Menstrual cycle phase affects active hamstring mechanical properties after exercise-induced muscle damage

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Summary

17β-estradiol (E2) and progesterone (P4) may modulate the severity of exercise-induced muscle damage. The rigidity of the contracting *semitendinosus* was altered after exercise only during the end of the luteal phase, when P4 levels are high and E2 concentrations decline. Recovery of maximal voluntary force was also impaired at the end of the menstrual cycle.

Introduction

Fluctuations in 17β-estradiol (E2) and progesterone (P4) concentrations along the menstrual cycle and their attenuation with oral contraceptive (OC) use may influence the severity of exercise-induced muscle damage [1]. However, muscle damage does not occur uniformly across the muscle heads activated during exercise. Shear wave elastography provides a sensitive and muscle-specific indirect evaluation of muscle damage. This study aimed to examine changes in hamstring mechanical properties during contraction after eccentric exercise, depending on the menstrual cycle phase or OC use.

Methods

Fifty-seven healthy female participants performed a maximal isokinetic eccentric exercise of the knee flexors, either during the early follicular (EF), late follicular (LF), mid-luteal phase (ML) or while using OC. E2 and P4 blood concentrations, blood creatine kinase (CK) activity, isometric maximal voluntary contraction (iMVC) force of the knee flexors and shear wave speed (SWS) were assessed before (PRE), immediately after (POST, except for blood analyses), two days (D2) and seven days (D7) after the exercise. The SWS, a proxy of tissue rigidity, was evaluated in the *biceps femoris* (BF), *semitendinosus* (ST) and *semimembranosus* (SM) during isometric contractions performed at 50% of the iMVC of each testing session and at 50% of the iMVC measured at PRE (to ensure a stable absolute force level across sessions).

Results and Discussion

E2 and P4 levels were higher at PRE in the ML and LF groups ($p < 0.05$), but only the ML group showed a decrease in E2 concentration, up to D7 ($p < 0.05$). CK activity increased while iMVC force decreased, similarly across all groups ($p < 0.001$). These alterations persisted throughout the entire follow-up. iMVC force partially recovered between POST and D2 only in the EF group ($p < 0.01$) and between POST and D7 in the EF, LF and OC groups ($p < 0.001$), indicating poorer recovery in ML (Figure 1**A**) [2]. No differences between groups were found in the SWS of BF or SM. At 50% of each session's iMVC, ST SWS decreased from PRE to POST in LF and ML ($p < 0.05$), from PRE to D2 in LF, ML and OC ($p < 0.001$), and from PRE to D7 in ML ($p < 0.01$), mirroring the loss of iMVC force (Figure 1**B**). Conversely, at 50% of PRE iMVC force, ST SWS decreased from PRE and POST to D2 only in ML ($p < 0.05$) (Figure 1**C**). Whether the greater impairment of active rigidity in this group is linked to a direct effect of E2 or P4 remains to be determined [3].

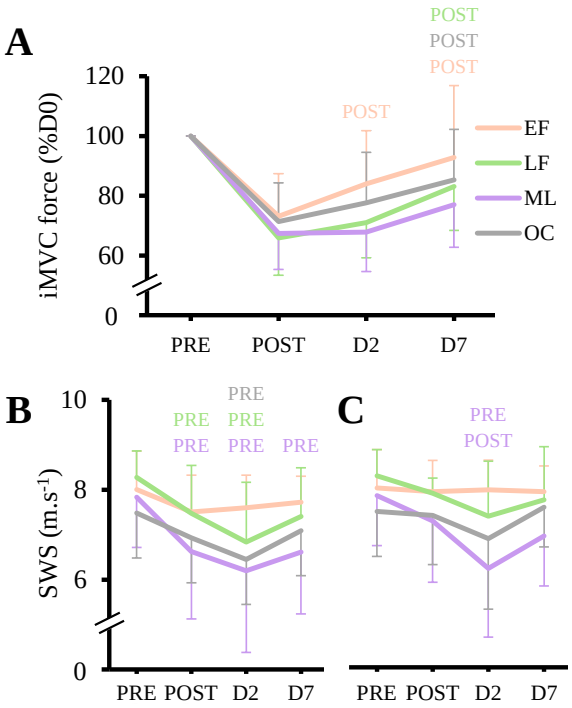

Figure 1: **A-** iMVC force of the knee flexors and ST SWS **B-** at 50% of the iMVC of each testing session and **C-** at 50% of the iMVC measured at PRE. Group-colored labels denote significant differences from PRE or POST.

Conclusions

Active muscle mechanical properties, as measured by shear wave elastography, are altered following eccentric exercise, especially when high P4 levels coincide with declining E2 concentrations. Our findings suggest that these hormonal variations may also impair the functional recovery from an eccentric exercise.

References

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