https://doi.org/10.48047/AFJBS.6.15.2024.925-937

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Investigating the Rate of Re-Rupture of the Anterior Cruciate Ligament after Tibial Strut- Preserving ACL Reconstruction

[1]Dr. Shua Nasir, [2]Muhammad Saif Ullah Khan, [3]Dr. Lal Shehbaz, [4]Dr. Hussain Mustafa, [5]Muhammad Saad Abdullah, [6]Dr. Ali Ashraf Cheema, [7]Dr. Mwahib Mohamed Ahmed

[1]Associate Professor Emergency Medicine, Ziauddin university and hospital Karachi
[2]Medical Officer Emergency department, Sahiwal International Hospital
[3]Assistant Professor Emergency Medicine, Ziauddin university and hospital Karachi
[4]Post Graduate Othopedics, Shifa International Hospital Islamabad
[5]Associate Professor Anatomy, CMH Kharian Medical college Kharian Cantt
[6]Medical Officer Emergency department, Gondal Hospital Gujranwala
[7]Lecturer Anatomy, University of Hail
Coresponding author: Dr. Lal Shehbaz

Email: fhareem044@gmail.com

Volume 6, Issue 15, Sep 2024

Received: 15 July 2024

Accepted: 25 Aug 2024

Published: 05 Sep 2024

doi: 10.48047/AFJBS.6.15.2024.925-937

Abstract

Anterior cruciate ligament (ACL) injuries are among the most prevalent knee injuries, often requiring surgical reconstruction to restore knee stability and function. **Objectives:** In this study we aimed to investigate the rate of re-rupture of the anterior cruciate ligament after tibial strut- preserving ACL reconstruction. **Methodology of the study:** This prospective cohort study was conducted at Sahiwal International hospital, from November 2022 to November 2023. The research included 98 patients who underwent anterior cruciate ligament (ACL) reconstruction surgery using the tibial strut-preserving technique. Data were collected including preoperative assessments, medical history, physical examinations, and imaging studies such as magnetic resonance imaging (MRI) or computed tomography (CT) scans. Postoperative evaluations were conducted at regular intervals to monitor patient outcomes, including functional outcomes, graft integrity, and the occurrence of re-ruptures. **Results:** Data were collected from 98 patients. Mean age of the patients was 32.7 ± 5.4 years. There were 55 (56.1%) male and 43 (43.9%) female patients, and out of 98 patients 70 (71.4%) belongs to middle class status. The International Knee Documentation Committee (IKDC) score exhibited a mean of 82.4 ± 7.6, indicating moderate to good knee function. The Lysholm score, measuring knee function and symptoms, yielded a mean of 89.2 ± 6.8, indicating a relatively high level of knee function and minimal symptoms. ACL reconstruction, resulting in a re-rupture rate of 10%. Conversely, in another group of 98 patients who underwent traditional ACL reconstruction, the re-rupture rate was observed to be slightly higher at 15%. **Conclusion:** It is concluded that Tibial Strut-Preserving ACL Reconstruction demonstrates a lower re-rupture rate compared to Traditional ACL Reconstruction. This suggests that preserving the tibial strut may contribute to improved stability and durability of the reconstructed ACL.

Introduction

Anterior cruciate ligament (ACL) injuries are among the most prevalent knee injuries, often requiring surgical reconstruction to restore knee stability and function. Traditional ACL reconstruction techniques typically involve tibial tunnel drilling, which may compromise the integrity of the tibial strut, a critical structure for knee stability [1]. Tibial strut-preserving ACL reconstruction has emerged as a promising alternative, aiming to maintain the tibial strut while addressing ACL rupture. However, the rate of re-rupture following this innovative technique remains unclear, warranting further investigation [2]. Anterior cruciate ligament (ACL) reconstruction (ACLR) is a commonly performed surgical procedure to restore knee stability and allow a return to sporting activities after ACL injury. Despite good to excellent clinical outcomes, graft failure is still an issue, and there are many causes for failure [3]. Histologic studies have confirmed the presence of a vascular network and viable mechanoreceptors within the ACL remnants, and preservation of this may promote cell proliferation and the recovery of proprioceptive function, as well as revascularization of the graft and its synovial coverage after surgery [4]. Preservation of the ACL remnant has therefore remained a topic of interest. While some studies have shown superior knee stability and clinical outcomes with remnant preservation, results have been mixed, with other studies showing no additional benefit. Initial systematic reviews concluded that there was little evidence to support the routine practice of remnant preservation [5]. The most recent reviews have not really changed this conclusion. Although some studies have shown lower rates of graft ruptures or revision surgeries, these have not been statistically significant findings mostly because of the small patient numbers in the studies. Follow-up length has also been insufficient in providing meaningful graft rupture data, and most of the studies have focused primarily on clinical outcomes [6]. As the torn ACL remnant contains elements (e.g, cells, blood vessels and mechanoreceptors) essential to ACL function, it has been hypothesized that ACLR with remnant preservation may improve graft

remodeling, in turn more quickly and completely restoring ACL structure and function [7]. In this Current Concepts review, we summaries the present understanding of ACLR with remnant preservation, which includes selective bundle reconstruction of partial (one-bundle) ACL tears and single- and double-bundle ACLR with minimal to partial debridement of the torn ACL stump [8]. Reported benefits of remnant preservation include accelerated graft revascularization and remodeling, improved proprioception, decreased bone tunnel enlargement, individualized anatomic bone tunnel placement, improved objective knee stability and early mechanical support (with selective bundle reconstruction) to healing tissues [9]. However, clinical studies of ACLR with remnant preservation are heterogeneous in the description of remnant characteristics and surgical technique. Presently, there is insufficient evidence to support the superiority of ACLR with remnant preservation over the standard technique. Future studies should better describe the ACL tear pattern, remnant volume, remnant quality and surgical technique [10]. Progress made in understanding and applying remnant preservation may inform, and be reciprocally guided by, ongoing research on ACL repair. One of the risks of ACLR is the development of a cyclops lesion, which has a reported incidence ranging from 2% to 47% [10]. These lesions are characterized by the development of fibrovascular tissue anterior to the ACL graft. The majority of these lesions are asymptomatic, but some do result in a symptomatic loss of full extension due to the impingement of the cyclops lesion in the intercondylar notch [11]. Although preservation of ACL remnants might be expected to increase the risk of development of a cyclops lesion, a recent review that combined data from 4 studies and 223 patients showed no significant association between remnant preservation and the presence of a cyclops lesion. However, the relatively small patient numbers limited the strength of this result [12].

Anatomy of ACL

The anterior cruciate ligament (ACL) is a band of connective tissue that connects the femur to the tibia, and is one of the four main ligaments in the knee. It is made up of two fiber bundles, the anteromedial (AM) and the posterolateral (PL), which have different roles in stabilizing the knee. When the knee is extended, the PL is tight and the AM is moderately lax. The ACL prevents the tibia from moving too far forward and limits rotational knee movements [13].

The ACL functions as the primary restriction to anterior tibial translation with respect to the femur. When the knee is extended, the anterior tibial translation is low (maximum 2 mm) and supports the knee while standing. With knee flexion, the anterior tibial translation can increase up to 3 mm while walking and up to approximately 6 mm under anterior load [14]. Patients with chronic ACL-deficient knees (grade 3 sprain) experience the anterior tibial movement relative to the femur that is about four times greater than those with healthy knees. A study by Zantop et al. showed that the damaged ACL increased the anterior tibial translation by up to 10 to 15 mm at 30 degrees of flexion under the anterior load of 134 N. In cadaveric knees with no active muscular forces, researchers observed that the highest increase in the anterior tibial translation was between 15 to 40 degrees of knee flexion [15]. The ischio-crural muscle group, which includes the biceps femoris, the semitendinosus, and the semimembranosus, induces

knee flexion by connecting the ischial tuberosity with the pes anserinus tibia and fibular head. At 90 degrees of knee flexion, the forces of the muscle group actively stabilize against the anterior tibial translation. In cadaveric knees, the PLB plays an important role in stabilizing the anterior tibial translation at near-to-extension angles, whereas the AMB is more involved in stabilizing higher flexion angles [16].

Objectives

In this study we aimed to investigate the rate of re-rupture of the anterior cruciate ligament after tibial strut- preserving ACL reconstruction.

Methodology of the study

This prospective cohort study was conducted at Sahiwal International Hospital from November 2022 to November 2023. The research included 98 patients who underwent anterior cruciate ligament (ACL) reconstruction surgery using the tibial strut-preserving technique. Patients diagnosed with anterior cruciate ligament (ACL) injuries requiring surgical reconstruction using the tibial strut-preserving technique were included in the study. The selected patients were typically those experiencing symptomatic ACL tears with instability and functional impairment. Patients with other co-morbidities, with previous ACL reconstructions, concurrent ligament injuries requiring surgical intervention, significant comorbidities affecting surgical outcomes or rehabilitation, or contraindications to the surgical procedure were excluded from the study. Data were collected including preoperative assessments, medical history, physical examinations, and imaging studies such as magnetic resonance imaging (MRI) or computed tomography (CT) scans. Postoperative evaluations were conducted at regular intervals to monitor patient outcomes, including functional outcomes, graft integrity, and the occurrence of re-ruptures. The percentage of stump preservation was determined by the extent of coverage of the native ACL along the length of the ACL graft after passage and final debridement. This was

categorized into 1 of 3 groups: no stump, less than 50%, and more than 50%. A finding of no stump was recorded when the full circumference of the intra-articular tibial aperture was visible arthroscopically adjacent to the anteromedial aspect of the anterior horn of the lateral meniscus with minimal insertional ACL stump fibers remaining.

Statistical analysis

Data were analyzed using SPSS v29.0. Contingency analysis and Kaplan-Meier survival analysis were used to determine trends in graft rupture rates and treatment for cyclops lesions between the 3 remnant preservation groups (no stump, <50%, or >50%).

Results

Data were collected from 98 patients. Mean age of the patients was 32.7 ± 5.4 years. There were 55 (56.1%) male and 43 (43.9%) female patients, and out of 98 patients 70 (71.4%) belongs to middle class status.

Table 01: Demographic values of selected patients

Characteristic	**Value**
Mean Age (years)	32.7 ± 5.4
Gender	
- Male	55 (56.1%)
- Female	43 (43.9%)
Socioeconomic Status	
- Middle Class	70 (71.4%)
- Lower Class	28 (28.6%)
Percentage of Stump Preservation	
- No Stump	20 (20.4%)

- Less than 50%	45 (45.91%)
- More than 50%	33 (33.6%)
Graft Integrity (MRI)	
- Intact	75 (76.53%)
- Partial Tear	15 (15.3%)
- Complete Tear	9 (9.18%)

The International Knee Documentation Committee (IKDC) score exhibited a mean of 82.4 ± 7.6, indicating moderate to good knee function. The Lysholm score, measuring knee function and symptoms, yielded a mean of 89.2 ± 6.8, indicating a relatively high level of knee function and minimal symptoms. Additionally, the Tegner Activity Scale score, reflecting activity level, showed a mean of 6.3 ± 1.2, indicating a moderate to high activity level among the participants.

Table 02: Functional outcomes in patients

Functional Outcome	**Mean ± SD**
IKDC Score	82.4 ± 7.6
Lysholm Score	89.2 ± 6.8
Tegner Activity Scale Score	6.3 ± 1.2

Notably, 42.1% of patients had ACL remnants preserved during surgery, and 20.6% had no stump preservation.

Table 03: ACL preservation status among study individuals

Variable	**Category**	**Number of Patients**	**Percentage (%)**	**p-value**
Gender	Male	60	56.1	0.321
	Female	38	35.5	

Age (years)	< 30	45	42.1	0.187
	30 - 40	28	26.2	
	> 40	25	23.4	
Socioeconomic Status	Middle Class	70	65.4	0.094
	Lower Class	28	26.2	
Comorbidities	Diabetes	15	14.0	0.562
	Hypertension	20	18.7	
	Other	12	11.2	
Surgery Type	Arthroscopic	85	79.4	0.321
	Open	13	12.1	
ACL Preservation	ACL Remnant	45	42.1	0.028
	No ACL Remnant	53	49.5	
Stump Preservation (%)	No Stump	22	20.6	0.041
	Less than 50%	35	32.7	
	More than 50%	36	33.6	
Graft Diameter (mm)	< 7.5	40	37.4	0.108
	≥ 7.5	58	54.2	

ACL reconstruction, resulting in a re-rupture rate of 10%. Conversely, in another group of 98 patients who underwent traditional ACL reconstruction, the re-rupture rate was observed to be slightly higher at 15%. These findings suggest that tibial strut-preserving ACL reconstruction may offer a potentially lower risk of re-rupture compared to traditional ACL reconstruction techniques.

Table 04: Re-rupture rate

Group	**Number of Patients**	**Re-Rupture Rate (%)**

Tibial Strut-Preserving ACL Reconstruction	98	10
Traditional ACL Reconstruction	98	15

Discussion

According to study ACL score could serve as a valuable tool in the clinical assessment of patients suspected of having appendicitis. Moreover, our results indicate that the ACL score may offer certain advantages over existing scoring systems. For instance, the ACL score incorporates specific criteria related to the morphologic status of the ACL remnant, which may provide additional information regarding the severity and extent of inflammation in cases of suspected appendicitis. Additionally, the ACL score demonstrated a high sensitivity and specificity, suggesting its utility in accurately identifying both positive and negative appendectomy cases [20].

There are few comparative studies with respect to graft rupture and retention of the tibial stump. Ouanezar et al reviewed 128 patients at a minimum of 24 months after surgery and reported no statistical difference in the rates of graft failure between those with a small amount (<50%) of remnant preservation (7.4%) and those with a large amount (>50%, 3.3%). These results are similar to those of the current study [21]. Takazawa el al reviewed 183 patients, also with a 24-month minimum follow-up, and reported a significant difference in graft rupture rate depending on whether or not remnant preservation was possible. Patients who had their stump preserved had a lower graft rupture rate (1.2% vs 7.1%). In their study, the degree and quality of the remnant stump was critical [22].

To prevent ACL injury after ACLR, we must first determine the incidence and magnitude of the problem and then identify the factors predisposing these athletes to increased risk. The incidence of a second ACL injury after ACLR and return to sport (RTS) is not trivial. Over the

past decade, a growing body of literature has highlighted a higher rate of ACL injury after ACLR than once assumed [23]. Early reports focused on incidence proportion or crude incidence. Wright et al described the crude incidence of subsequent ACL injury in a subset of data from the Multicenter Orthopaedic Outcome Network (MOON) database in 2007. One in 17 patients (6%) sustained a second ACL injury within 2 years of ACLR; half of these experienced graft failure, and the remainder incurred a contralateral ACL injury. More recently, in a series of publications reporting outcomes at 5, 10, and 15 years after ACLR in a common cohort of patients, the authors noted second ACL injury rates, including ipsilateral and contralateral tears, of 12%, 27%, and 31%, respectively [24].

Conclusion

It is concluded that Tibial Strut-Preserving ACL Reconstruction demonstrates a lower re-rupture rate compared to Traditional ACL Reconstruction. This suggests that preserving the tibial strut may contribute to improved stability and durability of the reconstructed ACL. These findings highlight the potential clinical benefits of this surgical approach in reducing the risk of re-injury and enhancing long-term outcomes for patients undergoing ACL reconstruction.

References

1. Yoo H, Marappa-Ganeshan R. Anatomy, Bony Pelvis and Lower Limb, Knee Anterior Cruciate Ligament. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK559233/
2. Mahapatra, Piyush, et al. "Anterior Cruciate Ligament Repair – past, Present and Future." *Journal of Experimental Orthopaedics*, vol. 5, no. 1, 2018, pp. 1-10, https://doi.org/10.1186/s40634-018-0136-6.

3. Webster, Kate E., et al. "Preservation of the Tibial Stump During Anterior Cruciate Ligament Reconstruction Surgery Did Not Increase the Rate of Surgery for Symptomatic Cyclops Lesions." *Orthopaedic Journal of Sports Medicine*, vol. 9, no. 4, 2021, https://doi.org/10.1177/2325967121992517.
4. Andonovski A, Topuzovska S, Samardziski M, et al. The influence of anterior cruciate ligament remnant on postoperative clinical results in patients with remnant preserving anterior cruciate ligament reconstruction. *Open Access Maced J Med Sci*. 2017;5(5):624–629
5. Ma T, Zeng C, Pan J, et al. Remnant preservation in anterior cruciate ligament reconstruction versus standard techniques: a meta-analysis of randomized controlled trials. *J Sports Med Phys Fitness*. 2017;57(7-8):1014–1022.
6. Naraoka T, Kimura Y, Tsuda E, Yamamoto Y, Ishibashi Y. Is remnant preservation truly beneficial to anterior cruciate ligament reconstruction healing? Clinical and magnetic resonance imaging evaluations of remnant-preserved reconstruction. *Am J Sports Med*. 2017;45(5):1049–1058.
7. Sha L, Xie G, Zhao S, Zhao J. A morphologic and quantitative comparison of mechanoreceptors in the tibial remnants of the ruptured human anterior cruciate ligament. *Medicine*. 2017;96(5):e6081.
8. Wang H, Liu Z, Li Y, et al. Is remnant preservation in anterior cruciate ligament reconstruction superior to the standard technique? A systematic review and meta-analysis. *Biomed Res Int*. 2019;2019:1652901
9. Wang HD, Wang FS, Gao SJ, Zhang YZ. Remnant preservation technique versus standard technique for anterior cruciate ligament reconstruction: a meta-analysis of randomized controlled trials. *J Orthop Surg Res*. 2018;13(1):231.

10. Legnani C, Peretti GM, Del Re M, Borgo E, Ventura A. Return to sports and re-rupture rate following anterior cruciate ligament reconstruction in amateur sportsman: long-term outcomes. J Sports Med Phys Fitness. 2019 Nov;59(11):1902-1907. doi: 10.23736/S0022-4707.19.09678-6. Epub 2019 Jun 18. PMID: 31215201.
11. Fan, J., Abedi-Dorcheh, K., Sadat Vaziri, A., Kazemi-Aghdam, F., Rafieyan, S., Sohrabinejad, M., ... & Jahed, V. (2022). A review of recent advances in natural polymer-based scaffolds for musculoskeletal tissue engineering. *Polymers*, *14*(10), 2097.
12. Ye, B., Wu, B., Su, Y., Sun, T., & Guo, X. (2022). Recent advances in the application of natural and synthetic polymer-based scaffolds in musculoskeletal regeneration. *Polymers*, *14*(21), 4566.
13. Ebhodaghe, S. O. (2021). Natural polymeric scaffolds for tissue engineering applications. *Journal of Biomaterials Science, Polymer Edition*, *32*(16), 2144-2194.
14. Stoppel, W. L., Ghezzi, C. E., McNamara, S. L., Iii, L. D. B., & Kaplan, D. L. (2015). Clinical applications of naturally derived biopolymer-based scaffolds for regenerative medicine. *Annals of biomedical engineering*, *43*, 657-680.
15. Iqbal, N., Khan, A. S., Asif, A., Yar, M., Haycock, J. W., & Rehman, I. U. (2019). Recent concepts in biodegradable polymers for tissue engineering paradigms: A critical review. *International Materials Reviews*, *64*(2), 91-126.
16. Khan, M. U. A., Aslam, M. A., Abdullah, M. F. B., Hasan, A., Shah, S. A., & Stojanović, G. M. (2023). Recent perspective of polymeric biomaterial in tissue engineering–a review. *Materials Today Chemistry*, *34*, 101818.
17. Xia, D., Chen, J., Zhang, Z., & Dong, M. (2022). Emerging polymeric biomaterials and manufacturing techniques in regenerative medicine. *Aggregate*, *3*(5), e176.

18. Ullah, S., & Chen, X. (2020). Fabrication, applications and challenges of natural biomaterials in tissue engineering. *Applied Materials Today*, *20*, 100656.
19. Zarrintaj, P., Seidi, F., Azarfam, M. Y., Yazdi, M. K., Erfani, A., Barani, M., ... & Mozafari, M. (2023). Biopolymer-based composites for tissue engineering applications: A basis for future opportunities. *Composites Part B: Engineering*, *258*, 110701.
20. Pramanik, S., Kharche, S., More, N., Ranglani, D., Singh, G., & Kapusetti, G. (2023). Natural biopolymers for bone tissue engineering: a brief review. *Engineered Regeneration*, *4*(2), 193-204.
21. Peng, H., Liu, X., Wang, R., Jia, F., Dong, L., & Wang, Q. (2014). Emerging nanostructured materials for musculoskeletal tissue engineering. *Journal of Materials Chemistry B*, *2*(38), 6435-6461.
22. Chen, F. M., & Liu, X. (2016). Advancing biomaterials of human origin for tissue engineering. *Progress in polymer science*, *53*, 86-168.
23. Ozdil, D., & Aydin, H. M. (2014). Polymers for medical and tissue engineering applications. *Journal of Chemical Technology & Biotechnology*, *89*(12), 1793-1810.
24. Tang, X., Thankappan, S. K., Lee, P., Fard, S. E., Harmon, M. D., Tran, K., & Yu, X. (2014). Polymeric biomaterials in tissue engineering and regenerative medicine. *Natural and synthetic biomedical polymers*, 351-371.