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**Dr. Lalit Chellappa Karpenter**
Resident, Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai, Tamil Nadu, India

**Dr. Manimaran KP**
Professor, Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai, Tamil Nadu, India

**Dr. Shanmugasundaram M**
Assistant Professor, Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai, Tamil Nadu, India

**Corresponding Author:**
**Dr. Lalit Chellappa Karpenter**
Assistant Professor, Department of Orthopaedics, Arunai Medical College & Hospital, Tiruvannamalai, Tamil Nadu, India

# Comparative analysis of the functional outcomes of hamstring graft and patellar bone tendon graft in arthroscopic anterior cruciate ligament reconstruction

**Lalit Chellappa Karpenter, Manimaran KP and Shanmugasundaram M**

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**Abstract**
**Background:** Anterior cruciate ligament (ACL) rupture is a common sports-related injury requiring surgical reconstruction. Patellar bone tendon (PT) and hamstring tendon (HT) autografts are widely used, but debate persists regarding their superiority in terms of functional outcome and complications.
**Aim:** To compare the functional results and postoperative complications of ACL reconstruction using PT and HT autografts.
**Materials and Methods:** A comparative study was conducted on 40 patients (aged 18-60 years), who underwent arthroscopic ACL reconstruction with either PT or HT autograft between June 2018 and November 2022. Patients were followed up at 3, 6 and 12 months. Clinical assessment included Lachman and Pivot shift tests. Functional outcomes were evaluated using the International Knee Documentation Committee (IKDC) and Lysholm knee scores. Statistical analysis was performed using SPSS v23, with $p<0.05$ considered significant.
**Results:** Both groups showed significant postoperative improvement in stability: Lachman scores improved from 2.3 to 1.2 in PT and 2.4 to 1.4 HT. Pivot shift improved from 1.4 to 0.3 in PT and 1.6 to 0.4 in HT (all $p<0.05$ within groups, no intergroup difference). Functional outcomes were similar, with IKDC improving from 50.2 to 85.6 (PT) and 52.8 to 87.1 (HT). Lysholm score improved from 50.0 to 83.6 in PT and 53.1 to 82.2 in HT at 1 year ($p>0.05$). Complications were higher in PT (70% vs 20%, P=0.047), mainly anterior knee pain (50%) and superficial infection (20%), while only one donor site infection occurred in HT; most HT patients (80%) had no complications.
**Conclusion:** Both PT and HT autografts provide comparable functional recovery and stability at 1 year following ACL reconstruction. HT autograft demonstrated a lower complication rate in this study, suggesting that it may be a preferable option in selected patients.

**Keywords:** ACL reconstruction, anterior cruciate ligament, hamstring tendon graft, patellar tendon, functional outcomes, knee instability

## Introduction
The anterior cruciate ligament (ACL) is essential for stabilising the knee by preventing the tibia from sliding forward relative to the femur. It also contributes to controlling excessive rotational movements and stresses on the knee, including varus or valgus forces, particularly when the joint is fully extended [1]. This role is especially important for athletes, such as football players, during activities that require sudden changes in direction, pivoting, or kicking. The reported incidence of ACL injuries is 14.4-18.0 per 100,000 athletic exposures [2]. ACL injuries most commonly occur through non-contact events involving rapid deceleration, such as sudden stopping or quick changes in direction. These ligament tears are frequently associated with damage to the meniscus and articular cartilage. An ACL-deficient knee describes a situation in which the ligament is absent or its function is lost, resulting in biomechanical instability [3]. Although the long-term progression of ACL deficiency remains unclear, research shows that affected individuals often report pain, repeated episodes of knee instability, and a decrease or complete discontinuation of their pre-injury sports participation [4]. An injury to the ACL may result in persistent knee instability, gradual deterioration of the meniscus and cartilage, and a reduction in overall quality of life. It can also contribute to the development of osteoarthritis [5, 6].

When appropriate, the preferred treatment for ACL deficiency is surgical reconstruction, which replaces the injured ligament with a tendon graft. The main aim of this surgery is to re-establish functional knee stability while minimising complications and risks associated with the procedure [7]. However, non-operative management is often selected for individuals with lower activity levels, minor instability, or those who cannot or prefer not to engage in rigorous post-operative rehabilitation [8].

There are multiple graft options available for ACL reconstruction, including allografts sourced from cadaveric donors and, less commonly, synthetic grafts. However, autografts, which use the patient's own tendon, are more frequently preferred by surgeons. The two primary autograft choices are the patellar tendon (PT) and hamstring tendon (HT). A PT graft involves harvesting the central third of the patellar tendon along with bone blocks from the patella and tibia, while an HT graft is obtained from the tendinous portion of the semitendinosus and/or gracilis muscles.[9] This study was designed to compare the functional outcomes, evaluated through both subjective scoring systems and objective clinical assessments, following arthroscopic ACL reconstruction using either HT autografts or PT-bone grafts.

## Materials and Methods

### Study design and setting

This prospective and retrospective comparative study involved 40 patients with ACL injuries treated at the Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai. The study was carried out over four years, from June 2018 to November 2022, following approval from the Institutional Ethical Committee. Written informed consent was obtained from all participants before inclusion.

### Inclusion criteria

The study enrolled patients with 18 to 60 years of age who had an isolated ACL tear found through clinical assessment and magnetic resonance imaging (MRI). Only individuals with a normal contralateral knee and no prior history of knee surgery were considered eligible.

### Exclusion criteria

Patients were excluded if they were < 18 or > 60 years old, had osteoarthritic changes in the affected knee, had a history of previous knee surgeries, or had associated ligament injuries. Patients with severe systemic illnesses and terminal conditions were also excluded.

### Methods

All eligible patients underwent a detailed clinical evaluation at the time of admission, including history, mechanism of injury, and physical examination. All the forty patients underwent arthroscopic ACL reconstruction, with 20 receiving a PT autograft and 20 receiving an HT autograft.

In the PT group, surgeons harvested the central portion of the patellar tendon along with attached bone blocks, which were then anchored on the femoral and tibial sides using interference screws. For the HT group, a graft composed of quadrupled semitendinosus and gracilis tendons was prepared and fixed with an EndoButton on the femoral side and an interference screw on the tibial side. To ensure consistency, all patients underwent the same surgical procedure and standardised postoperative care.

Rehabilitation after surgery was initiated on the first postoperative day under the guidance of the operating surgeon. The program involved early mobilisation of the patella, strengthening exercises for the quadriceps and hamstring muscle groups and progressive range of motion (ROM) training. Weight-bearing was gradually increased from partial to full as tolerated by the patient. Follow-up assessments were performed at 1, 3, and 6 months, and again at 1 year to evaluate functional recovery and knee stability.

At each follow-up visit, functional recovery was assessed using the International Knee Documentation Committee (IKDC) score and the Lysholm knee score. Knee stability was evaluated through clinical examinations, including the Lachman and pivot-shift tests. Additionally, any complications such as donor-site infection, anterior knee pain, loss of extension, or graft laxity were documented.

### Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, v23. Categorical data were reported as counts and percentages, while continuous variables were expressed as mean values with standard deviations. Comparisons between the two graft groups were conducted using the independent-samples t-test for numerical data and either the chi-square test or Fisher's exact test for categorical data. A p-value < 0.05 was considered significant.

**Table 1:** Comparison of demographic and clinical characteristics between groups

| Category | Subtype | PT (N=20) | HT (N=20) | P-Value |
|---|---|---|---|---|
| Gender | Female | 2 (10%) | 4 (20%) | 1 |
| | Male | 18 (90%) | 16 (80%) | |
| Side of injury | Left | 10 (50%) | 10 (50%) | 1 |
| | Right | 10 (50%) | 10 (50%) | |
| Mode of injury | RTA | 6 (30%) | 2 (10%) | 0.513 |
| | Self-fall | 10 (50%) | 14 (70%) | |
| | Sports | 4 (20%) | 4 (20%) | |
| Complications | Donor site infection | 0 | 2 (10%) | 0.047 |
| | Knee pain | 10 (50%) | 2 (10%) | |
| | Superficial infection | 4 (20%) | 0 | |
| | Nil | 6 (30%) | 16 (80%) | |

## Results

In the PT group, 90% were males (18/20), whereas in the HT group, 80% were males (16/20), (P=1.000). The sides of injury were equally distributed between the left and right sides in both groups (10/20 each, P=1.000). Self-fall was the most frequent cause of injury in both groups (50% in PT [10/20] vs. 70% in HT [14/20]), followed by road traffic accidents (30% [6/20] vs. 10% [2/20]) and sports injuries

(20% [4/20] vs. 20% [4/20]) (P=0.513). Postoperative complications differed significantly between groups (P=0.047): donor site infection occurred only in two HT cases (10%); knee pain was more common in PT (50%, 10/20 vs. 10%, 2/20 in HT); superficial infection was seen only in PT (20%, 4/20); and the absence of complications was more frequent in HT (80%, 16/20 vs. 30%, 6/20 in PT), (Table 1).

The average age was 29.2±7.3 years for the PT patients and 26.0±4.9 years for the HT patients, showing no significant difference (P=0.264). The mean interval from injury to surgery was 30.6±8.0 days in the PT patients and 41.2±14.1 days in the HT patients, which was also not significant (P=0.053), (Table 2).

**Table 2:** Comparison of age and duration since injury between groups

| Variable | Group | | P-Value |
|---|---|---|---|
| | PT | HT | |
| Age | 29.2±7.3 | 26.0±4.9 | 0.264 |
| Duration since injury | 30.6±8.0 | 41.2±14.1 | 0.053 |

Preoperative Lachman and pivot-shift scores were similar between the PT group and HT patients (P=0.818 and P=0.398). Both scores improved postoperatively, with no significant difference at follow-up (P=0.618 and P=0.660). IKDC scores rose from 50.2 to 85.6 in PT and 52.8 to 87.1 in HT, while Lysholm scores increased from 50.0 to 83.6 in PT and 53.1 to 82.2 in HT. Comparisons at all-time points showed no significant differences ($p$>0.05) (Table 3).

**Table 3:** Comparison of functional outcomes between groups

| Test/score | Time | Group | | P-Value |
|---|---|---|---|---|
| | | PT | HT | |
| Lachmann Test | Pre-op | 2.30±0.95 | 2.40±0.97 | 0.818 |
| | Post-op | 1.20±0.79 | 1.40±0.97 | 0.618 |
| Pivot Shift Test | Pre-op | 1.40±0.52 | 1.60±0.52 | 0.398 |
| | Post-op | 0.30±0.48 | 0.40±0.52 | 0.660 |
| IKDC Score | Pre-op | 50.20±12.98 | 52.80±13.54 | 0.666 |
| | 3 months | 70.80±10.28 | 71.20±10.02 | 0.931 |
| | 6 months | 82.70±8.47 | 82.90±9.48 | 0.961 |
| | 1 year | 85.60±7.24 | 87.10±9.15 | 0.689 |
| Lysholm Knee Score | Pre-op | 50.00±13.20 | 53.10±13.96 | 0.616 |
| | 3 months | 71.00±8.81 | 70.60±8.64 | 0.919 |
| | 6 months | 80.40±9.51 | 79.80±10.81 | 0.897 |
| | 1 year | 83.60±9.83 | 82.20±10.52 | 0.762 |

## Discussion

Our study found no major gender variations in the PT and HT groups. Both had similar sides of injury distribution. The causes of injury varied and included road accidents, falls, and sports. Complications were more common in the PT group, whereas the HT group had fewer issues. Overall, more patients in the HT group recovered without complications. Wagh *et al*. studied 32 PT graft ACL reconstructions, with a mean age of 27 years, mostly males (87.5%), and patients aged 21-30 years (62.5%). Sports trauma is the main cause (46%), followed by road traffic accidents (34%) and falls (20%). Patellofemoral discomfort decreased from 30% at 6 months to 6% at 1 year, effusion from 5% to none, and no infections were reported [10].

Arida *et al*. analysed 60 patients undergoing ACL reconstruction, 30 with Bone patellar tendon bone graft (PT) and 30 with hamstring graft (HT), finding an average age of 29.9±11.3 years with no difference between groups (PT: 29.8±11.1; HT: 30.0±11.7, P=0.946), a gender distribution of 19 women and 41 men (P=0.267), and nearly equal side involvement (right: 32, left: 28, P=1.000) [11]. These findings suggest that demographic features and mechanisms of injury were broadly comparable across studies, while complications were fewer with hamstring grafts, highlighting their relative advantage in recovery.

The average age of patients in our study was comparable between the PT and HT patients. The time elapsed since injury was slightly longer in the HT patients than in the PT patients, but the difference was not meaningful. Wagh *et al*. reported a predominance of younger individuals, with 62.5% in the 21-30 year age group and a mean age of 27 years, though they did not mention the interval from injury to surgery [10]. Tareen *et al*. documented an average age of 29.4 years, which was similar to our findings [12]. Biz *et al*. found a mean age of 31.5±11.9 years, with comparable values in bone patellar tendon (PT) (31.9±12.5) and hamstring tendon (HT) (31.0±11.7) groups (P=0.84), and reported an average follow-up of 44.8±20.4 months, but no data on time from injury to surgery [13].

Arida *et al*. observed a similar age distribution, with PT patients averaging 29.8 years and HT patients 30.0 years [11]. Fallah *et al*. reported an average age of 25.8 years, with no significant difference between hamstring tendon (HT) (25.8±3.9), quadriceps tendon (QT) (25.2±4.0), and PT (26.3±4.1) groups [14]. Chung *et al*. described a slightly older cohort, with mean ages of 33.3±10.3 years in PT and 31.3±8.0 years in HT (P=0.148), and also noted a similar interval from injury to operation in both groups (8.2±2.5 weeks vs. 8.3±2.4 weeks, P=0.596) [15]. Overall, most studies reported a mean patient age in the mid-20s to early 30s with no significant differences between graft types, while the interval from injury to surgery showed minimal variation and was not clinically significant.

Both groups in our study showed marked improvements after surgery. Stability tests, functional scores, and patient-reported outcomes improved significantly in both groups. The extent of recovery was similar, with no significant difference between the two groups. These findings indicate that both graft types provide comparable functional outcomes. Wagh *et al*. found good outcomes in 32 patients, with 29 achieving

excellent Lysholm scores (> 90) at 1 year, an average score of 95, pain-free status in 27, and residual laxity in only 7% on anterior drawer and 3% on Lachman's test [10]. Tareen *et al*. found stability in 90% of HT and 94% of PT at 1 year, with better ROM in HT (130°±5 vs. 125°±5), similar return to sport (78% vs. 82%), and higher satisfaction in HT (92% vs. 85%) [12]. Biz *et al*. studied 43 patients with PT allograft or HT autograft, reporting no significant differences in IKDC (94.5 vs. 94.4), Knee Injury and Osteoarthritis Outcome Score (KOOS) (93.9 vs. 94.9), or Lysholm (96.4 vs. 96.0, $p>0.05$), with most showing negative stability tests, near-full ROM, and no major complications [13].

Arida *et al*. observed significant improvements: in PT, IKDC improved from 83.3±10.5 to 89.7±10.5, Lysholm from 88.8±9.3 to 95.3±6.3, and Tegner from 6.1±1.3 to 8.0±1.4 (all $p<0.005$); in HT, IKDC rose from 79.6±12.3 to 86.9±11.6, Lysholm from 87.6±6.7 to 93.7±4.7, and Tegner from 5.6±1.3 to 7.2±1.6 (all $p<0.005$) [11]. Chung *et al*. also found no overall difference between grafts at 32-34 months, with Lysholm scores of 85.2±8.9 in PT and 85.0±7.5 in HT (P=0.576), and IKDC subjective scores of 83.5±6.6 and 81.6±8.2 (P=0.110). The stability tests showed no significant differences. However, in patients with grade II and III MCL injuries, hamstring grafts were associated with greater medial joint opening (P=0.006, P=0.039) and lower IKDC scores (P=0.045, P=0.038) than BPT [15]. Overall, both PT and HT grafts provided significant functional improvement with comparable outcomes across stability tests, ROM, and patient-reported scores, indicating that graft choice did not substantially affect recovery, although hamstring grafts showed some limitations in patients with higher-grade MCL injuries.

## Limitations

This study was carried out in a single tertiary care centre with a limited sample size, which may affect the generalisability of the results. In addition, the relatively short follow-up period restricted the evaluation of long-term functional outcomes and procedure-related complications.

## Conclusion

Both techniques showed significant improvement in the IKDC and Lysholm scores at one year, with no significant intergroup differences. Although minor variations in complications were observed, both graft options provided comparable stability and functional recovery after surgery. Additional studies involving large patient populations and longer follow-up periods are needed to better understand long-term outcomes and the durability of grafts.

## Conflict of Interest

Not available

## Financial Support

Not available

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