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Original Research Article

Outcome of arthroscopic anterior cruciate ligament reconstruction by quadrupled semitendinosus and gracilis tendon graft through modified transtibial technique

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ABSTRACT

Background: Anterior cruciate ligament injury is a common sports-related injury that significantly reduces activity and quality of life. Arthroscopic reconstruction using hamstring autografts has gained popularity, though optimal femoral tunnel drilling technique remains debated. The study objective was to assess the functional outcome of arthroscopic anterior cruciate ligament reconstruction using quadrupled semitendinosus and gracilis tendon graft through modified transtibial technique.
Methods: This quasi-experimental study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, from September 2018 to November 2019 and from December 2021 to March 2023. Twenty-eight patients underwent arthroscopic ACL reconstruction using quadrupled semitendinosus and gracilis autograft via modified transtibial technique. Functional outcomes were assessed using the Lysholm score, Lachman test, anterior drawer test, and range of motion preoperatively and at 1st POD, 2 weeks, 6 weeks, 3 months, 6 months, and 9 months.
Results: The mean age was 27.17±6.56 years, with male predominance (89.29%). Sports injury was the most common cause (61%). The mean graft diameter was 8.04±2.85 mm. Lysholm score improved significantly from 55.14±8.56 preoperatively to 91.42±7.13 at final follow-up ($p<0.001$). Preoperative Lachman test was grade 3+ positive in all patients, with 97% becoming negative postoperatively. Anterior drawer test was negative in 97% at final follow-up. Good to excellent outcomes were achieved in 93% of patients.
Conclusions: Arthroscopic anterior cruciate ligament reconstruction using a quadrupled semitendinosus and gracilis autograft through the modified transtibial technique yields excellent functional outcomes, with the advantages of shorter surgical time, technical simplicity, and anatomical graft placement.

Keywords: Anterior cruciate ligament, Arthroscopy, Functional outcome, Gracilis, Knee reconstruction

INTRODUCTION

Anterior cruciate ligament (ACL) injury represents one of the most common and debilitating knee injuries sustained during athletic activities, accounting for over half of all knee injuries in sports.[1] The estimated annual incidence ranges from 30 to 78 injuries per 100,000 persons, with rising rates particularly in adolescents. Epidemiological data from professional soccer leagues have demonstrated an overall ACL injury incidence of 0.062 per 1000 hours of exposure, with a 14-fold higher risk during matches compared to training sessions.[2] The burden of ACL injury extends beyond the immediate functional impairment, as delays in treatment may lead to increased risk of meniscal tears, chondral injuries, and early-onset knee osteoarthritis.[1] In symptomatic patients with moderate to high functional demands, ACL reconstruction (ACLR) is frequently recommended to restore knee stability, facilitate return to sporting activities, and reduce the risk of long-term complications.

The selection of appropriate graft material remains a critical determinant of surgical outcomes following ACLR. The most commonly utilized grafts include hamstring tendon autografts, bone-patellar tendon-bone autografts, quadriceps tendon autografts, allografts, and synthetic grafts.[3] Hamstring tendon autografts, comprising the semitendinosus and gracilis tendons, have gained substantial popularity, currently accounting for over 50% of ACLR procedures.[4] The quadrupled semitendinosus and gracilis tendon autograft offer several distinct advantages, including favorable biomechanical strength with a maximum load to failure of approximately 4500 Newtons, reduced donor site morbidity, lower risk of anterior knee pain, and smaller incisions for harvest.[3] Biomechanical studies have demonstrated that hamstring graft strength increases with graft diameter, and graft diameter of 8.0 mm or greater is associated with a significant reduction in graft failure risk.[5] The quadrupled hamstring tendon autograft provides excellent biomechanical strength while minimizing donor site complications.[6] Beyond graft selection, the technique of femoral tunnel drilling significantly influences the biomechanical properties of the reconstructed ligament and subsequent knee function. The traditional transtibial technique, while technically straightforward, has been associated with non-anatomical femoral tunnel placement, potentially compromising rotational stability and long-term outcomes.[7] In response to these limitations, the modified transtibial technique has been developed to achieve more anatomical femoral tunnel placement while maintaining the advantages of the transtibial approach.[8] The modified transtibial technique utilizes a free-hand guide pin placement through the tibial tunnel toward the anatomical femoral footprint, enabling more accurate positioning of the femoral tunnel.[9] Systematic reviews have demonstrated that the modified transtibial technique can create an anatomical femoral tunnel with optimal tunnel length and angulation, with most patients achieving satisfactory subjective outcomes and physical examinations following ACLR.[10] The use of a large-offset femoral tunnel guide has been shown to facilitate more anatomical placement of the femoral tunnel compared to conventional techniques.[8] The functional outcomes following ACLR are commonly assessed using validated scoring systems, with the Lysholm knee scoring scale being one of the most widely employed instruments.[11] The Lysholm score evaluates multiple domains including limp, support, locking, instability, pain, swelling, stair climbing, and squatting, providing a comprehensive assessment of knee function. Studies have demonstrated significant improvements in Lysholm scores following ACLR using hamstring autografts, with mean scores improving from approximately 54 preoperatively to over 90 at mid-term follow-up.[12] The modified transtibial technique has been associated with satisfactory Lysholm scores, with pooled analyses demonstrating mean scores of 90.39 at minimum 12-month follow-up.[10] Clinical assessments including the Lachman test and anterior drawer test remain essential components of the postoperative evaluation, providing objective measures of anteroposterior knee stability.[7] Despite the growing body of evidence supporting ACLR using hamstring autografts, comparative data specifically evaluating the functional outcomes of the modified transtibial technique with quadrupled semitendinosus and gracilis tendon grafts remain limited. The modified transtibial technique offers potential advantages including shorter surgical time, technical simplicity, and the ability to achieve anatomical graft placement without the need for accessory portals.[9] However, the clinical outcomes of this specific combination of graft choice and surgical technique warrant further investigation. Given this knowledge gap, the present study was undertaken to assess the functional outcome of arthroscopic ACL reconstruction using quadrupled semitendinosus and gracilis tendon autograft through the modified transtibial technique. We hypothesized that this approach would yield excellent functional outcomes with favorable stability parameters and patient-reported scores.

METHODS

This quasi-experimental study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, from September 2018 to November 2019 and December 2021 to March 2023. A total of 28 patients with anterior cruciate ligament injury were enrolled using purposive sampling based on predefined inclusion and exclusion criteria. Informed written consent was obtained from all participants prior to enrolment.

Inclusion criteria

Patients aged between 18 and 50 years with complete unilateral anterior cruciate ligament tear confirmed by magnetic resonance imaging, presenting with symptomatic knee instability, and willing to undergo arthroscopic ACL reconstruction were included. Only patients with closed physes and no prior knee surgery were enrolled.

Exclusion criteria

Patients with multi-ligament knee injuries, associated fractures around the knee, severe osteoarthritis (Kellgren-Lawrence grade 3 or 4), inflammatory joint disease, or those with previous ACL reconstruction on the ipsilateral knee were excluded. Patients with insufficient graft diameter (<7 mm) were also excluded from the study.

Study procedure

All patients underwent arthroscopic ACL reconstruction using quadrupled semitendinosus and gracilis tendon autograft through the modified transtibial technique.[9] The graft was harvested through a small oblique incision over the pes anserinus. The quadrupled graft diameter was measured using a sizing tube. A femoral tunnel was created using the modified transtibial technique with a free-hand guide pin placement toward the anatomical femoral footprint.[8] The graft was fixed with an interference screw on both femoral and tibial sides. Postoperatively, patients followed a standardized rehabilitation protocol. Clinical assessments were performed preoperatively and postoperatively at 1st POD, 2 weeks, 6 weeks, 3 months, 6 months, and 9 months. Ligamentous stability was evaluated using the Lachman test and anterior drawer test. Functional outcomes were assessed using the Lysholm knee scoring scale.[11] Range of motion was measured using a goniometer.

Data analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0. Quantitative variables were expressed as mean±standard deviation, while categorical variables were presented as frequencies and percentages. The paired Student's t-test was used to compare preoperative and postoperative Lysholm scores. The level of significance was set at a 95% confidence level, with p-values <0.05 considered statistically significant.

RESULTS

A total of 28 patients with anterior cruciate ligament injury underwent arthroscopic ACL reconstruction using quadrupled semitendinosus and gracilis tendon autograft through modified transtibial technique. All patients completed the nine-month follow-up period.

The demographic characteristics of the study population are presented in Table 1. The mean age of the patients was 27.17±6.56 years, with a male predominance (89.29%). The majority of patients were students (46.43%), followed by service holders (21.43%). Sports injury was the most common cause of ACL injury, accounting for 60.71% of cases, followed by road traffic accidents (21.43%) and falls (17.86%). The mean duration from injury to surgery was 14.58±5.03 weeks. The mean diameter of the quadrupled semitendinosus and gracilis tendon autograft was 8.04±2.85 mm.

Table 1: Relative risk of abnormal Doppler indices with adverse perinatal outcome.

Characteristics	Values
Age (years)	
Mean±SD	27.17±6.56
Range	18-45
Sex	
Male	25 (89.29)
Female	3 (10.71)
Occupation, N (%)	
Student	13 (46.43)
Service holder	6 (21.43)
Business	4 (14.29)
Others	5 (17.86)
Mode of injury, N (%)	
Sports injury	17 (60.71)
Road traffic accident	6 (21.43)
Fall	5 (17.86)
Duration from injury to surgery (weeks)	
Mean±SD	14.58±5.03
Graft diameter (mm)	
Mean±SD	8.04±2.85

Values are presented as mean±standard deviation, range, or frequency (percentage).

Preoperative and postoperative ligamentous stability assessments are shown in Table 2. Preoperatively, the Lachman test was positive grade 3+ in all patients (100%). At the final nine-month follow-up, the Lachman test was negative in 96.43% of patients, with only 3.57% showing grade 1+ laxity. Similarly, the anterior drawer test was positive in all patients (100%) preoperatively, while at final follow-up, 96.43% had a negative anterior drawer test. The improvement in both stability parameters was statistically significant (p<0.001).

Functional outcomes assessed using the Lysholm knee scoring scale demonstrated significant improvement from preoperative to final follow-up in Table 3. The mean Lysholm score improved from 55.14±8.56 preoperatively to 91.42±7.13 at nine months postoperatively (p<0.001). Preoperatively, 89.29% of patients had poor Lysholm scores (<65), while only 10.71% had fair scores (65-83). At the final follow-up, 64.29% of patients achieved excellent scores (≥95), 28.57% achieved good scores (84-94), and only 7.14% had fair scores. No patient had a poor outcome at final follow-up. The serial improvement in Lysholm scores is illustrated in Figure 1.

Figure 1 demonstrates the progressive improvement in Lysholm scores over the nine-month follow-up period. The scores show a steady increase from a preoperative mean of 55.14, rising to 65.32 at 3 months, 78.45 at 6 months, and reaching 91.42 at the final 9-month follow-up, indicating sustained functional recovery following ACL reconstruction.

Table 2: Relative risk of abnormal Doppler indices with adverse perinatal outcome.

Clinical test	Preoperative	Final follow-up	P value*
	N (%)	N (%)	
Lachman test			
Grade 3+ positive	28 (100)	0 (0)	<0.001
Grade 2+ positive	0 (0)	0 (0)	
Grade 1+ positive	0 (0)	1 (3.57)	
Negative	0 (0)	27 (96.43)	
Anterior drawer test			
Positive	28 (100)	1 (3.57)	<0.001
Negative	0 (0)	27 (96.43)	

*Values are presented as mean±standard deviation, range, or frequency (percentage).

Table 3: Preoperative and postoperative Lysholm scores.

Parameter	Preoperative	Final follow-up (9 months)	P value
Lysholm score (Mean±SD)	55.14±8.56	91.42±7.13	<0.001*
Lysholm grade, N (%)			
Excellent (≥95)	0 (0)	18 (64.29)	<0.001**
Good (84-94)	0 (0)	8 (28.57)	
Fair (65-83)	3 (10.71)	2 (7.14)	
Poor (<65)	25 (89.29)	0 (0)	

Values are presented as mean±standard deviation or frequency (percentage). *Paired Student's t-test was used to compare preoperative and postoperative Lysholm scores. **Pearson's chi-square test was used. A p value < 0.05 was considered statistically significant.

Table 4: Preoperative and postoperative range of motion.

Range of motion	Preoperative	3 months	6 months	Final follow-up (9 months)
	N (%)	N (%)	N (%)	N (%)
Normal (0-135°)	27 (96.43)	28 (100)	27 (96.43)	26 (92.86)
Mild restriction (<10° loss)	1 (3.57)	0 (0)	1 (3.57)	2 (7.14)
Moderate restriction (10-20° loss)	0 (0)	0 (0)	0 (0)	0 (0)
Severe restriction (>20° loss)	0 (0)	0 (0)	0 (0)	0 (0)

Values are presented as frequency (percentage).

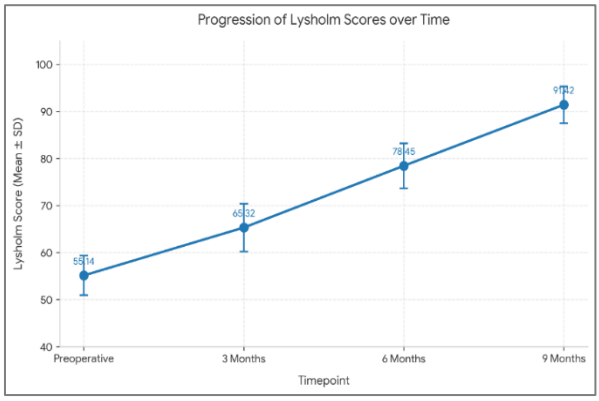


Figure 1: Line diagram showing serial changes in Lysholm score from preoperative to final follow-up at 9 months.

Range of motion assessments are presented in Table 4. Preoperatively, 96.43% of patients had normal knee range of motion (0-135°), while 3.57% had mild restriction (loss of <10° extension). At the final nine-month follow-up, 92.86% of patients had normal range of motion, while 7.14% had mild restriction. The serial changes in range of motion are depicted in Figure 2.

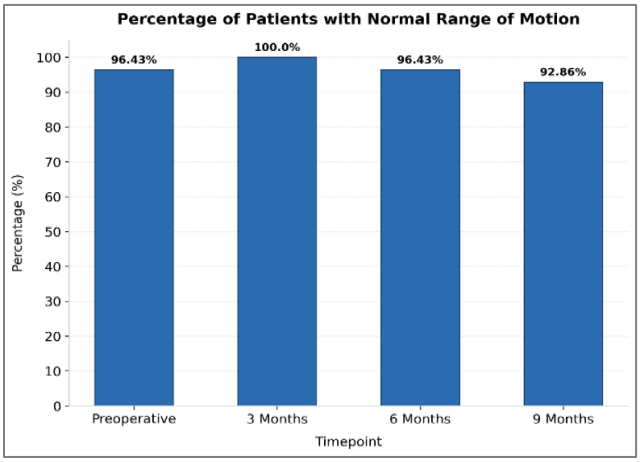


Figure 2: Bar chart showing preoperative and postoperative range of motion status at 9 months.

Figure 2 illustrates the improvement in knee range of motion following ACL reconstruction. The proportion of patients with normal range of motion increased from 96.43% preoperatively to 100% at 3 months, with 92.86% maintaining normal range of motion at the final 9-month follow-up. The small proportion of patients with mild restriction remained stable throughout the follow-up period.

Postoperative complications were minimal. No patient developed deep vein thrombosis, pulmonary embolism, graft failure, or surgical site infection requiring intervention. Minor complications included transient knee effusion (10.71%) and mild donor site discomfort (7.14%), all of which resolved with conservative management.

DISCUSSION

The present study was undertaken to assess the functional outcome of arthroscopic anterior cruciate ligament reconstruction using quadrupled semitendinosus and gracilis tendon autograft through the modified transtibial technique. Our findings demonstrate that this approach yields excellent functional outcomes, with significant improvements in Lysholm scores, ligamentous stability, and range of motion over the nine-month follow-up period. These results contribute valuable evidence supporting the efficacy of the modified transtibial technique in achieving favorable clinical outcomes. The most notable finding of this study was the significant improvement in Lysholm score from a preoperative mean of 55.14±8.56 to 91.42±7.13 at nine months postoperatively ($p<0.001$). This improvement is consistent with previously reported outcomes following ACL reconstruction using hamstring autografts. A systematic review and meta-analysis of modified transtibial techniques reported a pooled Lysholm score of 90.39 (95% CI 83.41-97.38) at a minimum 12-month follow-up.[12] Similarly, a prospective study of anatomical ACL reconstruction using quadruple hamstring graft demonstrated improvement in mean Lysholm score from 54.46 preoperatively to 91.06 at six months.[11] These comparable findings suggest that the modified transtibial technique consistently achieves satisfactory functional recovery across different populations and settings. The high proportion of patients achieving excellent (64.29%) or good (28.57%) outcomes in our study aligns with the existing literature. A prospective study of arthroscopic ACL reconstruction using quadrupled hamstring autograft reported that 90% of patients achieved excellent outcomes and the remaining 10% achieved good outcomes at a mean follow-up of 14.2 months.[10] Another study evaluating ACL reconstruction with quadriceps tendon reported excellent outcomes in 60% and good outcomes in 26.7% of cases at nine months.[4] The slightly higher proportion of excellent outcomes in our study may be attributed to the younger patient population (mean age 27.17 years) with predominantly sports-related injuries (60.71%), who typically have better healing potential and rehabilitation compliance. The significant improvement in ligamentous stability observed in our study, with the Lachman test becoming negative in 96.43% of patients and the anterior drawer test negative in 96.43% at final follow-up, underscores the effectiveness of the modified transtibial technique in restoring knee stability. These findings are comparable to those reported in a retrospective comparative study where no statistically significant difference was noted in anterior drawer and Lachman tests between modified transtibial and anteromedial portal techniques at two-year follow-up.[13] The low failure rate in our study (no graft failures) is consistent with findings from a recent study of athletes undergoing ACL reconstruction with modified transtibial technique, which reported an overall failure rate of 4.6%.[8] The absence of graft failures in our series may be related to the adequate graft diameter (mean 8.04±2.85 mm), as graft diameter of 8.0 mm or greater has been associated with significantly lower failure rates.[3] The modified transtibial technique offers several technical advantages that may contribute to the favorable outcomes observed in our study. Unlike the traditional transtibial technique, which has been associated with non-anatomical femoral tunnel placement, the modified approach utilizes a free-hand guide pin placement toward the anatomical femoral footprint, enabling more accurate positioning of the femoral tunnel.[7] A systematic review and meta-analysis demonstrated that the modified transtibial technique can create an anatomic femoral tunnel and maintain optimal tunnel length and angulation, with most patients achieving satisfactory subjective outcomes and physical examinations.[12] The technique also offers advantages including shorter surgical time, technical simplicity, and the ability to achieve anatomical graft placement without the need for accessory portals.[9] These attributes make the modified transtibial technique particularly attractive for surgeons transitioning from traditional transtibial to more anatomical approaches. Range of motion outcomes in our study were excellent, with 92.86% of patients maintaining normal range of motion at nine-month follow-up. This finding is consistent with the accelerated rehabilitation protocols commonly employed following ACL reconstruction. The low rate of complications (transient knee effusion in 10.71% and mild donor site discomfort in 7.14%) further supports the safety and tolerability of the modified transtibial technique with hamstring autograft. No cases of deep vein thrombosis, pulmonary embolism, or surgical site infection were encountered, reflecting the minimally invasive nature of the procedure and the favorable healing characteristics of hamstring tendon autografts.[5,14]Arthroscopic anterior cruciate ligament reconstruction using quadrupled semitendinosus and gracilis tendon autograft.[15] through the modified transtibial technique yields excellent functional outcomes with significant improvements in Lysholm scores, ligamentous stability, and range of motion. The technique offers the advantages of shorter surgical time, technical simplicity, and anatomical graft placement, making it a valuable option for ACL reconstruction. Future studies with larger sample sizes, longer follow-up periods, and comparative designs are warranted to further validate these findings and determine

the long-term durability of outcomes achieved with this approach.

Limitations of the study

The study is limited by its modest sample size, absence of a control group for technique comparison, relatively short nine-month follow-up period, lack of objective stability measures such as KT-1000 arthrometer readings, and single-center design, which may limit the generalizability of findings.

CONCLUSION

Arthroscopic anterior cruciate ligament reconstruction using quadrupled semitendinosus and gracilis tendon autograft through the modified transtibial technique yields excellent functional outcomes, with significant improvements in Lysholm scores, ligamentous stability, and range of motion over nine-month follow-up. The technique offers advantages of shorter surgical time, technical simplicity, and anatomical graft placement, making it a valuable and reliable option for ACL reconstruction.

Recommendations

Future prospective randomized controlled trials with larger sample sizes, longer follow-up periods, objective stability assessments, and comparative designs with alternative techniques such as the anteromedial portal are recommended to further validate these findings and determine the long-term durability of outcomes achieved with the modified transtibial technique.

AI declaration

Artificial intelligence tools contributed marginally to manuscript preparation and development. All core scientific content was human-verified.

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