

Functional Outcomes After Anterior Cruciate Ligament Reconstruction: Lysholm Score Analysis

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Ethical Approval

This study was approved by the Clinical Research Ethics Committee of Yüzüncü Yıl University Faculty of Medicine on February 13, 2019 (decision no. 06). The study was conducted in accordance with the Declaration of Helsinki.

Informed Consent

Written informed consent was obtained from all participants.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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AD: conceptualization, methodology, formal analysis; SÖ: conceptualization, methodology, formal analysis, writing – original draft; ŞK: data curation; CA: data curation; NG: data curation; TT: supervision; AA: writing – original draft, supervision; BE: supervision; YCÜ: methodology, data curation, writing – original draft. All authors approved the final manuscript.

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Data Availability

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Abstract

Background/Aim: Anterior cruciate ligament reconstruction is followed by a prolonged rehabilitation period, and the relative effectiveness of supervised clinical physical therapy versus a structured home exercise program remains clinically relevant. This study evaluated postoperative functional recovery using the Lysholm knee scoring system after arthroscopic anterior cruciate ligament reconstruction with autologous hamstring grafts and compared outcomes between patients who received supervised clinical physical therapy and those who followed an independent home exercise program.

Methods: In this prospective cohort study conducted from May 2019 through May 2021, 28 male patients with complete anterior cruciate ligament tears underwent arthroscopic single-bundle reconstruction using hamstring autografts, with femoral Endobutton fixation and tibial bioabsorbable interference screw fixation. Mean age was 33.03 (8.53) years (range, 18-56 years). Group 1 (n = 7) received supervised clinical physical therapy three times weekly for 12 weeks, whereas Group 2 (n = 21) followed a structured home exercise program. Lysholm scores were assessed preoperatively and at 3 and 6 months. Between-group comparisons were exploratory and used two-sided Welch t-tests calculated from reported summary statistics. Longitudinal changes were described without inferential testing.

Results: Preoperative Lysholm scores were 72.57 (10.21) in Group 1 and 70.95 (11.45) in Group 2 ($P = 0.731$). Mean scores increased over time in both groups. At 3 months, scores were 92.86 (5.14) and 83.71 (8.92), respectively ($P = 0.004$); at 6 months, they were 98.17 (2.36) and 89.76 (7.41), respectively ($P < 0.001$). The between-group comparison of change from baseline to 6 months was not statistically significant ($P = 0.145$). These P -values are unadjusted exploratory comparisons calculated from rounded summary statistics. Medial meniscal tears were present in 11 patients (39.3%).

Conclusion: Arthroscopic anterior cruciate ligament reconstruction with autologous hamstring grafts was associated with higher mean Lysholm scores at follow-up. The supervised physical therapy group had higher 6-month scores, but the between-group difference in baseline-to-6-month change was not statistically significant in exploratory unadjusted comparisons. Small, unequal, nonrandomized groups limit causal interpretation.

Keywords: anterior cruciate ligament reconstruction, lysholm score, hamstring autograft, rehabilitation, physical therapy

Introduction

Anterior cruciate ligament (ACL) rupture is a common and potentially disabling knee injury among physically active individuals [1]. These injuries often occur through noncontact pivoting or sudden deceleration during athletic activity [1, 2]. In patients with symptomatic instability, surgical reconstruction is commonly performed to restore joint stability, reduce the risk of secondary meniscal and chondral injury, and facilitate return to activity [2, 3].

Autologous hamstring tendon grafts, typically comprising the semitendinosus and gracilis tendons, are widely used in arthroscopic ACL reconstruction because they provide high tensile strength, limited donor-site morbidity, and favorable clinical outcomes [3, 4]. However, technically successful graft placement alone does not ensure full recovery. Functional restoration also depends on postoperative rehabilitation, recovery of muscle strength, and confidence in knee stability [4, 5].

Postoperative outcomes are commonly assessed using validated patient-reported measures. The Lysholm knee scoring system is widely used because it is practical, responsive to clinical change, and focused on symptoms related to knee instability [5, 6]. Although supervised physical therapy is generally recommended after ACL reconstruction, access to and adherence with formal rehabilitation programs vary.

This study evaluated short-term functional recovery using the Lysholm knee score in patients who underwent arthroscopic ACL reconstruction with autologous hamstring grafts and compared outcomes between supervised clinical physical therapy and a structured independent home exercise program during 6 months of follow-up.

Materials and methods

Study Design and Participants

This prospective, single-center cohort study included consecutive male patients who underwent primary arthroscopic single-bundle ACL reconstruction using autologous hamstring tendon grafts between May 2019 and May 2020. The study was approved by the Clinical Research Ethics Committee of Yüzüncü Yıl University Faculty of Medicine on February 13, 2019 (decision no. 06), before enrollment began in May 2019. The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment.

Eligible patients were men aged 18-60 years with a complete ACL rupture confirmed by clinical examination and magnetic resonance imaging, primary single-bundle reconstruction using a hamstring autograft, at least 6 months of follow-up, and complete preoperative and postoperative functional assessments. Patients were excluded if they had revision ACL reconstruction or previous surgery on the ipsilateral knee, a multiligamentous injury requiring concurrent ligament reconstruction, advanced knee osteoarthritis (Kellgren-Lawrence grade > 2), meniscal repair performed either before or concurrently with the index ACL reconstruction, or visual, hearing, neurologic, or psychiatric impairment that could prevent adherence to the protocol. Patients who underwent meniscectomy were eligible.

A total of 28 consecutive patients met the eligibility criteria during the study period and completed the 6-month protocol, with no loss to follow-up. No a priori sample-size or power calculation was performed; the sample comprised all available eligible patients with complete follow-up, and between-group comparisons were exploratory. Rehabilitation exposure depended on transportation access to supervised treatment and was not randomized. Group 1 comprised 7 patients who could attend supervised clinical physical therapy, and Group 2 comprised 21 patients who followed a structured independent home exercise program because transportation access limited attendance.

Surgical Procedure

All procedures were performed by senior orthopedic surgeons using a standardized arthroscopic technique under spinal or general anesthesia. Diagnostic arthroscopy was first performed to confirm complete ACL rupture and identify concomitant intra-articular abnormalities, including meniscal tears and chondral lesions. Meniscal tears that were not amenable to repair were treated with partial meniscectomy.

The semitendinosus and gracilis tendons were harvested through a 3-cm anteromedial incision over the pes anserinus. The tendons were stripped, debrided, folded into a quadrupled graft, and pretensioned. The femoral tunnel was prepared through an anteromedial portal. Femoral fixation was achieved using a cortical suspensory loop device (Endobutton, Smith & Nephew), and tibial fixation was achieved using a bioabsorbable interference screw with the knee in full extension after manual precycling.

Rehabilitation Protocols

All patients received standard perioperative care, including prophylactic antibiotics, analgesia, and a postoperative hinged knee brace locked in extension during ambulation for the first 2 weeks.

Patients in Group 1 attended outpatient physical therapy three times weekly for 12 weeks under the direct supervision of a physical therapist. The program included progressive patellar mobilization, active-assisted range-of-motion exercises, progressive closed-kinetic-chain quadriceps strengthening, hamstring activation, proprioceptive training, and sport-specific agility exercises.

Patients in Group 2 received a structured, illustrated home exercise booklet describing the same phased rehabilitation timeline, including quadriceps sets, straight-leg raises, progressive range-of-motion exercises, and closed-chain exercises. Patients performed the exercises independently at home and attended outpatient clinic assessments every 2 weeks.

Full weight-bearing was permitted at week 4 in both groups once adequate quadriceps control had been achieved. Bracing was discontinued at week 5. Straight-line running was permitted at 3 months, and pivoting sports were permitted at 6 months based on clinical stability.

Outcome Assessment

Functional outcomes were assessed preoperatively and at 3 and 6 months after surgery using the Lysholm knee scoring system. Scores range from 0 to 100 and are categorized as poor (< 65), fair (65-83), good (84-94), or excellent (95-100) [6]. Physical examination findings, including the anterior drawer, Lachman,

and pivot-shift tests, and standard anteroposterior and lateral radiographs were recorded.

Statistical Analysis

Continuous variables are presented as mean (standard deviation), and categorical variables as number and percentage. At proof correction, between-group comparisons were recalculated from reported group sizes, rounded means and standard deviations using two-sided Welch independent-samples t-tests; categorical comparisons used two-sided Fisher exact tests based on reported counts. Calculations were performed using Python and SciPy. *P*-values are approximate, unadjusted for multiple comparisons, and exploratory; a nominal threshold of 0.05 was used. Change-score comparisons use the reported means and standard deviations of individual change scores. Patient-level repeated-measures data and original model outputs were unavailable for these checks. Consequently, longitudinal change is described descriptively; no time-effect or group-by-time interaction *P*-value, sphericity result, Greenhouse-Geisser correction, or Bonferroni-adjusted result is claimed.

Results

Baseline Characteristics and Intra-Articular Pathologies

The cohort comprised 28 male patients with a mean age of 33.03 (8.53) years (range, 18-56 years). The right knee was involved in 7 patients (25.0%) and the left knee in 21 patients (75.0%). The injury mechanism was sports-related in 27 patients (96.4%). Spinal anesthesia was administered to 27 patients (96.4%), and general anesthesia was administered to 1 patient (3.6%).

Baseline characteristics, including age [33.28 (8.12) years in Group 1 vs. 32.95 (8.86) years in Group 2; *P* = 0.929] and side distribution (*P* = 1.000), did not differ significantly between the groups in exploratory comparisons (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics

Characteristic	Total cohort (N = 28)	Group 1: supervised PT (n = 7)	Group 2: home exercise (n = 21)	P-value
Age, mean (SD), years	33.03 (8.53)	33.28 (8.12)	32.95 (8.86)	0.929*
Age range, years	18-56	21-48	18-56	-
Male sex, n (%)	28 (100)	7 (100)	21 (100)	-
Involved side n (%) Right / left	7 (25.0) / 21 (75.0)	2 (28.6) / 5 (71.4)	5 (23.8) / 16 (76.2)	1.000**
Injury mechanism n (%) Sports / other trauma	27 (96.4) / 1 (3.6)	7 (100) / 0	20 (95.2) / 1 (4.8)	1.000**
Preoperative Lysholm score, mean (SD)	71.36 (11.02)	72.57 (10.21)	70.95 (11.45)	0.731*

Abbreviations: PT: physical therapy, SD: standard deviation. *Two-sided Welch independent-samples t-test recalculated from reported group sizes and rounded summary statistics. **Two-sided Fisher exact test based on reported counts. *P*-values are exploratory and unadjusted for multiplicity; nominal *P* < 0.05.

Diagnostic arthroscopy identified an isolated ACL tear in 12 patients (42.9%). Concomitant intra-articular pathologies were present in 16 patients (57.1%). Medial meniscal tears were the most common finding and occurred in 11 patients (39.3%), including 3 patients with coexisting cartilage damage. Isolated cartilage lesions were identified in 3 patients (10.7%) (Table 2).

Table 2. Intra-Articular Pathologies Identified During Arthroscopy

Intra-articular pathology	Patients n	Percentage %
Isolated ACL tear (no additional pathology)	12	42.9
Isolated medial meniscal tear	8	28.6
Medial meniscal tear with cartilage damage	3	10.7
Isolated cartilage damage	3	10.7
Isolated lateral meniscal tear	1	3.6
Multiligamentous injury managed conservatively except for ACL reconstruction	1	3.6

Abbreviations: ACL: anterior cruciate ligament.

Functional Outcome Analysis

Preoperative examination showed a positive anterior drawer test in 26 patients (92.8%), a positive Lachman test in 23 patients (82.1%), and a positive pivot-shift test in 10 patients (35.7%). At the complete 6-month clinical assessment of all 28 patients, no graft failure or persistent grade 2 or greater instability was recorded. These are recorded clinical findings; formal outcome definitions were not confirmed as prespecified.

Mean Lysholm scores increased over time in the overall cohort. Preoperative scores were 72.57 (10.21) in Group 1 and 70.95 (11.45) in Group 2 (*P* = 0.731). At 3 months, scores were 92.86 (5.14) and 83.71 (8.92), respectively (*P* = 0.004). At 6 months, scores were 98.17 (2.36) and 89.76 (7.41), respectively (*P* < 0.001). These unadjusted exploratory between-group comparisons were calculated from rounded summary statistics using two-sided Welch t-tests; longitudinal significance was not re-estimated.

The mean change from the preoperative assessment to 6 months was 25.60 (9.80) in Group 1 and 18.81 (10.15) in Group 2. The exploratory between-group Welch comparison of change scores, calculated from the reported means and SDs, was not statistically significant (*P* = 0.145; Table 3). At the final 6-month assessment, all 28 patients had clinically documented full knee range of motion, including flexion > 130 degrees.

Table 3. Lysholm Scores by Rehabilitation Group and Follow-Up Time

Follow-up time point	Group 1: supervised PT (n = 7) mean (SD)	Group 2: home exercise (n = 21) mean (SD)	Total cohort (N = 28) mean (SD)	Between-group P-value*
Preoperative	72.57 (10.21)	70.95 (11.45)	71.36 (11.02)	0.731
Postoperative month 3	92.86 (5.14)	83.71 (8.92)	86.00 (8.98)	0.004
Postoperative month 6	98.17 (2.36)	89.76 (7.41)	91.86 (7.48)	< 0.001
Change from preoperative to month 6	25.60 (9.80)	18.81 (10.15)	20.50 (10.35)	0.145

Abbreviations: PT: physical therapy, SD: standard deviation. *Two-sided Welch independent-samples t-tests between rehabilitation groups, recalculated from reported group sizes and rounded summary statistics. The change-score row compares individual baseline-to-6-month changes using their reported mean and SD; it is not a group-by-time interaction. All *P*-values are exploratory and unadjusted for multiple comparisons; nominal *P* < 0.05. No inferential longitudinal model is reported.

Discussion

This prospective cohort study showed substantial short-term improvement in patient-reported knee function after arthroscopic single-bundle ACL reconstruction with autologous hamstring grafts. Both rehabilitation groups improved during follow-up. The supervised physical therapy group had higher 6-month scores in an exploratory unadjusted comparison, but the between-group difference in baseline-to-6-month change was not statistically significant. Small, unequal groups and allocation based on transportation access limit causal interpretation.

The overall degree of functional recovery was consistent with previous reports. Türkoğlu [7] described favorable postoperative Lysholm scores after ACL reconstruction with a hamstring autograft, and Dalyaman [8] reported a marked postoperative increase in Lysholm scores. Favorable midterm

stability has also been reported after hamstring ACL reconstruction using Endobutton fixation [9].

Rehabilitation is central to recovery after ACL reconstruction [10, 11]. Supervised treatment may improve exercise technique, progression, quadriceps activation, and adherence. In the present study, supervised rehabilitation was associated with higher follow-up Lysholm scores, but the exploratory comparison of baseline-to-6-month change did not demonstrate a statistically significant between-group difference. Nevertheless, patients who followed the structured home program also achieved good functional scores, suggesting that a clearly defined home-based program may be a practical alternative when regular supervised therapy is unavailable [10-12]. Because the rehabilitation strategy was not randomized and potential confounders were not adjusted for, this comparison should be considered exploratory.

Concomitant intra-articular injuries are common in ACL-deficient knees. Medial meniscal tears were the most frequent secondary finding in this cohort, consistent with evidence that recurrent instability increases meniscal loading [13]. Chondral lesions were also observed at rates broadly consistent with previous reports of injuries associated with ACL insufficiency [14-16].

At 6 months, full knee range of motion was clinically documented in all 28 patients, and no arthrofibrosis was reported. Early controlled mobilization, an emphasis on full extension in the immediate postoperative period, and close follow-up may have contributed to this finding.

Study Limitations

This study has several limitations. The overall sample and supervised physical therapy group were small, reducing the precision of between-group estimates. Rehabilitation exposure depended on transportation access, was not randomized, and the groups were unequal; therefore, selection bias and unmeasured confounding cannot be excluded. The exploratory comparisons were unadjusted for confounders and multiplicity and do not establish a causal benefit of supervised treatment. The inclusion of only male patients limits generalizability to female patients. The 6-month follow-up period describes early functional recovery but does not address long-term return to sport, graft failure, or osteoarthritis. Muscle strength was assessed clinically rather than with objective isokinetic testing. No a priori sample-size or power calculation was performed. The available sample determined the cohort size. Between-group comparisons are exploratory. Summary-statistic checks do not verify individual observations, distributional assumptions, or longitudinal effects.

Conclusion

Arthroscopic single-bundle ACL reconstruction with autologous hamstring grafts was associated with higher mean Lysholm scores at follow-up, with no graft failure or persistent grade 2 or greater instability recorded at 6 months. The supervised physical therapy group had higher 6-month scores in exploratory unadjusted comparisons, but the between-group difference in baseline-to-6-month change was not statistically significant. Small, nonrandomized and imbalanced groups, allocation based on transportation access, and unadjusted comparisons limit causal interpretation.

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