

# Community-Based Self-Paced Exercises Improve Femoral Muscular Torque Ratios After ACL Reconstruction: A Case Report

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## ABSTRACT:

**Background:** Restoration of muscular balance after anterior cruciate ligament reconstruction (ACLR) is essential for knee stability, functional recovery, and injury prevention. Community-based self-paced rehabilitation may provide a practical alternative for patients unable to attend structured rehabilitation programs.

**Case Presentation:** A 24-year-old male, 20 weeks post-ACLR, was unable to participate in intensive institution-based rehabilitation because of preparation for competitive job examinations. A 12-week community-based self-paced exercise program was prescribed with periodic physiotherapy review.

**Intervention:** The program incorporated strengthening, functional training, endurance exercises, flexibility training, and agility drills performed independently at home, a local gymnasium, and community environments. Follow-up was conducted through telephone consultations and monthly outpatient reviews.

**Outcomes:** Isokinetic assessment demonstrated improvement in the hamstring-to-quadriceps ratio (0.608 to 0.660; +8.5%) and quadriceps-to-quadriceps ratio (0.844 to 0.922; +9.2%).

**Conclusion:** Community-based self-paced rehabilitation demonstrated clinically meaningful improvements in femoral muscular torque ratios and may represent a practical patient-centered alternative in selected individuals following ACLR.

**Keywords:** AI-driven marketing; digital real estate; Bangalore; residential housing; market dynamics.

## INTRODUCTION

Anterior cruciate ligament injury is among the most common serious knee injuries affecting physically active individuals.

Despite successful surgical reconstruction, restoration of muscular strength, neuromuscular control, and limb symmetry remains a major challenge.<sup>1</sup>

Quadriceps weakness may persist for months after surgery and has been linked to reduced functional performance and increased reinjury risk.<sup>2</sup> Isokinetic testing allows objective quantification of recovery.

The hamstring-to-quadriceps ratio reflects agonist-antagonist muscle balance, whereas the quadriceps-to-quadriceps ratio evaluates side to side symmetry.<sup>3</sup>

Many patients are unable to attend structured rehabilitation because of work, education, travel distance, financial limitations, or time constraints. Consequently, an alternative self-paced exercise rehabilitation strategy encourages management while maintaining necessary therapeutic effectiveness that is required. This case report describes the outcomes of a 12-week community-based self-paced exercise program following ACL reconstruction.

## CASE PRESENTATION

A 24-year-old male, 20 weeks after ACL reconstruction, was referred for continued rehabilitation. Because of academic commitments related to competitive job examinations, attendance at structured institution-based rehabilitation sessions was not feasible.

A 12-week community-based self-paced exercise program was prescribed, consisting of progressive strengthening, functional training, jogging/endurance activities, flexibility exercises,

and agility work. Following clinical evaluation, a structured community-based self-paced exercise program was prescribed. The patient agreed to comply with the exercise recommendations and periodic follow-up assessments.

Exercises were performed at a local gym, at home, and along a shoreline environment. Monitoring was provided through telephone consultations and monthly outpatient reviews.

## INTERVENTION

The rehabilitation program was formulated around established evidence-based principles of ACL reconstruction rehabilitation and progression, with modifications based on individual participant tolerance and functional capability.

The self-paced community-based program lasted 12 weeks and progressed through strengthening exercises, functional training, endurance conditioning, flexibility and agility work. Strengthening aimed to enhance the functional capability of the lower limb muscles with the use of resistance.

Functional activities concentrated on improving balance and neuromuscular control of movements.

Endurance work focused on the gradual progression of cardiovascular fitness and jogging. Flexibility was aimed at improving range of motion and extensibility of lower limb muscles while agility was added to improve dynamic movement patterns in anticipation of return to high level sport.

4 The participant undertook the exercises self-directed in the community, utilising a local gym, home environment and walking paths along the coastline. Adherence to the program and rate of progression was tracked through bi-weekly telephone calls and a monthly review appointment in outpatient.

**Table 1. Community-Based Self-Paced Exercise Program**

| Exercise Category                                                                                             | Exercise Components                                                                                         | Prescription Parameters                                                                    |
|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
|  <b>Strength Training</b>    | Leg press, bodyweight/weighted squats, static cycling, hamstring curls, weighted step-ups, weighted sit-ups | Moderate-to-high intensity;<br>3–4 sessions/week;<br>2–4 sets of 8–15 repetitions          |
|  <b>Functional Training</b>  | Single-leg balance exercises, resistance-band squats, controlled lunges, box jumps                          | Low-to-moderate intensity;<br>3–5 sessions/week;<br>2–3 sets of 30–60 seconds per exercise |
|  <b>Endurance Training</b>   | Progressive slow-to-fast jogging                                                                            | Progressive intensity;<br>3–5 sessions/week;<br>10–30 minutes/session                      |
|  <b>Flexibility Training</b> | Quadriceps, hamstring, hip-flexor, and calf stretching; general trunk and limb ROM exercises                | Daily;<br>3 repetitions of 30-second holds per stretch                                     |
|  <b>Agility Training</b>     | Fast marching, hopping, treadmill walking, fast jogging drills                                              | Moderate-to-high intensity;<br>2–3 sessions/week;<br>15–20 minutes/session                 |

Note: Exercise progression was individualized according to the participant's tolerance, symptom response, and functional performance. Regular telephonic follow-up and monthly outpatient reviews were conducted to monitor adherence and progression.

## OUTCOME MEASURES

Isokinetic strength assessment was performed using a TUR Isoforce Dynamometer (TUR Therapietechnik GmbH, Rostock, Germany) in concentric mode at an angular velocity of 15°/s. The participant was seated and stabilized using straps across the trunk and thighs to minimize compensatory movements. Dynamometer positioning was standardized according to the manufacturer's guidelines (TUR Isoforce Positioning Guide, 2014) with the following settings: height = 0°, rotation = 40°, tilt = 0°, chair rotation = 60°, backrest tilt = 100°, chair height = 3–5, and chair horizontal position = 110°.5

Assessments were conducted at baseline and after completion of the 12-week intervention. The primary outcome measures were the

hamstring-to-quadriceps (H:Q) torque ratio<sup>6</sup> and the quadriceps-to-quadriceps (Q:Q) torque ratio.<sup>7</sup> The H:Q ratio was calculated as the ratio of peak hamstring torque to peak quadriceps torque, whereas the Q:Q ratio was calculated as the ratio of peak torque of the involved quadriceps to that of the uninvolved quadriceps.

## RESULTS

Following the 12-week community-based self-paced rehabilitation program, improvements were observed in both femoral muscular torque ratios. The hamstring-to-quadriceps (H:Q) ratio, calculated from peak torque values measured in Newton-meters (Nm), increased from 0.608 at baseline to 0.660 post-intervention, representing an 8.5% improvement. Similarly, the quadriceps-to-quadriceps (Q:Q) ratio improved from 0.844 to 0.922, corresponding to a 9.2% increase. These changes indicate enhanced muscular balance between the hamstrings and quadriceps, as well as improved quadriceps strength symmetry between the involved and uninvolved lower limbs.

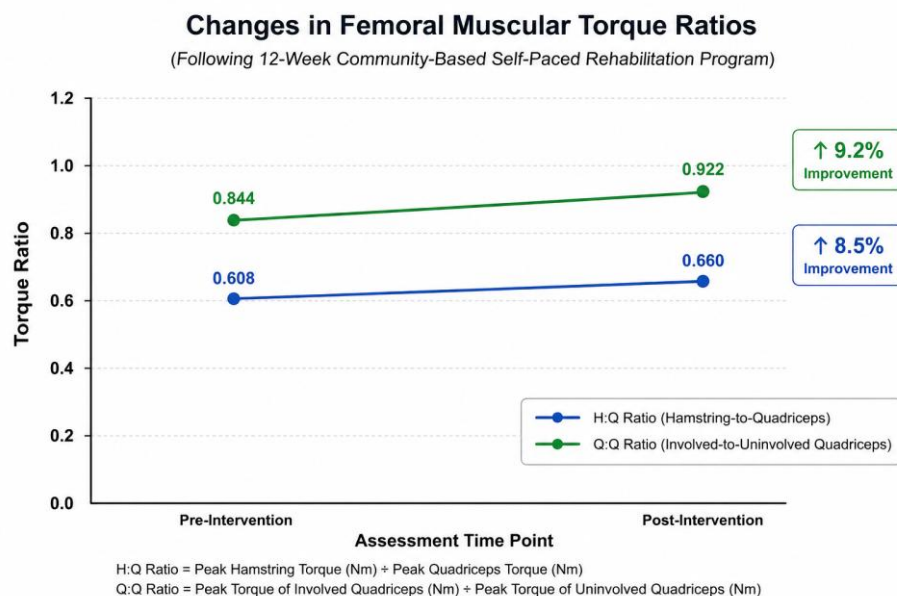
**Table 2. Pre- and Post-Intervention Femoral Muscular Torque Ratios**

| Torque Ratio*     | Pre-Intervention | Post-Intervention | Improvement (%) |
|-------------------|------------------|-------------------|-----------------|
| H:Q Ratio (Nm/Nm) | 0.608            | 0.660             | 8.5             |
| Q:Q Ratio (Nm/Nm) | 0.844            | 0.922             | 9.2             |

H:Q Ratio = Peak Hamstring Torque (Nm) ÷ Peak Quadriceps Torque (Nm)

Q:Q Ratio = Peak Torque of the Involved Quadriceps (Nm) ÷ Peak Torque of the Uninvolved Quadriceps (Nm)

\*Although peak torque was measured in Newton-meters (Nm), the ratios are dimensionless because they represent the quotient of two values expressed in the same unit. This table therefore reports torque ratios derived from isokinetic peak torque measurements.



## DISCUSSION

This case report illustrates that the hamstring:quadriceps (H:Q) and quadriceps:quadriceps (Q:Q) ratios improved over the 12-week duration of a community-based self-paced rehabilitation program after anterior cruciate ligament reconstruction (ACLR). The restoration of muscular balance is a cornerstone of post-ACLR rehabilitation, as any quadriceps deficit and imbalances between hamstrings and quadriceps could impair knee function and predispose the athlete to reinjury. Our findings with changes in torque ratios indicate a beneficial response from muscle performance and a restoration of lower limb symmetry within the rehabilitation program.

The increase in the H:Q ratio from 0.608 to 0.660 indicates enhanced balance between the knee flexor and extensor muscle groups. Adequate

hamstring strength relative to quadriceps strength plays an important role in dynamic knee stabilization by limiting excessive anterior tibial translation and reducing stress on the reconstructed ACL. Previous studies have reported that improved hamstring–quadriceps coordination contributes to better knee joint stability and may reduce the likelihood of secondary injury during functional activities.<sup>8,9</sup> Therefore, the improvement observed in the present case may reflect a positive neuromuscular adaptation resulting from the progressive strengthening and functional training components of the exercise program.

Similarly, the increase in the Q:Q ratio from 0.844 to 0.922 suggests improved quadriceps symmetry between the involved and uninvolved limbs. Restoration of inter-limb symmetry is considered

a key criterion in ACL rehabilitation, as residual strength deficits in the reconstructed limb have been associated with impaired functional performance, altered movement patterns, and delayed return to activity. The progressive resistance exercises, functional tasks, endurance activities, and agility drills incorporated within the rehabilitation program may have contributed to the recovery of quadriceps strength and improved muscular symmetry. These findings are consistent with previous literature emphasizing the importance of progressive exercise loading and neuromuscular training in optimizing post-ACLR outcomes.<sup>10,11</sup>

One key advantage of the current rehabilitation was its home-based and self-initiated, self-managed characteristic. As the participants were unable to adhere to supervised, hospital-based, physiotherapy, the provision of exercises on community-based facilities (e.g. House, local gymnasium and pathway along the shore) allowed participation to be maintained, and their ability to exercise independently was augmented by weekly follow up over the phone and bimonthly outpatient consultations.

For patients who are unable to attend supervised exercise programmes the method of this form of rehabilitation is economical and applicable, although caution is advised as these findings reflect the single patient in a single case study. Research with a larger sample size, and comparison to standard hospital-based exercise, and for longer periods of follow up, are recommended.

### CLINICAL IMPLICATIONS

This case highlights the potential role of community-based self-paced rehabilitation as a practical alternative for individuals who are unable to attend regular supervised physiotherapy sessions due to academic, occupational, geographical, or personal constraints.

In the present case, the participant successfully continued rehabilitation while preparing for competitive employment examinations,

demonstrating that recovery can be effectively integrated into daily life when flexibility is required.

The improvements observed in the H:Q and Q:Q torque ratios suggest that a structured self-paced exercise program, combined with periodic professional monitoring, may promote recovery of muscular balance and lower-limb symmetry following ACL reconstruction. Community-based rehabilitation may also enhance accessibility, encourage patient independence, improve adherence to exercise, and reduce the burden associated with frequent hospital visits.

These findings support the consideration of community-based self-paced rehabilitation as a feasible adjunct or alternative to conventional supervised rehabilitation for appropriately selected individuals following ACL reconstruction.

### PATIENT PERSPECTIVE

The patient reported satisfaction with the flexibility of the program and appreciated the ability to integrate rehabilitation into daily life without disrupting examination preparation. The patient perceived improvements in confidence, mobility, and functional capacity.

### LIMITATIONS

This report describes a single individual and therefore cannot establish causality or generalizability. Adherence was self-reported, and long-term follow-up data were unavailable. Controlled studies with larger sample sizes are required.

### CONCLUSION

A 12-week self-administered community exercise protocol was related to significant positive changes in femoral muscular torque ratios after ACL reconstruction. This patient-centered model could offer a feasible add-on or a substitute to traditional rehabilitation in a minority of patients.



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