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The Acute Administration of Reflexive Performance Reset on Upper and Lower Body Muscular Power Output in Division III Male College Ice Hockey Players: A Preliminary Study

Original Research

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Abstract

Introduction: The aim of this study was to investigate the effects of acute administration of reflexive performance reset (RPR) on muscular power output and muscular fatigue in college-aged male ice hockey players. **Methods**: In a randomized repeated-measures cross-over design, NCAA Division III college ice hockey players (n=9) performed a 10RM in barbell bench and squat exercises after either a passive range of motion (PROM) sham-control or RPR pre-exercise warm-up routine. Participants were encouraged to move the bar explosively during each repetition, and power produced per repetition was recorded using a Tendo unit attached to the barbell. **Results**: There was no significant interaction (P= 0.323) in average power produced over time between barbell exercise and intervention. There was no significant interaction (P=0.946) between mean power produced over time and intervention. No significant interactions (P=0.18, 0.18, 0.19) were found for average 10RM, peak, and total power produced between barbell exercises and intervention, respectively. **Conclusions**: RPR was shown to neither acutely augment, nor reduce, upper or lower body power over 10 repetitions. However, RPR appears to be a practical and safe method to use in conjunction with other pre-exercise neuromuscular activation techniques before athletic events in male athletes, but further work is needed.

Key Words: Post-activation potentiation; neuromuscular activation; athletic performance.

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Introduction

One of the primary components of any good exercise program is the implementation of a pre-exercise “warm-up” routine. Reflexive Performance Reset (RPR) is an emerging neural activation technique, used exclusively before exercise, to improve neural activity and feedback during exercise. RPR is a series of supposed body “wake up drills” that have the potential to improve athletic performance by reducing pain, increasing flexibility, and promoting resilience to injury (1). This novel pre-exercise routine is a hands-on activation and can be done by a partner or oneself. RPR was created and popularized by Cal Dietz, Head Olympic Strength and Conditioning Coach at the University of Minnesota, Chris Korfist, a world class sprint coach, and JL Holdsworth, a world champion powerlifter.

RPR is an emerging technique with no preceding scientific testimony in both its biological mechanisms and implementation in sport. Its creators suggest RPR’s simple system of diaphragmatic breathing and tactile input can rest one’s body out of compensatory patterns, a main cause of non-contact injuries, and into performance (21). However, RPR is just one of many pre-exercise techniques used by athletes to alter sport performance and research in the exercise physiology field has observed the effects of other warm-up methodologies on both neurological and muscular functioning (4,17, 22). Unlike RPR, Post-activation potentiation (PAP) is a well-established pre-exercise neuromuscular activation technique. However, PAP's physiological effects on muscular performance might be comparable to RPR's. PAP promotes optimal muscle stiffness, tonicity, and contractility before a sport or activity requiring explosive strength, power, or endurance (3, 7). PAP works by encouraging greater muscle contractile frequency in specific musculature due to a previous maximum or near-maximum exercise targeting the same musculature used in the primary exercise (7). The neuromuscular effects of PAP have been well documented in scientific literature, as many studies have shown this training technique to increase both peak force and rate of force development in subsequent skeletal muscle contractions, thus being a viable option to help increase strength performance in an athletic population (3, 14). It is possible that RPR acts in a parallel manner to PAP, though the rise in popularity of using RPR in the collegiate setting warrants investigation into the acute impact of RPR on peak muscular power output and muscular fatigue rates in college athletes.

Accordingly, the purpose of this study was to investigate the effect of RPR on muscular power output and delay of muscular fatigue when administered immediately before exercise in college-aged male ice hockey players. It was hypothesized that RPR will increase muscular power output and postpone muscular fatigue when performed immediately before exercise in college-aged male ice hockey players.

Methods

Participants

Twenty-six male college ice hockey players aged 19-24 were recruited for this study. The participants were instructed to avoid alcohol, caffeine, supplements and strenuous exercise 12 hours prior to each of the three exercise trials. Other than these restrictions, participants were instructed to maintain a similar diet and exercise plan to what they were accustomed to. Participants were non-smokers and free of any cardiovascular, renal, musculoskeletal, or metabolic diseases, assessed via the American College of Sports Medicine/American Heart Association pre-participation form and the Physical Activity Readiness Questionnaire (PAR-Q). Participants were required to be able to perform a barbell bench press and back squat and were excluded if they couldn't complete these movements through their full range of motion. To reduce potential for bias, only those naïve to RPR could be included in the study. As this is the first study to assess RPR, the study was exploratory in nature thus effect sizes were not available for an ad hoc power analysis. To maintain homogeneity, our targeted population was restricted to division III collegiate male ice hockey players. Participants provided written informed consent prior to participation in the study. This study was reviewed and approved by the College Institutional Review Board (#1910-834) and was in accordance with the most recent revisions to the Declaration of Helsinki.

Protocol

This study used a randomized, placebo-controlled, repeated-measures crossover design (Figure 1). Participants came in for one baseline visit to determine 1 repetition maximums for the bench press and the squat, and two experimental visits to assess muscular power over 10 reps after exposure to RPR or control (PROM).

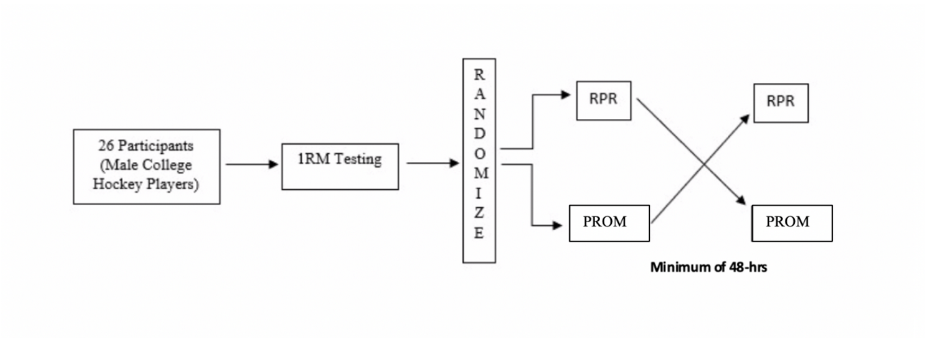


Figure 1. Overview of study design. 1RM = One Repetition Max. RPR = Reflexive Performance Reset. Control = Passive Range of Motion (PROM).

Baseline markers of age, height, and weight were obtained prior to one-rep maximum (1RM) testing for the bench press and back squat. A one-rep maximum (1RM) is the maximum amount of weight the subject can possibly lift for one repetition. Prior to 1RM testing, the subjects performed a standardized dynamic warm-up (Table 1). 1RM testing was then conducted following the NSCA guidelines, as part of regular team testing (6). Following 1RM assessments, 75% 1RM were calculated for each subject. According to the NSCA Training Load Chart, subjects should be able to complete 10 repetitions at 75% 1RM, with maximal explosive effort for each repetition (8). If participants could not complete 10 repetitions at 75% 1RM, then they were further excluded from the study. The participants were then randomized into either the experimental condition, Reflexive Performance Reset (RPR), or the placebo-control condition, passive range of motion (PROM).

Table 1. Standardized dynamic warm-up for all participants.

Dynamic Stretches (20 yards each)	**Mobility (2 x 10 each)**
Knee Hug to Lunge Quad Pull Hamstring Scoops Lateral Lunge	Greatest Stretch
	Toe Squats
High Knees Butt Kicks Lateral Shuffle (R & L) Carioca (R & L) 2 Linear Sprints	Walk-Out to Push-Up
	Scapula Reach Pec Open

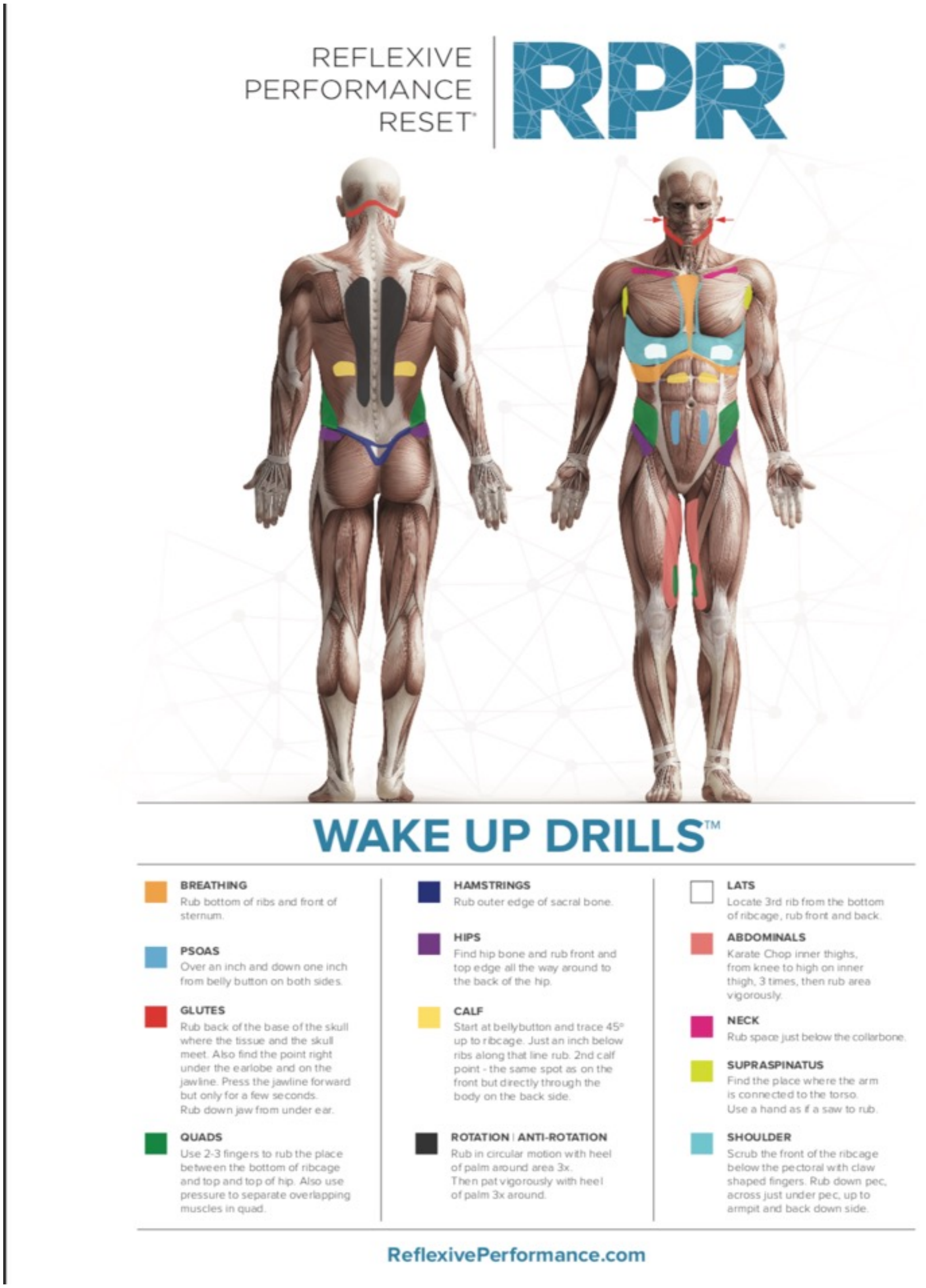
After a minimum of 48-hours post-1RM testing, the participants returned for their first condition stage and completed the identical warm-up completed at baseline. After the warm-up, participants were subject to either RPR or PROM interventions and then completed 10 repetitions at 75% 1RM in the barbell bench and squat exercises. Power output was measured using a Tendo unit for each repetition (9). After a minimum of 48-hours following Stage 1, the participants returned for Stage 2 where they performed the identical standardized warm-up but completed the other intervention (Figure 1). The experimental conditions required hands-on activation performed by all three researchers. All investigators were trained and had experience and practice performing both of the experimental conditions before the start of the experiment. The inter-researcher intensity of RPR and PROM administrations were regulated as best as possible throughout the experiment. Multiple pre-experiment practice sessions were completed in order to normalize for proper RPR and PROM intensity. The PROM time duration was elicited to be of similar duration to the RPR.

The placebo-controlled condition involved physical manipulation of a joint by the researchers. The researchers moved the major joints of both extremities through PROM but made sure not to reach the end range of motion, so the participants did not receive a stretch. RPR involved physical manipulation of both upper and lower extremity musculature by the researchers. Researchers rubbed and palpated trigger points necessary to activate the musculature needed for barbell squat and bench press. Subjects were notified before the start of the experiment that if any pain or discomfort was felt to let the researchers know so the intensity of RPR and PROM administration could be modified accordingly. Fortunately, all subjects withstood both RPR and PROM with little to no discomfort.

Before performing the squat set, RPR techniques to activate the gluteal, quadricep, hamstring, and abdominal muscles were performed (Figure 2), while for the control condition, PROM was performed for the major joints of the lower extremities (hip, knee and ankle). Before the bench set, RPR techniques were utilized to activate the pectorals, shoulders, and abdominals (Figure 2). For the control condition, PROM was used for the major joints of the upper extremities (wrist, shoulder, elbow).

Statistical Analysis

Statistical comparisons were performed with the use of commercially available software (SPSS v. 26.0, IBM Inc., Armonk, NY, USA; and R-Studio). To analyze average power production over time, three-way repeated measures analysis of variance (ANOVA) were used to determine if main effects were found for condition (RPR vs. PROM), exercise (barbell squat vs. barbell bench), time (repetitions 1 to 10), and the interactions between the three variables. To analyze average 10RM, total, and peak power production, two-way repeated measures ANOVA were used to determine if main effects were found for condition (RPR vs. PROM), exercise (barbell squat vs. barbell bench), and the interaction between the two variables. Tests for normality were performed and if a violation was found, the degrees of freedom were adjusted using Greenhouse-Geisser. The level of significance was established, a priori, at $P<0.05$. All data are expressed as mean ± standard deviation (SD).



REFLEXIVE PERFORMANCE RESET® RPR®

WAKE UP DRILLS™

🟧 **BREATHING** Rub bottom of ribs and front of sternum.	🟦 **HAMSTRINGS** Rub outer edge of sacral bone.	⬜ **LATS** Locate 3rd rib from the bottom of ribcage, rub front and back.
🟦 **PSOAS** Over an inch and down one inch from belly button on both sides.	🟪 **HIPS** Find hip bone and rub front and top edge all the way around to the back of the hip.	🟥 **ABDOMINALS** Karate Chop inner thighs, from knee to high on inner thigh, 3 times, then rub area vigorously.
🟥 **GLUTES** Rub back of the base of the skull where the tissue and the skull meet. Also find the point right under the earlobe and on the jawline. Press the jawline forward but only for a few seconds. Rub down jaw from under ear.	🟨 **CALF** Start at bellybutton and trace 45° up to ribcage. Just an inch below ribs along that line rub. 2nd calf point - the same spot as on the front but directly through the body on the back side.	🟪 **NECK** Rub space just below the collarbone. 🟩 **SUPRASPINATUS** Find the place where the arm is connected to the torso. Use a hand as if a saw to rub.
🟩 **QUADS** Use 2-3 fingers to rub the place between the bottom of ribcage and top and top of hip. Also use pressure to separate overlapping muscles in quad.	⬛ **ROTATION | ANTI-ROTATION** Rub in circular motion with heel of palm around area 3x. Then pat vigorously with heel of palm 3x around.	🟦 **SHOULDER** Scrub the front of the ribcage below the pectoral with claw shaped fingers. Rub down pec, across just under pec, up to armpit and back down side.

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Figure 2. RPR techniques used to activate muscle groups utilized in barbell bench press and squat (23).

Results

Participants

A total of 9 male college ice hockey players (21.4± 0.7 y,1.8 ± 0.05m, 80.1 ± 4.3 kg) out of 26 on the Skidmore Men's Ice Hockey team were eligible, agreed to the study, and completed both experimental visits in accordance to the criteria designated above.

Muscular Power and Muscular Fatigue Protocol

There was no significant interaction (P=0.946) between average power produced over time and intervention (Figure 3A). There was no significant interaction (P=0.86) between average power produced over time and squat and bench press exercises (Figure 3B). There was no significant interaction (P= 0.18) in mean power produced over time between barbell exercises and interventions (Figure 3C). A significant difference (P=0.003) of repetition power over time was apparent during the 10RM (Figure 3).

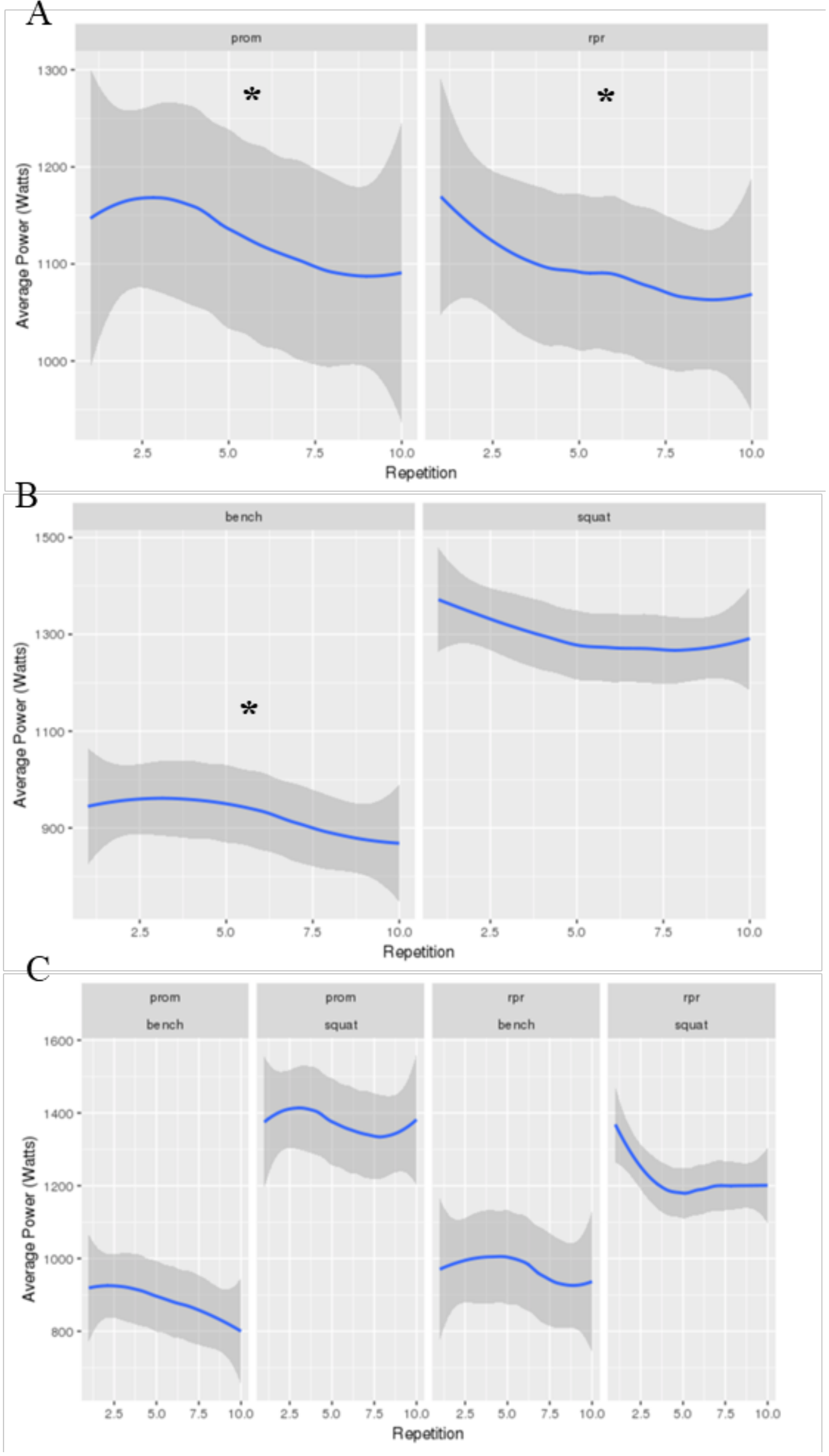

Figure 3. Repetition by Repetition Power Data over 10 repetitions in 9 male college ice hockey players. A) Average repetition power produced over time during PROM and RPR interventions (Condition Effect). B) Average repetition power produced over time in barbell squat and bench press exercises (Exercise Effect). C) Average repetition power produced over time in barbell squat and bench press exercises between PROM and RPR interventions (Interactions). Data are means ± SD. * Indicates a significant difference (P≤0.05) in average power over time.

No significant interaction was found (P=0.18) in average 10RM power between barbell exercise and intervention. (PROM squat: 1373.6 ± 296.4 watts; RPR squat: 1223.4 ± 146.2 watts; PROM bench: 880.2 ± 240.4 watts; RPR bench: 969.3 ± 322.8 watts) (Figure 4A). There were significant differences (P<0.001) in average 10RM power production between barbell squat and bench press exercises (squat: 1298.5 ± 187.6 watts; bench: 924.7 ± 241.3 watts) (Figure 4A). There was no significant difference (P>0.1) in average 10RM power production between PROM and RPR interventions (PROM: 1127 ± 194.2 watts; RPR: 1096.4 ± 196.9 watts) (Figure 4A). There was no significant interaction (P=0.18) in average total power produced between barbell exercise and intervention. (PROM squat: 13736.2 ± 2964 watts; RPR squat: 12234.4 ± 1462.4 watts; PROM bench: 8802 ± 2404 watts; RPR bench: 9693 ± 3228.4 watts) (Figure 4B). There were significant differences (P<0.001) in average total power production between barbell squat and bench press exercises (squat: 12985 ± 1875.8 watts; bench: 9247.2 ± 2412.6 watts) (Figure 4B). There was no significant difference (P>0.1) in average total power production between PROM and RPR interventions (PROM: 11268.9 ± 1941.9 watts; RPR: 10963.7 ± 1959 watts) (Figure 4B). There was no significant interaction (P=0.19) in average peak power produced during barbell exercise and intervention. (PROM squat: 1513 ± 325.3 watts; RPR squat: 1390.6 ± 158.1 watts; PROM bench: 997.4 ± 197.9 watts; RPR bench: 1116.6 ± 349) (Figure 4C). There were significant differences (P<0.001) in average peak power production between barbell squat and bench press exercises (squat: 1452 ± 155.7 watts; bench: 1057 ± 243.9 watts) (Figure 4C). There was no significant difference (P>0.1) in average peak power production between PROM and RPR interventions (PROM: 1255.2 ± 190.7 watts; RPR: 1253.6 ± 183.8 watts) (Figure 4C).

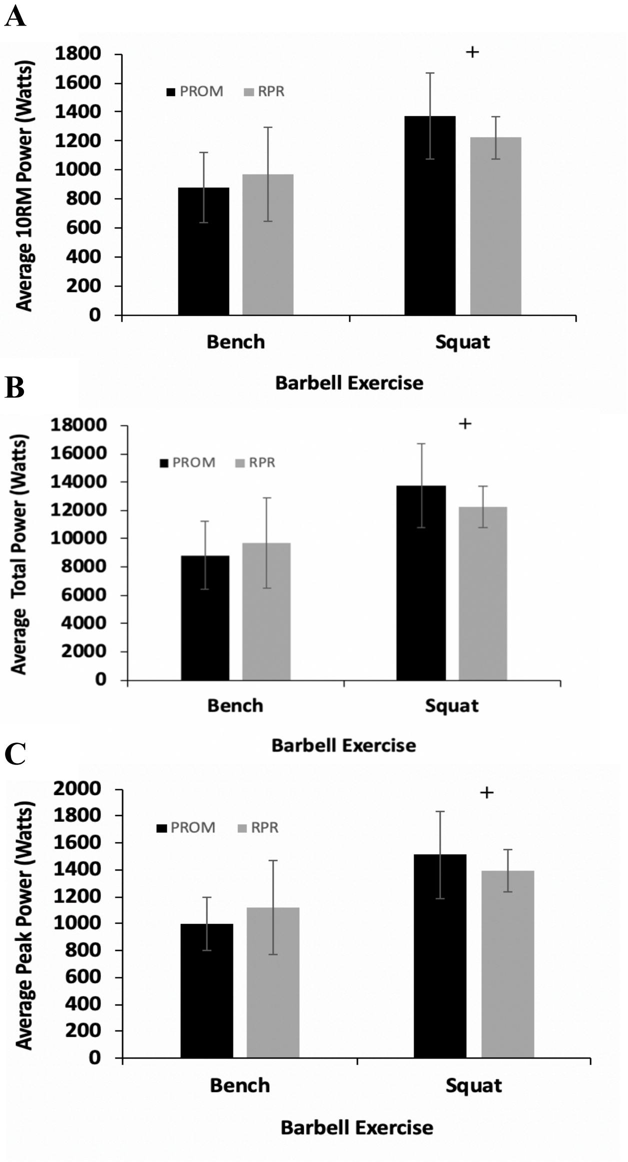

Figure 4. Average power production in 9 male college ice hockey players. A) Mean 10RM power barbell squat and bench press exercises between PROM and RPR interventions. B) Average total power produced during 10RM in barbell squat and bench press exercises between PROM and RPR interventions. C) Average peak power produced during 10RM in barbell squat and bench press exercises between PROM and RPR interventions. Mean ± SD. + Indicates a significant difference ($P \leq 0.001$) in average power between barbell squat and bench press exercises.

Discussion

Differences in pre-exercise warm-ups between athletes can cause discrepancies in power output and overall muscular performance. This study investigated the acute administration of RPR on muscular power output and onset of muscular fatigue in NCAA Division III male college ice hockey players. Being the first study to analyze RPR, the results revealed no differences in power production over time between the two pre-exercise muscular activation techniques, at least in the current model, suggesting no clear benefit in using RPR to enhance resistance to muscular fatigue. Furthermore, average power production in the squat and bench press exercises were comparable between RPR and control, suggesting little benefit in using RPR to acutely enhance muscular power.

Previous literature has shown that other pre-exercise muscular activation techniques can, in fact, have meaningful impacts on muscular power, yet these results are contradictory (3, 4, 11, 13, 15, 16, 18-20). Specifically, using PAP of high-dynamic loading intensities (> 80% of 1RM) prior to exercise may improve speed and power production in elite athletes, as well as average power output and power output relative to body weight in men (3, 11, 13, 15, 18-20). Researchers have shown that utilizing PAP before a high-intensity dynamic loading event (80–95% 1RM) can significantly improve acute jump height and average power output in trained athletes (4, 20). However, other studies have opposed these results and illustrate that PAP does not encourage positive increases in average power, velocity force, or vertical jump height, especially in men (11, 16). These studies suggest that training status, strength, and skill level determine athletic performance (11, 16). Studies have also analyzed the longitudinal effects of PAP on athletic performance and muscular fatigue, albeit revealing mixed results. Researchers have observed that the effects of PAP longitudinally promote an increase in jumping performance (4, 12, 17, 18), while others proclaim that the effects of PAP on sustained muscular power diminish over ensuing repetitions of a movement, illustrating that post-activation potentiation should be used cautiously (5, 10).

In the current study, we found no clear benefit of acute RPR on repetition by repetition muscle power (Figure 3) nor in cumulative assessments of the 10-repetition protocol (Figure 4). However, there are several important considerations for future research that might explore the effects of RPR and reasons why a positive effect may not have been observed in the present investigation. First, the effective dose of RPR is not known. In the current study, we administered wake-up drills to prime only the musculature necessary to squat and bench press, but perhaps a full-body RPR protocol is needed have an effect on specific musculature. Second, the timing of the effects of RPR are not known, utilizing a similar timeframe to previous PAP studies, the acute short-term effects of RPR seem minimal but it is possible that the timing needs to be different to see an effect. Third, the benefit of RPR might be more apparent in other methods or modes of performance assessment, such as maximal, or strength based, attempts (e.g. 1RM, not the 10RM used in our study) or in other types of exercise such as sprinting. Finally, perhaps RPR needs to be accumulated, trained, or learned over time in order to be effective and studies including other, and larger, populations may reveal this to be true.

Although the effectiveness of utilizing PAP to augment athletic performance can differ from RPR, the two neuromuscular activation warm-ups could share similar physiological processes. The mechanisms of PAP have been analyzed in previous studies and are attributed to the phosphorylation of myosin regulatory light chains, which makes actin and myosin more sensitive to Ca^{2+}. This potentiated state of the subcellular components of muscle have also been attributed to an increase in α-motoneuron excitability as reflected by changes in the H-reflex (7). Adhesive taping is another pre-exercise technique that could share similar physiological mechanisms as RPR. Adhesive taping has been shown to improve joint stabilization due to the tape's ability to promote mechanical stiffness. This joint stability is influenced by elevations in neuromuscular proprioceptive and physiological feedback, characterized by relative augmentations in localized electromyographic activation (2). The mechanisms of RPR are not well known but are thought utilize a simple system of breathing and tactile input to improve performance while inhibiting compensatory body patterns (21). Overall, there is a possibility that RPR could alter muscular power output and thus athletic performance by mechanisms similar to PAP and/or adhesive taping which include the phosphorylation of muscular components or the activation of localized proprioceptors in the musculature being primed for exercise. However, additional research investigating the effects of both diaphragmatic breathing and tactile input on muscular activity are needed to fully understand the exact relationship between RPR and acute changes in targeted neuromuscular physiology.

Ultimately, RPR appears to be a safe and quick pre-exercise warm-up that is easy to learn and does not require any external assistance. However, some major limitations of this current study are the small sample size, lack of evidence for RPR effectiveness, as well as the overall inexperience of the investigators administering RPR. Future studies should analyze the acute and longitudinal effects of a novel pre-exercise warm-up routine, that incorporates RPR, on both lower and upper body muscular power and muscular fatigue. Studies would benefit by using non-ice hockey and female athletes, allowing for an examination and comparison of the localized effects of RPR in different types of athletes and genders. Moreover, future research should incorporate different timing, exercises and frequencies of pre-exercise RPR administration to observe its effects on muscular and/or athletic performance. Finally, more research is needed to notice a difference between acute and longitudinal muscular power when RPR is done by oneself, a partner, or a trained professional.

Media-Friendly Summary

This study suggests no clear benefit, or detriment, in using a novel warm-up technique, reflexive performance reset, on weightlifting performance in college ice hockey players. More work is needed to determine the optimal timing and/or amount of RPR to improve performance. Although RPR does not seem to have the capability to improve muscle power in male athletes, it could easily be incorporated into a training program than other pre-exercise warm-up activities.

Acknowledgements

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