Daily Knee Joint Laxity in Females Across a Menstrual Cycle and Males Across a Calendar Month

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INTRODUCTION

Increased athletic participation of females has resulted in a high occurrence of anterior cruciate ligament (ACL) injuries. Rates of ACL injuries in female athletes were found to be 3 and 4 times higher than male athletes participating in soccer and basketball, respectively (Mihata, Beutler, & Boden, 2006). Excessive knee joint laxity during hormonal peaks of endogenous sex hormones during the follicular, ovulatory, and luteal phases of the menstrual cycle has been associated with ACL injury risk (Shultz, Sander, Kirk, & Perrin, 2005). Since, the ACL primarily serves to resist anterior tibial translation; researchers have used anterior knee joint laxity as a measure of ACL integrity (Pollard, Braun, & Hamill, 2006). The purpose of the study was to determine the effect of gender and menstrual phase on knee joint laxity over the full course of a normal menstrual cycle in females and across a calendar month in males.

METHODS

Ten apparently healthy normal menstruating females (mean age [y] 21.00 ± 1.56, mean height [cm] 160.89 ± 5.89, mean weight [kg] 56.79 ± 4.71) and twelve males (mean age [y] 21.83 ± 2.33, mean height [cm] 175.99 ± 9.46, mean weight [kg] 76.4 ± 15.23) volunteered to participate.

Daily anterior knee joint laxity was quantified on both the right and left knee using the KT- 1000 Knee Joint Arthrometer (MEDmetric Corporation, San Diego, CA USA). A passive drawer test was conducted at a displacement load of 133N (30lb). The mean of three trials was calculated and recorded as the participant's overall anterior knee laxity measure. Right and left leg measurements of anterior tibial translation were collapsed together and averaged into a single daily value for each participant. Measurements for female participants were started on the first day of menses (self-report) and continued until the onset of the subsequent menstrual cycle. Anterior knee joint laxity in male participants was taken for 28 consecutive days.

The independent variables for the study were gender (2 levels – male/female) and menstrual cycle phase (3 levels – follicular/ovulatory/luteal). The dependant variable was anterior knee joint laxity. A 2 x 3 (repeated measures) ANOVA with Tukey's post hoc was used to analyze the data for significant differences. Alpha was set at 0.05 level of significance.

RESULTS AND DISCUSSION

Mean anterior knee joint laxity data for female and male participants are presented in Figure 1. The interaction effect between gender and phase was not statistically significant, $F(2,40)=0.44$, $p=0.65$. The main effect for gender, $F(1,20)=0.88$, $p=0.36$, also did not reach statistical significance. However, there was a statistically significant main effect for phase, $F(2,40)=6.53$, $p=0.00$.

Post-hoc comparisons indicated that the mean laxity during the follicular phase (M=5.78mm) was significantly different from the ovulatory phase (M=6.11mm) and the luteal phase (M=6.06mm).
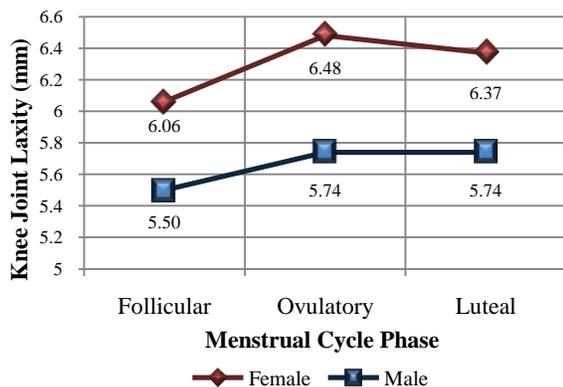
Figure 1. Mean anterior laxity across menstrual cycle in females and 28 days in males.

Observed changes in knee joint laxity from the follicular to the ovulatory phase in females is suggestive of a possible hormonal influence on ACL tissue and resulting laxity measurements. These results should be placed contextually with the data collected from the male participants. Since male participants demonstrated a similar inclination between phases, the significance of this trend should be interpreted as a possible random occurrence. Due to the absence of a gender difference in knee joint laxity, it may be plausible that sex hormone concentrations have little to no effect on anterior knee laxity.

The lack of significance in the interaction for gender by phase further strengthens this assertion. It is possible that the inter-subject variability was the reason for the lack of a significant gender difference. For example, within the follicular phase, the range of values for men was 3.11mm – 8.43mm, while the range for women was 4.51mm – 7.71mm.

SUMMARY AND CONCLUSIONS

Additional research that includes monitoring of daily circulating hormone concentrations and knee joint laxity over consecutive months is needed. Findings may identify patterns of hormonal influence or render data that are observably random. While the exact mechanism for ACL injury cannot be determined conclusively from this study, structural, neuromuscular, and biomechanical factors may have a greater influence on a female athlete's susceptibility to ACL injuries than possible effects attributable to the menstrual cycle.

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