

Functional Outcome of Arthroscopic Management of Anterior Cruciate Ligament Injury using Four-strand Hamstring Tendon Graft: A Prospective Cohort Study

R KAVIN KUMAR¹, M MOHAN², C RISHAB³, L SABARI VAASAN⁴

ABSTRACT

Introduction: Anterior Cruciate Ligament (ACL) injuries are common, particularly among athletes and can significantly affect an individual's functional abilities and sports career. ACL reconstruction using a four-strand hamstring tendon graft has become the gold standard for restoring knee stability and function.

Aim: To assess the functional outcomes resulting from arthroscopic ACL reconstruction using a four-strand hamstring tendon graft.

Materials and Methods: This prospective cohort study was conducted at SRM Medical College and Hospital, Chennai, Tamil Nadu, India, including 33 patients with Grade II and Grade III ACL tears with or without associated meniscal injuries, who underwent ACL reconstruction using a four-strand hamstring tendon graft. The study population included patients aged 20-55 years, with follow-up assessments conducted at three and six months postoperatively. Knee function was measured using the Tegner Lysholm Knee Score, and pain levels were assessed

using the Visual Analogue Scale (VAS). Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 16.0, employing Analysis of Variance (ANOVA) to evaluate clinical outcomes.

Results: The majority of patients, i.e., 18 (54.55%), were between 21 and 30 years of age. Most of the participants were male, 29 (87.88%). The involvement of the right knee was slightly higher, with 17 (51.52%) compared to the left knee, which had 16 (48.48%). Isolated ACL tears were diagnosed in 21 (63.64%) of the patients. The Tegner Lysholm Knee Score improved significantly from a preoperative mean of 35.97 to 71.97 at three months and 88.85 at six months (p -value<0.0001). Pain, as measured by VAS, showed a significant reduction from the second postoperative day to the six-month follow-up (p -value<0.0001).

Conclusion: ACL reconstruction using a four-strand hamstring tendon graft resulted in significant improvements in knee function and a reduction in pain within six months of surgery.

Keywords: Arthroscopy, Knee function, Tegner Lysholm score, Visual analogue scale

INTRODUCTION

The knee is the most commonly injured joint in the body. The ACL is a ligament located in the middle of the knee and injuries to this ligament are common and referred to as ACL injuries [1]. The primary function of the ACL is to provide anteroposterior and rotational stability, while its secondary function includes acting as a proprioceptor for the joint, offering mediolateral stability and resisting valgus and varus stress [2]. Athletes and sports persons are more prone to ACL injuries [3]. Such serious injuries can significantly impede the careers of athletes and sports professionals. An ACL injury may result from a hyperextended knee and if there is a muscle tear, it can lead to a more severe injury [4-6]. Studies indicate that 50% of ACL injuries involve a combination of damage to the meniscus, articular cartilage and other ligaments [7-9]. Furthermore, research shows that female athletes have a greater likelihood of knee injuries compared to their male counterparts, attributed to differences in physical conditioning, muscular strength and other factors [10,11].

Arthroscopic ACL reconstruction has become the gold standard for treating torn ACLs. This procedure allows patients to return to their preinjury activity levels while delaying meniscal degenerative injuries and the onset of osteoarthritis. Despite these established benefits, ongoing research is focused on optimising ACL reconstruction techniques, particularly about using various grafts and the anatomical reconstruction of both the anteromedial and posterolateral bundles to improve rotational stability. Accurate placement of the femoral

tunnel has also been shown to play a crucial role in determining the success of the procedure [11]. While ACL reconstruction using a four-strand hamstring tendon autograft has demonstrated benefits such as the elimination of anterior tibial subluxation, improved functional knee scores and enhanced isokinetic knee extension strength, there remains a need for further investigation.

The novelty of present study lies in evaluating the functional outcomes of this specific technique in a cohort of patients and its impact on postoperative recovery. By focusing on the functional outcomes of arthroscopic management using a four-strand hamstring tendon graft, present study aimed to provide additional evidence to refine surgical techniques and improve patient outcomes.

MATERIALS AND METHODS

This prospective cohort study was conducted at the Department of Orthopaedics, SRM Medical College and Hospital and Research Centre, Chennai, Tamil Nadu, India, from January 2016 to June 2017, including the follow-up period. A total of 33 participants who met the study's inclusion criteria and were treated during the study period were selected. Ethical approval was obtained from the SRM Institutional Ethics Committee (Ethics clearance number: 903/IEC/2015), and the study's progress was periodically reviewed.

Inclusion criteria: Patients with unilateral Grade II and Grade III ACL tears, aged between 20 and 55 years, with or without associated meniscal injuries, who had experienced traumatic knee injuries, were included in the study.

Exclusion criteria: Individuals having multiligament injuries, skeletal immaturity, lower limb bony injuries, prior knee surgeries, or any medical conditions contraindicating an anaesthesia were excluded from the study.

The surgical procedure involved ACL reconstruction using a four-strand hamstring tendon graft, where the femoral tunnel was created through the transtibial technique, and the tibial tunnel was made using the “Tibial Zig” technique. Patients were monitored for a minimum period of six months, with regular follow-ups.

Clinical evaluations were conducted at baseline (preoperatively) and at various postoperative intervals. Two key clinical parameters were assessed during the follow-up: the Tegner Lysholm score [12] and the VAS. The Tegner Lysholm score was utilised to measure knee function, addressing common complaints such as limping, pain, swelling, locking and instability, both before surgery and at three and six months postoperatively. The VAS was employed to assess pain levels, with patients rating their pain on a scale of 0 (no pain) to 10 (unbearable pain) at different time points: preoperatively, on the second postoperative day, at the second week, the third month and the sixth month.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS version 16.0. The collected data were analysed using various statistical tools, including mean±Standard Deviation (SD), frequency and percentage distributions, and ANOVA tests to assess changes in clinical outcomes over time.

RESULTS

The age distribution showed that the majority of patients i.e., 18 (54.55%), were between 21 and 30 years of age. Most of the participants were male, accounting for 29 (87.88%), with only 12.12% being female [Table/Fig-1]. The involvement of the right knee was slightly higher compared to the left knee [Table/Fig-2].

Parameters	n (%)
Age (years)	
≤20	1 (3.03)
21-30	18 (54.55)
31-40	9 (27.27)
41-50	5 (15.15)
Gender	
Male	29 (87.88)
Female	4 (12.12)

[Table/Fig-1]: Demographic details.

Knee- side involved	n (%)
Right-side	17 (51.52)
Left-side	16 (48.48)

[Table/Fig-2]: Knee involvement.

Regarding diagnosis, 21 (63.64%) of the patients had isolated ACL tears. The distribution of diagnosis showed no significant variation (p-value=0.2251) [Table/Fig-3].

Diagnosis	n (%)
ACL tear	21 (63.64)
ACL tear with medial meniscal tear	10 (30.30)
ACL tear with lateral meniscal tear	1 (3.03)
ACL tear with medial and lateral meniscal tear	1 (3.03)

[Table/Fig-3]: Diagnosis distribution.

Preoperative and postoperative outcomes were assessed using the Tegner Lysholm Knee Score. The mean preoperative score was 35.97, which significantly improved to 71.97 at three months

and 88.85 at six months postoperatively, with highly significant p-values (<0.0001) across all time comparisons, indicating a strong improvement in knee function postsurgery [Table/Fig-4].

The Tegner Lysholm Knee Score	Preoperative	Postoperative (3 months)	Postoperative (6 months)
Mean±SD	35.97±19.01	71.97±8.27	88.85±5.56
p-value	Preoperative vs postoperative (3 months)		<0.0001
	Preoperative vs postoperative (6 months)		<0.0001
	Postoperative (3 months) Vs Postoperative (6 months)		<0.0001
p-value ANOVA -	<0.0001		
Two factor without replication	<0.0001		

[Table/Fig-4]: Mean preoperative and postoperative Tegner-Lysholm Knee Scores.

VAS scores were highest on the second postoperative day and steadily declined by the six-month follow-up, with significant improvements demonstrated by ANOVA (p-value<0.0001). Notably, patients undergoing arthroscopic ACL reconstruction with both medial and lateral meniscectomies had the highest preoperative VAS score (6.00), though pain levels reduced substantially over time [Table/Fig-5]. An MRI image showing pre- and postoperative reconstruction of the ACL tear is presented in [Table/Fig-6].

DISCUSSION

The current work examines the functional success of arthroscopic therapy for ACL restoration using a four-strand hamstring tendon graft. An investigation conducted by Jameson S, Emmerson K, revealed that single-bundle ACL restoration is the most effective approach [13]. However, Suomalainen P et al., also discovered that the double-bundle reconstruction methodology ultimately reduces the rate of degenerative changes [14]. A critical analysis of the rate of subsequent surgery and its predictors after undergoing ACL reconstruction found that 0.49% of the patients, approximately six individuals with an average follow-up treatment of two and a half months, experienced deep infections after the surgery [15]. In contrast, present study did not report any postoperative infections, suggesting a successful outcome of the medical procedure.

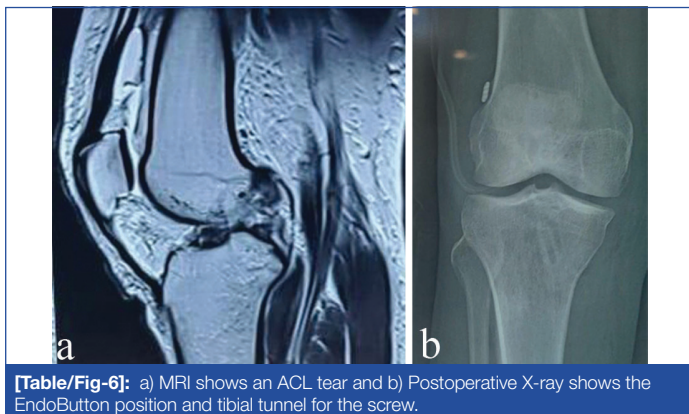
A comparative study was conducted to assess the functional outcome of preserving remaining tissue in arthroscopic ACL restoration using a quadrupled hamstring graft. A comprehensive empirical examination of 16 patients revealed a significant difference in functional outcomes and proprioception. Accordingly, it was discovered that the preservation of the remaining tibia positively correlates with proprioceptive function [16].

Present study revealed highly significant knee scores, which align with the findings of the study by Williams RJ et al., which also reported notably higher functional knee scores [17]. A recent study conducted by Yahia A, also showed notable improvements in functional knee ratings throughout follow-up, which aligns with the findings of present study investigation [16].

In a study conducted by Jagdeesh PC and Shaikh SR patients with ACL injuries who underwent arthroscopic anatomical ACL reconstruction using a quadrupled hamstring autograft were evaluated using the International Knee Documentation Committee score (IKDC), Lysholm scoring systems, the Tegner activity scale, and a subjective questionnaire. About 95% of the patients had favourable outcomes (IKDC, Lysholm score, subjective questionnaire) across all three scoring systems [18]. However, long-term follow-up is needed to determine the additional benefits of ACL reconstruction with four-strand hamstring tendon grafts, like delaying degeneration, improving sports activity and lesser chondral injuries. Comparative studies are needed to know the advantages of hamstring tendon grafts over other types of reconstruction.

Visual analog scale score-procedures	Preoperative	Postoperative (2 nd day)	Postoperative (2 nd week)	Postoperative (3 months)	Postoperative (6 months)	p-value ANOVA-two factor without replication
Arthroscopic ACL reconstruction	2.38	6.48	3.86	0.62	0.24	<0.0001
Arthroscopic ACL reconstruction with medial meniscectomy	3.5	6.8	3.9	1	0.4	<0.0001
Arthroscopic ACL reconstruction with lateral meniscectomy	0.00	5.00	2.00	0.00	0.00	<0.0001
Arthroscopic ACL reconstruction with medial and lateral meniscectomy	6.00	8.00	3.00	2.00	1.00	<0.0001

[Table/Fig-5]: Visual Analogue Scale (VAS) scores.



[Table/Fig-6]: a) MRI shows an ACL tear and b) Postoperative X-ray shows the EndoButton position and tibial tunnel for the screw.

Limitation(s)

The limitations of this study include a small sample size of 33 patients, which restricts the generalisability of the findings. Additionally, the short follow-up duration of six months is insufficient to assess long-term outcomes such as knee degeneration, osteoarthritis, or the rate of reinjury. As a single-centre study, the results may not reflect broader populations or variations in clinical practice across different healthcare settings. The absence of a comparison group between different ACL reconstruction techniques or graft options, such as patellar tendon grafts, further limits the ability to evaluate the specific advantages of the four-strand hamstring tendon graft. Furthermore, some assessments, like the VAS for pain, rely on subjective patient-reported data, which may introduce potential bias.

CONCLUSION(S)

Patients who underwent ACL reconstruction with an autologous four-strand hamstring tendon graft demonstrated good functional outcomes and clinical stability, with no significant complications. Future longitudinal and comparative studies are essential to ascertain the procedure's impact on knee degeneration over time.

REFERENCES

- Blackburn JT, Bell DR, Norcross MF, Hudson JD, Kimsey MH. Sex comparison of hamstring structural and material properties. *Clin Biomech.* 2009;24(1):65-70.
- Pinczewski LA, Lyman J, Salmon LJ, Russell VJ, Roe J, Linklater J. A 10-year comparison of anterior cruciate ligament reconstructions with hamstring tendon and patellar tendon autograft: A controlled, prospective trial. *Am J Sports Med.* 2007;35(4):564-74.
- Feller JA, Siebold R, Webster KE. ACL reconstruction in females: Patellar tendon versus hamstring tendon autograft. In *orthopaedic proceedings. Orthop Procs.* 2005;87-B(SUPP_III):305-05.
- Goldblatt JP, Fitzsimmons SE, Balk E, Richmond JC. Reconstruction of the anterior cruciate ligament: Meta-analysis of patellar tendon versus hamstring tendon autograft. *Arthroscopy.* 2005;21(7):791-803.
- Hamada M, Shino K, Horibe S, Mitsuoka T, Toritsuka Y, Nakamura N. Changes in cross-sectional area of hamstring anterior cruciate ligament grafts as a function of time following transplantation. *Arthroscopy.* 2005;21(8):917-22.
- Lidén M, Sernert N, Rostgård-Christensen L, Kartus C, Ejerhed L. Osteoarthritic changes after anterior cruciate ligament reconstruction using bone-patellar tendon-bone or hamstring tendon autografts: A retrospective, 7-year radiographic and clinical follow-up study. *Arthroscopy.* 2008;24(8):899-908.
- Yasumoto M, Deie M, Sunagawa T, Adachi N, Kobayashi K, Ochi M. Predictive value of preoperative 3-dimensional computer tomography measurement of semitendinosus tendon harvested for anterior cruciate ligament reconstruction. *Arthroscopy.* 2006;22(3):259-64.
- Buchner M, Schmeer T, Schmitt H. Anterior cruciate ligament reconstruction with quadrupled semitendinosus tendon- minimum 6 year clinical and radiological follow-up. *The Knee.* 2007;14(4):321-27.
- Lee BI, Kwon SW, Kim JB, Choi HS, Min KD. Comparison of clinical results according to amount of preserved remnant in arthroscopic anterior cruciate ligament reconstruction using quadrupled hamstring graft. *Arthroscopy.* 2008;24(5):560-68.
- Tjoumakaris FP, Buonocristiani A, Starman JS, Fu FH. Anatomic double-bundle anterior cruciate ligament reconstruction using tibialis anterior allograft. *Operative Techniques in Sports Medicine.* 2007;15(2):62-67.
- Kondo E, Yasuda K. Second-look arthroscopic evaluations of anatomic double-bundle anterior cruciate ligament reconstruction: Relation with postoperative knee stability. *Arthroscopy.* 2007;23(11):1198-209.
- Briggs KK, Steadman JR, Hay CJ, Hines SL. Lysholm score and Tegner activity level in individuals with normal knees. *Am J Sports Med.* 2009;37(5):898-901. Doi: 10.1177/0363546508330149. Epub 2009 Mar 23. PMID: 19307332.
- Jameson S, Emmerson K. Altered sensation over the lower leg following hamstring graft anterior cruciate ligament reconstruction with transverse femoral fixation. *The Knee.* 2007;14(4):314-20.
- Suomalainen P, Kannus P, Järvelä T. Double-bundle anterior cruciate ligament reconstruction: A review of literature. *International Orthopaedics.* 2013;37:227-32.
- Aune AK, Holm I, Risberg MA, Jensen HK, Steen H. Four-strand hamstring tendon autograft compared with patellar tendon-bone autograft for anterior cruciate ligament reconstruction: A randomized study with two-year follow-up. *Am J Sport Med.* 2001;29(6):722-28.
- Yahia A. Anterior cruciate ligament arthroscopic ligamentoplasty using the four-strand hamstring technique. *Cureus.* 2023;15(6):e40330.
- Williams RJ III, Hyman J, Petrigliano F, Rozental T, Wickiewicz TL. Anterior cruciate ligament reconstruction with a four-strand hamstring tendon autograft. *J Bone Joint Surg Am.* 2004;86(2):225-32.
- Jagdeesh PC, Shaikh SR. A study on functional outcome of arthroscopic anatomical reconstruction of anterior cruciate ligament using quadrupled hamstring graft. *Int J Res Orthop.* 2017;3:854-61.

PARTICULARS OF CONTRIBUTORS:

- Assistant Professor, Department of Orthopaedics, SRM Institute of Science and Technology, Chennai, Tamil Nadu, India.
- Assistant Professor, Department of Orthopaedics, SRM Institute of Science and Technology, Chennai, Tamil Nadu, India.
- Assistant Professor, Department of Orthopaedics, SRM Institute of Science and Technology, Chennai, Tamil Nadu, India.
- Associate Professor, Department of Orthopaedics, SRM Institute of Science and Technology, Chennai, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. C Rishab,
3153, Estancia Residential Township, GST Road, Vallanchery,
Guduvanchery-603202, Chennai, Tamil Nadu, India.
E-mail: rishabc@srmist.edu.in

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Aug 24, 2023
- Manual Googling: Oct 22, 2024
- iThenticate Software: Oct 24, 2024 (13%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Aug 20, 2023**

Date of Peer Review: **Nov 02, 2023**

Date of Acceptance: **Oct 26, 2024**

Date of Publishing: **Jan 01, 2025**