



Quality of the life of people with a bilateral tear of the anterior cruciate ligament of the knee

Dijana Avdić^{1*}, Amila Jaganjac¹, Amila Kapetanović², Amra Mačak Hadžimerović¹, Aida Pilav^{1,3}, Bakir Katana¹, Bojan Pavlović¹

¹Faculty of Health Studies, University of Sarajevo, Sarajevo, Bosnia and Herzegovina, ²Institute for Medical Rehabilitation and Spa therapy, Reumal, Fojnica, Bosnia and Herzegovina, ³Clinical Center of the University of Sarajevo, Sarajevo, Bosnia and Herzegovina

ABSTRACT

Introduction: A number of people with facial injuries after surgical treatment one knee time comes and a violation of the opposite knee. These injuries have a major impact on quality of life (QOL) if they are not treated properly, but also have consequences and after surgery. The aim of this paper is to analyze the questionnaires used to assess the QOL after mutual ruptured anterior cruciate ligament (ACL) and to make recommendations for optimal use of the same. Our goal is to establish a correlation between the results obtained from questionnaires used descriptive answers to descriptive questions about aspects of everyday life, aspects of physical activity as well as aspects of the personal perception of the current health and satisfaction with it.

Methods: We analyzed questionnaires used to evaluate the QOL after a bilateral rupture of the ACL, which are listed in the attached work. In accordance with the subject of research, in this paper was used the following scientific research methods: A method of deduction, analysis, classification, comparison, and analysis methods of written documents.

Results: By searching the PubMed database for the purpose of this master's thesis under the terms "unilateral rupture ACL" we came across a 2792 articles, while the term "bilateral rupture of the ACL" retrieved only 73 articles, "contralateral ACL rupture" 192 articles, and "QOL ACL" 41 articles. The most important dates in our study are certainly "QOL after bilateral rupture of the ACL," where we all find only two articles on this topic.

Conclusion: The most commonly used questionnaires to be used in assessing the success of treatment and QOL after a bilateral rupture of the ACL are: QOL, international knee documentation committee (IKDC), knee injury and osteoarthritis outcome score, hospital for special surgery knee ligament rating form, activities of daily living, SF-36, and Western Ontario and McMaster Universities. IKDC proved to be most suitable for patients with ACL rupture in this study.

Key words: Anterior cruciate ligament; quality of life

*Corresponding author: Dijana Avdic, Faculty of Health Studies, University of Sarajevo, Bolnička 25, 71000 Sarajevo, Bosnia and Herzegovina. E-mail: dijana.avdic@jhsci.ba

Submitted: 20 February 2017/Accepted: 28 March 2017

DOI: <https://doi.org/10.17532/jhsci.2017.507>

INTRODUCTION

The knee injury, most specifically the injuries of the anterior cruciate ligament (ACL), (Ligamentum Cruciatum Anterius - ACL) happen more often as a result of heightened activity in sports, a higher



degree of exertion at work as well as the involvement in traffic accidents. A tear in the cruciate ligament of the knee most commonly occurs during sporting activities and represents the "beginning of the end" of the knee unless it is remediated surgically. In this case, the tear leads to several additional lesions both on the level of the soft tissue and bone structure of the knee and promotes faster growth of secondary degenerative changes. The incidents of ACL occur in 1 of 3.000 athletes. These injuries represent a significant epidemic problem, especially since they occur among youth engaged in sports and the working population (1-3).

Considering that in the epidemiological studies of injuries of the ACL of the knee, 1.5–1.7% of cases occurred in the healthy population active in sports, the quality of life (QOL) within this population takes an important place in the overview of problems with knee injuries, especially if we take into consideration the fact that this kind of injury is common in the young population active in sports. A certain percentage of these injuries result in the repeated injury of the same knee, and another percentage in the injury of the ACL of the opposite uninjured knee.

It is expected that the prolonged inability to practice sports and attend competitions within this population is perceived as a lowered QOL (4). The goal of reconstruction of ACL is to reinstate the stability of the knee and a higher QOL, maintain range of motion and prevent further changes of the cartilage areas and meniscus, as well as to protect the knee from new injuries. However, a certain number of people with ACL injury, after the surgical treatment of the knee, develop an injury of the other knee with time. The reason for this it has not yet been explained, but different assumptions are made about the cause of contra-lateral injury (1).

Around 100,000 injuries of anterior cross ligament have been documented in the United States per year; however, a very small number of studies of bilateral ACL rupture is available in the literature and are mostly presented as case studies (5-7).

Isolated ACL injuries occurred with the mechanism of hyperextension and inner rotation, and the second mechanism is landing on a flexed knee or fall from heights as with parachutists (8). A tear

in the ACL accounts for 40% of all knee injuries. 56–70% of all tears are self-induced (4). Ekstrand and Gillquist state in their work that the most common injuries occur in football. They observed 86 respondents through a period of 2 months, and quote that most of the injuries occurred as a result of the inflexibility of muscle structure and the differences in the ratio of the associated joint systems (9). Knappik and Ramos state that the functioning of the knee joints depends on the correct distribution of strength between agonist and antagonist (*mm. quadriceps m. biceps femoris*). The strength of the muscles on the backside of the thighs should be 60–100% of the strength of the thighs at the front side of the same leg, depending of the speed of movement. During slower movement, the percentage of the associated joint systems becomes smaller and during every angular increase of speed of the movement inside the knee the ratio is getting closer. Every deviation in this ratio results in a higher probability of an injury in the knee system. The relation between both legs is of the same importance. Every difference can result in an overcharge of the specific joint system, mostly the weaker leg (10). Grace and Associates conducted studies about injuries and reported that an imbalance in the muscle structure between the dominant and subdominant leg above 10%, can be the element that causes potential injuries. Furthermore, Kvist states that an imbalance higher than 15% increases the possibility of injury by 2.6 times (11,12).

The injury is caused by the mechanism of landing or the sudden stopping with an exterior rotation of the tibia (3). Then, depending on the type of injury, the intensity of strength that acts on the knee joint as well as the individual body strength of the person, partial or complete termination of continuity of the anterior connection is caused. Often this kind of injury is combined with injuries of other soft tissues on the knee joint, especially other ligaments and the meniscus. These injuries can develop during the first injury of ACL or subsequently within newly-incurred injuries of the knee joint, mostly caused by the insufficient stability of the knee joint. At the moment of the injury, the person feels like "something broke" in the knee joint, and there is a momentary instability as the knee "escaped." Symptoms include pain, swelling of the knee in

a 6 hours ratio, limited movement and instability of the knee, especially during sudden moves. This instability does not have to manifest in the initial phase due to the contraction of the surrounding muscles, which can obstruct the clinical examination of the newly-incurred injury (13,14).

The surgical treatment consists of the reconstruction of anterior cruciate connection, the autologous or homologous graft. Lately, the ACL reconstruction has significantly improved due to the development of arthroscopic surgery techniques and a better understanding of anatomy and biomechanics of the ACL. The arthroscopic technique of reconstructing the anterior cruciate connection has significant advantages in the sense of better cosmetic results, a better visualization and possibilities of precise surgery techniques with decreased possibilities of development of arthrofibrosis (15-17).

Anterior injuries lack defined guidance for the optimum governance of the same. Simultaneous ACL reconstruction is considered an appropriate strategy for directing bilateral injuries of ACL (18-21).

Most of the reasearches show that a simultaneous reconstruction is effective in terms of time, which, in turn, leads to a faster rehabilitation and therefore to a faster return to everyday activities. In his, research Lasronisar presents results from 11 patients that underwent a bilateral construction of the ACL using allograft. They recognized an extended frequency of complications compared to a one-sided procedure of reconstruction (21). Similarly, Jarii Shelbourne, in his research which involved 28 patients who underwent a bilateral construction of the ACL, and a controlled group of patients with a one-sided procedure, points to significant differences in the post-surgical intensity of pain and the use of analgesics (22). Hechtmanisar states that the simultaneous bilateral reconstruction is an efficient, fast and cost-effective method. Overall, the time of rehabilitation is shorter, and patients are faster returning to their everyday activities (23).

Our aim was an analysis of a questionnaire that is used for the evaluation of the QOL following the bilateral rapture of ACL, and the recommendations for its optimal use. We also wanted to analyze the connection between the most commonly used surveys and value of benefits as a measure for the

QOL. Next, we wanted to evaluate the applicability of the survey in regard with specific problems in similar studies, where bilateral ACL injuries of the knee are evaluated. Next, we determined the correlation between the results of survey with received descriptive answers on given questions about aspects of everyday life, aspects of physical activity, as well as aspects of the personal perception of health and satisfaction with it.

METHODS

The research is retrospective, analytically-descriptive, comparative and for the most part of a clinically applicable character. During this research, we used available data from official medical database as material. We analyzed surveys which are generally used for the evaluation of the QOL after a bilateral rupture of ACL. According to the subject of this research, the following scientific methods are used in our work: Method of deduction and analyses, method of classification and comparison, and method of analyses of written documents.

RESULTS

By searching the PubMed database for the purpose of this master's thesis under the terms "unilateral rupture ACL" we came across a 2792 articles, while the term "bilateral rupture of the ACL" retrieved only 73 articles, "contralateral ACL rupture" 192 articles, and "QOL ACL" 41 articles. The most important dates in our study are certainly "QOL after bilateral rupture of the ACL," where we all find only two articles on this topic. The most commonly used questionnaires to be used in assessing the success of treatment and QOL after a bilateral rupture of the ACL are: QOL, international knee documentation committee (IKDC), knee injury and osteoarthritis outcome score (KOOS), hospital for special surgery knee ligament rating form (HSS), activities of daily living (ADL), SF-36, and Western Ontario and McMaster Universities (WOMAC). IKDC proved to be most suitable for patients with ACL rupture in this study.

DISCUSSION

Following an ACL reconstruction, the QOL can be evaluated by specific and non-specific generic

research. It is suggested that the QOL is routinely evaluated in the case of insufficiency of ACL (24). SF-36 questionnaire has been evaluated as a valid tool in the evaluation of the QOL in patients with muscle/skeleton pathology (25).

In past two decades, many instruments and scales have been introduced related to the knee. These measure results from the patients' point of view. Only a few of those instruments have been validated for reliability, validity, and sensibility in terms of adequate answers (26).

With a purpose of adequately monitoring the outcome of surgical treatments, the surgeons use specific questionnaires that are completed by patients (PRO). These are questionnaires that measure specific health aspects. They are completed by the patients without any interference by doctors or other persons. PRO questionnaires are an important tool to assess the success of certain surgical treatments as well as the quality of the patient's life. The professional development of specific PRO questionnaires for the treatment of knee injuries within young and active patients leads to a better, more objective evaluation of surgical procedures on the knee. Based on this, we can improve treatments of the patients and enhance chances for a successful outcome (27).

Through an insight into literature we found that most commonly used questionnaires for the monitoring of the QOL within patients that underwent bilateral reconstruction of LCA are: QOL, IKDC, KOOS, HSS, visual analog scale (VAS), ADL, Americans Academy Of Orthopedic Surgeons (AAOS), Lysholmscore, SF-36 questionnaire, and WOMAC.

Properly designed clinical researches about the function of the knee and its influence on everyday live, and more generally on the QOL, must use relevant instruments to analyze illness and estimate response on treatment (28). The result of a treatment of knee injuries is based on objective clinical results and functional tests (29).

During the past two centuries, clinical personnel has concluded that the patients' perception is necessary to receive a complete picture of therapy effects of the injured knee (30). New measuring instruments (questionnaire) are designed in a way that includes patients, their subjective opinion on the recovery,

severity of symptoms, pain level, and functional restrictions that influence everyday life (31,32).

In their research, Tanner and Associates set a goal to demonstrate which of the questionnaires from the literature are the most appropriate to evaluate the QOL within people with knee injuries. Their research has shown that the questionnaire Mothadi QOL about the QOL had the best results. It has the highest number of questions 27/31, and the biggest percentage of questions (87%) related to the QOL among people with ACL injuries. These questions have been qualified as the most relevant by patients. The IKDC questionnaire, which has 72% of questions (13/18), was supported by 51% of patients, who deemed it important regarding the QOL. KOOS questionnaire contains 42 questions where 51% of patients support only 19 (45%). The same number of respondents has supported 7 out of 10 questions in the HSS questionnaire, and they have found it important for the QOL after ACL injury. The other five instruments (Cincinnati, Lysholm, VAS, ADL, and AAOS) were deemed as less relevant by patients. The patients considered the most important questions to be the ability of post-operational active involvement in sports and recreation, as well as those regarding a fear of renewed injury (33).

QOL- questionnaire

ACL - QOL was published for the first time in 1993 in a section about the evaluation of results after ACL reconstruction in a surgery book. It was developed for the purpose of collecting patients' opinions regarding problems with the knees. ACL-QOL represents a survey designed to measure the QOL within patients with ACL injuries. It consists of 32 questions and 5 domains: Physical symptoms (5 questions), restrictions in work (4 questions), recreational activities (12 questions), style of living (6 questions), and social and emotional problems (5 questions). Every question has one VAS from 0 mm (exceptionally worried) to 100 mm (I'm not worried). The results are calculated in percentage including all five domains. The highest QOL is calculated as 100%. This is a good, very reliable questionnaire (standard mistake measures 6%) and it is adjustable to changes (34).

IKDC

This is a questionnaire specifically designed for the knee, but not specifically for the disease of the same. It consists of a demographic section, a section about current health, a section related to the knee, the history of injury/illness related to the knee, and a physical examination of the knee. It consists of 18 questions which are represented in percentage in the final result come in percentages. The favorability of the questionnaire is strengthened by the factor of its sensibility in regard to the result of individual study cases. In one of the cases, the IKDC shows that the pre-operative strength of the quadriceps could be predicted in a period of 6 months after the ACL reconstruction. The IKDC questionnaire is a combination of a subjective estimation from the patient's side as well as an objective evaluation of the functional state of the knee. In the subjective evaluation of the knee function from the patients' side, three main categories are represented and further divided into subcategories: Symptoms, level of sporting activity, and knee function. The result of the subjective rating is the sum of points which are converted in percentage using the formula: $\text{IKDC questionnaire} = (\text{sum of assessment}/\text{maximum sum}) \times 100$. An objective evaluation is made by a physiotherapist, and the following modifiers are evaluated: A swell in the knee, passive movement, ligament system, evaluation of function of medial, lateral and anterior compartment, and state of the location where the graft is taken from, X-ray of the knee, functional tests (one leg hop test). Based on these parameters, the patients are divided into four categories: A, B, C, and D. The lowest grade within each parameter of the categorization is taken into consideration (35).

KOOS

This is an extension of WOMAC. It evaluates the functional status and QOL in younger and/or more active population with any kind of knee injury and increased risk of osteoporosis. KOOS is valid for use in the USA, Sweden, Singapore, Iran, France, the Netherlands, and Portugal. It serves the purpose of a few orthopedic interventions, as total arthroplasty, injuries of ACL, meniscectomy, and different stages of osteoarthritis. It is a reliable and valid instrument for the evaluation of conditions in athletes

with ACL reconstruction (36). KOOS is a specific questionnaire that contains 42 items, developed for monitoring patients with ACL injuries, injuries of the meniscus and osteoarthritis. It consists of five separated domains: Pain, symptoms, limitations in everyday activities, recreation, and QOL. Every question has five offered answers (always, often, sometimes, seldom, and never) (37,38).

The Lysholm score scale

It was implemented by Lysholm and Gillquist in 1982. A revised form was published in 1985, which is also in use today. For an evaluation of the meniscus injury, an altered version is available. The Lysholm scale is designed with an emphasis on the tracking of symptoms of instability followed by ligament reconstruction. It consists of five symptoms and three types of activities with different levels of gradation to be chosen by the patient. The performance is graded from 0 (worst) to 100 (best). Result ≥ 95 indicates a knee without difficulties, result 84–94 indicates problems during sporting activities, score 83–65 indicates problems during sporting activities and sometimes in everyday life, score < 65 indicates constant problems in everyday life. The Lysholm test appears to be a test with good certainty and validity (39).

Questionnaire about ADL

In this questionnaire, the patients report functional limitations in daily activities caused by knee disease. ADL consists of 17 items and evaluates the influence of symptoms and functional limitations in daily activities. The average result ranges from 0 to 100. Many researches on a large number of patients have shown that the scale is valid and sensitive for this type of research (40).

Questionnaire SF 36

It consists of 36 entries, whose content refers to different aspects of health conditions. The referred test measures health in multi-dimensional fashion: Body functionality, limits in functionality caused by health, bodily pains, social functioning, physical limitations caused by emotional suffering, vitality, mental health, and general self-assessment of health conditions. SF-36 measures the subjective sense of

health through eight different dimensions of health. It represents the practical applicability of two major theory-based and empirically proven health concepts as in physical and mental health, as well as two of its manifestations: The functioning and benefits (41,42).

WOMAC

WOMAC was developed in 1988 with the purpose of the evaluation of patients with hip and knee diseases and has remained one of the most commonly used questionnaires regarding those patients. It consists of 24 questions divided into three categories: Pain, immobility, and physical activity. There is also a shorter version of WOMAC with 12 questions (12-item WOMAC). There are two versions of questionnaires, the one that uses VAS and the other that uses Likert's scale. It is questionable if there is a difference in results if different scales are used (43,44).

Tegner score

The Tegner score is focused on activities following the lesion of ligaments, and it is based on 10 levels of activity. The evaluation given by Tegner's questionnaire provides us with information on the highest levels of activity. All patients give information about their level of activity before the injury, before the surgery and 3–6 months after the surgery. The extent of activities is divided into 10 levels (39).

HSS

The questionnaire is specifically designed for surgical departments which are involved in the reconstruction of knee ligaments with a purpose of monitoring the recovery. The examiner submits symptoms and clinical signs: Pain, functioning, size of movement, muscular strength, shortened flexion, and instability. All questions are on the scale from 0 to 100. Total results are categorized: Excellent (85-100), good (70–84), average good (60–69), and bad (<60) (39).

The subjects of bilateral injury of the ACL as compared to unilateral injuries of the same have seldom been discussed in scientific literature. Following, we have separated works that present success of treatment of the bilateral reconstruction of ACL.

Ristic and associates conducted a study with the purpose of analyzing effects of both-sided reconstruction of ACL on patients' QOL and a return to sporting activities. This survey included 32 surgically-treated patients during a period of 10 years. The participants completed a modified package KOOS questionnaire and gave information on pre-surgical and post-surgical periods. The outcome of these studies states that the correlation between age and the achieved subjective level of physical activity, as well as the parameters of Lisholm's scale after second knee surgery, did not show major differences. The average values from the KOOS questionnaire are 95.1–98.2 point. In conclusion, they state that a return to the same or higher level of sporting activities after ACL reconstruction is one of the requirements for the emergence of tearing of ligaments of the other knee. Athletes lose 2½ years on average before they can return to competitions. Even though satisfactory results were recorded, only every second athlete with bilateral injury and a previous reconstruction procedure was able to return to competitions fully (45).

Most of the authors state similar results. Orchard and Associates have discovered that the biggest risk of an opposite injury of ACL is likely to occur due to a previous reconstruction of the same on the opposite leg in the past 12 months (46-50).

According to Swedish researchers, people with bilateral ACL have a lower function of the knee, lower activity levels, and a lower QOL compared to patients who had a reconstruction of a single ACL. Lysholm's score for bilateral injury patients was 82 points, which is considerably lower comparing to patients who underwent unilateral ACL reconstruction, 94 points. Even re-operated patients with complications had better results (39).

Based on this research, Motohashi and Associates have concluded that life quality within the people with unilateral ACL injury is far better than in people with bilateral ACL injury. Only 10% of patients with bilateral injury were able to perform sporting activities without limitation, compared to 35% of successful patients with unilateral injuries (51).

In most of the studies the percentage of subjects that returned to active sporting activities after the first operation is about 75% and after second operation 10–40% (39,45,52).

Analyzing patients after bilateral ACL reconstruction Ardern and Associates have discovered that 60% of athlete patients have not returned to their previous sporting activities, the cause of which was grounded more in subjective perception rather than lower life quality. Patients have reported the following reasons: Distrust in the knee (27), fear of new injuries (24%), and decreased function of the knee (22%) (52).

In the studies performed in the USA, Souryal and Associates established that out of 1120 patients with ACL injuries 45 were bilateral. The average age of the patients with 1st time injury was 19.8 years, and the time it took for the injury in the second knee to occur was 3.9 years (53). In their studies, Wriht and Associates stated that the higher risk of occurrence of collateral rupture of ACL knee is grounded in the insufficiency of rehabilitation of the opposite knee during recovery from unilateral injury (54).

One of the main goals of ACL reconstruction is the return to sporting activities. However, Goddard and Associates stated that this increases the risk of bilateral injury. In their study, IKDC questionnaire was used, and they gained good results (85.6 scores) where 55% of the patients continue difficult and very difficult activities. That leads to the possibility of recovery of people with bilateral injury, as well as the ones with a unilateral injury of ACL and return to sporting activities (55).

About 12% of patients with ACL injury in the period of 5 years gain contra-lateral injury, too. Fältström and Associates conducted a study about the QOL and the level of activities within people with bilateral ACL injury. This study included 147 patients aged 18–45 with bilateral ACL injury. 83 of them complied with the criteria for their involvement in the study; they needed to have their first ACL injury 12 years ago excluding any other bigger knee injuries. The patients who went through unilateral ACL reconstruction ($n = 182$) were used for comparison. Patients with bilateral ACL injuries had significantly lower values on the KOOS subscale for pain, sport and recreational functions and QOL measured with ACL-QOL score. In conclusion, they state that patients with bilateral ACL injury have lower knee functions and life quality comparing to patients with unilateral ACL reconstruction. Their activities

have changed, and they are not satisfied with their current activities (39).

CONCLUSION

The most commonly used questionnaires in the evaluation of the success of therapy and life quality followed by bilateral ACL rupture are QOL, IKDC, KOOS, HSS, VAS, ADL, AAOS, Lysholm score, SF-36 questionnaire, and WOMAC.

A significant connection has been established between the use of questionnaires and the beneficial values of life quality. In this study, the IKDC has proven to be the best option with patients who are afflicted with ACL injuries. The personal perception from the patient's side regarding the life quality after a surgery of the second knee is lowered compared to the one before the first surgery. The subject "QOL after bilateral ACL injuries" is insufficiently represented in research activities, here as well as abroad. It leaves space for more detailed observation, research, and analyses. Limitations of the above-mentioned questionnaires for evaluating the limiting of activities, as one of the very important life quality segments, is the fact that it relies on patients' estimation on his/her functional abilities. When someone does not participate in activities, for any reason, the self-examination of the ability to perform activities can be either overrated or underestimated.

CONFLICTS OF INTEREST

Authors declare to have no conflicts of interest.

REFERENCES

1. Kiapour AM, Murray MM. Basic science of anterior cruciate ligament injury and repair. *Bone Joint Res.* 2014;3:20-31. <https://doi.org/10.1302/2046-3758.32.2000241>.
2. Labella CR, Hennrikus W, Hewett TE. Anterior Cruciate ligament injuries: Diagnosis, treatment, and prevention. *Pediatrics* 2014;133(5):1437-50. <https://doi.org/10.1542/peds.2014-0623>.
3. Koržinek K. *Arthroscopy of the Knees, Shoulders and Ankles.* Zagreb: Medicinska Naklada; 2003.
4. Cochrane JL. Characteristics of anterior cruciate ligament injuries in Australian football. *J of Sci Med Sport* 2007;10:96-104. <https://doi.org/10.1016/j.jsams.2006.05.015>.
5. Sadoghi P, Von Keudell A, Vavken P. Effectiveness of anterior cruciate ligament injury prevention training programs. *J Bone Joint Surg Am* 2012;94(9):769-76. <https://doi.org/10.2106/JBJS.K.00467>.
6. Sanchis-Alfonso V, Tinto-Pedrerol M. Simultaneous bilateral anterior

- cruciate ligament tears in a female beginner skier. *Knee Surg Sports Traumatol Arthrosc* 2000;8:241-3.
<https://doi.org/10.1007/s001670000128>.
7. Tifford CD, Jackson DW. Simultaneous bilateral anterior cruciate ligament ruptures in a cheerleader. *Arthroscopy* 2001;17(4):E17.
<https://doi.org/10.1053/jars.2001.22409>.
 8. Bulatović N, Kezunović M. Aetiology and mechanisms of injuries of the front crossed knee ligament in athletes. *Sport Mont* 2007;28:257-9.
 9. Ekstrand J, Gillquist J. Frequency of muscle tightness and injuries in soccer players. *Am J Sports Med* 1982;10:75-8.
<https://doi.org/10.1177/036354658201000202>.
 10. Ekstrand J, Gillquist J. Soccer injuries and their mechanisms. *Med Sci Sports Exercise* 1983;15:267-70.
<https://doi.org/10.1249/00005768-198315030-00014>.
 11. Grace TG, Sweetser ER, Nelson MA. Isokinetic muscle imbalance and knee-joint injuries. *J Bone Joint Surg* 1984;66(5):734-9.
<https://doi.org/10.2106/0004623-198466050-00012>.
 12. Kvist J. Rehabilitation following anterior cruciate ligament injury. *Sports Med* 2004;34(4):270-80.
<https://doi.org/10.2165/00007256-200434040-00006>.
 13. Pečina M. *Orthopedics*. Zagreb: Naklada Ljevak; 2004. p. 36-40.
 14. Hodler J, Highby P, Trudell D. The cruciate ligament of the knee: Correlations between MR appearance and gross and histological findings in cadaveric specimens. *AJR Am J Roentgenol* 1992;25(2):159-357.
<https://doi.org/10.2214/ajr.159.2.1632355>.
 15. Martinek V, Latterman C, Usas A, Abramowitch S, Woo SL, Fu FH, et al. Enhancement of tendon-bone integration of anterior cruciate ligament grafts with bone morphogenetic protein-2 gene transfer: A histological and biomechanical study. *J Bone Joint Surg Am* 2002;84(7):1123-31.
<https://doi.org/10.2106/0004623-200207000-00005>.
 16. Hoffmann F, Friebe H, Schiller M. The semitendinosus tendon and replacement for the anterior cruciate ligament. *Zentralbl Chir* 1998;123:994-1001.
 17. Marder RA, Raskind JR, Carroll M. Prospective evaluation of arthroscopically assisted anterior cruciate ligament reconstruction. *Patellar tendon versus semitendinosus and gracilis tendons*. *Am J Sports Med* 1991;19(5):478-484.
<https://doi.org/10.1177/036354659101900510>.
 18. Maywood RM, Hechtman KS. Simultaneous bilateral anterior cruciate ligament tears. *Am J Knee Surg* 1995;8(4):134-6.
 19. Jari S, Shelbourne KD. Simultaneous bilateral anterior cruciate ligament reconstruction. *Am J Sports Med* 2002;30(6):891-5.
<https://doi.org/10.1177/03635465020300062201>.
 20. Saithna A, Arbutnot J, Carey-Smith R, Spalding T. Simultaneous bilateral anterior cruciate ligament reconstruction: a safe option. *Knee Surg Sports Traumatol Arthrosc* 2010;18:1071-4.
<https://doi.org/10.1007/s00167-009-0971-1>.
 21. Larson CM, Fischer DA, Smith JP, Boyd JL. Bilateral anterior cruciate ligament reconstruction as a single procedure: Evaluation of cost and early functional results. *Am J Sports Med* 2004;32(1):197-200.
<https://doi.org/10.1177/0363546503260721>.
 22. Shelbourne KD, Patel DV. Timing of surgery in anterior cruciate ligament-injured knees. *Knee Surg Sports Traumatol Arthrosc* 1995;3(3):148-56.
<https://doi.org/10.1007/BF01565474>.
 23. Hechtman KS, Tjin-Tsoi EW, Uribe JW, Zvijac JE. Simultaneous vs. staged bilateral anterior cruciate ligament reconstruction with endoscopic technique. *Arthroscopy* 1998;14:17.
 24. Johnson DS, Smith RB. Outcome measurement in ACL deficient knee. What's the score? *Knee* 2001;8(1):51-7.
[https://doi.org/10.1016/S0968-0160\(01\)00068-0](https://doi.org/10.1016/S0968-0160(01)00068-0).
 25. Beaton DE, Schemitsch E. Measures of health-related quality of life and physical function. *Clin Orthop* 2003;413:90-105.
<https://doi.org/10.1097/01.blo.0000079772.06654.c8>.
 26. Rodriguez-Merchan EC. Knee instruments and rating scales designed to measure outcomes. *J Orthop Traumatol* 2012;13(1):1-6.
<https://doi.org/10.1007/s10195-011-0177-4>.
 27. Mokkink LB, Terwee CB, Patrick DL, Alonso J, Stratford PW, Knol DL, et al. The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: An international Delphi study. *Qual Life Res* 2010;19(4):539-49.
<https://doi.org/10.1007/s11136-010-9606-8>.
 28. Irrgang JJ, Ho H, Harner CD, Fu FH. Use of the international knee documentation committee guidelines to assess outcome following anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc* 1998;6(2):107-14.
<https://doi.org/10.1007/s001670050082>.
 29. Daniel DM, Malcom LL, Losse G, Stone ML, Sachs R, Burks R. Instrumented measurement of anterior laxity of the knee. *J Bone Joint Surg Am* 1985;67(5):720-6.
<https://doi.org/10.2106/0004623-198567050-00006>.
 30. Marx RG. Knee rating scales. *Arthroscopy* 2003;19:1103-8.
<https://doi.org/10.1016/j.arthro.2003.10.029>.
 31. Relman AS. Assessment and accountability: The third revolution in medical care. *N Engl J Med* 1988;319(18):1220-1222.
<https://doi.org/10.1056/NEJM198811033191810>.
 32. Verbrugge LM, Jette AM. The disablement process. *Soc Sci Med* 1994;38(1):1-14.
[https://doi.org/10.1016/0277-9536\(94\)90294-1](https://doi.org/10.1016/0277-9536(94)90294-1).
 33. Tanner MS, Dainty KN, Marx RG, Kirkley A. Knee specific quality of life instruments. *Am J Sports Med* 2007;35(9):1450.
<https://doi.org/10.1177/0363546507301883>.
 34. Mohtadi N. Development and validation of the quality of life outcome measure (questionnaire) for chronic anterior cruciate ligament deficiency. *Am J Sports Med* 1998;26(3):350-9.
<https://doi.org/10.1177/03635465980260030201>.
 35. Logerstedt D, Lynch A, Axe MJ, Snyder-Mackler L. Pre-operative quadriceps strength predicts IKDC2000 scores 6 months after anterior cruciate ligament reconstruction. *Knee* 2013;20(3):208-12.
<https://doi.org/10.1016/j.knee.2012.07.011>.
 36. Salavati M, Akhbari B, Mohammadi F, Mazaheri M, Khorrami M. Neu Knee injury and osteoarthritis outcome score (KOOS): Reliability and validity in competitive athletes after anterior cruciate ligament reconstruction romuscular strategy to prevent ACL injury. *Osteoarthr Cartilage* 2011;19(4):406-10.
<https://doi.org/10.1016/j.joca.2011.01.010>.
 37. Roos EM, Roos HP, Ekdahl C, Lohmander LS. Knee injury and osteoarthritis outcome score (KOOS)—validation of a Swedish version. *Scand J Med Sci Sports* 1998;8(6):439-48.
<https://doi.org/10.1111/j.1600-0838.1998.tb00465.x>.
 38. Di Fabio RP, Boissonnault W. Physical therapy and health-related outcomes for patients with common orthopaedic diagnoses. *J Orthop Sports Phys Ther* 1998;27(3):219-30.
<https://doi.org/10.2519/jospt.1998.27.3.219>.
 39. Fallstrom A, Häggglund M, Kvist J. Patient-reported knee function, quality of life, and activity level after bilateral anterior cruciate ligament injuries. *Am J Sports Med* 2013;41(12):2805-13.
<https://doi.org/10.1177/0363546513502309>.

40. Chen T, Li L, Kochen MM. A systematic review: how to choose appropriate health-related quality of life (HRQOL) measures in routine general practice. *J Zhejiang Univ Sci B* 2005;6(9):936-40.
<https://doi.org/10.1631/jzus.2005.B0936>.
41. Chen Y, While AE, Hicks A. Self-rated health and associated factors among older people living alone in Shanghai. *Geriatr Gerontol Int* 2015;15(4):457-64.
<https://doi.org/10.1111/ggi.12298>.
42. Ware JE, Snow K, Kosinski M, Gandek B. SF-36 Health Survey: Manual and Interpretation Guide. Lincoln (RI): Quality Metric Incorporated; 2000.
43. Villanueva-Torrecillas I, del Mar MG, Javier TF, Ariza-Ariza R, Navarro F. Relative efficiency and validity properties of a visual analogue vs. a categorical scaled version of the Western Ontario and McMaster Universities Osteoarthritis (WOMAC) index: Spanish versions. *Osteoarthritis Cartilage* 2004;12(2):225-31.
<https://doi.org/10.1016/j.joca.2003.11.006>.
44. Kersten P, White PJ, Tennant A. The analogue WOMAC 3.0 scale—internal validity and responsiveness of the VAS version. *BMC musculoskeletal disorders*, *BMC Musculoskelet Disord*. 2010;11:80.
<https://doi.org/10.1186/1471-2474-11-80>.
45. Ristić V, Ristić S, Maljanović M, Milankov V, Harhaji V, Đurićin A, et al. Quality of life after bilateral anterior cruciate ligament reconstructions. *Med Pregl* 2015;68(9-10):308-15.
<https://doi.org/10.2298/MPNS1510308R>.
46. Salmon L, Russell V, Musgrove T, Pinczewski L, Refshauge K. Incidence and risk factors for graft rupture and contralateral rupture after anterior cruciate ligament reconstruction. *Arthroscopy* 2005;21(8):948-57.
<https://doi.org/10.1016/j.arthro.2005.04.110>.
47. Sward P, Kostogiannis I, Roos H. Risk factors for a contralateral anterior cruciate ligament injury. *Knee Surg Sports Traumatol Arthrosc* 2010;18(3):277-91.
<https://doi.org/10.1007/s00167-009-1026-3>.
48. Ristić V, Maljanović M, Harhaji V, Milankov M. Infections after reconstructions of anterior cruciate ligament. *Med Pregl* 2014;67(1-2):11-5.
<https://doi.org/10.2298/MPNS140211R>.
49. Ristić V, Ristić S, Maljanović M, Đan V, Milankov V, Harhaji V. Risk factors for bilateral anterior cruciate ligament injuries. *Med Pregl* 2015;68(5-6):198-203.
<https://doi.org/10.2298/MPNS1506192R>.
50. Orchard J, Seward H, McGivern J, Hood S. Intrinsic and extrinsic risk factors for anterior cruciate ligament injury in Australian footballers. *Am J Sports Med* 2001;29(2):196-200.
<https://doi.org/10.1177/03635465010290021301>.
51. Motohashi M. Profile of bilateral anterior cruciate ligament injuries: A retrospective follow-up study. *J Orthop Surg (Hong Kong)*. 2004;12(2):210-5.
<https://doi.org/10.1177/230949900401200214>.
52. Ardern CL, Österberg A, Tagesson S, Gauffin H, Webster KE, Kvist J. The impact of psychological readiness to return to sport and recreational activities after anterior cruciate ligament reconstruction. *Br J Sports Med* 2014;48(22):1613-9.
<https://doi.org/10.1136/bjsports-2014-093842>.
53. Souryal TO, Moore HA, Evans JP. Bilaterality in anterior cruciate ligament injuries: Associated intercondylar notch stenosis. *Am J Sports Med* 1988;16(5):449-54.
<https://doi.org/10.1177/036354658801600504>.
54. Wright WR, Magnussen AR, Dunn RW, Spindler KP. Ipsilateral Graft and contralateral ACL rupture at five years or more following ACL reconstruction. *J Bone Joint Surg Am* 2011;93(12):1159-65.
<https://doi.org/10.2106/JBJS.J.00898>.
55. Goddard M, Salmon L, Waller A, Papapetros E, Pinczewski L.A. Incidence of graft rupture 15 years after bilateral anterior cruciate ligament reconstructions. *Bone Joint J* 2013;95-B(12):798-802.
<https://doi.org/10.1302/0301-620X.95B6.30841>.