THE IMPACT OF INTER-SET ARTERIAL OCCLUSION ON MUSCLE POWER AND BIOMECHANICAL PROPERTIES OF SKELETAL MUSCLES

Summary

Aim of the study: The primary aim of the study was to analyze the impact of the inter-set arterial occlusion protocol (M-AOP) with a cuff pressure equal to 100% Arterial Occlusion Pressure (AOP) on the mechanical variables of resistance exercises and the countermovement jump (CMJ) test, as well as the biomechanical properties of skeletal muscle tissues across diverse training protocols, while considering changes in AOP values during subsequent M-AOP cycles.

Methods:

Phases I-II: 6 athletes from the National Team in Nordic Combined (phase I) and 12 athletes from the National Team in Ski Jumping and Nordic Combined (phase II) participated in 2 experimental sessions: a control condition without M-AOP (CONT) and an experimental condition with M-AOP (MBFR). The protocol consisted of 3 sets of 2 repetitions of barbell squats with 60%, 70%, and 80% 1RM, with a 6 minute rest interval. Before the 1 set and during rest intervals in MBFR condition M-AOP (100% AOP; 4.5 min occlusion; 0.5 min reperfusion; 1 min cuff application – phase I; 100% AOP; 3 min occlusion; 1.5 min reperfusion; 1.5 min cuff application – phase II) was applied. In the CONT condition M-AOP was not applied. CMJ performance and biomechanical properties of the *vastus lateralis* muscle were assessed at multiple time points.

Phases III-IV: 12 healthy, physically active men participated in 2 experimental sessions: CONT and MBFR. The research protocol consisted of 5 sets of 2 repetitions of barbell squats with 70% 1RM, with a 5.5-minute rest interval. Before the 1 set and during rest intervals in the MBFR condition M-AOP (100% AOP; 3 min occlusion; 1 min reperfusion; 1.5 min cuff application) was applied. In CONT condition M-AOP was not applied. Assessments included CMJ performance (Phase III) and biomechanical properties of the *vastus lateralis* (Phase III) and the long head of the *triceps brachii* (Phase IV).

Results:

In phases I–II, the two-way ANOVA for MV and PV values did not reveal any statistically significant differences for the interaction effect [2 groups (CONT vs. MBFR) × 3 sets]. In phase II, a significant main effect of "group" was observed. *Post hoc* Tukey's test for the "group" effect showed significantly higher MV and PV values in the MBFR group compared to the CONT group (0.96 vs. 0.93 m/s; $p < 0.001$; $d = 0.07–0.40$ and 1.78 vs. 1.72 m/s; $p < 0.001$; $d = 0.26–0.44$; respectively).

In phases III–IV, the two-way ANOVA for MV and PV values did not reveal any statistically significant differences for the interaction effect [2 groups (CONT vs. MBFR) × 5 sets]; however, a significant main effect of "group" was observed. In phase III, Tukey's *post hoc* test for the "group" effect showed significantly higher MV and PV values in the MBFR group compared to the CONT group (0.66 vs. 0.61 m/s; $p < 0.001$; $d = 0.44–0.80$ and 1.24 vs. 1.15 m/s; $p < 0.001$; $d = 0.40–0.81$; respectively). In phase IV, Tukey's *post hoc* test for the "group" effect revealed significantly higher MV and PV values in the MBFR group compared to the CONT group (0.58 vs. 0.54 m/s; $p = 0.01$; $d = 0.19–0.45$ oraz 0.74 vs. 0.68 m/s; $p < 0.001$; $d = 0.30–0.50$; respectively).

Across phases I–IV, the three-way ANOVA for T (oscillation frequency [Hz]) and S (dynamic stiffness [N/m]) values did not show any statistically significant differences for the multi-interaction effect [2 groups (CONT vs. MBFR) × 2 limbs (left vs. right) × 5 time points].

Across phases I–III, the three-way ANOVA for CMJ_{RPP}, CMJ_{PV}, CMJ_{H} oraz CMJ_{PF} values did not reveal any statistically significant differences for the multi-interaction effect [2 groups (CONT vs. MBFR) × 2 time points × 2 trials].

Conclusions: The application of M-AOP with a cuff pressure equal to 100% AOP during resistance exercises significantly increases exercise performance, as evidenced by the increase in MV and PV. The effectiveness of this method depends on the precise selection of the occlusion-to-reperfusion time ratio (optimally 2:1–3:1). Due to high vascular reactivity and the increase in the AOP threshold in subsequent sets, continuous re-calibration of the cuff pressure is essential to maintain methodological rigor and to maximize the training stimulus.

Keywords: resistance training, muscle strength, muscle power, local hypoxia, blood flow occlusion