The effect of maximum voluntary isometric contraction immediately before drop jump on jump performance

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Introduction In sports, explosive power generated by muscles is required and it is an important factor strongly associated with sports performance. Post-activation potentiation (PAP) is able to strengthen muscle contraction swiftly and briefly. The purpose of this experiment is to evaluate the effect of PAP on drop jump, on which the stretch-shortening cycle contributes significantly, in order to provide useful information for pre-exercise improving performance.

Methodology

Subjects

14 mail athletes who have no medical history on legs
(Age: 21.1 ± 1.4 years, Hight: 173.6 ± 4.7 cm, Weight, 64.7 ± 4.0 kg)

Measurement(Method)

- 3D motion analysis system (Mac3D, manufactured by Motion Analysis)
  Reflective markers: 32 points on whole body(Fig1)
- Electromyogram
  Target muscles: tibialis anterior (TA), soleus (SOL), medial gastrocnemius (MG), lateral gastrocnemius (LG), rectus femoris (RF), and biceps femoris (BF)
- Floor reaction force (force plates, manufactured by Bertec)
  The sampling frequency: 1000 Hz

Trial

Drop jump(Hight of platform: 30 cm)

Conditions

- PAP condition
  Participants do the conditioning contraction
- Control condition
  Participants do not do the conditioning contraction

Conditioning contraction

Maximal voluntary isometric contraction of the calf for 6 seconds(Fig 2)

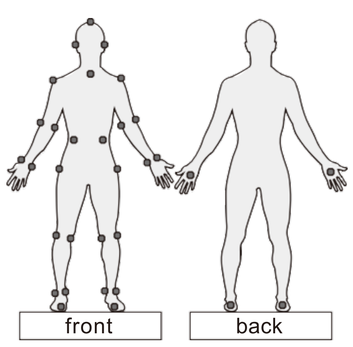

Fig 1. Markers' position

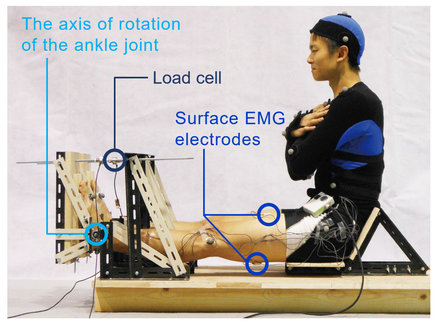

Fig 2. Maximum voluntary isometric dorsiflexion on conditioning

Phase definition

The ground contact and take-off: 3% of the body weight(Fig 3)

- Down phase: GC [1] – LP [2]
- Up Phase: LP – take-off(Fig 4)

[1] GC: the ground contact
[2] LP: the lowest point of the center of gravity

Statistical processing

Two-way repeated measures ANOVA

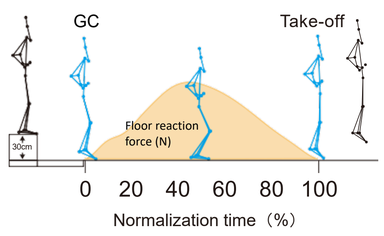

Fig 3. The definition of the ground contact and take-off

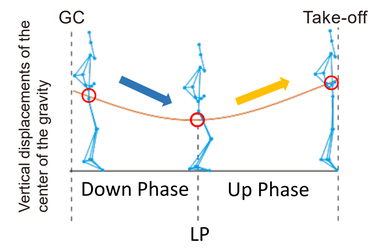

Fig 4. The definition of down phase and up phase

Result

Jump height

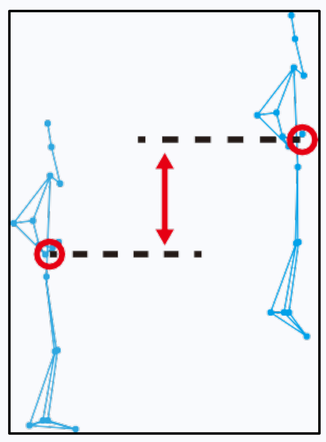

Table 1. Jump height

	pre	post
PAP	0.3544±0.0421	0.3931±0.0420
control	0.3618±0.0356	0.3597±0.0444

(m)

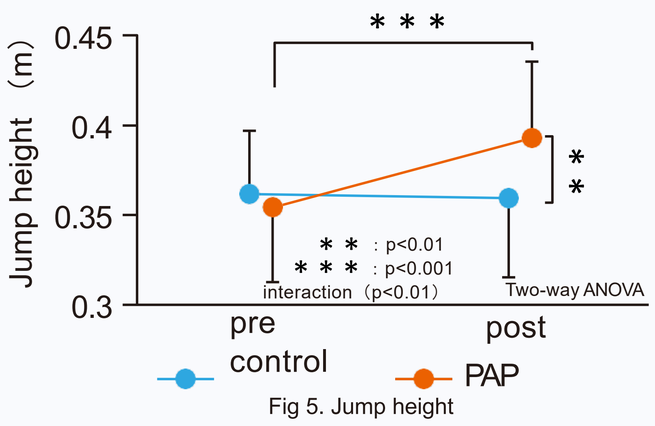

Fig 5. Jump height

Velocity of the center of gravity

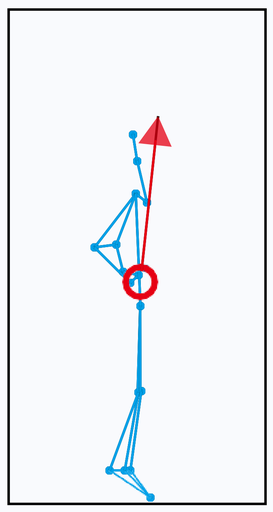

Table 2. Velocity of the center of gravity on the point of take-off

	pre	post
PAP	2.4856±0.1973	2.6335±0.1819
control	2.5158±0.1857	2.5042±0.2001

(m/s)

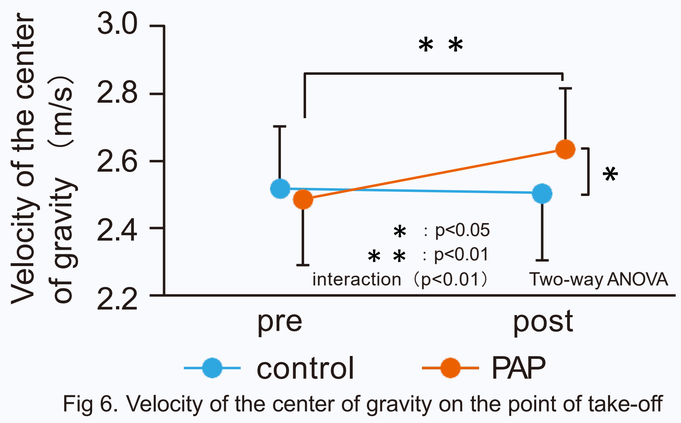

Fig 6. Velocity of the center of gravity on the point of take-off

Torque on an ankle joint

Table 3. The maximum ankle joint torque of plantarflexion while ground contact

	pre	post
PAP	4.1585±0.6648	4.3537±0.6841
control	4.2338±0.7648	4.0436±0.5385

(N•m/kg)

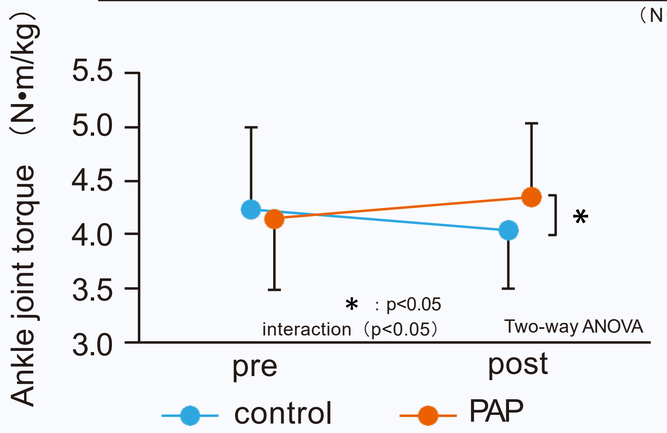

Fig 7. The maximum ankle joint torque of plantarflexion while ground contact

Electromyogram

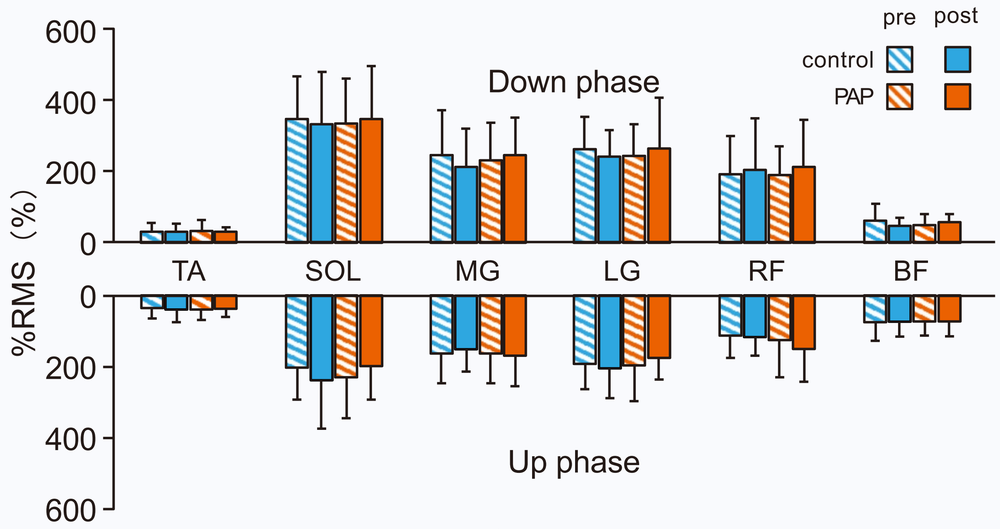

Fig 8. %RMS in Down and Up phase

Discussion In this experiment, Jump height in PAP condition significantly increased as the velocity of the center of gravity and ankle joint torque rose. However, there was no difference in muscle activity based on EMG in any trials. This phenomenon suggests that PAP was able to strengthen the work of the ankle joint and emphasize the stretch-shortening cycle due to activating the triceps surae muscle and it increased the jump height except for the enhancement of muscle strength due to excitement of the nervous system.

Reference

1) Duncan N. F, William J. K, and Carlton B. C, 2003. Changes in dynamic Exercise Performance Following a Sequence of Preconditioning Isometric Muscle Actions, Journal of Strength and Conditioning Research, 17(4), 678-685.

2) Fukutani, A, Miyamoto, N, Kanehisa, H, Yanai, T, and Kawakami, Y, 2013. Potentiation of isokinetic torque is velocity-dependent following an isometric conditioning contraction. SpringerPlus 2, 554.