EFFECT OF ACUTE FEEDBACK ON KNEE ANGLE AND MOMENTS DURING A HORIZONTAL LAND AND CUT MANEUVER

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The purpose of this study was to assess the effect of acute feedback and preferred plant leg on peak knee flexion and valgus angle, ground reaction force (GRF), and abduction moment of the knee during a horizontal land and cut maneuver. Eight division II women soccer players randomly performed horizontal landing and cutting maneuvers: 3 left and 3 right cuts pre- and post-feedback. Feedback was provided according to previous research. ANOVA revealed lower knee valgus angles for the feedback and preferred plant leg conditions ($p<0.05$). Knee flexion angle was greater when cutting on the preferred plant leg, but did not differ pre- or post-feedback ($p >0.05$). There were no differences in GRF or knee abduction moment. Acute feedback may decrease knee valgus angle during cutting tasks, but does not appear to acutely alter other measures that are thought to decrease ACL injury risk.

KEYWORDS: jump landing, impact, knee injury, ground reaction forces, injury risk.

INTRODUCTION: Female athletes have been shown to have a 4 to 6 times greater risk of non-contact Anterior Cruciate Ligament (ACL) injury than their male counterparts (Hewett, Myers, Ford, Heidt, Colosimo, McLean, van den Bogert, & Paterno, 2005). Hewett and colleagues (2005) identified a landing pattern characterized by decreased knee flexion and increased knee valgus angles, with greater relative vertical ground reaction force (GRF) and external knee abduction moment as factors that increase the risk of ACL injury. Myers and Hawkins (2010) have shown that increasing knee flexion decreases peak ground reaction force and theoretically the risk of injury. Thus the ability to decrease these factors during landing maneuvers should lower the risk of ACL injury and have led to these techniques being used in a number of injury prevention programs.

Research investigating injury prevention programs has shown that acute feedback decreases peak GRF and knee flexion on drop landing tasks (McNair, Prapavessis, & Callender, 2000; Mizner, Kawaguchi, & Chmielewski, 2008). However, Nagano and coworkers (2011) have shown that while feedback given for five weeks decreased knee flexion angle during jump landing, it did not alter frontal or transverse kinematics. The latter movements also affect knee abduction moments, which are a main cause of non-contact ACL injuries according to Markolf and colleagues (1995).

Furthermore, while drop landings are used to assess ACL injury risk, cutting movements following a landing also create increased moments on the knee joint. Pollard and colleagues (2005) examined joint coupling variability in men and women during an unanticipated cutting maneuver and found that women have decreased variability in joint coupling, which may result in higher joint moments. This was the case even when there was no difference between genders in knee or hip rotation and flexion angles (Pollard, Davis & Hamil, 2004).

What remains to be seen is whether feedback regarding a jump landing and cutting maneuver can alter kinematic and kinetic variables in women. Specifically, does the knee abduction moment decrease following feedback instruction? Furthermore, to the authors' knowledge, there has been no previous research investigating feedback effects on these variables between planting and kicking legs. The purpose of the current study was to assess the effects of acute feedback and cutting leg on peak knee flexion and valgus angle, ground reaction force (GRF), and abduction moment of the knee during a horizontal land and cut maneuver.

METHODS: Eight division II women soccer players (19.80 ±0.63 y; 165.25 ±8.27 cm; 62.44 ±8.49 kg) randomly performed 12 horizontal land and cut maneuvers, with 3 left cuts and 3 right cuts pre- and post-feedback. All participants were without orthopedic lower limb or known cardiovascular pathology. Informed written consent was provided and the study was approved by the institutional review board.

The session began with 5 minutes of low intensity warm up on a bicycle ergometer followed by dynamic warm up of the lower body. After the warm up, the subjects rested for 5 minutes prior to the testing trials.

Each individual performed 12 horizontal forward bounds of 70 cm landing on both legs with one foot on each of two force platforms (OR6-5-2000, AMTI, Watertown, MA, USA). A light appeared mid-flight of the horizontal bound prompting each participant to cut in the direction of the light and run to a marker, at an angle of 45°, approximately 2 meters away. Each athlete completed several familiarization trials of jumping, landing, and cutting to each side before testing began. The participants all wore spandex shorts and court shoes during data collection.

Following three trials in each direction, feedback designed to improve landing technique was provided. Feedback was based on a script and results from previous studies. Specifically, participants were told to land soft (to reduce GRF), low (to ensure increased hip and knee flexion) and to keep their knee from going inward (reducing knee valgus) (Oñate, Guskiewicz, Marshall, Giuliani, Yu, & Garrett, 2005; Mizner et al, 2008; Myers & Hawkins, 2010). The participants were asked if they understood the directions, they were allowed two practice trials, and additional feedback was given before data were collected post-feedback. Cutting leg was the leg used to push off while cutting in the opposite direction. Subjects were also asked which leg they preferred to use as the plant leg when kicking a ball.

Three-dimensional kinematic data were obtained at 200 Hz using a 6-camera infrared motion analysis system (Motion Analysis Corporation, Santa Rosa, CA, USA). Reflective markers were placed on the left and right acromion process, anterior superior iliac spine (ASIS), thigh, medial and lateral knee joint line, shank, medial and lateral malleoli, heel, and third metatarsal of both right and left legs with an additional marker on the participant's sacrum and one on the right scapula for a total of 22 markers. Data were then analyzed using Cortex software version 2.5.3 (Motion Analysis Corporation, Santa Rosa, CA, USA). Coordinate data were low-pass filtered using a fourth-order Butterworth filter with a 6-Hz cutoff frequency (Winter, 1990).

The average of the three trials for each condition (pre/post and right/left) was calculated and used for comparison. A two-way repeated measures ANOVA was used to compare the differences in peak knee flexion and valgus angles, peak GRF and peak abduction moment of the knee. The independent variables were the cutting leg (preferred plant leg/preferred kicking leg) and feedback (pre/post). Significance was set at $p<0.05$. When significant main effects were detected, a Bonferoni corrected pair-wise comparison was performed.

RESULTS: Table 1 displays the results of the two-way repeated measures ANOVA for the dependent variables. Knee valgus angle was significantly different for both leg and feedback conditions ($p<0.05$), but displayed no interaction ($p >0.05$). Knee flexion angle was greater for the left leg ($p<0.05$), but there was no difference between the feedback conditions or interaction leg and feedback condition ($p >0.05$). Furthermore there were no main effects or interaction of the leg or feedback conditions for peak GRF or knee abduction moment ($p >0.05$) as shown in Table 1.

DISCUSSION: To our knowledge this is the first study to investigate the acute effect of feedback on kinematic and kinetic variables of the knee during a landing and cutting maneuver. The main finding was a decrease in knee valgus angle during a landing and cutting movement, but no change was seen in knee flexion, ground reaction force, or knee abduction moment with acute feedback. This is in contrast to previous research that found feedback increased knee flexion (Mizner et al., 2008; Nagano, Ida, Akai, & Fukubayashi,

2011) and decreased peak GRF during a jump landing (McNair, et al., 2000; Nagano, et al., 2011). However, it should be noted that Cowley and coworkers (2006) found that knee valgus angle during a landing and cutting maneuver was greater than that of a jump landing movement. Thus adaptations from feedback may be due to differences in the movement task. In addition, the current subjects were instructed to try to “soft, low, and to keep their knee from going inward”, but otherwise were not told how their performance compared to the non-feedback condition. Hence the lack of change post-feedback for peak GRF, knee flexion and knee abduction moment may have been due to the inability of the subjects to compare their pre- and post-feedback performance.

Table 1: Mean ±SD values for knee flexion and valgus angles, peak GRF, and knee abduction moment for the pre- and post-feedback of both legs during a landing and cutting maneuver (n=8).

	Knee flexion angle (°) [a]	Knee valgus angle (°) [a, b]	Peak vertical GRF (N)	Knee Abduction Moment ($Nm{\cdot}kg^{-1}$)
Pre-Feedback				
Non-plant leg	59.6 ±6.3	18.3 ±3.0	1126.8 ±176.0	0.934 ±0.384
Plant leg	62.5 ±10.5	13.8 ±3.7	1068.3 ±159.4	0.808 ±0.284
Post-Feedback				
Non-plant leg	59.4 ±8.9	19.8 ±4.0	1073.8 ±132.2	0.795 ±0.211
Plant leg	65.0 ±14.0	12.5 ±4.8	986.2 ±149.5	0.800 ±0.261

[a] Significant difference between legs ($p < 0.05$)
[b] Significant difference between pre- and post-feedback ($p < 0.05$)

In addition to differences in feedback conditions, the preferred plant leg displayed greater knee flexion angle and less valgus angle than the kicking leg. These movements both tend to decrease the strain on the ACL during jump landings (Markolf et al. 1995; Hewett et al. 2005). It might be speculated that the preferred plant leg would be more stable and this stability carried over to differences in knee kinematics that are less likely to cause ACL injury. Further study is recommended to investigate this possibility.

CONCLUSION: Knee valgus angle decreased with acute feedback while the other variables of interest, peak GRF, knee flexion angle and knee abduction moment, were not affected by the same acute feedback given during a horizontal land and cut task. Therefore, while acute feedback may be a useful tool for decreasing knee valgus angle during cutting tasks in ACL injury prevention programs, it does not appear to acutely alter other measures that are thought to affect ACL injury risk. Another possibility is that the relatively small sample of the current study (n=8) may have decreased the chance of finding differences pre- and post feedback; thus additional study may be warranted.

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