

PERTURBATION TRAINING IMPROVES GAIT PATTERNS IN ACL DEFICIENT FEMALES

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INTRODUCTION

Research has well established that women are at higher risk for ACL injury than men. Outcomes of a functional screening examination that classifies athletes with ACL injury showed that women were more likely to be classified as non-copers than men.[1] Knee instability is characteristic of non-copers, and these athletes present with the poorest functional performance acutely after injury. The movement strategies of men and women classified as non-copers have not been compared.

Perturbation training is a specialized neuromuscular training paradigm that normalizes movement behaviors in ACL-deficient athletes who have recurrent knee instability.[2] The capability of non-copers to improve knee function and resolve aberrant movement patterns suggest that this cohort possesses a more malleable neuromuscular system than previously thought.[2] Uninjured athletic females have also shown positive adaptations to perturbation training.[3]

Investigations of healthy control subjects suggest little difference between the sagittal plane kinematics and kinetics of men and women. Observed differences in movement patterns between genders acutely after ACL injury or after perturbation training can therefore be attributed to a gender-specific response. We hypothesized that females and males would have asymmetrical gait kinematics and kinetics after injury, and that these differences would resolve with pre-operative perturbation training.

METHODS

21 ACL-deficient athletes (9 females, 12 males; ages 15-50) were classified as non-copers using a validated functional screening examination.[4] All athletes participated in cutting, pivoting, or jumping

activities for more than 50 hours/year. Subjects were selected for this study from an ongoing randomized controlled trial if they received a combination of pre-operative perturbation training and progressive strength training. All testing procedures were approved the University of Delaware Institutional Review Board and all subjects provided written informed consent prior to study participation.

Table 1. Subject Demographics

	Men	Women
Age (years)	25 ± 8.7	33.7 ± 12.6
BMI (kg/m ²)	30.5 ± 5.1	28.4 ± 7.2
Training (wks)	3.5 ± 1.7	3.5 ± 1.9

Three-dimensional gait data were collected using standard motion analysis techniques before (PRE) and after (POST) 10 sessions of perturbation training. Five walking trials at a controlled, self-selected speed, were collected and analyzed for each limb. Kinematic and kinetic data were processed using custom software programming (Visual3D and LabVIEW). Sagittal plane hip and knee angles and moments at peak knee flexion (PKF), and knee excursions from initial contact to PKF were calculated.

To evaluate limb symmetry between men and women, we used an ANOVA with one repeated measure of time. Paired t-tests were used to determine where limb differences existed. A priori significance level was set at 0.05.

RESULTS AND DISCUSSION

Prior to perturbation training, only the women demonstrated kinematic differences between limbs both at the knee (Figure 1) and the hip (Figure 2). After perturbation training, knee ($p = 0.134$) and hip ($p = 0.515$) angles at PKF were similar.

We hypothesized that men and women would present acutely after injury with asymmetrical limb movement, as aberrant motion is the hallmark of this cohort. In support of these findings, a recent investigation of non-copers' return to sport capabilities after ACL reconstruction suggests that there may be larger variability within this group than initially described.[5]

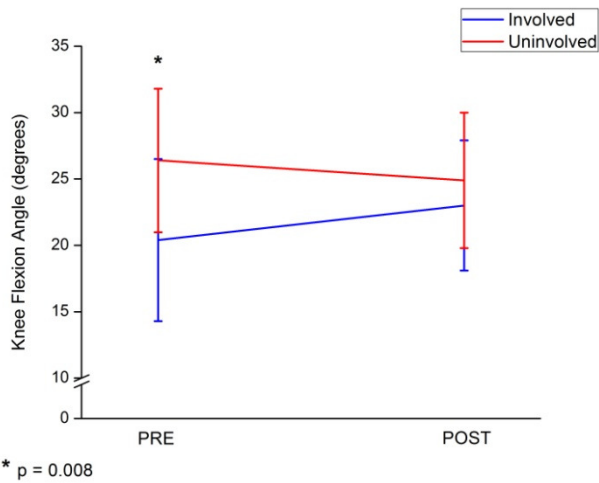


Figure 1. Women's knee flexion angles at PKF, before and after perturbation training. Bars = standard deviation.

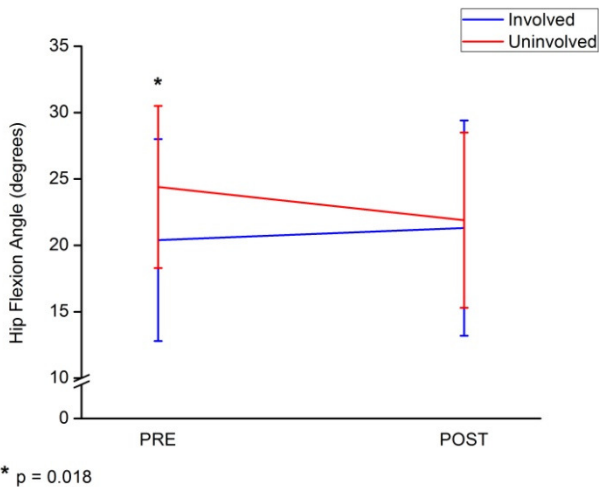


Figure 2. Women's hip flexion angles at PKF, before and after perturbation training.

Pre-training limb asymmetries in knee flexion excursion (Involved: $14.3^\circ \pm 5.8$; Uninvolved: $18.2^\circ \pm 5.7$) and hip flexion excursion (Involved: $11.5^\circ \pm 4.7$; Uninvolved: $6.9^\circ \pm 4.2$) also resolved after perturbation training (Knee - Involved: $14.8^\circ \pm 5.8$;

Uninvolved: $16.8^\circ \pm 5.9$; Hip - Involved: $9.7^\circ \pm 3.8$; Uninvolved: $7.9^\circ \pm 4.3$).

Men demonstrated symmetrical knee and hip kinematics acutely after injury, and perturbation training did not alter their movement behaviors (Table 2). Asymmetrical hip and knee moments between genders were not found between pre- to post-training.

Table 2. Men's hip and knee joint angles at PKF, before and after perturbation training.

	PRE	POST
Involved Knee	$24.7^\circ \pm 7.8$	$24.8^\circ \pm 6.6$
Uninvolved Knee	$26.4^\circ \pm 5.4$	$28.1^\circ \pm 5.1$
Involved Hip	$25.4^\circ \pm 6.5$	$27.3^\circ \pm 5.6$
Uninvolved Hip	$26.2^\circ \pm 5.4$	$28.1^\circ \pm 6.1$

CONCLUSIONS

Differences in gait characteristics of male and female non-copers have not been previously described. Our findings provide evidence to support that non-copers are a variable group, and more specifically, that gender is a meaningful subgroup in this population. A differential response to ACL reconstruction and post-operative rehabilitation may also be evident. Future investigations into the gait characteristics and functional performance of non-copers should consider the effects of gender.

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