MENSTRUAL CYCLE AND FRONTAL KNEE LOADING DURING A CUTTING MANOEUVRE – A PILOT STUDY

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The aim of this study was to compare the knee internal adduction moment during an unanticipated cutting manoeuvre in different phases of the menstrual cycle. Data were collected using a motion capture system integrated with a force platform. The knee internal adduction moment of four young women were compared in menstrual and ovulation phase of the menstrual cycle. The results of this study showed that knee internal adduction moment is higher in the time of ovulation phase and may increase the potential risk for noncontact ACL injury during this phase of the menstrual cycle. These results could affect the development of training schedules for women athletes.

KEY WORDS: woman, ACL injury, knee adduction moment, cutting manoeuvre

INTRODUCTION: Woman have a 2-10 fold higher incidence of anterior cruciate ligament (ACL) than men (Jacinda Silvers et al., 2007). The highest incidence of non-contact ACL injury is in athletes who participate in sports activities involving landing from a jump, cutting, or with a sudden deceleration (Arendt & Dick, 1995). Although much attention of researches has been focused on sex differences, the reasons why the females are more predisposed to this type of injury remains unclear. In women who were not taking oral contraceptives, a significant association between time of ACL injury and the phase of menstrual cycle has been reported with more injuries occurring in the ovulatory phase of the menstrual cycle (Wojtys et al., 2002). Women also exhibit greater anterior knee joint laxity across all phases of the menstrual cycle compared to typical values recorded in man (Pollard et al., 2006). Moreover, knee joint laxity is increased at the time ovulation (Park et et al., 2009). In a prospective cohort study, ACL rupture was predicted by knee internal adduction moment with 73% specificity and 78% sensitivity (Hewett et al., 2005). ACL rupture mostly occurs during the weight acceptance phase of ground contact, i.e. first 30% of stance phase after initial contact where peak internal rotation and/or external valgus knee moments are observed during the cutting manoeuvre (Besier et al., 2001a; Besier et al., 2001b; Donnelly et al., 2012). Therefore, the purpose of this study was to compare internal adduction moment captured in two phases of menstrual cycle (menstrual and ovulation phase)**.** We hypothesised that there will be increased internal knee adduction moment at the time of ovulation phase (Wojtys et al., 2002).

METHODS: Four young women (18.4 ± 2.3 years, 1.67 ± 0.1 m, 61.7 ± 7.2 kg), considered recreational team sport athletes, participated in this study. All women regularly participated in a team sports associated with running and cutting manoeuvres (e.g. football, volleyball and floorball). Inclusion criteria were: 1) normal length of menstrual cycle (Cole et al., 2009; Wilcox et al., 2000); 2) no use oral contraceptives for the past 6 months; 3) no previous lower limb injuries; and 4) injury-free at the time of data collection. An ovulation kit was given to each individual to determine the time of ovulation. Participants completed two data collections following the same protocol. Each data collection occurred at a specific time to coincide with different phases of menstrual cycle. These times consisted of onset menses and time of ovulation. The start of data collection depended on which event occurred first. Kinematic data were recorded using a 10 camera Qualisys motion analysis system (Qualisys, Oqus 700, Gothenburg, Sweden) at a sampling frequency of 240 Hz and kinetic data with an integrated force platform sampling at 1200 Hz (Kistler, 9287CAQ02, Switzerland). The vertical ground reaction force component was used to identify the stance phase (initial contact to toe off). The approach velocity was monitored using a time-measuring device (P-2RB/1, EGMedical, Ltd., Czech Republic) and two photocells (OPZZ, EMGmedical, Ltd., Czech Republic). All participants ran in neutral running shoes. Reflective markers and clusters were placed on the pelvis and lower limbs. Participants performed three unanticipated tasks consisting of a 45° cutting manoeuvre, a straight ahead run, and a jump stop (Pollard et al., 2004). Data of five randomly performed task of cutting manoeuvre were analysed. The run and jump stop were included in order to decrease anticipation of the cutting manoeuvre. An Illuminated target board was used to randomly signal for the appropriate task. The local coordinate system of the thighs and shanks were derived from the standing calibration trial. Knee internal adduction moment were calculated using Visual3D software (C-motion, Rockville, MD, USA) via inverse dynamics. Effect size (ES) was calculated to determine if relevant differences between two menstrual cycle phases with the effect size defined as small (0.2), moderate (0.5) and large (0.8) (Cohen, 1988).

RESULTS: Moderate effect size were observed indicating greater knee internal adduction moment at the ovulation phase compared to menstrual phase (88.0 ± 37.9 and 66.6 ± 32.6 N•m respectively, ES = 0.6). There was no practical significant difference in the velocity at initial contact (4.7 ± 0.3 and 4.8 ± 0.4 m•s-1) and toe off (4.7 ± 0.4 and 4.8 ± 0.6 m•s-1) between two experimental conditions.

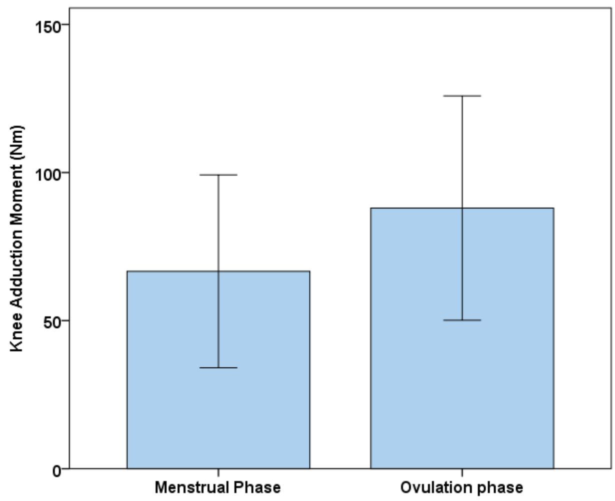

Figure 1. Mean (±SD) knee internal adduction moment (Nm) during the stance phase of cutting manoeuvre in the menstrual and ovulation phases.

DISCUSSION: The purpose of this study was to examine the internal knee adduction moment in an unanticipated cutting task during two phases of the menstrual cycle. We hypothesised that there would be increased internal knee adduction moment during ovulation phase than in the menstrual phase. The results of our study confirmed this hypothesis. These results suggest that female athletes could be exposed to a greater risk for ACL injury during the ovulation phase of their menstrual cycle. A prior study demonstrated that one of the highest risk factors for an ACL injury for women is an increased internal knee adduction moment (Chappell et al., 2002). Moreover, since women also have a significantly greater estrogen level and anterior knee laxity than males (Pollard et al., 2006), the increased risk of injury during the ovulation phase is increased.

We speculated that one of the reasons for these differences may be associated with different reaction time prior to cutting manoeuvre. Previous research by Kumar et al. (2013) found that visual reaction time during different phases of menstrual cycle is prolongated in the luteal phase (i.e. greater estrogen level as in ovulatory phase) . Thus, the possible cause of our finding may be the altered neuro-mechanics caused by levels of circulating hormones during different phases of the menstrual cycle.

In this study, we chose to use a relatively high task locomotor speed. Previous research show approach speed variation between experimental conditions (Chappell et al., 2002; McLean et al., 1999; Pollard et al., 2004), which could influence the internal knee moment. Future research should investigate the effect of performance speed on the internal knee adduction moment. Further investigation is also necessary to determine the exact level of the hormone exposure for which women are at risk for an ACL injury. Further studies should be encouraged, investigating phase of the menstrual cycle and knee internal adduction moment with larger sample sizes.

CONCLUSION: There was higher internal knee adduction moment during the period of ovulation time. Athletes during the period of ovulation time may be at higher risk of ACL injury during cutting manoeuvre. Coaches should be aware of the relationship between risk exposure and menstrual cycle when preparing a training schedule.

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