The influence of the menstrual cycle on the biomechanics and injuries of the ankle joint: a scoping review

Seraina Friedli[1,2], Julia Suter[1], Annika Zind[1], Eveline S. Graf[1]
[1]ZHAW Zurich University of Applied Sciences, School of Health Sciences, Winterthur, Switzerland
[2]University of Fribourg, Faculty of Science and Medicine, Fribourg, Switzerland

Email: seraina.friedli@zhaw.ch

Summary

This scoping review synthesizes evidence on the impact of the menstrual cycle on ankle biomechanics and injury risk. In the eight identified studies, methodological variability, including inconsistent definitions of menstrual phases, complicates comparisons. While studies on ligament mechanics found no significant changes across phases, increased neuromuscular activity during ovulation and altered ankle kinematics in the luteal phase were observed. Despite the limited and inconsistent findings, there is evidence suggesting that hormonal fluctuations may influence ankle mechanics and neuromuscular control.

Introduction

Sex hormones fluctuate throughout the menstrual cycle, influencing physiological processes and mechanical properties of ligaments. Receptors for sex hormones have been identified in various musculoskeletal structures [1]; but their presence in ankle ligaments remains unclear. One study suggests that women with high general joint laxity might be more sensitive to the effects of estrogen, resulting in changes to the anterior talofibular ligament during the ovulation phase [2]. Consequently, the occurrence of ligamentous injuries may depend on the levels of sex hormones circulating in the female body. This scoping review aims to synthesize existing evidence on the influence of the menstrual cycle on the biomechanics and injuries of the ankle joint.

Methods

The literature search was performed in Pubmed, CINAHL, Cochrane, and Scopus using the following search string: ("menstrual cycle" or "menstruation" or "hormone") AND ("ankle" or "ankle joint") AND ("biomechanic*" or "injur*). Title/abstract screening was done by one author, full-text screening by two authors using Covidence (Covidence, Australia). The results were reported according to the PRISMA guidelines for Scoping Reviews.

Results and Discussion

A total of 477 articles were found, after removing duplicates and full-text review, eight were included in the review. Only three studies reported measurements of hormonal concentrations of estrogen and progesterone while the others used phases of the menstrual cycle based on reports of onset of menstruation or positive ovulation tests. The definition of the timepoints for measurement varied widely between studies (Figure 1). Some studies scheduled specific measurements based on a positive ovulation test.

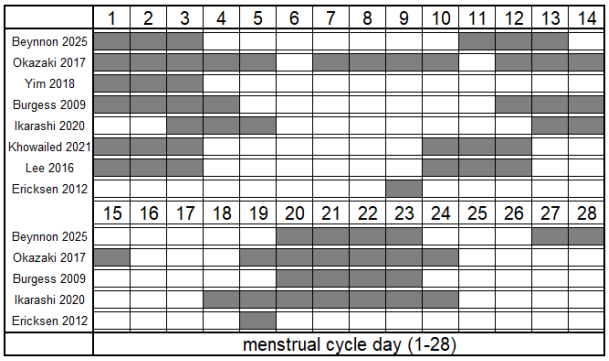

Figure 1: Timepoints for measurement defined based on menstruation and for a representative cycle duration of 28 days.

The three studies measuring mechanical properties of ankle structures (laxity, tendon stiffness, Young's modulus) found neither changes related to different phases of the menstrual cycle nor strong correlations between the changes of mechanical properties and hormonal concentrations. The co-contraction of M. peroneus longus (PL) and M. tibialis anterior (TA) during balancing tasks was assessed by two studies. They found increased TA/PL-ratio during challenging balance tasks during ovulation compared to early follicular phase indicating an increased activity of TA when estrogen is increased. One study measuring ankle kinematic during a single leg drop landing found increased adduction and eversion during the luteal phase compared to menstruation and the follicular phase. Further, dorsiflexion was reduced in the luteal phase compared to the follicular phase. Together with a shorter time to peak in the luteal phase, this could indicate reduced shock absorbance and consequently increased risk of (ankle) injury in this phase.

Conclusions

This scoping review highlights the limited and inconsistent evidence regarding the influence of the menstrual cycle on ankle biomechanics and injuries. The variability in study methodologies complicates direct comparisons and may introduce bias. Despite these limitations, there are indications that hormonal fluctuations may influence ankle joint mechanics and neuromuscular control. To clarify this potential link, further research with consistent hormonal concentration measurements is needed.

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References

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