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Patient characteristics of non-operative anterior cruciate ligament injury associated with poor knee functions on activities of daily living: a cross-sectional study

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ABSTRACT

Introduction: The ACL injury has commonly occurred in a greater number of athletes, less publication is about poor knee function and ACL injury in the patient with non-operative treatment. This study aimed to describe the characteristics of patients with ACL injury non-operative, which are associated with poor knee function on daily living activities.

Methods: We included patients with ACL injury that has been diagnosed for ACL injury by an orthopedic surgeon or physiotherapist in a hospital or private clinic. All participants were recruited from February 2019 to April 2019. The inclusion criteria were patients who at least 18 years old. We used the KOOS ADL function cut-off score ≤80 to dichotomous the patient with knee problems, and score >80 have no statistical analysis problem. We calculated using binary logistic regression on the KOOS ADL function for each variable.

Results: The mean score of KOOS daily living was 72.8 points, of which 66 participants had poor scores, and 37 were acceptable. Women were 9.2 times more likely to had poor KOOS daily living scores than men in non-operative ACL injury patients (p=0.044), and non-elite athletes had a higher possibility by 8.5 times higher than those who were participated in sports only for leisure or recreation (p=0.002).

Conclusion: This study confirmed that patients who did not undergo the ACL reconstruction had a poor knee function in daily living. It was associated with women and non-elite athlete participants, yet the concomitant injuries were possibly confounder for the association.

Keywords: non-operative ACL injury, knee function, activities of daily living, KOOS
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INTRODUCTION

Worldwide, the anterior cruciate ligament (ACL) injury is a common injury in the younger adult population.[1] The incidence of ACL injury is more than 200,000 cases, with 100,000 of these knees reconstructed annually.[2] The references found that the amateur sporting groups generally had a higher incidence of ACL than the entire population and lower than among professional athletes.[3] Besides, the ACL injury has commonly occurred in a greater number of athletes, in which women have 2 – 9 times greater risk of the ACL injury than men.[4]

Since most people with ACL injury are younger adults, the long term consequences of the ACL injury has highly contributed to the poor knee function that causes chronic medical pain, joint functional limitation, decrease quality of life, and disability.[5] While the ACL has a critical role in the knee movement and proprioception, when it is injured, then it will cause poor lower body movement and normal human performance that affect the limitation of activity daily living and quality of life.[6]

While studies published about the ACL injury in the patient with knee reconstruction in the multiple dimension.[7,8] Less publication is about poor knee function and ACL injury in the patient with non-operative treatment. This study has to describe the characteristics of patients with ACL injury non-operative, which are associated with poor knee function on daily living activities. This study will give information and knowledge for clinical practice and enrich the references in the field of sports injury and rehabilitation research.

METHODS

Participants and data collection

The population conducted in this cross-sectional

design study were the patients who had joined the ACL community of Indonesia. This community is a national wide community that members by ACL patient, orthopedic surgeon, physical therapist, and other sports professionals that aims to share injury experience and educate the treatment of the ACL injury (including the reconstruction and rehabilitation phases). We included patients with ACL injury that has been diagnosed for ACL injury by an orthopedic surgeon or physiotherapist in a hospital or private clinic. Non–operative ACL was defined by patients who decided not to undergo surgical treatment on their injury condition.[1] All participants were recruited from February 2019 to April 2019. Data on the demographic characteristics and knee functions for daily living were collected via telephone interviews and a website. The inclusion criteria were 1) patients who at least 18 years old and 2) willing to filled and signed the informed consent to participate in this study. Exclusion criteria were 1) patient who had previous injury history at the current knee or opposite knee, 2) patient had an injury or another knee disability on the opposite knee, 3) patient who had cognitive impairment to avoid the uncooperative behavior. There are 103 participants eligible for the statistical analysis. Ethical Committee of the Institutional Review Board College of Medicine Universitas Udayana/ Central Public Hospital Sanglah Denpasar, Bali, Indonesia, has approved the study protocol with the permission number of 60/UN14.2.2.VII.14/ LP/2019. All participants have given inform consent before included in this study.

Measures

Demographic data including age, sex, height, weight, and education level were collected using a website and confirmed by telephone interview. The knee functions for daily living were measured using activities of daily living (ADL) subscale as a part of the self-administered Knee Osteoarthritis Outcome Score (KOOS). This part has 17 items with a Likert scale used to score each item from 0 (no problems) to 4 (extreme problems). The KOOS ADL score was estimated from the mean of ADL functions, then divided by 4, multiplied by 100, then subtracted this number from 100, with zero representing extreme knee problems and 100 representing no knee problems.[9,10]

The information about the time of injury was determined as the date of an ACL injury that was defined as the first time the involved knee injured with symptoms such as a "pop" sound and sharp pain until the date of our data collection. The assessment time was defined as the first ACL injury until an orthopedic surgeon or physiotherapist confirmed the case. Injury leg was defined from the answer of "Which leg has an injury?" and "Which leg that you use to shoot a ball or which one is your strongest leg?" then the answer would be categorized into non-dominant and dominant. Injury methods were defined as the type of sport that causes current injury and separated into contact sports (e.g., football, basketball, futsal, rugby, martial arts, etc.) with contact injury (i.e., kicked, hit, crushed, pushed, tackled) or non-contact injury (i.e., twisted, slipped, collapsed); and non-contact sports (e.g., tennis, badminton, volleyball, cycling, running, gymnastic).

The level of participation was defined as an indication of professional experience and competitiveness in sports that consists of three categories: 1) leisure or recreational athletes, 2) non-elite athlete, 3) and elite athlete.[11] We also collected data on each patient's first aid treatment, which was defined as the self-reported of any first aid intervention of the patient's ACL injury on the incidence during the sports activity.

Statistical Analysis

We did the descriptive analysis to explain the distribution of variables using arithmetical means and standards deviations for continuous variables and proportions percentages for categories variables. We used the KOOS ADL function cut-off score ≤80 to dichotomous the patient with knee problems, and score >80 have no statistical analysis problem.[12] We calculated univariate analysis using binary logistic regression on the KOOS ADL function for each variable. The variables with p-value <0.25 were included in the multivariate analysis, and the variables would be statistically significant if p-value<0.05. We performed all the statistical tests using SPSS for Windows (19.0 version).

RESULTS

All patients who participated in this study had data on demographic characteristics and knee functions of activities daily living. As shown in Table 1, the mean of age, body mass index, time of injury, time of examination was 27.5 years, 24.7 kg/m2, 34.0 months, respectively. Of 89.3% of participants were male, 54.4% achieved college level, and 64.1% injured the dominant leg's ACL. Most of the participants by 55.3% got injury by the contact sports (such as soccer, futsal, basketball) with the non-contact method (such as collapsed the knee and tackled, pushed, and crashed by opponents), 43.7% during a recreational sport, and 72.8% participants received first aids after an ACL injury. The mean score of KOOS daily living was 72.8 points, of which 66 participants had poor scores, and 37 were acceptable.

Table 1. Characteristics of the non-operative anterior cruciate ligament injury patients (*n*=103)

Characteristics	mean±SD or n (%)
Age, years	27.5±6.6
Sex	
Women	11 (10.7)
Men	92 (89.3)
BMI, kg/m^2	24.7±6.3
Education	
>12 years	56 (54.4)
≤12 years	47 (45.6)
Injury leg	
Non-dominant	37 (35.9)
Dominant	66 (64.1)
Injury methods	
Contact sports – contact injury	57 (55.3)
Contact sports – non-contact injury	32 (31.1)
Non-contact sports	5 (4.9)
Others	9 (8.7)
Injury to baseline, months	34.0±52.9
Injury to examination, months	16.9±48.1
Level of participations	
Leisure/Recreation	45 (43.7)
Non-elite athlete	29 (28.2)
Elite athlete	29 (28.2)
First aid	
Yes	75 (72.8)
No	28 (27.2)
KOOS activities of daily living	72.8±18.9

BMI, body mass index; KOOS, knee injury and osteoarthritis outcome score; n, number of participants; SD, standard deviation

The univariate analysis logistic regression model in Table 2 showed that only participants included in the non-elite athlete were a significant factor associated with the poor KOOS daily living score with the odds by 8.29 times higher than those who were in leisure or recreation (p=0.002). The women participants had a borderline association with the poor KOOS daily living with odds of 6.4 times higher than men (p=0.082). Every increase of one month for the time of injury would have magnitude odds increased by 1% (p=0.217).

The multivariate analysis logistic regression model in Table 3 showed that women were 9.2 times more likely to had poor KOOS daily living scores than men in non-operative ACL injury patients (p=0.044). The participation also consistently showed a significant correlation that patients who were participated in sports as a non-elite athlete had a higher possibility by 8.5 times higher than those who were participated in sports only for leisure or recreation to have a poor KOOS daily living (p=0.002).

DISCUSSION

In the present study, we evaluate the non-operative ACL injury patients, including non-elite athletes and women participants, against poor knee function. KOOS scores were significantly poor in the non-elite athlete than those who did sport in leisure or recreation and were significantly poor in women compared to men. As the instrument we used in this study, KOOS is a specific knee instrument developed by Ewa M. Roos and colleagues in 1995, which evaluate the short and long-term due to the injury.[13] This KOOS was used to predict pre-injury level activity, where the poorer score highly related to the fear of getting re-injury among athletes.[14]

The previous study showed that sex differences are one of the risk factors in sports injury incidents.[15] In agility sports, such as volley, basketball, and soccer, the risk number increases 3-5 times to experience ACL injury in females compared to males.[5] Females also have a high risk of ACL injury and knee osteoarthritis (OA) compared to males.[16] The differences anatomically and biomechanically have been studied to contribute to the risk of injury.[17] The morphology of the knee joint between sexes also had an important role in the risk of injury. The investigation of muscle size and mass between the different sexes has been demonstrated in the previous study.[18] Female has a 30% smaller muscle size of knee flexor (KF) and 25% of knee extensor (KE) compared to male but larger in vastus lateral (VL) and biceps femoris (BF) morphologically, which underlined as a trigger for decreased knee joint stability to lead the incidence of ACL injury.[19] The lower strength of hamstrings muscle to quadriceps (H/Q) in female-led the cause of muscular stability reduction of the knee.[19] The strong hamstring can counteract the shear of anterior tibial muscle to protect the ACL by increasing the joint stability. Yet, less knee joint stability in female-led to the quadriceps' contraction then elicit the translation of anterior tibial, especially when the knee in full extension position, causing ACL ruptured.[20] Hence, the smaller size of female muscle quadriceps and hamstrings is highly related to knee joint injury.[21] Those balance differences in muscle morphology are the primary reason to reduce knee joint functional stability joint and the great factor of ACL injury in females.[19]

The ratio strength of KF and KE muscles in females was 50%, while 56% in males, indicating that females have a lower strength.[22] In detail, sartorius (SA) and gracilis (GR) muscles, which part of KF has a smaller ratio size in females compared to males (44% and 42% respectively).[19] Moreover, both SA and GR are important in controlling valgus knee forces; the greater ratio of

size and strength produces higher forces.[23] Those factors also underlined the occurrence number of ACL rupture in the female. From several studies that have been completed, a lower ratio of muscle size and strength among females than males supports the result in our study where KOOS in the patient of non-operative ACL injury has a worse score among females. Besides morphology, men and women have a different psychological response against injury.[24] The hormonal changes and different neuromuscular control are the underlying stark difference post-injury.[25] More than that, many women athletes did not return to the sport despite undergoing knee reconstruction post-ACL injury.[26] The mental conflict after the injury among women build anxiety and establish psychological distress. The coping mechanism is also affected by emotional stress.

Table 2. Univariate analysis using logistic regression model of patient characteristics to the KOOS activities of daily living (*n*=103)

Characteristics	OR (95% CI)	p-value
Age	1.01 (0.95-1.07)	0.869
Sex		
Women	6.43 (0.79-52.38)	0.082
Men	reference	
BMI, kg/m^2	1.08 (0.98-1.19)	0.141
Education		
>12 years	1.02 (0.46-2.29)	0.962
≤12 years	reference	
Injury leg		
Non-dominant	1.27 (0.54-2.97)	0.581
Dominant	reference	
Injury methods		
Contact sports – non-contact injury	0.90 (0.37-2.21)	0.820
Non-contact sports	0.36 (0.06-2.34)	0.285
Others	1.89 (0.36-9.98)	0.452
Contact sports – contact injury	reference	
Injury to baseline, months	1.01 (1.00-1.02)	0.217
Injury to examination, months	1.01 (0.99-1.03)	0.279
Level of participations		
Non-elite athlete	8.29 (2.19-31.36)	0.002
Elite athlete	1.36 (0.53-3.48)	0.527
Leisure/Recreation	reference	
First aid		
No	0.67 (0.27-1.62)	0.371
Yes	reference	

BMI, body mass index; CI, confidence interval; KOOS, knee injury and osteoarthritis outcome score; n, number of participants; OR, odd ratio; SD, standard deviation

Table 3. Multivariate analysis using logistic regression model of patient characteristics to the KOOS activities of daily living (*n*=103)

Characteristics	Adjusted OR (95% CI)	p-value
Sex		
Women	9.22 (1.06-79.85)	0.044
Men	Reference	
BMI, kg/m^2	1.08 (0.98-1.18)	0.133
Injury to baseline, months	1.01 (0.99-1.02)	0.430
Level of participations		
Non-elite athlete	8.51 (2.19-32.99)	0.002
Elite athlete	0.90 (0.32-2.53)	0.527
Leisure/Recreation	reference	

BMI, body mass index; CI, confidence interval; KOOS, knee injury and osteoarthritis outcome score; n, number of participants; OR, odd ratio; SD, standard deviation

ACL rupture is a common injury that occurred among elite and non-elite athletes.[27] Thirty-four of seventy-eight athletes did not return to the sport for several reasons, such as inflammation, instability, joint stiffness, and failure to perform the same as pre-injury. However, one study successfully revealed that 54% of the athlete could return to sport at 9-12 months and maintain to play until 60 months of post-ACL injury. Among them, the elite athlete can return to sport compared to the non-elite athletes. For instance, rugby athlete has 100% able to return to sport after 6 months, while another source mentioned 81 % they were able to return to sport at 12 months, and 71.4% at 43 months.[28] There are various reasons behind not return to sport between the athletes. The five highest reasons are fear of the second injury, lack of confidence, failure to regain pre-injury fitness performance, and pain sensation after the injury.[27] A non-elite athlete has a higher Kinesiophobia score, which represents fear of re-injury caused by activities.[29] Yet, fear of the second injury is not a significant variable because it may underlie activity limitations.[27] The factors of self-efficacy, optimism, and motivation are also important among the athlete during the rehabilitation process. The functional knee score between elite athletes was also greater than non-elite athletes.[28] From this previous study, they found that non-elite athlete has a significant number to not return to sport after ACL-injury.[30] Those findings support our result where the KOOS score is significantly poor among non-elite athletes after non-operative ACL-injury.

In this study, several limitations need to be explained. Firstly, this study's results cannot represent all ACL patients who did not undergo the ACL reconstruction in Indonesia. Our participants were relatively small, and only those accessible to the internet would participate in this study. Secondly, a lack of objective measures to identify the concomitant injuries probably has confounded our results. Most of our participants did not undergo the MRI assessment; thus, it seemed very difficult to determine concomitant injuries on the knee index.

CONCLUSION

This study confirmed that patients who did not undergo the ACL reconstruction had a poor knee function in daily living. Further, it was associated with women and non-elite athlete participants, and yet, concomitant injuries on a first-time knee injury and following ACL injury might confound this association. For further study, we suggest performing a longitudinal follow up for non-operative ACL injury to achieve the cause-effect association.

CONFLICT OF INTEREST

The author declares there is no conflict of interest regarding publication of the study.

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REFERENCE

1. Kaeding CC, Pedroza AD, Reinke EK, Huston LJ, Consortium M, Spindler KP. Risk factors and predictors of subsequent ACL injury in either knee after ACL reconstruction: prospective analysis of 2488 primary ACL reconstructions from the MOON cohort. The American journal of sports medicine. 2015;43(7):1583-90.
2. Singh N. International epidemiology of anterior cruciate ligament injuries. Orthopedic Res Online J. 2018;1.
3. Moses B, Orchard J, Orchard J. Systematic review: annual incidence of ACL injury and surgery in various populations. Res Sports Med. 2012;20(3-4):157-79.
4. Ristić V, Ninković S, Harhaji V, Milankov M. Causes of anterior cruciate ligament injuries. Med Pregl. 2010;63(7-8):541-5.
5. Lohmander LS, Englund PM, Dahl LL, Roos EM. The long-term consequence of anterior cruciate ligament and meniscus injuries: osteoarthritis. The American journal of sports medicine. 2007;35(10):1756-69.
6. Filbay S, Culvenor A, Ackerman I, Russell T, Crossley K. Quality of life in anterior cruciate ligament-deficient individuals: a systematic review and meta-analysis. Br J Sports Med. 2015;49(16):1033-41.
7. Biau DJ, Tournoux C, Katsahian S, Schranz P, Nizard R. ACL reconstruction: a meta-analysis of functional scores. Clinical Orthopaedics and Related Research®. 2007;458:180-7.
8. Paterno MV, Rauh MJ, Schmitt LC, Ford KR, Hewett TE. Incidence of second ACL injuries 2 years after primary ACL reconstruction and return to sport. The American journal of sports medicine. 2014;42(7):1567-73.
9. Roos EM, Lohmander LS. The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis. Health and quality of life outcomes. 2003;1(1):1-8.
10. Roos EM, Engelhart L, Ranstam J, Anderson AF, Irrgang JJ, Marx RG, et al. ICRS recommendation document: patient-reported outcome instruments for use in patients with articular cartilage defects. Cartilage. 2011;2(2):122-36.
11. Deelen I, Ettema D, Kamphuis CB. Sports participation in sport clubs, gyms or public spaces: How users of different sports settings differ in their motivations, goals, and sports frequency. PLoS One. 2018;13(10):e0205198.
12. Paradowski PT, Bergman S, Sundén-Lundius A, Lohmander LS, Roos EM. Knee complaints vary with age and gender in the adult population. Population-based reference data for the Knee injury and Osteoarthritis Outcome Score (KOOS). BMC Musculoskelet Disord. 2006;7(1):38.
13. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynnon BD. Knee Injury and Osteoarthritis Outcome Score (KOOS)—development of a self-administered outcome measure. J Orthop Sports Phys Ther. 1998;28(2):88-96.
14. Kvist J, Ek A, Sporrstedt K, Good L. Fear of re-injury: a hindrance for returning to sports after anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc. 2005;13(5):393-7.
15. Myklebust G, Engebretsen L, Brækken IH, Skjølberg A, Olsen O-E, Bahr R. Prevention of anterior cruciate ligament injuries in female team handball players: a prospective intervention study over three seasons. Clin J Sport Med. 2003;13(2):71-8.
16. Srikanth VK, Fryer JL, Zhai G, Winzenberg TM, Hosmer D, Jones G. A meta-analysis of sex differences prevalence, incidence and severity of osteoarthritis. Osteoarthritis Cartilage. 2005;13(9):769-81.
17. Koga H, Nakamae A, Shima Y, Iwasa J, Myklebust G, Engebretsen L, et al. Mechanisms for noncontact anterior cruciate ligament injuries: knee joint kinematics in 10 injury situations from female team handball and basketball. The American journal of sports medicine. 2010;38(11):2218-25.
18. Krosshaug T, Slauterbeck JR, Engebretsen L, Bahr R. Biomechanical analysis of anterior cruciate ligament injury mechanisms: three-dimensional motion reconstruction from video sequences. Scand J Med Sci Sports. 2007;17(5):508-19.
19. Behan FP, Maden-Wilkinson TM, Pain MT, Folland JP. Sex differences in muscle morphology of the knee flexors and knee extensors. PLoS One. 2018;13(1):e0190903.
20. DeMorat G, Weinhold P, Blackburn T, Chudik S, Garrett W. Aggressive quadriceps loading can induce noncontact anterior cruciate ligament injury. The American journal of sports medicine. 2004;32(2):477-83.
21. Evangelidis PE, Massey GJ, Pain MT, Folland JP. Strength and size relationships of the quadriceps and hamstrings with special reference to reciprocal muscle balance. Eur J Appl Physiol. 2016;116(3):593-600.
22. Hannah R, Folland JP, Smith SL, Minshull C. Explosive hamstrings-to-quadriceps force ratio of males versus females. Eur J Appl Physiol. 2015;115(4):837-47.
23. Buchanan TS, Lloyd DG. Muscle activation at the human knee during isometric flexion-extension and varus-valgus loads. J Orthop Res. 1997;15(1):11-7.
24. Sims M, Mulcahey MK. Sex-Specific differences in psychological response to injury and return to sport following ACL reconstruction. Jbjs Reviews. 2018;6(7):e9.
25. Tan SHS, Lau BPH, Khin LW, Lingaraj K. The importance of patient sex in the outcomes of anterior cruciate ligament reconstructions: a systematic review and meta-analysis. The American journal of sports medicine. 2016;44(1):242-54.
26. Nyland J, Cottrell B, Harreld K, Caborn DN. Self-reported outcomes after anterior cruciate ligament reconstruction: an internal health locus of control score comparison. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2006;22(11):1225-32.
27. Patel NK, Sabharwal S, Hadley C, Blanchard E, Church S. Factors affecting return to sport following hamstrings anterior cruciate ligament reconstruction in non-elite athletes. Eur J Orthop Surg Traumatol. 2019;29(8):1771-9.

28. Smith F, Rosenlund E, Aune A, MacLean J, Hillis S. Subjective functional assessments and the return to competitive sport after anterior cruciate ligament reconstruction. Br J Sports Med. 2004;38(3):279-84.
29. Lentz TA, Zeppieri Jr G, Tillman SM, Indelicato PA, Moser MW, George SZ, et al. Return to preinjury sports participation following anterior cruciate ligament reconstruction: contributions of demographic, knee impairment, and self-report measures. J Orthop Sports Phys Ther. 2012;42(11):893-901.
30. Udry E, Shelbourne KD, Gray T. Psychological readiness for anterior cruciate ligament surgery: describing and comparing the adolescent and adult experiences. J Athl Train. 2003;38(2):167.