Influence of sex and menstrual cycle on balance control and neural drive during dynamic balance perturbations

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Summary

Sex differences and the influence of the menstrual cycle (MC) on balance control and neural drive during dynamic balance perturbations were assessed. Females were measured during the early follicular and mid-luteal phases and males were measured twice with 7-14 days between measurements. Females showed a tendency towards a reduction in balance control properties in the luteal phase while males slightly improved balance control properties between measurements, resulting in significant between-sex differences. In addition, females showed a tendency towards a greater reduction in neural drive during balance perturbations performed in the luteal phase compared to the follicular phase. This observation could be related to changes in concentrations of ovarian hormones over the MC as e.g., progesterone, which has neuroinhibitory effects.

Introduction

It has been argued that neural drive does not differ between sexes [1] but that the natural fluctuation of ovarian hormones during the MC may affect neural function [2]. For instance, increased progesterone, such as during the luteal phase, may have inhibitory effects on the central nervous system [3]. Thus, both sex differences and the influence of MC phases on balance control and neural drive (V-wave) during dynamic balance perturbations were assessed in this study.

Methods

10 females and 15 males 20–40 yr were measured twice (M^A and M^B). Measurements for females were scheduled according to the MC where M^A = +1–4 days after the onset of the bleeding in the early follicular phase and M^B = +6-8 days after a positive ovulation test (luteinizing hormone-surge) in the mid-luteal phase. Males were measured with 7-14 days between M^A and M^B. Balance was assessed using a custom-built dynamic balance platform. Horizontal, anterior-posterior perturbations (x20, velocity: 0.25 m/s, acceleration: 2.5 m/s^2, amplitude 0.3 m) were measured. Balance was analyzed from center-of-pressure (COP) of posterior perturbations by peak-to-peak displacement (P-to-P max), COP avg. speed, and COP trace. Neural drive was assessed from the soleus-muscle at 40, 70, 100, and 130 ms after the onset of ankle movement.

Results and Discussion

Sex differences in relative change of balance control properties from M^A to M^B were observed (fig. 1). A significant main effect for sex was observed at M^B (p=0.013) for neural drive during balance perturbations, including a significant between-sex difference or statistical trends in the last three latencies, which were not observed at M^A (fig. 2).

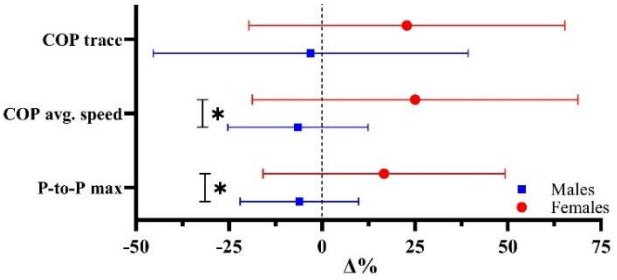

Figure 1: Δ%±SD in balance control properties (weight × height normalized) between M^A and M^B. Zero-line indicates M^A. Significant relative sex difference found in COP avg. speed (p=0.028) and P-to-Pmax (p=0.039). Increase in Δ% indicates a reduction in balance control.

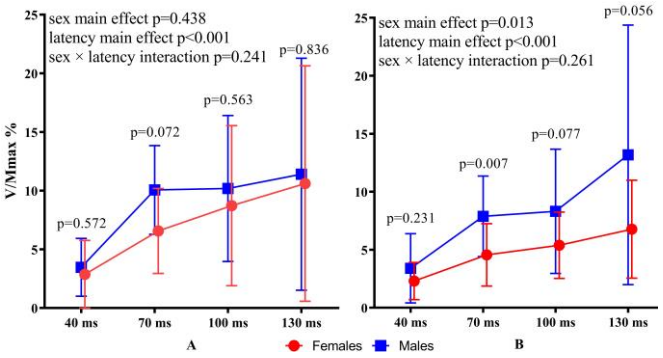

Figure 2: Neural drive (avg. V/M_{max}% ±SD during dynamic balance perturbations at four latencies from M^A (left) and M^B (right). P-values represent between-sex comparisons.

A reduction in properties of balance control from M^A to M^B was observed in females compared to males, who maintained or slightly improved properties of balance control. Neural drive tended to be lower in females at M^B compared to males.

Conclusions

Females exhibited a greater reduction in balance control properties from M^A to M^B and a tendency towards reduction in neural drive during balance perturbations when compared to males at M^B. We hypothesize that ovarian hormone concentrations associated with the MC might influence properties of balance control via increased neural inhibition caused by increased concentrations of progesterone [4] associated with the luteal phase.

References

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