

KNEE KINEMATICS DURING ACTIVITY IN ACL DEFICIENT PATIENTS ARE LESS AFFECTED IN THOSE WHO COPE WELL WITH THE INJURY

Peter J. Barrance¹, Glenn N. Williams², Thomas S. Buchanan¹

¹ Center for Biomedical Engineering Research, University of Delaware, Newark, DE

² Graduate Program in P.T. & Rehabilitation Science, The University of Iowa, Iowa City, IA

E-mail: peteb@udel.edu

INTRODUCTION

Pathological knee kinematics, such as increased anterior translation of the tibia, have been observed during activity in people with ACL deficiency. ACL injury has been associated with the development of osteoarthritis. Changes in functional kinematics due to the loss of joint stabilization have been proposed to contribute to the cartilage degeneration process in people with this injury. While reconstructive surgery is recommended for most young, athletic ACL deficient patients, non-operative management has been successful in a select group of these people. These ACL deficient 'copers' have been able to return to their pre-injury levels of activity in sports that challenge knee stability without experiencing giving-way episodes. The purpose of this study was to compare the knee kinematics of ACL deficient copers, ACL deficient non-copers, and people without a history of knee injury during a common dynamic task. We hypothesized that copers would exhibit knee kinematics similar to those of uninjured controls.

METHODS

Cine phase contrast magnetic resonance imaging (cine-PC MRI) and a previously reported cine-PC rigid body tracking technique (Barrance et al. 2002) were used to measure the six degree-of-freedom knee kinematics of subjects who performed cyclic

knee flexion/extension while lying supine within the bore of an MRI scanner (GE Signa LX). The motions of 3-D geometric models of each bone are registered with the cine phase contrast data. Knee kinematics are calculated from anatomical coordinate systems embedded in each 3-D model. For data collection, the thigh was placed on a ramp to put the hip in a flexed position, and knee extensions were performed against the weight of the shank. The ramp was adjusted to achieve full knee extension when the toe touched the highest point of the imager's bore; this allowed flexion of the knee to approximately 30 degrees, depending on subject size. Subjects voluntarily synchronized their flexion/extension motions to the beat of a metronome set to produce a repetition frequency of 35 cycles per minute. The scan duration was about six minutes.

Twenty-seven subjects volunteered to participate in this study. Nine of these were non-copers (mean age: 21.4±9.2 yrs) who had sustained a complete isolated unilateral ACL ruptures within six months of testing and were scheduled to undergo reconstructive surgery. Nine other subjects were ACL deficient copers (mean age: 35.9±9.0 yrs) who had sustained complete, isolated ACL ruptures and had returned to participation in high-risk sports for at least one year without reporting knee instability or noteworthy functional deficits. The remaining nine subjects were people (mean age: 21.0±7.1 yrs) with no history of knee injury that were

age, sex, and activity-level matched to the non-copers. The copers and uninjured subjects were regular participants in sports requiring cutting, pivoting, and-or jumping at the time of testing, whereas the non-copers had been immediately prior to their acute ACL injuries. There were seven males and two females in each group. All subjects gave written informed consent to participation in this University of Delaware Human Subjects Review Committee approved study.

Paired t-tests (significance level $p=0.05$) were used to test for differences in kinematic parameters at each flexion angle between pairs of knees in each group. For the non-coper and coper groups, side-to-side differences were evaluated by comparing injured knees to their uninjured knees. The knees chosen to serve as the test knee of the control subjects in the side-to-side comparisons were assigned by selecting the side that corresponded with the injured knee of the non-coper subjects to which they were matched; the opposite knee served as the reference.

RESULTS AND DISCUSSION

The tibial position of the non-copers' involved knees was significantly anterior to that of their uninjured knees at angles between 5 and 20 degrees (Fig. 1). The average value of the mean difference over the flexion range of motion was 2.8 ± 0.2 mm. The mean differences in side-to-side A/P tibial position in the copers and control subjects were similar (1.0 ± 0.7 mm, -1.3 ± 0.7 mm). The peak side-to-side tibial position differences were greatest in the non-copers (3.1 ± 2.7 mm at 20°). The copers' side-to-side differences in six degree-of-freedom knee kinematics usually fell between those of the non-copers and the uninjured controls. However, the between-subject variability in side-to-side kinematic differences was

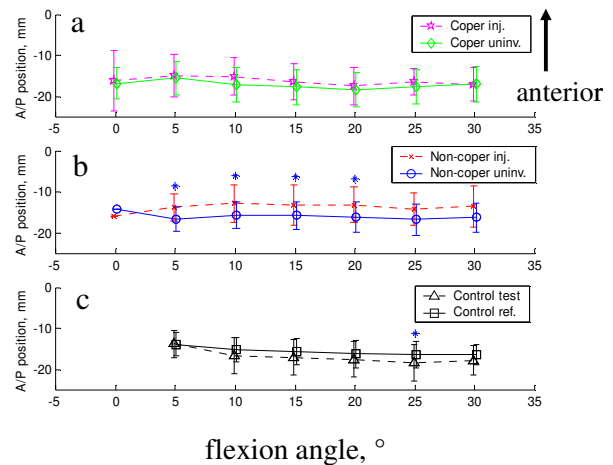


Figure 1: Anterior/posterior position parameter at 5° increments of flexion angle. (a) Copers, (b) Non-copers, (c) Control group. *: Significant difference between means within group.

greatest within the coper group, suggesting that copers have idiosyncratic responses to ACL injury. This is consistent with previous reports.

SUMMARY

The tibias of the non-copers' ACL deficient knees were positioned significantly anterior to the tibias of their opposite knee when the kinematic patterns of their knees was compared. The copers' knee kinematics did not differ significantly from that of people with no history of knee injury. Greater within group variability was observed in the copers' knee kinematics, suggesting that their response to ACL injury is idiosyncratic. Future studies, using in vivo measurements of kinematics during dynamic tasks promise to further elucidate these differences.

REFERENCES

Barrance, PJ. et al, *Fourth World Congress of Biomechanics*, August 2002.

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