Clinical Trial Protocol
Iranian Registry of Clinical Trials

10 Jun 2026

The effect of 6 weeks of plyometric exercises on the strength of muscles around the knee and lower extremity Functional performance in male underwent Anterior cruciate ligament reconstruction: A clinical trial study

Protocol summary

Study aim

To determine the effect of 6 weeks of plyometric training on knee muscle strength and lower extremity functional performance in male athletes following anterior cruciate ligament reconstruction

Design

This is a randomized, controlled, double-blind clinical trial with a parallel design. Thirty male athletes (18–35 years) with ACL reconstruction will be randomly assigned (1:1) to either a plyometric training group or a control group. The intervention lasts 6 weeks (3 sessions/week). Muscle strength and lower limb function will be assessed pre- and post-intervention. The outcome assessor and data analyst will be blinded.

Settings and conduct

The study will be conducted in Sari at a sports rehabilitation/training center under supervision of a physician and corrective exercise specialist. The intervention includes 3 supervised sessions per week for 6 weeks.

Participants/Inclusion and exclusion criteria

Inclusion criteria: Men between the ages of 18-35 years and confirmation of anterior cruciate ligament reconstruction (patellar tendon and hamstring autograft) by a knee specialist with radiography and MRI, no history of back and lower limb surgery (other than the knee), and a history of ACL reconstruction at least 6 months and no more than 12 months ago. Exclusion criteria: meniscus surgery with anterior cruciate ligament, use of allograft in cruciate ligament surgery, history of performing plyometric exercises, failure to complete rehabilitation phases before 6 months, age over 35 years

Intervention groups

For 6 weeks, 3 sessions per week (each session 50 minutes), they perform plyometric exercises including jumping, zigzag, lateral, and vertical hopping under the supervision of a corrective exercise specialist.

Main outcome variables

Quadriceps strength Hamstring strength Hamstring-to-quadriceps strength ratio (H/Q) Lower limb functional performance (single-leg and triple hop tests)

General information

Reason for update

Acronym

ACLR

IRCT registration information

IRCT registration number: **IRCT20250703066348N1**
Registration date: **2025-08-31, 1404/06/09**
Registration timing: **prospective**

Last update: **2025-08-31, 1404/06/09**
Update count: **0**

Registration date

2025-08-31, 1404/06/09

Registrant information

Name

reza rezaeian vaskasi

Name of organization / entity

Shomal university

Country

Iran (Islamic Republic of)

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Recruitment status

Recruitment complete

Funding source

Expected recruitment start date

2025-09-01, 1404/06/10

Expected recruitment end date

2025-12-01, 1404/09/10

Actual recruitment start date

empty

Actual recruitment end date

empty

Trial completion date

empty

Scientific title

The effect of 6 weeks of plyometric exercises on the strength of muscles around the knee and lower extremity Functional performance in male underwent Anterior cruciate ligament reconstruction: A clinical trial study

Public title

Investigating the effect of plyometric exercises on knee muscle strength and improvement of motor performance after anterior cruciate ligament surgery

Purpose

Treatment

Inclusion/Exclusion criteria

Inclusion criteria:

Males aged 18-35 years Confirmation of ACL reconstruction (patellar and hamstring tendon autograft) by a knee specialist with radiographs and MRI No history of back or lower extremity surgery (other than knee) ACL reconstruction history at least 6 months and no more than 12 months ago

Exclusion criteria:

Concomitant injury or surgery to other knee ligaments or structures Injury or surgery in other lower limb joints (hip, ankle) Neuromuscular or cardiovascular disorders limiting exercise participation Participation in other rehabilitation or training programs within the past 3 months Non-adherence (absence from >2 training or testing sessions)

Age

From **18 years** old to **35 years** old

Gender

Male

Phase

2

Groups that have been masked

- Outcome assessor
- Data analyser

Sample size

Target sample size: **30**

Randomization (investigator's opinion)

Randomized

Randomization description

In this quasi-experimental study, 30 male athletes (with a history of one ACL reconstruction within the past 6 to 12 months) who were eligible for inclusion in the study were purposively identified and then divided into two equal groups (15 in the plyometric training group and 15 in the control group) by simple randomization. The randomization process was performed as follows: An independent person, unaware of the study objectives, randomly generated a list of numbers from 1 to 30 using random number generation software (such as Excel or Randomizer.org). Half of the numbers (e.g., even numbers) were assigned to the training group (Plyometric) and the other half (odd numbers) were assigned to the control group. In order to prevent any bias, the assignment of subjects to groups was done by an independent person and the researcher was unaware of the group assignment until the final list was completed (allocation concealment). During the randomization process, inclusion and exclusion criteria were predetermined, and only those who met all inclusion criteria were included in this allocation.

Blinding (investigator's opinion)

Double blinded

Blinding description

1. Blinded Outcome Assessor: All outcome measurements, including isokinetic strength assessments of the quadriceps and hamstrings, as well as functional performance tests of the lower extremity (e.g., single-leg hop tests), will be conducted by a trained assessor who is completely blinded to the participants' group allocation. The outcome assessor will not be involved in the intervention phase and will only participate in the pre-test and post-test assessments. Participants will be instructed not to disclose their group assignment or any intervention details during testing. All assessments will be performed under standardized conditions (time, location, and equipment) for all participants. 2. Blinded Data Analyst: The collected data will be coded (e.g., as Group A and Group B) before statistical analysis. The data analyst will be blinded to the actual group identities throughout the entire analysis process. Group codes will only be revealed after statistical comparisons and interpretations are completed.

Placebo

Not used

Assignment

Parallel

Other design features

Secondary Ids

empty

Ethics committees

1

Ethics committee

Name of ethics committee

Shahrood University of Technology Research Ethics Committee

Street address

Shahrood University of Technology,Haft Tir Square, Shahrood , Semnan, Iran

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Semnan

Postal code

3619995161

Approval date

2025-06-28, 1404/04/07

Ethics committee reference number
IR.SHAHROODUT.REC.1404.010

Health conditions studied

1

Description of health condition studied
Anterior Cruciate Ligament Reconstruction
ICD-10 code
S83.5
ICD-10 code description
Sprain of cruciate ligament of knee

Primary outcomes

1

Description
1. Quadriceps muscle strength: measured with an isokinetic device at a 6-degree angle, recording normalized torque based on body weight.
Timepoint
Quadriceps muscle strength will be measured once before the start of the intervention (week 0) and once immediately after the end of the training period (week 6).
Method of measurement
Quadriceps muscle strength is assessed using an isokinetic machine at an angular velocity of 60 degrees/second. After sitting on the machine seat, the subject extends the knee with maximum force, and the maximum torque produced (in Newton meters/kg) is recorded.

2

Description
1. hamstring muscle strength: measured with an isokinetic device at a 6-degree angle, recording normalized torque based on body weight.
Timepoint
hamstring muscle strength will be measured once before the start of the intervention (week 0) and once immediately after the end of the training period (week 6).
Method of measurement
Hamstring muscle strength is assessed using an isokinetic device at an angular velocity of 60 degrees/second. After sitting on the device seat, the subject flexes the knee with maximum force, and the maximum torque produced (in Newton meters/kg) is recorded.

3

Description
2. Hamstring to quadriceps muscle strength ratio: measured with an isokinetic device at an angular velocity of 60 degrees, recording normalized torque based on body weight
Timepoint
The ratio of hamstring to quadriceps muscle strength will be measured once before the start of the intervention (week 0) and once immediately after the end of the training period (week 6).
Method of measurement
The hamstring to quadriceps strength ratio (H/Q Ratio) is obtained by dividing the hamstring muscle torque by the quadriceps muscle torque (in the 60-degree isokinetic test).

4

Description
4. Single-leg jump test with both legs, measuring jump distance with a tape measure.
Timepoint
Single-leg measurements will be measured once before the start of the intervention (week 0) and once immediately after the end of the training period (week 6).
Method of measurement
Single-leg hop: The subject jumps forward with one leg and lands on the same leg. The longest distance of the successful jump is recorded.

5

Description
5. Triple jump test with both legs, measuring the jump distance with a tape measure.
Timepoint
triple-leg hop: The subject jumps forward with one leg and lands on the same leg. The longest distance of the successful jump is recorded.
Method of measurement
Triple jump: Three consecutive jumps on one leg, maintaining balance at the end, and measuring the total distance traveled. The jump distance is measured with a tape measure on the ground and in centimeters.

Secondary outcomes

empty

Intervention groups

1

Description
Intervention group : Participants in the intervention group will undergo a supervised plyometric training program for 6 weeks, with 3 sessions per week (approximately 50 minutes per session: 5 min warm-up, 40 min training, 5 min cool-down).Exercises include single- and double-leg jumps, forward-backward hopping, lateral hopping, vertical jumps, and zigzag patterns. The intensity and complexity of the exercises will be progressively increased through three planned phases.
Category
Rehabilitation

2

Description
Control group: Participants in the control group will not receive any additional intervention during the 6-week study period. They will continue their usual daily activities, team practices, or general physical routines without any structured plyometric training.Weekly follow-up (by phone or in-person) will be conducted to ensure adherence and confirm no major changes in physical activity.Pre- and post-intervention assessments will be performed identically to the intervention group.At the end of the study, participants will be offered access to the training protocol if interested.

Category
Rehabilitation

Recruitment centers

1

Recruitment center

Name of recruitment center
Sari Sports Medical Board

Full name of responsible person
Rose fooladi

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Sponsors / Funding sources

1

Sponsor

Name of organization / entity
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Full name of responsible person
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Grant name

Grant code / Reference number

Is the source of funding the same sponsor organization/entity?
No

Title of funding source
Vice President for Research, Shomal University

Proportion provided by this source
100

Public or private sector
Private

Domestic or foreign origin
Domestic

Category of foreign source of funding
empty

Country of origin

Type of organization providing the funding
Academic

Person responsible for general inquiries

Contact

Name of organization / entity
shomal university

Full name of responsible person
Reza Rezaeian vaskasi

Position
student

Latest degree
Bachelor

Other areas of specialty/work
sports injury

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Sharing plan

Deidentified Individual Participant Data Set (IPD)
No - There is not a plan to make this available

Justification/reason for indecision/not sharing IPD
Due to ethical considerations and the need to protect the confidentiality of participants' personal information, individual-level raw data will not be made publicly available. Sharing such data could potentially lead to identification of participants even after anonymization

Study Protocol
Yes - There is a plan to make this available

Statistical Analysis Plan
No - There is not a plan to make this available

Informed Consent Form
Yes - There is a plan to make this available

Clinical Study Report
No - There is not a plan to make this available

Analytic Code
No - There is not a plan to make this available

Data Dictionary
No - There is not a plan to make this available

Title and more details about the data/document
The dataset includes demographic information (age, height, weight, BMI), isokinetic test results (quadriceps strength, hamstring strength, H/Q ratio), and lower limb functional performance (single-leg hop and triple-hop tests) in male athletes following ACL reconstruction. Data are collected at two time points (baseline and week 6) and stored in digital formats (Excel/SPSS).

When the data will become available and for how long
Data will be available upon request and with ethics committee approval after study completion and initial analysis (within 12 months after study end) and will remain accessible for 3 years.

To whom data/document is available
Data and documents will be accessible only to qualified researchers who submit a written request and obtain approval from the ethics committee.

Under which criteria data/document could be used
Data and documents will be used solely for scientific and research purposes. Access will be granted only upon written request, ethics committee approval, and a signed commitment to maintain confidentiality and not to use the data beyond the agreed research scope.

From where data/document is obtainable
Name: Reza Rezaeian vaskasi Position: Principal Investigator Email: rezaeianr7@gmail.com Phone: 00989360679338 Location: Sari Sports Medical Board

What processes are involved for a request to access data/document
Access requests must be submitted in writing to the Principal Investigator. Each request will be reviewed by the ethics committee. If approved and a confidentiality agreement is signed by the requesting researcher, the data/documents will be provided within the defined time frame.

Comments