

Quadriceps Tendon Versus Hamstring Tendon Autograft for Anterior Cruciate Ligament Reconstruction: A Randomized Controlled Study

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How to citation this article: Dr. Paragjyoti Gogoi, Dr. Shubham Anil Kumar Singh, Dr. Jugantar Roy, Dr. Nabo Pallob Bhattacharjee, “Quadriceps Tendon Versus Hamstring Tendon Autograft for Anterior Cruciate Ligament Reconstruction: A Randomized Controlled Study”, IJMACR – May – 2026, Volume – 9, Issue – 3, P. No. 01 – 08.

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Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Anterior cruciate ligament (ACL) reconstruction commonly uses hamstring tendon (HT) and quadriceps tendon (QT) autografts, but direct comparisons of their outcomes are limited.

Aims: To compare functional outcomes, knee stability, pain levels, strength recovery, and complication rates between HT and QT autografts in ACL reconstruction.

Methods: A prospective, comparative study was conducted on 30 patients aged 18–50 years with primary ACL tears at a tertiary care center. Patients were randomly assigned to HT or QT autograft groups. Functional outcomes (Lysholm, IKDC scores), knee

stability (Pivot Shift, Lachman tests), and pain (VAS) were assessed preoperatively and at 2, 6, 12 weeks and 6, 12 months postoperatively.

Results: At 6 months, 60% showed no Pivot Shift instability and 76.7% had no Lachman laxity. The QT group demonstrated slightly better functional outcomes (Lysholm 91.93, IKDC 89.27) compared to the HT group (Lysholm 87.53, IKDC 85.93). Both groups had an average return to activity time of 6.7 months with no graft failures or reoperations.

Conclusion: Both HT and QT autografts offer reliable outcomes for ACL reconstruction with good knee stability and minimal complications. The QT autograft

showed a slight advantage in functional recovery but overall, both grafts are effective options..

Keywords: ACL Reconstruction, Quadriceps Tendon, Hamstring Tendon, Autograft, Knee Stability

Introduction

The anterior cruciate ligament (ACL) plays a vital role in stabilizing the knee joint by preventing excessive anterior translation of the tibia. ACL injuries are frequent among athletes and active individuals, often leading to instability, impaired function, and early-onset osteoarthritis¹. Surgical reconstruction is the standard treatment to restore knee function and stability¹.

Autografts, particularly hamstring tendon (HT) and quadriceps tendon (QT) grafts, are commonly used due to their lower risk of rejection and better integration compared to allografts and synthetic grafts². Hamstring tendon grafts are easy to harvest and offer good outcomes, but may result in postoperative hamstring weakness and graft elongation³. Quadriceps tendon grafts, with their greater strength and cross-sectional area, avoid compromising the hamstring muscles and may better preserve knee flexion strength⁴.

However, adoption of QT grafts has been limited by technical challenges and concerns over anterior knee pain⁵. Comparative studies of HT and QT grafts have yielded mixed results, with some suggesting superior functional outcomes with QT grafts and others finding no significant differences⁶. Preservation of muscle strength, rehabilitation timelines, and return to activity are key factors influencing graft choice^{7,8}.

Given the inconsistencies in current literature, randomized controlled studies using validated outcome measures such as the Lysholm Knee Score and the IKDC score are essential to objectively compare HT and QT autografts^{9,10}. This study aims to evaluate and

compare the clinical and functional outcomes of ACL reconstruction using these two graft types.

Aim and Objectives

The aim of this study is to compare the functional outcomes of anterior cruciate ligament (ACL) reconstruction using hamstring tendon (HT) and quadriceps tendon (QT) autografts. The primary objectives include evaluating knee function using IKDC and Lysholm scores, assessing postoperative stability through Pivot Shift and Lachman tests, and measuring pain levels via the Visual Analogue Scale (VAS). Additionally, the study compares isokinetic strength recovery in knee flexion and extension, time to return to activity, and complication rates such as graft failure and reoperation. The analysis also aims to identify any statistically significant differences in clinical and functional outcomes between the two graft types.

Materials and Methods

This prospective, comparative, and observational study was conducted to evaluate the functional outcomes of quadriceps tendon (QT) versus hamstring tendon (HT) autografts in anterior cruciate ligament (ACL) reconstruction. Both objective and subjective parameters—including knee stability, muscular strength, range of motion, and patient-reported outcomes—were assessed over a minimum follow-up period of 12 months.

The study was carried out in the Department of Orthopaedics at a tertiary care institution equipped with comprehensive diagnostic and rehabilitation infrastructure. The total duration of the study was 18 months, which included a 6-month recruitment phase followed by postoperative follow-up at 3, 6, 9, and 12 months.

Inclusion criteria comprised patients aged between 18 and 50 years with clinically and radiologically confirmed primary ACL rupture, willing to provide informed consent and adhere to study procedures, and without major comorbidities likely to interfere with postoperative recovery. Exclusion criteria included ACL injuries associated with open wounds or fractures, significant neurovascular involvement or polytrauma, prior surgeries on the affected knee, medical contraindications to surgery, and conditions such as pregnancy, lactation, active infections, or inflammatory joint diseases.

Patients attending the outpatient and inpatient departments at Gauhati Medical College and Hospital were enrolled using randomized sampling techniques. Upon consent, they were randomly assigned to either the QT or HT autograft group. A total of 30 patients were included in the study, with 15 patients in each group. The sample size was determined based on effect sizes observed in previous literature comparing functional outcomes of different autografts.

Parameters assessed during the study included pain levels measured by the Visual Analogue Scale (VAS), range of motion, isokinetic strength of quadriceps and hamstrings, gait analysis, and knee stability evaluated using the Lachman and Pivot Shift tests. Functional outcomes were measured using validated scoring systems including the Lysholm Knee Score and the International Knee Documentation Committee (IKDC) score. Complication rates such as graft failure, postoperative infections, and reoperations were also documented.

All surgical procedures were performed using a standardized technique by experienced orthopedic surgeons. In the hamstring tendon (HT) group, graft

harvesting was performed using the standard procedure with a tendon stripper (fig. 1). In the quadriceps tendon (QT) group, grafts were obtained using the open quadriceps harvest technique (fig. 2). Postoperative rehabilitation protocols were uniform across both study groups, ensuring consistency in recovery regimens.



Figure 1: semitendinosus graft harvest



Figure 2: Quadriceps graft harvest

Data were collected through a structured and pretested proforma that captured demographic information, clinical examination findings, intraoperative details, and postoperative outcomes. Patient-reported outcomes were documented using standardized and validated questionnaires.

For statistical analysis, descriptive statistics such as means, medians, and standard deviations were used for continuous variables, while categorical variables were summarized using frequencies and percentages. Group comparisons were performed using paired t-tests for

continuous variables and chi-square tests for categorical data. A p-value of less than 0.05 was considered statistically significant.

Ethical clearance for the study was obtained from the Institutional Review Board (IRB) of GMCH. Written informed consent was secured from all participants prior to inclusion, and patient confidentiality was strictly maintained. Participants retained the right to withdraw from the study at any stage without any impact on their standard care or treatment.

Time point	IKDC		LYSHOLM SCORE	
	QUADRICEPS	HAMSTRING	QUADRICEPS	HAMSTRING
Preoperative score	42.53 ± 9.985	46.67 ± 10.814	52.60 ± 10.473	52.00 ± 7.407
Post operative at 6 months	89.27 ± 7.304	85.93 ± 8.198	91.93 ± 6.861	87.53 ± 5.743

Table 1: preoperative and postoperative IKDC & LYSHOLM Score comparison between quadriceps and hamstring graft group.

Preoperative assessment of knee stability revealed that Grade 1 instability on the Pivot Shift test was the most common finding, present in 50% of patients, followed by Grade 3 instability in 23.3%. On the Lachman test, Grade 2 laxity was observed in 36.7% of cases, while Grade 3 laxity was noted in 33.3%.

All patients underwent femoral fixation using a suspensory device. Tibial fixation methods varied, with 73.3% of cases utilizing an interference screw and 26.7% using cortical button fixation. Notably, QT grafts were significantly more likely to be fixed with an interference screw (93.3%) compared to HT grafts, a difference that was statistically significant ($p = 0.013$).

Intraoperative complications included bleeding in 40% of cases, which was more commonly associated with HT grafts. Minor hematoma formation occurred exclusively in the QT group (16.7%) and was statistically significant ($p = 0.049$). Postoperative infections were infrequent,

Results

The study included a total of 30 patients aged between 20 and 50 years, with a mean age of 36.6 ± 9.03 years. The majority of patients (46.7%) fell within the 40–50-year age group, and 66.7% of the study population were male. The right knee was affected more frequently (60%). Patients were equally distributed into two groups, with 15 receiving hamstring tendon (HT) autografts and 15 receiving quadriceps tendon (QT) autografts.

occurring in only 6.7% of patients, with no significant difference between the groups ($p = 0.143$).

At six months postoperatively, knee stability had improved markedly. On the Pivot Shift test, 60% of patients demonstrated Grade 0 (no instability), and on the Lachman test, 76.7% showed Grade 0 (no laxity). There was no statistically significant difference between the HT and QT groups in either test ($p = 1.000$ and $p = 0.666$, respectively).

Functional outcome scores showed significant improvement following surgery. The mean preoperative Lysholm score was 52.3 ± 8.9 and improved to 89.73 ± 6.6 at six months. Similarly, the IKDC score improved from 44.6 ± 10.4 preoperatively to 87.60 ± 7.8 postoperatively. While the QT group had marginally higher mean scores (Lysholm: 91.93 vs. 87.53), the difference did not reach statistical significance ($p = 0.067$) data summarised in Table 1 above.

Pain levels measured by the Visual Analogue Scale (VAS) on postoperative Day 1 were slightly lower in the QT group (3.80) compared to the HT group (4.80), but this difference was not statistically significant ($p = 0.348$). Quadriceps strength, assessed using manual muscle testing (MMT), was comparable between groups, with a mean score of 3.97 ± 0.85 .

The average time to return to activity was 6.7 ± 1.34 months, with no significant difference observed between the two graft groups ($p = 0.506$). Importantly, there were no cases of graft failure or reoperation in either group during the follow-up period, indicating satisfactory surgical outcomes across both cohorts.

In summary, no statistically significant differences were found in baseline demographics, preoperative scores, postoperative range of motion, pain, muscle strength, or return to activity between the HT and QT groups. However, significant differences were observed in the tibial fixation method ($p = 0.013$), with a higher preference for interference screws in the QT group, and in the incidence of surgical complications ($p = 0.049$), where hematomas were more common in the QT group and intraoperative bleeding was more frequent with HT grafts.

Discussion

The present study aimed to compare the functional outcomes, knee stability, pain levels, and complication rates of quadriceps tendon (QT) and hamstring tendon (HT) autografts in anterior cruciate ligament (ACL) reconstruction. By assessing a randomized cohort of 30 patients, the study provides valuable insight into the comparative efficacy of these two commonly used autografts and contributes to the ongoing discourse regarding optimal graft selection in ACL surgery.

The demographic distribution of the study population showed a predominance of patients in the 40–50-year age group (46.7%), followed by those aged 20–30 years (33.3%). This age profile is consistent with the findings of Björnsson et al. (2016), who reported similar age demographics in patients undergoing ACL reconstruction. Additionally, the study showed a male predominance (66.7%), aligning with Getgood et al. (2016), who documented a higher incidence of ACL injuries in males, likely due to greater participation in high-risk physical activities. The higher frequency of right knee involvement (60%) is also in agreement with Horstmann et al. (2021), who attributed this to the dominance of the right leg in most individuals, making it more susceptible to injury.

Preoperative clinical assessments revealed significant instability, with the majority of patients exhibiting Grade 1 to Grade 3 findings on Pivot Shift and Lachman tests. These findings parallel those reported by Khatri et al. (2023), who emphasized that varying degrees of preoperative instability did not significantly influence postoperative graft outcomes. This was further supported by Martin-Alguacil et al. (2019), who found both HT and QT autografts to be effective in restoring knee stability, regardless of the initial severity of instability.

Surgical technique and fixation methods were standardized for femoral fixation, while tibial fixation varied. Interference screw fixation was more common in the QT group (93.3%), a statistically significant finding ($p = 0.013$), consistent with the preferences reported by Ebert et al. (2024), who noted better mechanical stability with interference screws, especially for larger grafts such as the quadriceps tendon. This reinforces the importance of graft-specific fixation strategies in achieving optimal stability.

Postoperative knee stability at six months was excellent, with 60% of patients showing Grade 0 on the Pivot Shift test and 76.7% on the Lachman test. These results affirm the findings of Abouheif (2024), who reported a high rate of stability following ACL reconstruction with QT grafts, and those of Khatri et al. (2023), who observed comparable stability in both HT and QT groups. This suggests that both graft types can effectively restore anterior knee stability post-reconstruction.

Functional outcomes showed significant improvement, with postoperative Lysholm and IKDC scores rising from 52.3 ± 8.9 to 89.73 ± 6.6 and from 44.6 ± 10.4 to 87.60 ± 7.8 , respectively. Although the QT group demonstrated slightly better outcomes, the difference was not statistically significant ($p = 0.067$). These findings are supported by Sinding et al. (2020), who also found no meaningful difference in long-term functional scores between HT and QT grafts, although QT grafts were associated with slightly better extension strength recovery, echoing the trend noted in this study.

Pain assessment using the Visual Analogue Scale (VAS) on postoperative Day 1 showed a lower mean score in the QT group (3.80) than in the HT group (4.80), though not statistically significant ($p = 0.348$). This is consistent with the results reported by Martin-Alguacil et al. (2019), who found initial differences in postoperative pain between the grafts but observed convergence in long-term outcomes.

Intraoperative bleeding occurred in 40% of patients, more frequently with HT grafts. Minor hematoma formation was exclusive to the QT group (16.7%, $p = 0.049$). These findings mirror those of Khatri et al. (2023), who documented greater intraoperative bleeding with HT graft harvesting due to the vascularity and extent of dissection involved. Despite these

complications, 43.3% of patients had no surgical complications, supporting the safety profile of both grafts as noted by Horstmann et al. (2021).

Importantly, no graft failures or reoperations were observed during the follow-up period, indicating high graft integrity and satisfactory surgical outcomes. This aligns with the results of Ebert et al. (2024), who also reported zero graft failures in a comparative study of HT and QT autografts. Similarly, Getgood et al. (2016) observed durable outcomes with HT grafts and found no significant differences in survivability compared to other graft types, supporting the conclusion that both grafts offer reliable long-term results when appropriately selected and surgically handled.

The randomized design of the present study strengthens its internal validity, allowing a balanced and unbiased comparison between the graft types. Standardized surgical protocols and postoperative rehabilitation further enhance the reliability of outcome measures. These findings suggest that the choice between HT and QT grafts may be guided more by patient-specific factors and surgeon preference than by substantial differences in clinical outcomes.

However, the study is not without limitations. The relatively small sample size and a follow-up period limited to six months may not fully capture the long-term risks of graft failure, osteoarthritis, or return-to-sport durability. Additionally, the psychological impact and quality-of-life outcomes associated with each graft type were not assessed, representing an avenue for future research. As also suggested by Ebert et al. (2024), longer-term, larger-scale studies incorporating imaging and patient-reported outcomes are necessary to build a more comprehensive understanding.

In conclusion, the results of this study are in concordance with several previous investigations, confirming that both quadriceps and hamstring tendon autografts are effective and safe options for ACL reconstruction. No significant superiority was observed between the two grafts in terms of knee stability, functional recovery, or complication rates, emphasizing the importance of individualized treatment strategies in ACL reconstruction.

Conclusion

This randomized comparative study demonstrates that both quadriceps tendon (QT) and hamstring tendon (HT) autografts are effective and reliable options for anterior cruciate ligament (ACL) reconstruction. Both graft types provided excellent postoperative knee stability, significant functional recovery, low complication rates, and no cases of graft failure or reoperation within the 12-month follow-up period. Although the QT group showed slightly higher functional outcome scores and lower immediate postoperative pain, the differences were not statistically significant. Given the comparable results, graft selection can be tailored to individual patient characteristics, surgeon expertise, and rehabilitation goals rather than a clear superiority of one graft over the other. Future research involving larger sample sizes and longer follow-up periods is warranted to further validate these findings and assess long-term outcomes such as graft survivorship and joint health.

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