Effects of isometric mid-thigh pull for the real world on countermovement jump: A pilot study

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Postactivation potentiation | Isometric mid-thigh pull | Jump

Headline

The countermovement jump (CMJ) measures a long stretch-shortening cycle (SSC) ability (1). In addition, improved CMJ benefits jumping sports such as volleyball (2). To improve CMJ, 1) increase eccentric RFD (braking phase), 2) increase peak concentric force (propulsive phase), and 3) reduce movement time (3).

Post-activation potentiation (PAP) is a change in the phosphorylation level of myosin light chains and increased mobilization of higher motor units due to conditioning activity, subsequently increasing power output and force production. As a result, jump performance and sprinting improve after PAP (4). Several studies conducted high-load back squats and isometric leg extensions to induce PAP (4). However, these methods are not suitable for the real world because it requires equipment. Therefore, it is necessary to consider more straightforward approaches applied in the real world.

Aim

The purpose of this study was to examine PAP induced by IMTP using Judo-belt and then CMJ performance.

Design

Case Reports and Series.

Methods

Participants. Four healthy men participated in the study (age 28.8 ± 3.3 years, height 171.3 ± 4.9 cm, body mass 66.3± 12.9kg). Participants were running at a recreational level and were not conducting resistance training. The participants consented to informed consent before this study.

Methodology. Participants performed IMTP using a judo belt. We selected the judo belt because it is easy to carry and strong. The protocol in this study was based on Hirayama's protocol, which was modified into a shape that was easy to apply in the real world (5); 1) the general warm-up consisted of 5 minutes of low-intensity cycling, and 2) participants performed three exercises of dynamic stretching (jackknife, lateral squat, and squat), 3) One minute later, two countermovement jumps (CMJ) were performed (30-sec. rest interval in between) as a pre-test. And 3 minutes after the dynamic stretch, three sets of 5-second IMTP were performed (the rest interval was 5 seconds). We instructed them to pull on the judo belt as fast and hard as possible. 4) One minute after the IMTP, the CMJ was measured as a post-test using the same procedure as the pre-test (Figure 1).

CMJ test. Participants stood vertically with hands-on-hips and quickly bent their hip and knee joints to perform a countermovement. Then, they quickly extended their hip and knee joints to perform a jump—all CMJ tests were conducted on a force plate (1000Hz, Kistler, Winterhur, Switzerlan). Participants stood still on the force plate for >1 second at the start2.5% below newton's value for the standing position defined as the starting point of unweighting (6). CMJ heights were calculated using the flight time method and statistically analyzed for the highest CMJ height. The analyzed variables were CMJ height, net peak concentric force/BW, concentric time, contraction time, and reactive strength index modified (RSImod). And RSImod was calculated from the highest CMJ height.

Statistical analysis. The effect sizes showed Cohen's d. The thresholds for effect size were as follows; trivial ($0 \leq d \leq 0.2$), small ($0.2 \leq d \leq 0.6$), moderate ($0.6 \leq d \leq 1.2$), large ($1.2 \leq d \leq 2.0$) and very large ($2.0 \leq d \leq 4.0$) (7). The magnitude-based inference showed to assess the influence. The confidence interval was 90%, and the following scale: 25–75% possibly; 75–95% likely; 95–99.5% very likely; >99.5% most likely (8). The SWC was set at 0.2 of the effect size.

Results

Measurements are presented as mean ± SD (Table 1). The IMTP appeared to be most likely beneficial effect for RSImod (d = 0.96, 90%CI = 0.35 - 1.58). There were likely beneficial effect for CMJ height (d = 0.57, 90%CI = -0.03 - 1.16), net concentric peak force/BW (d = 0.72, 90%CI = 0.12 - 1.32), concentric time(d = -0.52, 90%CI = -1.11 - 0.07) , contraction time (d = -0.57, 90%CI = -1.16 – 0.03) , respectively (Figure 2).

Discussion

The protocols in this study were designed to have short rest intervals between IMTP sets and CMJs, assuming real-world conditions. Because of a likely beneficial effect on CMJ height, we consider that PAP was induced. The balance between potentiation and fatigue is essential for the induction of PAP. In the previous study, the rest interval of <2 min. was d=0.17 (95% CI= -0.23 - 0.58) 9). However, in this study, an effect of d = 0.57 (90% CI = -0.03 - 1.16) was found. Therefore, we consider that fatigue decreased rapidly.

A likely beneficial effect was relative muscle strength gains and time reductions in the concentric phase. Therefore, we consider that the greater force can be generated in a shorter time. Lum et al. compared the effects of one second and three seconds of isometric training duration and reported that the three-second duration increased muscle strength (10). In addition, Hirayama reported that repetitive stimulation with gradually increasing load increased the rate of improvement in CMJ height (5). These results suggest that longer durations and repetitions would increase the recruitment of Type II. We consider that the IMTP in this study had a similar effect because it was repeated three times for five seconds.

RSImod measures lower-body explosiveness in CMJ (11). In this study, CMJ height improved, and contraction time was reduced. Therefore, there was a most likely beneficial effect on RSImod. Isometric training as fast and as hard as possible has the effect of improving explosive strength (12). IMTP in this study was instructed to be as fast and as hard as possible. Therefore, we consider that RSImod has improved.

Table 1. Variables of countermovement jump performance

	Pre Mean ± SD	Post Mean ± SD	ES (d)
Countermovement jump height (cm)	38.98 ± 2.94	40.43 ± 2.13	0.57
Net peak concentric force/BW (N)	14.3 ± 2.1	15.5 ± 1.3	0.72
Concentric time (sec.)	0.268±0.044	0.248±0.034	-0.52
Contraction time (sec.)	0.815±0.086	0.774±0.057	-0.57
RSImod (m/sec.)	0.48±0.06	0.52±0.02	0.96

ES = effect size; BW = body weight; RSImod = reactive strength index modified.

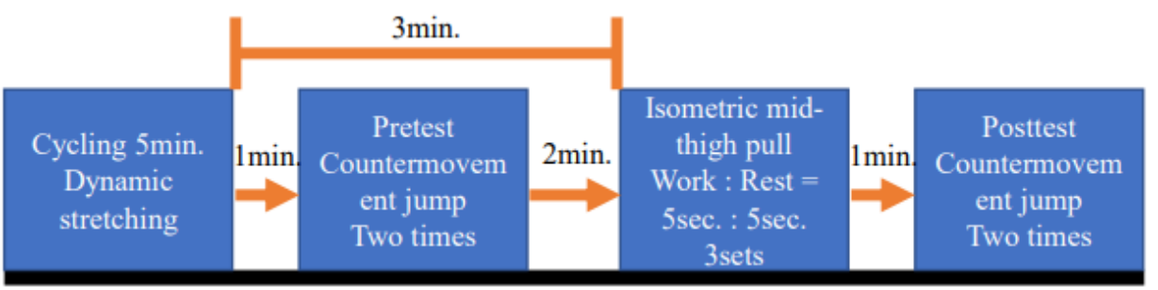

Fig. 1. Testing protocol

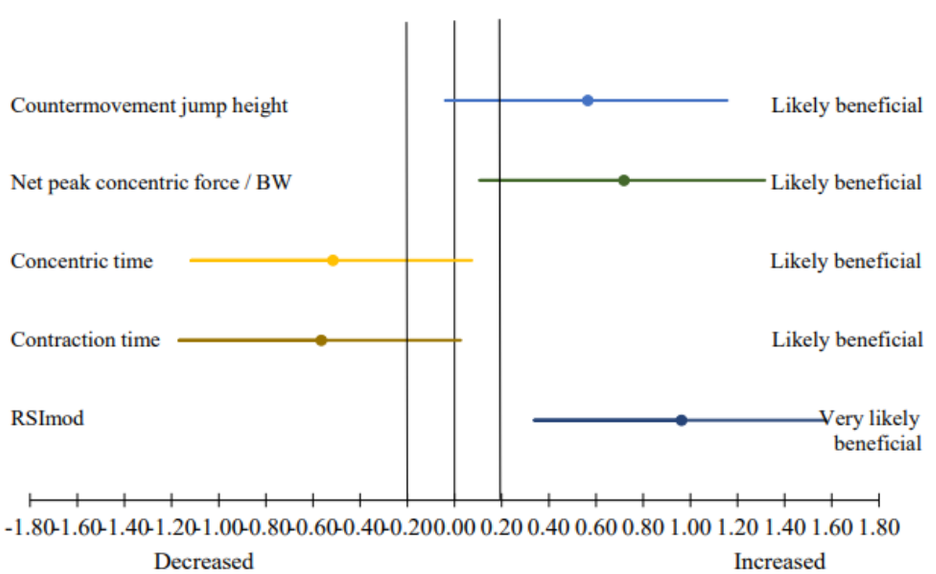

Fig. 2. Magnitude-based inference (effect size ± 90% confidence interval) RSImod = reactive strength index modified.

Practical Applications

- It may improve the performance of long SSC such as CMJ (250 ms<).
- Composition in the warm-up can be expected to produce greater muscle strength and improve lower body stiffness.

Limitations

- The participants in this study were all healthy men running at a recreational level. In addition, they did not conduct resistance training. Therefore, it is unclear how it can be applied to athletes and trained individuals.
- Because there was no control group, it is required to establish control groups in future studies.

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