

ORIGINAL ARTICLE

Functional and Clinical Outcomes Following Arthroscopic Anterior Cruciate Ligament Reconstruction Using Quadriceps Tendon Autograft

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ABSTRACT

Background: Anterior cruciate ligament injury is a common cause of knee instability and functional limitation, particularly among young and active individuals. Quadriceps tendon autograft has emerged as a promising graft option with favorable biomechanical properties and potentially lower donor-site morbidity. **Aim of the study:** This study aimed to evaluate the functional and clinical outcomes of arthroscopic ACL reconstruction using quadriceps tendon autograft. **Methods & Materials:** A prospective observational study was conducted among 18 patients aged 18–50 years who underwent arthroscopic ACL reconstruction using an ipsilateral quadriceps tendon autograft at Department of Orthopaedic Surgery, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, from January 2024 to June 2026. Functional outcomes were assessed using Lysholm, IKDC, Tegner, and VAS scores. Knee stability was evaluated using the Lachman, anterior drawer, and pivot-shift tests. Patients were followed at 3, 6, and 12 months for functional recovery, range of motion, return to activity, satisfaction, complications, graft failure, and revision surgery. Data were analyzed using SPSS v26.0, with $p < 0.05$ considered statistically significant. **Results:** Among 18 patients, the mean age was 28.6 ± 7.4 years, and 83.3% were male. At 12 months, the mean Lysholm score improved from 52.6 ± 8.9 to 91.2 ± 6.3 , IKDC from 45.3 ± 7.6 to 88.2 ± 6.5 , and Tegner score from 2.9 ± 1.0 to 5.8 ± 1.2 , while VAS pain decreased from 5.2 ± 1.3 to 0.6 ± 0.7 ; all changes were significant ($p < 0.001$). At final follow-up, 83.3% had Grade 0 Lachman, 83.3% had a Grade 0 anterior drawer test, 94.4% had a negative pivot-shift test, and 94.4% regained full range of motion. Return to previous activity or sport was achieved by 83.3%, while graft failure occurred in 5.6%. **Conclusion:** Arthroscopic ACL reconstruction using quadriceps tendon autograft resulted in favorable functional recovery, improved knee stability and range of motion, reduced pain, and a return to activity, with low graft failure and complication rates. Quadriceps tendon autograft appears to be an effective and reliable option for primary ACL reconstruction.

Keywords: Anterior cruciate ligament; Quadriceps tendon autograft; Arthroscopic ACL reconstruction; Knee stability

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INTRODUCTION

Anterior cruciate ligament (ACL) injury is one of the most clinically important ligamentous injuries of the knee, particularly among young and physically active individuals. Global estimates suggest that approximately two million ACL injuries occur annually, while reported incidence rates range from about 30 to 78 per 100,000 person-years^[1,2]. Such injuries frequently result from sports, pivoting activities, road traffic accidents, and other trauma, leading to recurrent instability, impaired functional capacity, reduced participation

in physical activity, and an increased risk of secondary meniscal and cartilage damage. For symptomatic and active patients, arthroscopic ACL reconstruction remains the principal surgical treatment for restoring knee stability and enabling return to activity^[1,3]. Selection of an appropriate graft is a crucial component of ACL reconstruction. Traditionally, hamstring tendon and bone-patellar tendon-bone (BPTB), autografts have been widely used; however, both are associated with graft-specific disadvantages. Hamstring harvesting may produce persistent flexor weakness and

variable graft diameter, whereas BPTB grafts may cause anterior knee pain, kneeling discomfort, and donor-site morbidity [3-5]. Consequently, the quadriceps tendon (QT) has gained increasing attention as an alternative autograft. Its advantages include a large and predictable cross-sectional area, adequate graft length, versatile harvesting with or without a bone block, favorable biomechanical properties, and preservation of the hamstring tendons [4-6]. Recent evidence indicates that QT autografts can produce functional outcomes and knee stability comparable with conventional graft choices [3,6,7]. Growing clinical evidence supports the effectiveness of QT autografts. At five-year follow-up, favorable improvements in Lysholm and IKDC outcomes, restoration of knee stability, and high rates of return to activity have been reported following QT-based reconstruction [8]. Similarly, improvements in Lysholm, IKDC, and Tegner scores have been demonstrated in young and athletic patients receiving all-soft-tissue QT grafts [9]. Comparative studies have also shown broadly similar functional and stability outcomes between QT and hamstring autografts [10,11]. More recently, a meta-analysis involving 2,964 patients found that QT autografts were associated with a lower risk of graft failure than hamstring grafts and less donor-site pain than BPTB grafts [12]. Nevertheless, concerns remain regarding postoperative quadriceps weakness, extensor mechanism recovery, graft-harvest morbidity, anterior knee pain, and the optimal rehabilitation strategy. Persistent quadriceps strength deficits can occur after ACL reconstruction and may influence functional recovery and decisions regarding safe return to sport [5,7]. Evidence also remains heterogeneous regarding graft thickness, harvesting technique, fixation method, rehabilitation protocols, and definitions of successful return to activity [4,6]. Consequently, evaluation should include not only patient-reported scores but also objective knee stability, range of motion, pain, complications, graft failure, and return to pre-injury activity. Within South Asia, locally generated evidence regarding QT autograft ACL reconstruction remains limited. An Indian clinical study demonstrated comparable outcomes between quadriceps and hamstring grafts, but published evidence specifically reflecting Bangladeshi patients is scarce [10]. Differences in injury mechanisms, delays in presentation, access to arthroscopic surgery, rehabilitation facilities, occupational demands, and adherence to postoperative rehabilitation may influence outcomes in this setting. Therefore, locally relevant assessment is needed to determine whether the favorable outcomes reported internationally are reproducible in Bangladeshi clinical practice. Accordingly, the present study aimed to evaluate the functional and clinical outcomes following arthroscopic ACL reconstruction using quadriceps tendon autograft, with particular emphasis on functional scores, knee stability, range of motion, pain, return to activity, patient satisfaction, and postoperative complications.

METHODS & MATERIALS

This was a prospective observational study. The study was conducted in the Department of Orthopaedic Surgery, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh among patients undergoing arthroscopic anterior cruciate ligament reconstruction with quadriceps tendon autograft. Over the study period of 2.5 years, from January 2024 to June 2026, 18 consecutive patients

with symptomatic ACL deficiency who fulfilled the eligibility criteria were enrolled. Patients aged 18–50 years with clinically and radiologically confirmed primary ACL tears and persistent instability despite appropriate conservative treatment were included. Patients with previous ligament reconstruction, multiligament knee injury requiring additional reconstruction, advanced osteoarthritis, active infection, inflammatory joint disease, or inadequate follow-up were excluded. Before surgery, demographic characteristics, mechanism and duration of injury, affected knee, body mass index, associated injuries, pain severity, knee stability, range of motion, and functional status were recorded. For functional assessment, the Lysholm Knee Score, International Knee Documentation Committee (IKDC) subjective score, Tegner Activity Score, and Visual Analogue Scale (VAS) for pain were used. Through clinical examination, knee stability was assessed using the Lachman test, anterior drawer test, and pivot-shift test. The anterior drawer test was performed with the knee flexed to approximately 90°, and anterior tibial translation was evaluated in comparison with the contralateral knee. Findings were recorded according to the degree of anterior translation as Grade 0, Grade I, Grade II, or Grade III. spinal or general anesthesia, arthroscopic ACL reconstruction was performed using an ipsilateral quadriceps tendon autograft. During arthroscopy, associated meniscal and chondral lesions were identified and managed appropriately. After graft harvesting and preparation, anatomically positioned femoral and tibial tunnels were created, followed by passage of the graft, tensioning, and fixation using standard techniques. Postoperatively, all participants followed a structured rehabilitation protocol emphasizing early knee extension, progressive flexion, quadriceps activation, weight-bearing, strengthening, and gradual return to activity. At 3, 6, and 12 months, patients were evaluated for pain, functional scores, clinical stability, range of motion, complications, and rehabilitation progress. At final follow-up, return to previous activity or sport, patient satisfaction, donor-site morbidity, graft failure, and need for revision surgery were assessed. Using SPSS (v. 26.0), the collected data were analyzed using descriptive and inferential statistics. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequency and percentage. Changes in repeated outcome measures were evaluated using appropriate repeated-measures tests, with $p < 0.05$ considered statistically significant. Ethical approval was obtained from the institutional review committee, and informed written consent was obtained from all participants.

RESULTS

The mean age of the 18 study participants was 28.6 ± 7.4 years, with half of the patients (50.0%) belonging to the 21–30-year age group. The majority of participants were male (83.3%), while females accounted for 16.7%. The mean BMI was 24.1 ± 3.1 kg/m². Regarding the affected knee, the right knee was involved in 55.6% of patients, while the left knee was affected in 44.4%. Sports-related injuries were the most common mechanism of ACL injury (50.0%), followed by road traffic accidents (33.3%) and falls or other trauma (16.7%). The mean duration between injury and surgery was 8.4 ± 5.6 months (Table 1).

Table I: Demographic and baseline clinical characteristics of the study participants (n=18).

Variables	Categories	n (%) / Mean $\pm$ SD
Age (years)	Mean $\pm$ SD	28.6 $\pm$ 7.4
	≤ 20 years	2 (11.1)
	21–30 years	9 (50.0)
	31–40 years	5 (27.8)
	> 40 years	2 (11.1)
Sex	Male	15 (83.3)
	Female	3 (16.7)
BMI (kg/m ²)	Mean $\pm$ SD	24.1 $\pm$ 3.1
Affected knee	Right	10 (55.6)
	Left	8 (44.4)
Mechanism of injury	Sports-related	9 (50.0)
	Road traffic accident	6 (33.3)
	Fall/other trauma	3 (16.7)
Duration from injury to surgery (months)	Mean $\pm$ SD	8.4 $\pm$ 5.6

The majority of participants had a complete ACL tear, accounting for 17 (94.4%) patients, while 1 (5.6%) had a partial/high-grade tear. Associated meniscal injury was present in most participants, with 5 (27.8%) having medial meniscal injury, 4 (22.2%) having lateral meniscal injury, and 2 (11.1%) having injuries involving both menisci; 7 (38.9%) had no associated meniscal injury. Cartilage lesions were present in 4 (22.2%) patients and absent in 14 (77.8%).

Regarding meniscal procedures, 4 (22.2%) underwent meniscal repair, 7 (38.9%) underwent partial meniscectomy, and 7 (38.9%) required no meniscal procedure. The mean quadriceps tendon graft diameter was 9.2 ± 0.7 mm, while the mean graft length was 74.6 ± 7.8 mm. The mean operative time was 87.4 ± 15.6 minutes, and the mean hospital stay was 2.1 ± 0.7 days (Table II).

Table II: Injury characteristics and operative findings of the study participants (n=18)

Variables	Categories	n (%) / Mean $\pm$ SD
Type of ACL tear	Complete	17 (94.4)
	Partial/high-grade	1 (5.6)
Associated meniscal injury	None	7 (38.9)
	Medial meniscus	5 (27.8)
	Lateral meniscus	4 (22.2)
	Both menisci	2 (11.1)
Cartilage lesion	Present	4 (22.2)
	Absent	14 (77.8)
Meniscal procedure	Meniscal repair	4 (22.2)
	Partial meniscectomy	7 (38.9)
	No procedure	7 (38.9)
Quadriceps tendon graft diameter (mm)	Mean $\pm$ SD	9.2 ± 0.7
Quadriceps tendon graft length (mm)	Mean $\pm$ SD	74.6 ± 7.8
Operative time (minutes)	Mean $\pm$ SD	87.4 ± 15.6
Hospital stay (days)	Mean $\pm$ SD	2.1 ± 0.7

There was a significant improvement in functional outcomes following ACL reconstruction among the 18 participants. The mean Lysholm Knee Score increased progressively from 52.6 ± 8.9 preoperatively to 91.2 ± 6.3 at 12 months. Similarly, the mean IKDC subjective score improved from 45.3 ± 7.6 before surgery to 88.2 ± 6.5 at 12 months. The Tegner Activity Score also demonstrated a gradual improvement from 2.9 ± 1.0 preoperatively to 5.8 ± 1.2 at 12 months. In contrast, the mean

VAS pain score decreased substantially from 5.2 ± 1.3 preoperatively to 0.6 ± 0.7 at 12 months. All changes across the follow-up period were statistically significant ($p < 0.001$), indicating significant improvement in knee function, activity level, and pain following quadriceps tendon autograft ACL reconstruction (Table III).

Table III: Changes in functional outcome scores following ACL reconstruction (n=18)

Outcome measure	Preoperative Mean $\pm$ SD	3 months Mean $\pm$ SD	6 months Mean $\pm$ SD	12 months Mean $\pm$ SD	p-value
Lysholm Knee Score	52.6 ± 8.9	70.8 ± 8.1	84.9 ± 6.8	91.2 ± 6.3	<0.001
IKDC subjective score	45.3 ± 7.6	62.8 ± 8.0	79.4 ± 7.1	88.2 ± 6.5	<0.001
Tegner Activity Score	2.9 ± 1.0	4.1 ± 1.1	5.0 ± 1.2	5.8 ± 1.2	<0.001
VAS pain score	5.2 ± 1.3	2.6 ± 1.0	1.3 ± 0.8	0.6 ± 0.7	<0.001

There was a significant improvement in knee stability and range of motion following ACL reconstruction. Preoperatively, 15 (83.3%) patients had Grade II–III Lachman test findings, which decreased to 1 (5.6%) at 6 months and none at 12 months, while Grade 0 Lachman findings increased from 0%

preoperatively to 83.3% at 12 months. Similarly, Grade II–III anterior drawer findings decreased from 77.8% preoperatively to 5.6% at 6 months and 0% at 12 months, with Grade 0 findings increasing to 83.3% at 12 months. A negative pivot-shift test was observed in 11.1% of patients preoperatively,

increasing to 83.3% at 6 months and 94.4% at 12 months. Mean knee flexion improved from $121.4 \pm 10.2^\circ$ preoperatively to $137.1 \pm 4.8^\circ$ at 12 months. Full knee extension increased from 55.6% to 100.0%, while the proportion with an extension deficit decreased from 44.4% to 0%. Full range of motion was

achieved in 33.3% of patients preoperatively compared with 94.4% at 12 months. All observed improvements were statistically significant ($p < 0.001$) *Table IV*.

Table IV: Clinical knee stability and range of motion before and after ACL reconstruction (n=18)

Clinical parameter	Preoperative	6 months	12 months	p-value
Lachman test (Grade 0)	0 (0.0%)	10 (55.6%)	15 (83.3%)	<0.001
Lachman test (Grade I)	3 (16.7%)	7 (38.9%)	3 (16.7%)	
Lachman test (Grade II-III)	15 (83.3%)	1 (5.6%)	0 (0.0%)	
Anterior drawer test (Grade 0)	0 (0.0%)	11 (61.1%)	15 (83.3%)	<0.001
Anterior drawer test (Grade I)	4 (22.2%)	6 (33.3%)	3 (16.7%)	
Anterior drawer test (Grade II-III)	14 (77.8%)	1 (5.6%)	0 (0.0%)	
Negative pivot-shift test	2 (11.1%)	15 (83.3%)	17 (94.4%)	<0.001
Knee flexion (degrees)	121.4 ± 10.2	132.8 ± 7.0	137.1 ± 4.8	<0.001
Full knee extension achieved	10 (55.6%)	17 (94.4%)	18 (100.0%)	<0.001
Extension deficit present	8 (44.4%)	1 (5.6%)	0 (0.0%)	<0.001
Full range of motion achieved	6 (33.3%)	16 (88.9%)	17 (94.4%)	<0.001

At 12 months following ACL reconstruction, the majority of patients demonstrated favorable functional outcomes. According to the Lysholm functional score, 8 (44.4%) patients achieved an excellent outcome and 7 (38.9%) achieved a good outcome, while 2 (11.1%) had a fair outcome and 1 (5.6%) had a poor outcome. Based on the IKDC clinical grade, 9 (50.0%) patients were classified as normal (Grade A), 7 (38.9%) as nearly normal (Grade B), and 2 (11.1%) as abnormal (Grade C);

none were severely abnormal. Overall, 15 (83.3%) patients returned to their previous activity or sport, while 12 (66.7%) returned to their pre-injury activity level. Regarding satisfaction, 10 (55.6%) patients were very satisfied, 6 (33.3%) were satisfied, and 2 (11.1%) were unsatisfied. The mean time required to return to activity or sport was 8.7 ± 1.8 months (*Table V*).

Table V: Final functional outcome and return to activity at 12-month follow-up (n=18)

Variables	Categories	n (%)
Lysholm functional outcome	Excellent	8 (44.4)
	Good	7 (38.9)
	Fair	2 (11.1)
	Poor	1 (5.6)
IKDC clinical grade	Normal (Grade A)	9 (50.0)
	Nearly normal (Grade B)	7 (38.9)
	Abnormal (Grade C)	2 (11.1)
	Severely abnormal (Grade D)	0 (0.0)
Return to previous activity/sport	Yes	15 (83.3)
	No	3 (16.7)
Return to pre-injury activity level	Yes	12 (66.7)
	Returned at a lower level	3 (16.7)
	Did not return	3 (16.7)
Patient satisfaction	Very satisfied	10 (55.6)
	Satisfied	6 (33.3)
	Unsatisfied	2 (11.1)
Time to return to activity/sport (months)	Mean $\pm$ SD	8.7 ± 1.8

Among the 18 patients, 13 (72.2%) experienced no postoperative complications during the follow-up period. The most frequently observed complications were anterior knee pain and quadriceps weakness, each occurring in 2 (11.1%) patients. Donor-site pain, knee stiffness/arthrofibrosis, extension deficit, knee effusion, and superficial surgical-site infection were each reported in 1 (5.6%) patient. Graft

failure/re-rupture occurred in 1 (5.6%) patient, while no patient developed sensory disturbance around the donor site or required revision ACL reconstruction during follow-up. Overall, the findings indicate a relatively low rate of postoperative complications following ACL reconstruction using a quadriceps tendon autograft (*Table VI*).

Table VI: Postoperative complications and graft-related outcomes (n=18)

Complications/outcomes	n (%)
No postoperative complication	13 (72.2%)
Anterior knee pain	2 (11.1%)
Quadriceps weakness	2 (11.1%)
Donor-site pain	1 (5.6%)
Knee stiffness/arthrofibrosis	1 (5.6%)
Extension deficit during follow-up	1 (5.6%)
Knee effusion	1 (5.6%)

Superficial surgical-site infection	1 (5.6%)
Sensory disturbance around donor site	0 (0.0%)
Graft failure/re-rupture	1 (5.6%)
Revision ACL reconstruction during follow-up	0 (0.0%)

DISCUSSION

The present study demonstrated substantial improvement in both functional and clinical outcomes following arthroscopic ACL reconstruction using quadriceps tendon autograft. At 12 months, the mean Lysholm score increased from 52.6 ± 8.9 to 91.2 ± 6.3 , while the IKDC subjective score improved from 45.3 ± 7.6 to 88.2 ± 6.5 , both with $p < 0.001$. These results closely align with the meta-analysis by Mouarbes et al., which reported postoperative Lysholm and IKDC outcomes that were comparable among quadriceps tendon, hamstring tendon, and bone-patellar tendon-bone autografts [13]. Similarly, the meta-analysis by Tan et al., involving 28,621 patients, found no significant differences between quadriceps and hamstring grafts in Lysholm or IKDC outcomes [14]. More recently, Raj et al. also found no significant differences in postoperative IKDC, Lysholm, or Tegner scores between quadriceps and hamstring grafts across randomized trials [15]. The improvement in activity level was also noteworthy, with the mean Tegner score increasing from 2.9 ± 1.0 to 5.8 ± 1.2 . The randomized trial by Horstmann et al. similarly demonstrated significant postoperative functional recovery with quadriceps tendon grafts, with outcomes comparable to those of hamstring autografts [16]. Long-term evidence from Barié et al. also showed comparable knee function and return-to-sport levels between quadriceps and patellar tendon autografts after approximately 10 years [17]. Additionally, the systematic review by Crum et al. reported postoperative Lysholm scores ranging from 85.7–97.4 for bone-quadriceps grafts, broadly encompassing the 91.2 observed in our study [4]. Objective knee stability improved considerably. By 12 months, 83.3% of patients had a Grade 0 Lachman test, and 94.4% demonstrated a negative pivot-shift test. These findings support the biomechanical effectiveness of quadriceps tendon grafts. The study by Horstmann et al. demonstrated a 5.5 ± 2.9 mm improvement in manual side-to-side displacement following quadriceps tendon reconstruction [16]. Similarly, the review by Crum et al. reported low rates of postoperative rotatory instability, particularly with soft-tissue quadriceps grafts [4]. The systematic review by Zakharia et al. also reported restoration of knee stability and postoperative IKDC scores ranging from 75.9 to 94.0 in younger populations [18]. Pain reduction was another prominent finding; the mean VAS score decreased from 5.2 ± 1.3 to 0.6 ± 0.7 . The meta-analysis by Ashy et al. reported a weighted VAS score of 0.9 ± 1.1 after quadriceps tendon revision ACL reconstruction, which is comparable with the present result [19]. Likewise, Mouarbes et al. found substantially less donor-site pain with quadriceps tendon than with patellar tendon autografts, with a risk ratio of 0.25 [13]. These findings suggest an important clinical advantage of quadriceps graft harvesting, particularly when anterior knee discomfort is a concern. Return to activity was achieved by 83.3% of patients, while 66.7% returned to their pre-injury activity level, at a mean of 8.7 ± 1.8 months. The study by Renfree et al. reported an 88% return-to-sport rate among cutting and pivoting athletes receiving quadriceps tendon grafts [20]. The systematic review by Zakharia et al. reported rates of 88.9–91.7%, while Rangasamy et al. found return to sports occurring approximately 6–13.5 months following reconstruction [18,21]. More recent evidence from Olsen et al. demonstrated that 90.3% of patients with primary ACL reconstruction returned to their pre-injury sport, and 73.1%

returned at the same or higher level [22]. The slightly lower return rate in our cohort may reflect differences in rehabilitation resources, socioeconomic circumstances, occupational demands, adherence to physiotherapy, and access to structured sports rehabilitation in Bangladesh. Complications were relatively uncommon, with 72.2% experiencing no complication. Anterior knee pain occurred in 11.1%, quadriceps weakness in 11.1%, donor-site pain in 5.6%, and graft re-rupture in 5.6%. The pediatric meta-analysis by Rangasamy et al. reported quadriceps graft rupture of 3.5%, closely resembling our rate, while the review by Crum et al. reported graft rupture rates of 0–3.8% with soft-tissue quadriceps grafts [4,21]. In contrast, Ashy et al. reported a higher failure rate of 7.6% in revision ACL reconstruction, plausibly because revision procedures involve poorer graft environments and more complex pathology [19]. The study by Meena et al. reported no graft failure among 57 patients older than 50 years [23]. Quadriceps weakness deserves particular attention despite occurring in only 11.1% of our patients. The study by Schagemann et al. found generally excellent clinical outcomes after quadriceps graft harvesting, although altered quadriceps neuromuscular activity was demonstrable [24]. Setliff et al. reported recovery to 80% quadriceps strength at approximately 131.7 ± 40.1 days, even after extensor mechanism graft harvesting in revision surgery [25]. These observations emphasize the importance of early quadriceps activation and progressive strengthening.

LIMITATIONS

The study was limited by its small sample size, single-center design, and relatively short follow-up period. The absence of a comparative graft group also limited direct assessment of the relative effectiveness of the quadriceps tendon autograft compared with other commonly used grafts. In addition, some functional outcomes were based on patient-reported measures, which may have introduced subjective bias.

CONCLUSION

Overall, arthroscopic anterior cruciate ligament reconstruction using quadriceps tendon autograft resulted in substantial improvement in knee function, clinical stability, range of motion, pain, and activity level. Most patients achieved good-to-excellent functional outcomes, regained satisfactory knee stability, and returned to their previous activities with a low incidence of graft failure and postoperative complications. These findings indicate that quadriceps tendon autograft is an effective and reliable graft option for primary ACL reconstruction, providing favorable functional and clinical outcomes with acceptable donor-site morbidity.

RECOMMENDATIONS

Based on the favorable functional and clinical outcomes observed in this study, quadriceps tendon autograft may be considered a reliable option for arthroscopic ACL reconstruction, particularly when preserving hamstring function and reducing donor-site morbidity are important. Greater emphasis should be placed on structured postoperative rehabilitation, especially progressive quadriceps strengthening, to optimize recovery and return to activity. Further multicenter studies with larger sample sizes, longer follow-up periods, and comparative graft groups are

recommended to evaluate long-term graft survival, donor-site morbidity, return-to-sport outcomes, and the relative effectiveness of quadriceps tendon autograft compared with other commonly used grafts.

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CONFLICT OF INTEREST

None declared

ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

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