Section: Orthopaedic

Original Research Article

CHOOSING THE OPTIMAL AUTOGRAFT FOR ACL RECONSTRUCTION A TWO-YEAR COMPARISON OF QUADRICEPS AND HAMSTRING TENDON GRAFTS

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Received *: 03/08/2026*
Received in revised form *: 02/09/2026*
Accepted *: 15/09/2026*

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DOI: 10.70034/ijmedph.2026.3.878

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 5693-5697

ABSTRACT

Background: Selection of an optimal autograft remains an important consideration in anterior cruciate ligament reconstruction. Quadriceps tendon and hamstring tendon autografts have distinct advantages and donor-site effects. **Objective:** To compare clinical and functional outcomes of quadriceps tendon and hamstring tendon autografts following primary ACL reconstruction over two years.

Materials and Methods: This prospective comparative study included 140 patients undergoing primary ACL reconstruction. Seventy patients received QT autografts and 70 received HT autografts. Patients were assessed using IKDC and Lysholm scores, clinical knee stability, muscle strength, return to sports, graft failure, and donor-site morbidity over two years.

Results: Both groups demonstrated significant functional improvement. At two years, mean IKDC scores were 91.3 ± 5.8 and 89.2 ± 6.5 in the QT and HT groups, respectively (p=0.046), while Lysholm scores were 93.5 ± 4.9 and 91.6 ± 5.7 (p=0.036). Knee stability and return-to-sport rates were comparable. Hamstring strength was significantly better in the QT group, whereas quadriceps strength was greater in the HT group. Graft failure occurred in 2.9% and 8.6%, respectively, without a statistically significant difference.

Conclusion: Both autografts provided favorable two-year outcomes. QT autograft offered comparable stability with better hamstring preservation and represents a reliable alternative to HT autograft for primary ACL reconstruction.

Keywords: anterior cruciate ligament; ACL reconstruction; quadriceps tendon; hamstring tendon; autograft; IKDC; Lysholm score.

INTRODUCTION

Anterior cruciate ligament (ACL) injury is one of the most common ligamentous injuries of the knee, particularly among young and physically active individuals. ACL reconstruction aims to restore knee stability, facilitate return to activity, and reduce recurrent instability. The choice of autograft remains an important determinant of postoperative recovery and graft-related morbidity. Quadriceps tendon (QT), hamstring tendon (HT), and bone–patellar tendon–bone grafts are commonly used, each having specific advantages and limitations. Slone et al. demonstrated that QT autograft provides favorable clinical outcomes and represents a reliable option for ACL reconstruction.[1]

The QT autograft has gained increasing attention because of its favorable biomechanical characteristics, adequate graft size, and potentially lower donor-site morbidity. Lund et al. demonstrated satisfactory clinical outcomes with QT grafts, supporting their use as an alternative

autograft for ACL reconstruction.[2] Cavaignac et al., while directly comparing QT and HT autografts, reported comparable or favorable outcomes with QT grafts in terms of knee stability and functional recovery.[3]

Hamstring tendon autografts remain widely used because of their relatively simple harvest and low anterior knee morbidity. However, concerns include variable graft diameter, hamstring weakness, and potential effects on dynamic knee stability. Todor et al. reported satisfactory outcomes with both QT and HT grafts at a minimum two-year follow-up, suggesting that both are effective options for primary ACL reconstruction.[4] A systematic review and meta-analysis by Mouarbes et al. also demonstrated comparable functional outcomes and stability between QT and other commonly used autografts.[5]

More recent comparative evidence suggests that QT autografts may provide similar patient-reported outcomes with potentially lower graft rupture rates than HT autografts.[6] Postoperative rehabilitation following QT harvest requires appropriate attention to early quadriceps activation and progressive strengthening to optimize recovery.[7]

Despite increasing use of QT autografts, the optimal graft choice remains uncertain. Therefore, the present study was undertaken to compare clinical and functional outcomes of quadriceps tendon and hamstring tendon autografts following primary ACL reconstruction over a two-year follow-up period.

MATERIALS AND METHODS

Study Design and Participants

This prospective comparative study included 140 patients undergoing primary arthroscopic ACL reconstruction at a tertiary care hospital. Patients were divided into two equal groups according to the autograft used:

Group QT: 70 patients undergoing ACL reconstruction using quadriceps tendon autograft.

Group HT: 70 patients undergoing ACL reconstruction using hamstring tendon autograft.

All patients were followed for two years after surgery.

Inclusion Criteria

Patients aged 18–45 years with symptomatic primary ACL deficiency confirmed clinically and by magnetic resonance imaging, requiring arthroscopic ACL reconstruction, were included. Patients willing to comply with the postoperative rehabilitation protocol and two-year follow-up were eligible.

Exclusion Criteria

Patients undergoing revision ACL reconstruction, those with multiligament knee injuries, previous major surgery on the affected knee, advanced osteoarthritis, significant contralateral knee pathology, fractures around the knee, or neurological or neuromuscular conditions affecting lower-limb function were excluded.

Preoperative Assessment

Demographic and clinical characteristics including age, sex, body mass index, mechanism of injury, affected side, duration from injury to surgery, and activity level were recorded. Knee stability was evaluated using the Lachman and pivot-shift tests. Baseline functional status was assessed using the International Knee Documentation Committee (IKDC) subjective score and Lysholm Knee Score.

Surgical Technique

All patients underwent arthroscopic single-bundle ACL reconstruction using a standardized surgical technique. In Group QT, an appropriate length and thickness of quadriceps tendon was harvested and prepared as the graft. In Group HT, semitendinosus with or without gracilis tendon was harvested and prepared according to graft requirements.

Femoral and tibial tunnels were created at the anatomical ACL footprints, and the graft was passed and secured using appropriate fixation devices. Associated meniscal injuries were treated when required.

Postoperative Rehabilitation

A standardized rehabilitation protocol was followed in both groups. Early rehabilitation included pain and swelling control, restoration of knee extension, progressive flexion, quadriceps activation, and protected weight bearing as appropriate. Progressive strengthening, proprioceptive training, and functional exercises were subsequently introduced.

Running and sports-specific exercises were permitted according to clinical recovery, strength, stability, and functional assessment. Return to sports was individualized based on rehabilitation progress.

Outcome Assessment

Patients were evaluated postoperatively at 6 weeks, 3 months, 6 months, 1 year, and 2 years. The primary outcomes were IKDC and Lysholm scores at two years.

Secondary outcomes included knee stability, range of motion, graft failure or re-rupture, donor-site morbidity, anterior knee pain, quadriceps and hamstring strength, complications, and return to sports.

Statistical Analysis

Data were analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages. Independent Student's t-test or Mann–Whitney U test was used to compare continuous variables between the groups. Paired tests were used to evaluate changes from baseline. Categorical variables were compared using the Chi-square or Fisher's exact test. Repeated-measures analysis was used to assess changes in functional outcomes during follow-up. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 140 patients undergoing primary ACL reconstruction were included, with 70 patients each in the quadriceps tendon (QT) and hamstring tendon (HT) autograft groups. The mean age was 27.1 ± 6.2 years in the QT group and 27.6 ± 6.5 years in the HT group. Baseline demographic and clinical characteristics were comparable between the two groups (p>0.05).

Table 1: Baseline Demographic and Clinical Characteristics

Variable	QT Group (n=70)	HT Group (n=70)	p-value
Age (years), mean ± SD	27.1 ± 6.2	27.6 ± 6.5	0.642
Male, n (%)	52 (74.3)	50 (71.4)	0.703
Female, n (%)	18 (25.7)	20 (28.6)	
BMI (kg/m²), mean ± SD	24.8 ± 2.9	25.1 ± 3.1	0.555
Right knee, n (%)	39 (55.7)	41 (58.6)	0.733
Left knee, n (%)	31 (44.3)	29 (41.4)	
Injury-to-surgery interval (months)	6.7 ± 3.4	6.5 ± 3.2	0.721
Preoperative IKDC score	53.8 ± 8.7	54.2 ± 8.5	0.784
Preoperative Lysholm score	57.6 ± 9.1	58.1 ± 9.4	0.749

No significant differences were observed between the groups in age, sex distribution, BMI, affected side, injury-to-surgery interval, or baseline functional scores.

Table 2: Functional Outcomes During Two-Year Follow-up

Outcome	Follow-up	QT Group	HT Group	p-value
IKDC score	6 months	78.4 ± 8.1	77.1 ± 8.4	0.353
	1 year	87.6 ± 6.9	85.8 ± 7.3	0.136
	2 years	91.3 ± 5.8	89.2 ± 6.5	**0.046**
Lysholm score	6 months	82.1 ± 7.6	80.8 ± 7.9	0.322
	1 year	90.2 ± 6.1	88.7 ± 6.6	0.166
	2 years	93.5 ± 4.9	91.6 ± 5.7	**0.036**

Both groups demonstrated substantial improvement in IKDC and Lysholm scores during follow-up. At two years, the QT group had modestly higher IKDC and Lysholm scores than the HT group, with statistically significant differences (p<0.05).

Table 3: Knee Stability, Muscle Strength and Return to Sports at Two Years

Parameter	QT Group (n=70)	HT Group (n=70)	p-value
Negative/Grade I Lachman, n (%)	67 (95.7)	65 (92.9)	0.468
Negative pivot-shift test, n (%)	66 (94.3)	64 (91.4)	0.512
Quadriceps strength (% of contralateral limb)	91.8 ± 6.4	94.6 ± 5.8	**0.008**
Hamstring strength (% of contralateral limb)	95.1 ± 5.2	89.4 ± 6.7	**<0.001**
Returned to any sport, n (%)	60 (85.7)	57 (81.4)	0.493
Returned to preinjury sports level, n (%)	49 (70.0)	44 (62.9)	0.372
Time to return to sport (months)	9.2 ± 1.8	9.5 ± 2.0	0.352

Clinical knee stability was comparable between the two grafts. At two years, quadriceps strength was slightly lower in the QT group, whereas hamstring strength was significantly lower in the HT group. Return-to-sport rates did not differ significantly between groups.

Table 4: Graft Failure, Donor-Site Morbidity and Complications

Outcome	QT Group (n=70)	HT Group (n=70)	p-value
Graft failure/re-rupture	2 (2.9%)	6 (8.6%)	0.145
Anterior knee pain	5 (7.1%)	3 (4.3%)	0.466
Harvest-site discomfort	4 (5.7%)	8 (11.4%)	0.229
Persistent quadriceps weakness	6 (8.6%)	2 (2.9%)	0.145
Persistent hamstring weakness	1 (1.4%)	9 (12.9%)	**0.009**
Knee stiffness	2 (2.9%)	3 (4.3%)	0.649
Superficial infection	1 (1.4%)	2 (2.9%)	0.559

Graft failure occurred in 2.9% of patients in the QT group compared with 8.6% in the HT group, although the difference was not statistically significant. Persistent hamstring weakness was significantly more frequent following HT harvest (12.9% vs. 1.4%, p=0.009). Other donor-site complications were uncommon and comparable between the groups.

DISCUSSION

The present study compared quadriceps tendon (QT) and hamstring tendon (HT) autografts for primary ACL reconstruction over a two-year follow-up. Both grafts resulted in substantial improvement in functional outcomes, with satisfactory knee stability and return-to-sport rates. At two years, the QT group demonstrated slightly higher IKDC and

Lysholm scores, although both groups achieved favorable overall outcomes.

Graft harvesting technique and donor-site morbidity are important considerations when selecting an ACL autograft. Slone et al. described minimally invasive QT harvesting as a technique capable of providing an adequate graft while limiting soft-tissue disruption.[8] In the present study, donor-site complications were relatively uncommon in the QT group, supporting the clinical acceptability of QT harvesting.

Graft selection in ACL reconstruction varies considerably according to patient characteristics, surgeon preference, and clinical setting. Houck et al. demonstrated variations in graft selection based on demographic and practice-related factors.[9] Similarly, Budny et al. highlighted changing trends in ACL reconstruction, including increasing interest in alternative autograft options.[10] The present findings support QT as a useful alternative to the traditionally preferred HT autograft.

Graft failure remains an important concern following ACL reconstruction. Samuelsen et al. demonstrated that graft choice may influence failure rates, particularly in young and active populations.[11] In the present study, graft failure occurred in 2.9% of QT patients compared with 8.6% of HT patients. Although this difference was not statistically significant, the numerical trend favored QT autografts.

Tibor et al. reported substantial changes in ACL reconstruction techniques and graft-selection patterns over time.[12] Such trends emphasize the need to evaluate graft choice based not only on stability but also on functional recovery and donor-site consequences.

Tan et al., in a systematic review and meta-analysis comparing QT and HT autografts, reported broadly comparable clinical outcomes, with differences in specific parameters related to muscle strength and donor-site morbidity.[13] In the present study, QT patients demonstrated slightly lower quadriceps strength, whereas HT patients had significantly greater persistent hamstring weakness. These findings reflect the expected influence of graft harvest on the respective muscle groups.

Runer et al. reported comparable clinical, functional, and patient-reported outcomes between QT and HT autografts, with lower donor-site morbidity associated with QT in their long-term matched comparison.[14] Similarly, recent pooled evidence has demonstrated that QT autografts provide clinical outcomes and stability comparable to commonly used ACL autografts.[15]

Evidence from randomized trials has further supported the effectiveness of QT grafts compared with HT grafts. Raj et al. reported generally comparable outcomes between these graft choices, while differences in donor-site morbidity and muscle strength may influence individualized graft selection.[16] The present findings are consistent with this evidence, as knee stability and return-to-sport rates were similar between groups despite differences in muscle strength profiles.

Overall, both QT and HT autografts provided satisfactory two-year outcomes. The QT autograft showed a favorable combination of functional recovery, preservation of hamstring strength, and a numerically lower graft-failure rate, whereas HT autograft was associated with better quadriceps strength. Graft selection should therefore consider patient activity, rehabilitation requirements, muscle demands, and donor-site morbidity in addition to conventional measures of knee stability.

CONCLUSION

Both quadriceps tendon and hamstring tendon autografts provided satisfactory clinical and functional outcomes following primary ACL reconstruction at two years. QT autografts demonstrated slightly better IKDC and Lysholm scores and better preservation of hamstring strength, whereas HT autografts showed better quadriceps strength. Knee stability and return-to-sport rates were comparable. Thus, QT represents an effective alternative to HT autograft, with graft selection individualized according to patient characteristics and functional requirements.

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