Assessing rehabilitation progress following ACL reconstruction surgery

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Introduction

Rupture of the anterior cruciate ligament (ACL) is a common lower limb injury, with approximately 250,000 instances occurring annually in the United States [1].

Almost 100,000 of these patients undergo ACL reconstruction (ACLR) surgery each year, which is accompanied by a rehabilitation program lasting several months [2].

The leg press is frequently used for developing lower-limb power after surgery, with the goal of improving athletic performance and safety [3]. Quantifying biomechanics during this commonly used rehabilitation task can increase patient access to rehabilitative care.

Leg Press Experiment

Setup

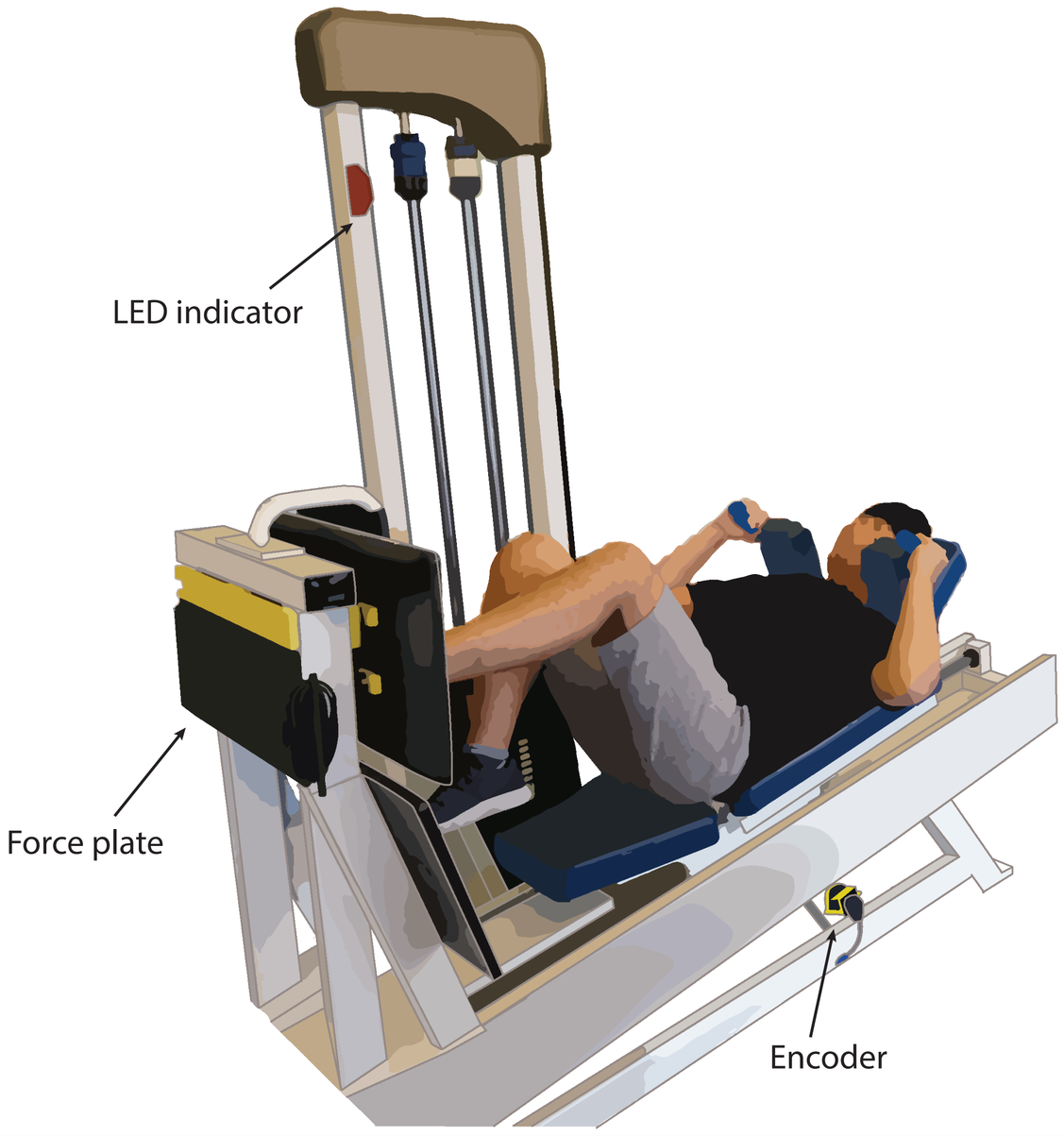
Each test was performed on a leg press (Body Masters MD-122) instrumented with a force plate (Loadstar Sensors, DI-1000) and encoder (US Digital H6-10000) at University of Michigan's MedSport Facility in Ann Arbor, Michigan.

Additionally, two stereo cameras (ZED Stereolabs) synchronously collecting video were mounted on a wall 4 meters away.

A magnetic switch was manually placed at the beginning of each test, triggering an LED light to ensure that subjects consistently reach a 90-degree knee angle.

Participants

Sixteen ACLR patients (3 female and 13 male, ages 17-48, avg height 1.79 ± 0.0798 m, avg body mass 78.6 ± 13.3 kg) were recruited for this study. The subjects were at least 4 months out of surgery.



Procedure

The ACLR subjects completed the leg press test 10 times over the course of the study, with at least one week in between tests.

During each testing session, the subject performed four 35-second leg press intervals (single-leg, two intervals on each). These intervals consisted of 30% and 50% of the subject's body weight on each leg.

Subjects were instructed to complete as many repetitions of the motion as possible, reaching a 90-degree knee angle on each cycle.

Acknowledgments

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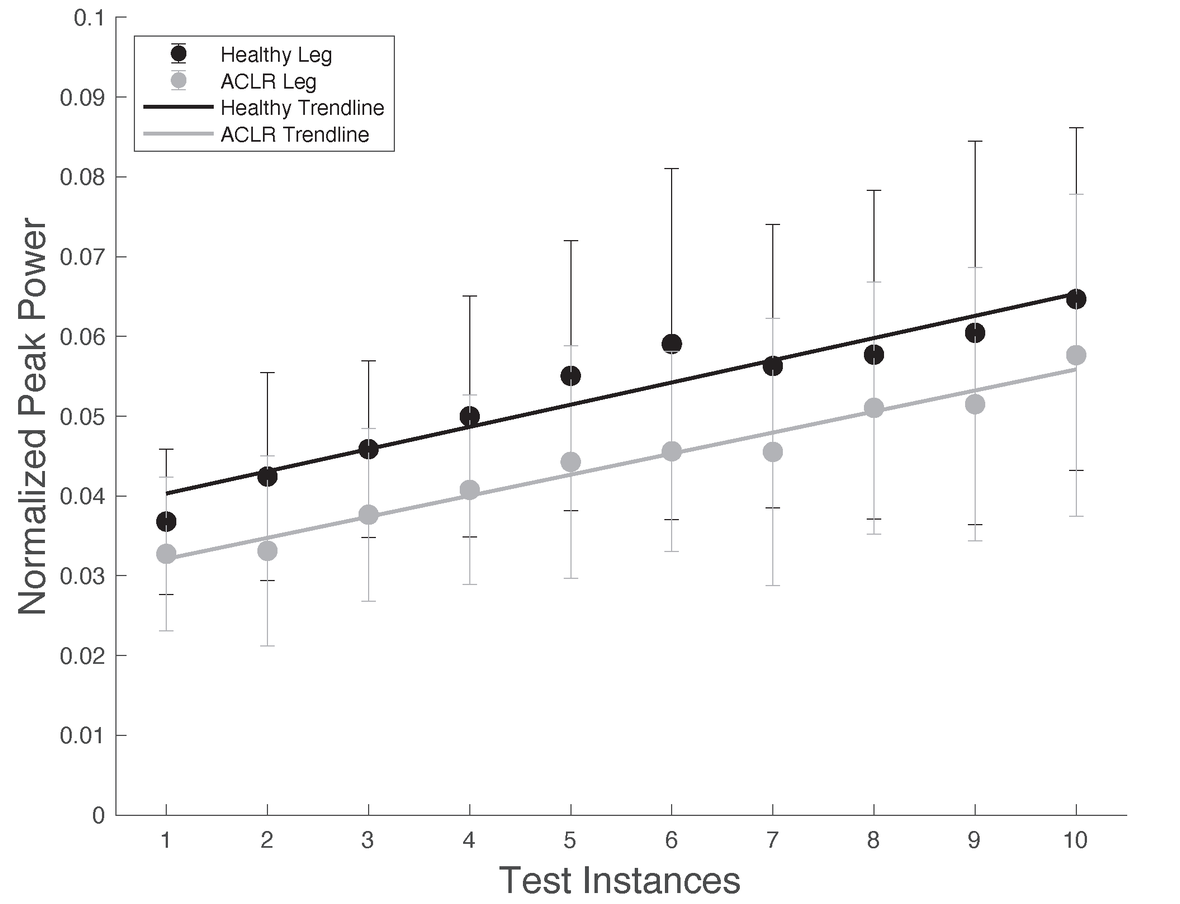
Results: Peak Power

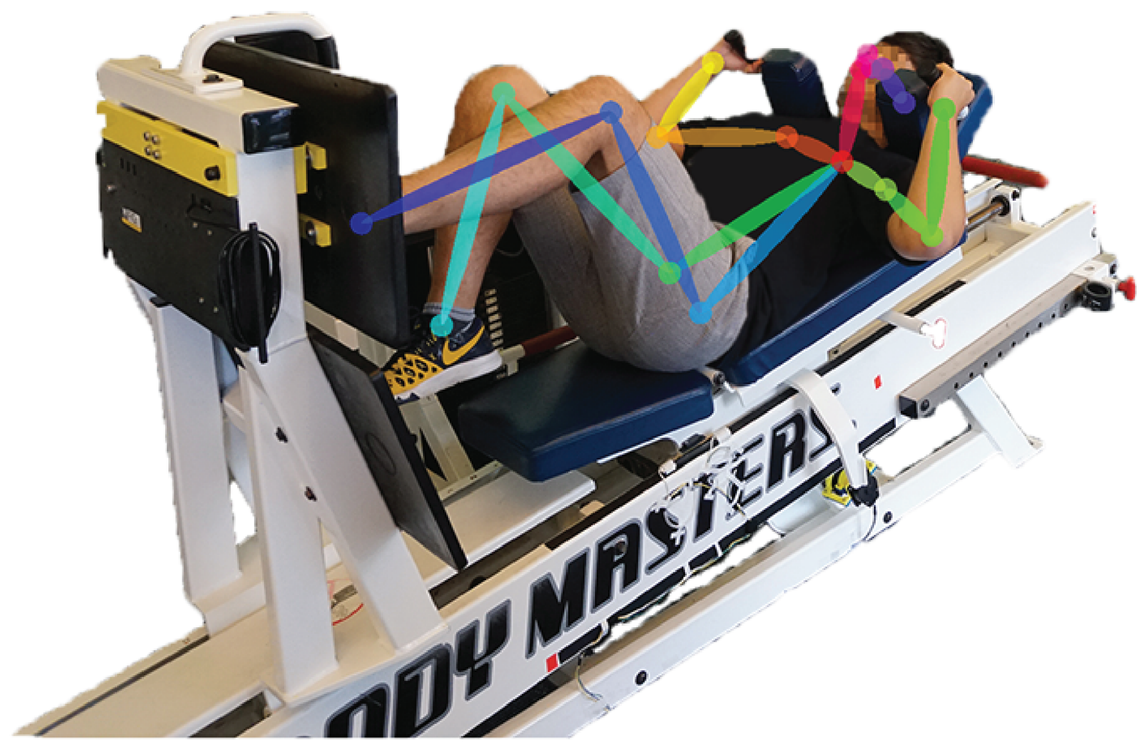
This plot shows results from the 50% body weight test, averaged across 16 subjects over 10 test instances.



In each test instance, the healthy leg (black line) outperforms the ACLR leg (gray line). The mean peak power in healthy and ACLR legs improves by 75.8% and 76.1%, respectively.

Although both legs show similar percent increase in power over the rehabilitation period, asymmetry between the healthy and surgery side remains.

Future Work: Using Video Data



Our previous work used 2D pose estimation (shown above), developed by [4], to re-create the force and encoder data using video observations alone [5].

In future work, we plan to utilize 3D pose estimation algorithms to estimate joint angles and loads.

References

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