Section: Orthopedics

Original Research Article

FUNCTIONAL OUTCOMES OF ARTHROSCOPIC ANATOMICAL ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING A QUADRUPLED HAMSTRING GRAFT

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ABSTRACT

Background: Anterior cruciate ligament injuries are common among active individuals and require surgical reconstruction to restore knee stability and function. Arthroscopic anatomical reconstruction using a quadrupled hamstring graft is widely used due to its favorable outcomes. The aim is to analyze the postoperative functional outcomes of arthroscopic anatomical reconstruction of anterior cruciate ligament using a quadrupled hamstring graft. **Materials and Methods:** A prospective observational study was conducted on 150 patients undergoing ACL reconstruction. Functional outcomes were assessed using IKDC score, Lysholm score, and single leg hop test. Statistical analysis was performed with significance set at $p < 0.05$. **Result:** Majority of patients were young males, with road traffic accidents being the most common cause. Postoperative outcomes showed 70.00% normal IKDC scores and 64.00% excellent Lysholm scores. Significant improvement in limb symmetry index was observed ($p < 0.001$). Complications were minimal. **Conclusion:** Arthroscopic ACL reconstruction using quadrupled hamstring graft provides excellent functional outcomes with high patient satisfaction and minimal complications.

INTRODUCTION

Anterior cruciate ligament (ACL) injury is one of the most common ligamentous injuries of the knee joint, particularly affecting young, active individuals and athletes involved in pivoting and high-demand sports. It results in significant functional instability, impaired performance, and an increased risk of secondary meniscal and chondral injuries if left untreated. Surgical reconstruction remains the gold standard for restoring knee stability and enabling return to pre-injury activity levels.[1]

Over the years, advances in arthroscopic techniques and graft selection have significantly improved the outcomes of ACL reconstruction (ACLR). Among various graft options, autografts such as bone–patellar tendon–bone (BPTB), hamstring tendon (HT), and quadriceps tendon (QT) are most commonly used. Each graft has its own advantages and limitations, with ongoing debate regarding the optimal choice for achieving superior functional outcomes and minimizing complications.[2]

Hamstring tendon autografts have gained widespread popularity due to reduced donor-site morbidity, less anterior knee pain, and improved cosmetic outcomes compared to BPTB grafts. In particular, the use of quadrupled hamstring grafts provides enhanced graft diameter and tensile strength, contributing to improved biomechanical stability and potentially reducing the risk of graft failure.[3] Furthermore, anatomical ACL reconstruction techniques aim to restore the native footprint and biomechanics of the ligament, thereby improving rotational stability and functional outcomes.[4]

Recent studies have demonstrated that ACLR using hamstring autografts provides comparable clinical outcomes to other graft types, including quadriceps tendon and BPTB grafts, with similar rates of graft failure, joint laxity, and patient-reported outcomes.[5] Additionally, hamstring grafts have been associated with a higher likelihood of achieving acceptable symptom states in sport and recreational activities, indicating favorable functional recovery.[6]

Despite these advantages, concerns have been raised regarding hamstring strength deficits following graft harvesting. Studies have shown that patients undergoing ACLR with hamstring grafts may exhibit persistent reductions in hamstring strength and altered neuromuscular function during early postoperative recovery, although gradual

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improvement is observed with rehabilitation.[7] These biomechanical alterations underline the importance of structured rehabilitation protocols to optimize functional outcomes.

The concept of quadrupled semitendinosus grafts has further evolved to preserve the gracilis tendon, potentially improving postoperative muscle strength without compromising graft stability. Comparative studies have shown no significant difference in functional outcomes, graft strength, or failure rates between quadrupled semitendinosus grafts and conventional semitendinosus-gracilis constructs, supporting the efficacy of this technique.[8]

Return to sports (RTS) is a critical parameter in evaluating the success of ACL reconstruction. Evidence suggests that the majority of patients can return to sports following ACLR, although the timing and level of return vary depending on multiple factors including graft type, rehabilitation, and patient characteristics. Importantly, graft choice does not appear to significantly influence RTS rates, highlighting the role of surgical technique and postoperative management in determining outcomes.[9]

In addition, long-term studies have demonstrated satisfactory functional outcomes, knee stability, and patient satisfaction following ACL reconstruction using autografts, with minimal complications when performed using anatomical techniques. These findings reinforce the reliability and effectiveness of modern ACLR procedures in restoring knee function.[10]

Given the evolving techniques and ongoing debate regarding graft selection, the present study aims to analyze the functional outcomes of arthroscopic anatomical reconstruction of the anterior cruciate ligament using a quadrupled hamstring graft, based on our clinical experience.

MATERIALS AND METHODS

This prospective observational study was conducted to evaluate the functional outcome of arthroscopic anatomical reconstruction of the anterior cruciate ligament using a quadrupled hamstring graft. The study was carried out in the Department of Orthopaedics at a tertiary care hospital over a defined study period. A total of 150 patients diagnosed with anterior cruciate ligament injury and meeting the inclusion criteria were enrolled in the study. Patients in the age group of 18–50 years with symptomatic ACL deficiency confirmed clinically and radiologically were included. Patients with multi-ligament injuries, associated fractures around the knee joint, previous knee surgeries, advanced osteoarthritis, or systemic conditions affecting mobility were excluded from the study.

All patients underwent a detailed clinical evaluation, including history taking, physical examination, and relevant imaging such as magnetic resonance imaging to confirm the diagnosis. Preoperative functional assessment was performed using standardized scoring systems such as the Lysholm Knee Scoring Scale and International Knee Documentation Committee (IKDC) score. After obtaining informed consent, all patients underwent arthroscopic anatomical ACL reconstruction using a quadrupled hamstring tendon graft harvested from the ipsilateral limb. Standard surgical techniques were followed, ensuring anatomical placement of femoral and tibial tunnels to replicate the native ACL footprint. Fixation of the graft was achieved using appropriate interference screws or suspensory fixation devices as per surgeon preference.

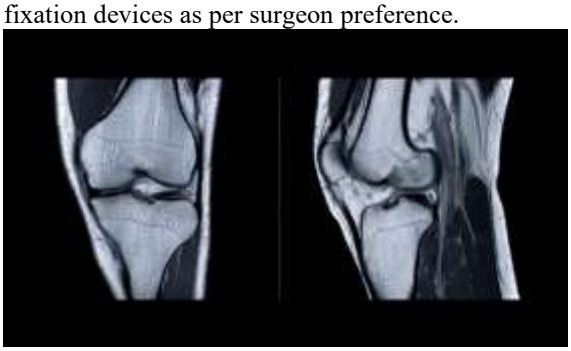

Figure 1: MRI of the knee showing complete disruption of anterior cruciate ligament fibers with increased signal intensity suggestive of complete ACL tear.

Postoperatively, all patients were subjected to a standardized rehabilitation protocol focusing on early mobilization, progressive weight-bearing, range of motion exercises, and muscle strengthening. Patients were followed up at regular intervals, including 3 months, 6 months, and 12 months post-surgery. Functional outcomes were assessed at each follow-up using the same scoring systems as used preoperatively. Clinical stability tests such as Lachman test, anterior drawer test, and pivot shift test were also performed during follow-up visits to assess knee stability.

The collected data were compiled and entered into a Microsoft Excel spreadsheet and analyzed using appropriate statistical software. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were expressed as frequencies and percentages. The comparison between preoperative and postoperative functional scores was performed using paired t-test or Wilcoxon signed-rank test depending on data distribution. A p-value of less than 0.05 was considered statistically significant.

Ethical clearance for the study was obtained from the Institutional Ethics Committee prior to commencement of the study. All procedures were conducted in accordance with ethical standards and the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants before their inclusion in the study.

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RESULTS

A total of 150 patients were included in the present study. The age and sex distribution showed that the majority of patients were in the younger age groups, with 48 patients (32.00%) in the 21–25 years category and 36 patients (24.00%) in the 26–30 years category. The age group of 15–20 years included 12 patients (8.00%), while 31–35 years and 36–40 years contributed 20 (13.33%) and 18 (12.00%) patients respectively. The least number of cases were observed in the 41–45 years and 46–50 years groups, each with 8 patients (5.33%). The mean age was 28.6 ± 7.4 years. Male predominance was clearly observed, with 120 patients (80.00%) compared to 30 females (20.00%) as shown in [Table 1].

[Table 1] describes the clinical presentation and injury characteristics of the study population. Left-sided injuries were more common, accounting for 98 patients (65.33%), while right-sided injuries were seen in 52 patients (34.67%). The most frequent cause of injury was road traffic accidents in 68 cases (45.33%), followed by sports injuries in 54 cases (36.00%) and falls in 28 cases (18.67%). Giving way of the knee was the most consistent symptom, reported in all 150 patients (100.00%). Pain was present in 138 patients (92.00%), swelling in 132 patients (88.00%), and clicking sensation in 60 patients (40.00%).

[Table 2] demonstrates the postoperative complications observed in the study. Graft site pain was reported in 18 patients (12.00%), while 132 patients (88.00%) had no pain. Superficial infection was seen in 6 cases (4.00%), with no cases of deep infection reported. Numbness was present in 10 patients (6.67%), laxity in 15 patients (10.00%), and clicking in 6 patients (4.00%). Flexion deformity was rare, observed in only 3 patients (2.00%). Overall, the complication rates were low and clinically acceptable.

[Table 3] highlights the postoperative functional outcomes. According to IKDC scoring, 105 patients (70.00%) achieved normal knee function, while 36 patients (24.00%) were classified as near normal and 9 patients (6.00%) as abnormal. Based on Lysholm Gillquist scoring, excellent outcomes were seen in 96 patients (64.00%), good in 45 patients (30.00%), and fair in 9 patients (6.00%), with no poor results recorded. Subjective satisfaction assessment revealed that 110 patients (73.33%) were very satisfied and 40 patients (26.67%) were satisfied with the surgical outcome.

[Table 4] presents the single leg hop test results assessing limb symmetry index. The preoperative mean value was 48.32 ± 8.45 with a range of 28.10 to 59.80, while the postoperative mean improved significantly to 82.45 ± 7.92 with a range of 62.40 to 97.20. This improvement was statistically significant ($p < 0.001$), indicating a marked enhancement in functional performance following reconstruction.

Table 1: Age and Sex Distribution

Age Group (years)	Number	Percent (%)
15–20	12	8.00
21–25	48	32.00
26–30	36	24.00
31–35	20	13.33
36–40	18	12.00
41–45	8	5.33
46–50	8	5.33
Total	150	100.00
Sex	Frequency	Percent (%)
Male	120	80.00
Female	30	20.00
Total	150	100.00

Table 2: Symptoms and Injury Characteristics

Parameter	Category	Frequency	Percent (%)
Side of injury	Right	52	34.67
	Left	98	65.33
Nature of injury	RTA	68	45.33
	Sports	54	36.00
	Fall	28	18.67
Presenting symptoms	Pain	138	92.00
	Swelling	132	88.00
	Giving way	150	100.00
	Clicking	60	40.00

Table 3: Complications

Complication	Yes (n)	Yes (%)	No (n)	No (%)
Pain	18	12.00	132	88.00
Superficial infection	6	4.00	144	96.00
Deep infection	0	0.00	150	100.00
Numbness	10	6.67	140	93.33
Laxity	15	10.00	135	90.00

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Clicking	6	4.00	144	96.00
FFD	3	2.00	147	98.00

Table 4: Postoperative Outcome

Outcome Measure	Category	Frequency	Percent (%)
IKDC scoring	Normal	105	70.00
	Near normal	36	24.00
	Abnormal	9	6.00
Lysholm score	Excellent	96	64.00
	Good	45	30.00
	Fair	9	6.00
	Poor	0	0.00
Subjective satisfaction	Very satisfied	110	73.33
	Satisfied	40	26.67
	Not satisfied	0	0.00

Table 5: Single Leg Hop Test (Limb Symmetry Index)

Parameter	Minimum	Maximum	Mean ± SD
Preoperative	28.10	59.80	48.32 ± 8.45
Postoperative	62.40	97.20	82.45 ± 7.92

DISCUSSION

The present study evaluated the functional outcomes of arthroscopic anatomical anterior cruciate ligament reconstruction using a quadrupled hamstring graft in 150 patients and demonstrated highly satisfactory results in terms of knee stability, functional recovery, and patient satisfaction. The demographic profile of the study revealed that 56.00% of patients were in the 21–30 years age group and 80.00% were males, which aligns with the known epidemiological trends of ACL injuries predominantly affecting young, active males engaged in high-demand physical activities.[11]

In the present study, left-sided injuries were more common (65.33%), and road traffic accidents were identified as the leading cause (45.33%), followed by sports-related injuries (36.00%). This reflects a changing pattern where high-velocity trauma contributes significantly to ACL injuries in addition to sports-related mechanisms. Similar findings have been highlighted in previous literature emphasizing the multifactorial etiology of ACL injuries.[12]

Clinically, giving way of the knee was observed in all patients (100.00%), making it the most consistent presenting complaint, followed by pain (92.00%) and swelling (88.00%). These findings reinforce the importance of instability as the primary indication for surgical reconstruction. Previous studies have also validated the role of clinical scoring systems in assessing functional impairment and guiding treatment decisions.[13]

Postoperative complications in the present study were minimal, with graft site pain seen in 12.00% of cases and superficial infection in 4.00%, while no cases of deep infection were observed. Laxity was present in 10.00% of patients, which is comparable to acceptable rates reported in contemporary studies. The low complication profile can be attributed to advancements in arthroscopic techniques, improved graft fixation methods, and adherence to anatomical reconstruction principles.[14]

Functional outcome assessment revealed that 70.00% of patients achieved normal IKDC scores, while 64.00% demonstrated excellent Lysholm scores, with no poor outcomes recorded. Subjective satisfaction was also high, with 73.33% of patients being very satisfied. These results indicate that quadrupled hamstring graft reconstruction provides reliable restoration of knee function and stability. Comparable studies have reported favorable outcomes with hamstring grafts, supporting their continued use in ACL reconstruction.[11]

The single leg hop test showed a significant improvement in limb symmetry index from a preoperative mean of 48.32 ± 8.45 to a postoperative mean of 82.45 ± 7.92 ($p < 0.001$). This statistically significant improvement highlights enhanced neuromuscular coordination and functional recovery following reconstruction. Similar improvements in functional performance have been reported in studies evaluating rehabilitation outcomes after ACL reconstruction.[15]

Overall, the findings of the present study demonstrate that arthroscopic anatomical ACL reconstruction using a quadrupled hamstring graft is an effective technique that provides excellent functional outcomes, minimal complications, and high patient satisfaction.

CONCLUSION

Arthroscopic anatomical reconstruction of the anterior cruciate ligament using a quadrupled hamstring graft is a safe and effective procedure for restoring knee stability and function. The technique yields excellent to good functional outcomes in the majority of patients, with minimal postoperative complications and high levels of patient satisfaction. Significant improvement in functional performance further supports the reliability of this method. Hence, quadrupled hamstring graft reconstruction can be considered a preferred surgical option for ACL injuries in active individuals.

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