there were no such cases in the fifth decade of life.

Incorrect bone tunnel positioning and new traumas were the most common causes of recurrent knee instability. Causes of increased risk of reinjury and surgery revision in adolescents were inadequate muscle strength and premature return to competition. Results of anterior cruciate ligament reoperations were significantly worse than of the primary reconstructions.

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