International Journal of Research and Review
[Indexed, Peer-Reviewed Journal]
Volume 12; Issue: 4; April 2025
Website: www.ijrrjournal.com
Research Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

The Relationship Between Preoperative Quadriceps Muscle Strength and International Knee Documentation Committee (IKDC) Scores at Six Months Post-Anterior Cruciate Ligament (ACL) Reconstruction

Cokorda Gde Rama Adi Pranata [1], Made Bramantya Karna [2], I Gusti Ngurah Wien Aryana [2]

[1]Resident, Dept. Orthopaedic & Traumatology, Prof IGNG Ngoerah General Hospital, Udayana University, Bali, Indonesia
[2]Orthopaedic Surgeon, Dept. Orthopaedic & Traumatology, Prof IGNG Ngoerah General Hospital, Udayana University, Bali, Indonesia

Corresponding Author: Cokorda Gde Rama Adi Pranata

DOI: https://doi.org/10.52403/ijrr.20250413

ABSTRACT

Introduction: Anterior cruciate ligament (ACL) injury is a common knee injury among athletes and active individuals, often requiring ACL reconstruction to restore knee stability and function. Postoperative rehabilitation plays a crucial role in recovery, with quadriceps strength being a key factor influencing functional outcomes. However, the extent to which preoperative quadriceps strength affects postoperative functional outcomes remains a subject of interest.
This study aims to evaluate the relationship between preoperative quadriceps strength and functional outcomes, as measured by the International Knee Documentation Committee (IKDC) score, at six months post-ACL reconstruction.
Material & methods: This cohort study was conducted at RSUP Prof. Dr. I.G.N.G. Ngoerah Denpasar, involving patients undergoing ACL reconstruction between February and December 2024. Preoperative quadriceps strength was assessed using a handheld dynamometer, and postoperative functional outcomes were evaluated using the IKDC questionnaire at six months postoperatively. Correlation and comparative analyses were performed to determine the relationship between preoperative quadriceps strength and postoperative IKDC scores.
Results: The study included 22 patients with an average age of 31.77 ± 11.92 years. Pearson correlation analysis showed a significant positive correlation between preoperative quadriceps strength and IKDC scores at six months postoperatively ($r = 0.426$, $p = 0.048$). Furthermore, patients with a quadriceps strength deficit of more than 20% preoperatively had significantly lower IKDC scores postoperatively compared to those with a deficit of 20% or less ($p = 0.042$).
Conclusions: Preoperative quadriceps strength is a significant predictor of functional outcomes following ACL reconstruction. Patients with greater preoperative quadriceps strength tend to achieve better functional recovery. These findings highlight the importance of preoperative rehabilitation focusing on

quadriceps strengthening to optimize postoperative outcomes.

Keywords: ACL reconstruction, quadriceps strength, IKDC score, functional outcomes, knee rehabilitation

INTRODUCTION

Anterior cruciate ligament (ACL) injuries are among the most common and severe knee injuries, particularly affecting athletes and physically active individuals. ACL reconstruction is the standard treatment to restore knee stability and function after injury. While surgical intervention generally yields good results, achieving optimal recovery requires a structured rehabilitation program. Postoperative rehabilitation is essential for regaining strength, restoring normal range of motion, and improving neuromuscular control, ultimately enabling patients to return to their pre-injury activity levels. A combination of precise ACL reconstruction and targeted rehabilitation enhances the chances of a successful recovery and functional restoration. ACL injuries account for over 50% of all knee injuries, with an incidence of 30-78 cases per 100,000 people 1. In the United States alone, more than 200,000 ACL injuries occur annually 2. Around 40% of these injuries result from non-contact mechanisms such as jumping, cutting, and pivoting 1. A meta-analysis found an ACL injury rate of 0.08 per 1,000 female athletes and 0.05 per 1,000 male athletes, with soccer posing the highest risk for women (1.1% per season) and American football for men (0.8% per season) 3. ACL injuries often occur alongside damage to other knee structures, including the medial collateral ligament (MCL) (19-38%), lateral collateral ligament (LCL) (20-45%), and medial meniscus (0-28%) 4.

Patients with ACL injuries frequently report acute pain, a "popping" sensation in the knee, hemarthrosis, and joint instability 5. Studies show that athletes who continue activity despite an ACL injury repeated instability episode, increasing their risk of meniscal and osteochondral damage, which can accelerate osteoarthritis development 2. The prevalence of osteochondral damage in ACL injuries is estimated at 21-31% 4,5, highlighting the importance of timely intervention. ACL injury management includes both non-operative and surgical approaches. Non-operative treatment is an option for patients willing to modify their activities to prevent knee instability. This approach involves intensive rehabilitation, focusing on strengthening the quadriceps and hamstrings. However, without surgical repair, knee instability may persist, leading to further injuries 4. Studies indicate that delaying ACL reconstruction can result in progressive meniscal and cartilage damage 6.

The goal of ACL reconstruction is to restore knee biomechanics and enable patients to return to their prior activity levels. However, quadriceps weakness remains a common postoperative issue, affecting functional outcomes and return-to-sport readiness. Preoperative quadriceps strength is a key predictor of post-surgical function, with greater preoperative strength associated with better recovery outcomes 7. Research suggests that intensive quadriceps training before surgery may improve postoperative results 8. Functional recovery following ACL reconstruction is commonly assessed using the International Knee Documentation Committee (IKDC) score, a widely used and validated tool for evaluating knee function 7. This study aims to explore the relationship between quadriceps strength and functional outcomes after ACL reconstruction, providing insights that could improve rehabilitation strategies and enhance patient recovery.

METHODS

This study is a cohort study involving patients with anterior cruciate ligament (ACL) injuries who underwent ACL reconstruction. Preoperative quadriceps muscle strength was assessed before the surgery. At six months post-ACL reconstruction, clinical outcome parameters

were evaluated using the International Knee Documentation Committee (IKDC) questionnaire.

Study Population

The study population consisted of patients who underwent ACL reconstruction at Prof. Dr. I.G.N.G. Ngoerah Central General Hospital, Denpasar, between February 2024 and December 2024. The required sample size for this study was 20 patients. Considering a potential dropout rate of 10% (2 patients), the minimum number of study subjects required was 22.

Participant Recruitment and Ethical Considerations

Subjects who met the inclusion and exclusion criteria were provided with detailed explanations regarding the research procedure, objectives, and potential benefits before participating in the study. All participants signed informed consent forms before enrollment and agreed to undergo the necessary assessments.

Data Collection and Assessments

Demographic and clinical data, including age, body weight, height, and the onset of ACL injury, were collected through history-taking and physical examination. Quadriceps muscle strength was assessed with patients seated on a chair with their knees flexed at 90 degrees. They were instructed to perform a knee extension movement while their muscle strength was evaluated. For clinical outcome assessment, patients completed the IKDC questionnaire, reflecting their condition at the time of examination.

Data Analysis

Research data were recorded on a research sheet and processed using SPSS for Windows version 29. The results were presented in tables, graphs, and narratives. Descriptive analysis was conducted to determine the standard deviation, mean, and median, as well as to assess the frequency distribution, which helped describe general characteristics and variations between groups. Normality and homogeneity analysis included the Shapiro-Wilk test to assess whether the sample data followed a normal distribution and Levene's Test for Equality of Variance to evaluate the equality of variances between groups. Inferential analysis involved correlational and comparative analyses. Correlational analysis was performed using Spearman's correlation test for non-parametric data (non-normally distributed) or Pearson's correlation test for parametric data (normally distributed). Comparative analysis was conducted using the Mann-Whitney test for non-parametric data and the T-test for parametric data.

RESULTS

General Characteristics of Study Subjects

A total of 22 patients with ACL injuries who underwent ACL reconstruction were included in this study. The mean age of the patients was 31.77 ± 11.92 years, with the youngest being 18 years old and the oldest 45 years old. Regarding Body Mass Index (BMI) distribution, the majority of patients were classified as having a normal BMI (12 patients, 54.54%), followed by those categorized as overweight (8 patients, 36.36%) and obese (2 patients, 9.09%). The mean IKDC score of all patients before ACL reconstruction was 66.95 ± 7.16, while the mean IKDC score at six months postoperatively increased to 85.14 ± 4.93. Statistical analysis of subject characteristics

Table 1 General Characteristics of Study Subjects

Variable	Total (%) (N=22)
Age (mean ± SD)	31,77 ± 11,92
Gender	
Male	12 (54,54)
Female	10 (45,45)
Onset to Treatment	
≤ 6 weeks	7 (31,81)
> 6 weeks	15 (68,18)
Body Mass Index (BMI)	
Normal	12 (54,54)
Overweight	8 (36,36)
Obese	2 (9,09)

showed no significant differences in the proportions of gender and BMI categories. Therefore, no confounding variables were identified in this study.

Correlation Between Preoperative Quadriceps Muscle Strength and IKDC Score at Six Months Post-ACL Reconstruction

Normality testing of the preoperative quadriceps muscle strength deficit and IKDC scores at six months post-ACL reconstruction was conducted using the Shapiro-Wilk test, which yielded a p-value > 0.05. This result indicated that the data were normally distributed, allowing further analysis using Pearson's correlation test.

The Pearson correlation test demonstrated a significant positive correlation between preoperative quadriceps muscle strength and IKDC scores at six months post-reconstruction, with a moderate correlation strength (r = 0.426, p = 0.048). This suggests that greater preoperative quadriceps strength is associated with better functional outcomes following ACL reconstruction.

Table 2 Correlation Between Preoperative Quadriceps Muscle Strength and IKDC Score at Six Months Post-ACL Reconstruction

Preoperative Quadriceps Muscle Strength Measurement (N=22)	Mean ± SD		r	p
	Preoperative Quadriceps Muscle Strength	IKDC Score at Six Months Post-ACL Reconstruction		
	76,91 ± 7,257	85,14 ± 4,931	0,426	0,048

Comparison of IKDC Scores at Six Months Post-ACL Reconstruction Between Patients with Preoperative Quadriceps Strength Deficit >20% and ≤20%

Inferential analysis was performed using the Independent T-test with a significance threshold of p < 0.05, which shows a statistically significant difference in IKDC scores at six months post-ACL reconstruction between patients with a quadriceps strength deficit of >20% and those with a deficit of ≤20% (p = 0.042; CI = -9.336 to -0.197). Patients with a quadriceps strength deficit of >20% tended to have lower IKDC scores compared to those with a deficit of ≤20%, indicating that greater quadriceps weakness before surgery is associated with poorer functional outcomes after ACL reconstruction.

Table 3 Comparison of IKDC Scores at Six Months Post-ACL Reconstruction Between Patients with Preoperative Quadriceps Strength Deficit >20% and ≤20%

IKDC Scores at Six Months Post-ACL Reconstruction	Mean ± SD		p	95% CI interval
	Preoperative Quadriceps Strength Deficit >20%	Preoperative Quadriceps Strength Deficit ≤20%		
	82,83 ± 2,855	87,6 ± 6,114	0,042	-9,336- -0,197

DISCUSSION

In this study, the average age of patients undergoing ACL reconstruction was 31.77 ± 11.92 years, with an age range of 18 to 45 years. These findings are consistent with previous research conducted in the United States, which reported a similar mean age of 30.9 ± 10 years for ACL reconstruction patients [9]. This similarity suggests that ACL injuries requiring surgical reconstruction commonly occur in young adults, likely due to their higher engagement in physical activities and sports that increase the risk of knee injuries. Regarding gender distribution, the majority of patients in this study were male (54.54%). This aligns with prior research in Indonesia, which reported that 92% of ACL reconstruction patients were

male [10]. The higher prevalence of ACL injuries in males may be attributed to greater participation in high-risk sports and physically demanding activities. However, it is important to note that ACL injuries also occur in females, and differences in biomechanics, hormonal influences, and neuromuscular control may contribute to variations in injury patterns between genders.

These findings reinforce the existing literature on ACL reconstruction demographics and highlight the importance of considering age and gender-related risk factors when assessing and managing ACL injuries.

This study found a significant positive correlation of moderate strength between preoperative quadriceps muscle strength and IKDC scores at six months post-ACL reconstruction ($r = 0.426$; $p = 0.048$). Restoration of quadriceps strength following knee injury is a crucial component of rehabilitation. One of the key factors influencing this process is arthrogenic muscle inhibition, a reflexive response following joint injury that results in the inability of the muscle to fully contract, despite no structural damage to the muscle or its innervating nerves. Patients who experience quadriceps strength deficits after ACL reconstruction tend to have reduced knee flexion angles and decreased knee torque during stance phases of walking and jogging. Persistent quadriceps weakness in the anterior thigh alters knee kinetics and kinematics during gait, with effects lasting up to 8 to 12 months after ACL injury and reconstruction.

These findings align with previous studies indicating a significant relationship between preoperative quadriceps strength deficits and short-term postoperative IKDC scores after ACL reconstruction. Preoperative quadriceps strength deficit has been identified as a predictor of postoperative knee function, with studies demonstrating that lower preoperative deficits correlate with better postoperative IKDC scores. This underscores the importance of preoperative quadriceps conditioning in improving postoperative outcomes [7]. Additionally, research by Güzel et al. (2023) comparing preoperative and six-month postoperative IKDC scores found that preoperative knee strength, particularly quadriceps strength, is directly linked to knee function and postoperative recovery. Significant quadriceps strength deficits before ACL reconstruction can hinder the recovery process and negatively impact IKDC scores. This emphasizes the importance of preoperative strength training, as deficits may not be fully compensated even up to two years postoperatively, highlighting the need for effective rehabilitation strategies to optimize recovery outcomes, especially in athletes [11].

Conversely, some studies have reported conflicting findings. For instance, a study by Novaretti et al. found that preoperative quadriceps strength deficits did not predict the return to pre-injury sports levels [12]. Furthermore, Hofer et al. (2022) observed significant improvements in quadriceps strength and knee function between six months and one year postoperatively, regardless of initial strength levels. This suggests that although preoperative quadriceps strength varies, the recovery trajectory for knee function, as measured by the IKDC score, remains positive and is not necessarily hindered by preoperative strength deficits [13].

Based on the findings of this study, the hypothesis that preoperative quadriceps strength is significantly associated with IKDC scores at six months post-ACL reconstruction is supported. The results of the comparative analysis between quadriceps strength deficits and postoperative IKDC scores confirmed a statistically significant difference ($p < 0.05$), reinforcing the importance of preoperative strength conditioning in optimizing functional outcomes after ACL reconstruction.

This study found a statistically significant difference in IKDC scores at six months post-ACL reconstruction between patients with a

preoperative quadriceps strength deficit of more than 20% and those with a deficit of 20% or less ($p = 0.042$; CI = -9.336 to -0.197). Evidence suggests that preoperative quadriceps strength can influence postoperative knee function; however, the strength and significance of this relationship vary across studies. A study found that patients with a preoperative quadriceps strength deficit of less than 25% had significantly better IKDC scores compared to those with deficits greater than 45% at one year postoperatively [7]. Additionally, Cunha et al. demonstrated that maximizing quadriceps strength before surgery enhances long-term knee function, as measured by the IKDC score. Patients with at least 80% quadriceps strength compared to the unaffected side were less likely to experience persistent strength deficits and showed better functional outcomes after ACL reconstruction [14].

Conversely, a study by Mariani et al. involving 59 patients who underwent ACL reconstruction found no significant relationship between preoperative quadriceps strength and short-term postoperative isometric strength following ACL reconstruction. While preoperative strength is often believed to impact postoperative outcomes, their findings suggest that quadriceps strength deficits are primarily associated with the ACL injury itself and may worsen after surgery. As a result, the correlation between preoperative quadriceps strength and postoperative IKDC scores remains uncertain, emphasizing the need for early postoperative quadriceps strengthening exercises to optimize recovery [15].

Based on this discussion, the hypothesis that there is a significant difference in IKDC scores at six months post-ACL reconstruction between patients with preoperative quadriceps strength deficits greater than 20% and those with deficits of 20% or less is supported. This study confirms the research hypothesis, as the comparative analysis of IKDC scores at six months post-ACL reconstruction between the two groups demonstrated a statistically significant difference ($p < 0.05$).

CONCLUSIONS

This study found a significant positive correlation of moderate strength between preoperative quadriceps muscle strength and IKDC scores at six months post-ACL reconstruction. Additionally, patients with a preoperative quadriceps strength deficit of more than 20% had lower IKDC scores six months after ACL reconstruction compared to those with a deficit of 20% or less. These findings highlight the importance of preoperative quadriceps strength in optimizing postoperative functional outcomes, suggesting that targeted prehabilitation strategies may enhance recovery following ACL reconstruction.

Declaration by Authors

Ethical Approval: Approved
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Kaeding, C.C., Léger-St-Jean, B., Magnussen, R.A., 2017. Epidemiology and Diagnosis of Anterior Cruciate Ligament Injuries. Clin Sports Med. https://doi.org/10.1016/j.csm.2016.08.001
2. Lyman, S., Koulouvaris, P., Sherman, S., Do, H., Mandl, L.A., Marx, R.G., 2009. Epidemiology of anterior cruciate ligament reconstruction. Trends, readmissions, and subsequent knee surgery. Journal of Bone and Joint Surgery 91, 2321–2328. https://doi.org/10.2106/JBJS.H.00539
3. Gornitzky, A.L., Lott, A., Yellin, J.L., Fabricant, P.D., Lawrence, J.T., Ganley, T.J., 2016. Sport-Specific Yearly Risk and Incidence of Anterior Cruciate Ligament Tears in High School Athletes: A Systematic Review and Meta-analysis. American Journal of Sports Medicine. https://doi.org/10.1177/0363546515617742
4. Mariscalco, M.W., Magnussen, R.A., Mehta, D., Hewett, T.E., Flanigan, D.C., Kaeding,

C.C., 2014. Autograft versus nonirradiated allograft tissue for anterior cruciate ligament reconstruction: A systematic review. American Journal of Sports Medicine. https://doi.org/10.1177/0363546513497566
5. Musahl, V., Karlsson, J., 2019. Anterior Cruciate Ligament Tear. New England Journal of Medicine 380, 2341–2348. https://doi.org/10.1056/nejmcp1805931
6. Krych, A.J., Pitts, R.T., Dajani, K.A., Stuart, M.J., Levy, B.A., Dahm, D.L., 2010. Surgical repair of meniscal tears with concomitant anterior cruciate ligament reconstruction in patients 18 years and younger. American Journal of Sports Medicine. https://doi.org/10.1177/0363546509354055
7. Kim, D.K., Park, G., Wang, J.H., Kuo, L.-T., Park, W.H., 2022. Preoperative quadriceps muscle strength deficit severity predicts knee function one year after anterior cruciate ligament reconstruction. Sci Rep 12, 5830. https://doi.org/10.1038/s41598-022-09816-3
8. Eitzen, I., Holm, I., Risberg, M.A., 2009. Preoperative quadriceps strength is a significant predictor of knee function two years after anterior cruciate ligament reconstruction. Br J Sports Med 43, 371–376. https://doi.org/10.1136/bjsm.2008.057059
9. Houck, D.A., Kraeutler, M.J., Belk, J.W., Goode, J.A., Mulcahey, M.K. & Bravman, J.T. (2019), "Primary Arthroscopic Repair of the Anterior Cruciate Ligament: A Systematic Review of Clinical Outcomes", *Arthroscopy - Journal of Arthroscopic and Related Surgery*, Arthroscopy Association of North America, Vol. 35 No. 12, pp. 3318–3327.
10. Deviandri, R., der Veen, H.C. va., Lubis, A.M.T., Postma, M.J. & van den Akker-Scheek, I. (2023), "Responsiveness of the Indonesian Versions of the Anterior Cruciate Ligament-Return to Sport After Injury Score, the International Knee Documentation Committee Subjective Knee Form, and the Lysholm Score in Patients With ACL Injury", Orthopaedic Journal of Sports Medicine, Vol. 11 No. 8, pp. 1–7.
11. Güzel, N., Genç, A.S., Yılmaz, A.K. & Kehribar, L. (2023), "The Relationship between Lower Extremity Functional Performance and Balance after Anterior Cruciate Ligament Reconstruction: Results of Patients Treated with the Modified All-Inside Technique", Journal of Personalized Medicine, Vol. 13 No. 3, pp. 1–14.
12. Novaretti, J.V., Franciozi, C.E., Forgas, A., Sasaki, P.H., Ingham, S.J.M.N. & Abdalla, R.J. (2018), "Quadriceps Strength Deficit at 6 Months After ACL Reconstruction Does Not Predict Return to Preinjury Sports Level", Sports Health, Vol. 10 No. 3, pp. 266–271.
13. Hofer, K., Lucas, B., Prohaska, D., Zackula, R. & Manske, R. (2022), "Quadriceps Strength and Knee Function After Anterior Cruciate Ligament Reconstruction with Quadriceps Tendon Bone Autograft: A Preliminary Report", Kansas Journal of Medicine, Vol. 15 No. 3, pp. 412–417.
14. Cunha, J. & Solomon, D.J. (2022), "ACL Prehabilitation Improves Postoperative Strength and Motion and Return to Sport in Athletes", Arthroscopy, Sports Medicine, and Rehabilitation, The Authors, Vol. 4 No. 1, pp. e65–e69.
15. Mariani, P.P., Laudani, L., Rocchi, J.E., Giombini, A. & Macaluso, A. (2020), "No Relationship between Preoperative and Early Postoperative Strength after ACL Reconstruction", Journal of Sport Rehabilitation, Vol. 29 No. 5, pp. 583–587.

How to cite this article: Cokorda Gde Rama Adi Pranata, Made Bramantya Karna, I Gusti Ngurah Wien Aryana. The relationship between preoperative quadriceps muscle strength and international knee documentation committee (IKDC) scores at six months post-anterior cruciate ligament (ACL) reconstruction. *International Journal of Research and Review*. 2025; 12(4): 108-114.
DOI: *https://doi.org/10.52403/ijrr.20250413*

******