INTRODUCTION:
For many athletes who sustain an anterior cruciate ligament (ACL) injury, the ability to return to their previous level of sports activity indicates a successful surgery and subsequent rehabilitation. Due to recurrent episodes of knee instability, the majority of athletes who tear their ACL have difficulty resuming high level activity without surgery. These individuals are classified as non-copers, and demonstrate aberrant and ineffective gait behaviors acutely after injury. To protect the knee against repeated instability during daily activities, non-copers employ an active knee stiffening strategy, evidenced by truncated knee motion, reduced knee moments, and increased hip moments on the injured limb.

Six months following ACL reconstruction, it is common for surgeons to allow patients to try to return to their previous level of activity. More recently, a series of functional tests and measures have been utilized to aid objective determination of return to sport (RTS) readiness. Despite intensive post-operative rehabilitation, however, less than half of non-copers demonstrate functional performance indicative of RTS readiness 6 months after surgery.

Functional limb symmetry on clinical tests is used as a marker of success for athletes following ACL reconstruction. It is unknown whether the gait asymmetries characteristic of non-copers early after injury, persist despite high levels of functional performance. Therefore, the purpose of this study was to compare the gait characteristics of non-copers who pass and non-copers who do not pass RTS criteria 6 months after ACL reconstruction.

METHODS:
Twenty-nine non-copers (23 males, 6 females; age: 29 years ± 10) who completed 6-month post-operative functional and biomechanical testing were selected from our larger randomized controlled trial evaluating outcomes of ACL-reconstructed athletes. All subjects participated regularly (≥50 hrs/year) in cutting, jumping, and pivoting activities, and had sustained an acute, unilateral ACL rupture within 7 months of their evaluation. Ligament reconstruction was performed using an allograft or a semitendinosus/ gracilis autograft by a single local orthopedic surgeon. Each subject underwent a supervised, progressive post-operative rehabilitation protocol that focused on resolution of joint effusion, range of motion deficits, quadriceps strength impairments, and functional limitations.

Subjects returned for functional and biomechanical gait analysis 6 months after surgery. Quadriceps strength assessment, performance on four single leg hop tests, and outcomes from two self-report questionnaires were used to determine RTS readiness. To pass RTS criteria, patients had to achieve at least 90% on each of the functional tests and measures. Gait analysis was conducted using a 3D passive camera system and an embedded force plate to capture joint kinematics and kinetics. Subjects walked at a consistent, self-selected speed through the capture volume until five usable trials were collected for each limb. Motion analysis data were post-processed with custom software, and time normalized to stance phase of gait for comparison between individuals.

Hip and knee kinematics and kinetics were examined from initial contact (IC) to peak knee flexion (PKF). Paired t-tests were used to evaluate limb symmetry of each group, and independent t-tests were used to compare the involved and uninvolved limbs between groups. A priori significance level was set at 0.05. This investigation and its protocols were approved by the University’s review board. All subjects were provided written informed consent prior to their participation.

RESULTS SECTION:
Kineinematic and kinetic data from the knee and hip of both limbs were compared between groups (Passed = 18, Did Not Pass = 11). 6 months after ACL-reconstruction, there were statistically significant asymmetries at the knee for both groups (Table 1). However, the magnitude of the differences in knee kinematics between the limbs of those who passed RTS criteria did not exceed the minimal clinically important difference (MCID = 3.0°).

DISCUSSION:
Our data suggest that non-copers who demonstrate superior functional performance 6 months after ACL reconstruction also present with fewer abnormal and asymmetrical gait behaviors than their poorer-performing counterparts. Non-copers who did not pass RTS criteria not only demonstrated more kinematic and kinetic asymmetries between limbs, but also appear to use a more pronounced hip strategy, which is a gait behavior more closely aligned with non-copers early after ACL rupture.

Large standard deviations in our data reflect a notoriously variable gait behavior more closely aligned with non-copers early after ACL rupture.

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