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ORIGINAL ARTICLE

Causal effect of intra-abdominal pressure on maximal voluntary isometric hip extension torque

Kota Tayashiki[1] · Fumihiro Mizuno[1] · Hiroaki Kanehisa[1] · Naokazu Miyamoto[1]

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Abstract
Purpose Intra-abdominal pressure (IAP) has been recently shown to be associated specifically with maximal voluntary isometric contraction (MVC) torque of hip extension, although the causal relationship remains unclear. The present study aimed to elucidate whether IAP has a causal effect on hip extension MVC torque.
Methods IAP during hip extension MVC was changed by controlling the lung volume (i.e., depth of inspiration). Twelve healthy males conducted MVCs of hip extension during breath-hold at full inspiration (inspiratory condition) or expiration (expiratory condition), or during normal breath-hold (normal condition). IAP during MVCs was measured a pressure transducer placed in the rectum.
Results The IAP during hip extension MVC was significantly higher in inspiratory condition (132.0 ± 46.1 mmHg) than in the other two conditions and also higher in normal condition (104.6 ± 35.9 mmHg) than in expiratory condition (77.0 ± 39.1 mmHg). The hip extension MVC torque was significantly higher in inspiratory condition (297.7 ± 82.7 N m) than in expiratory condition (266.4 ± 84.5 N m). In each condition, the hip extension MVC torque correlated with IAP during the MVC task.
Conclusion The current results suggest that IAP has a positive causal effect on hip extension MVC torque and that a sufficient increase in IAP directly leads to an enhancement of hip extension MVC torque.

Keywords Lung volume · Core stability · Abdominal muscle · Diaphragm · Electromyogram

Abbreviations

ANOVA	Analysis of variance
AEMG	Average amplitude of electromyogram
BF	Biceps femoris
CV	Coefficient of variation
EMG	Electromyogram
ES	Erector spinae
GM	Gluteus maximus
IAP	Intra-abdominal pressure
ICC	Intra-class coefficient
MVC	Maximal voluntary isometric contraction
OE	Oblique external
OI	Oblique internal
RA	Rectus abdominis

Introduction

It is well accepted that a strong and stable core is essential for achieving high athletic performance by providing a foundation for greater force production by limbs (Kibler et al. 2006; Willardson 2007). Thus, core stability training, which is considered to be effective for improving muscular function of abdominal muscles, has recently received remarkable attention in athletic fields (Behm et al. 2010; Willardson 2007). Several studies have reported improvements in maximal hip extension torque (Hoshikawa et al. 2013; Tayashiki et al. 2016a) and physical performance involving hip extension such as sprint running, jumping, and lifting (Jamison et al. 2012; Myer et al. 2006; Prieske et al. 2016; Sharma et al. 2012) following core stability training intervention. However, the

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✉ Naokazu Miyamoto
miyamoto@nifs-k.ac.jp

[1] National Institute of Fitness and Sports in Kanoya, 1 Shiromizu, Kanoya, Kagoshima 891-2311, Japan

mechanisms underlying such improvements are largely unknown.

A possible explanation for the aforementioned improvements of maximal hip extension torque and physical performance involving hip extension is a training-induced change in intra-abdominal pressure (IAP). IAP has been suggested to play an important role for stabilization of core and force generation during movement involving lower limb such as lifting (Essendrop et al. 2004; Harman et al. 1988; Kawabata et al. 2010; McGill et al. 1990). Nevertheless, Hagins et al. (2006) reported that when comparing IAP and force during lifting task between two breath-hold conditions (i.e., inspiratory and expiratory states), IAP was greater in inspiratory condition than in expiratory condition, whereas no significant difference was observed in maximal lifting force (Hagins et al. 2006). Similarly, when IAP and lifting performance were compared between conditions with and without wearing an abdominal belt, a significant difference was observed in IAP but not in lifting performance (McGill et al. 1990; Harman et al. 1989). In contrast, a previous study has recently reported that IAP was positively correlated with maximal voluntary isometric contraction (MVC) torque of hip extension independently of muscle size of the agonists (i.e., gluteus maximus (GM) and hamstring) while there was no significant association between IAP and hip flexion MVC torque (Tayashiki et al. 2017). Furthermore, an 8-week core stability training consisting of voluntary co-contraction of abdominal muscles (i.e., abdominal bracing) increased not only maximal IAP during abdominal bracing but also hip extension MVC torque (Tayashiki et al. 2016a) (but not hip flexion MVC torque (unpublished data)). Based on these observations, we hypothesized that IAP has a causal effect on MVC torque at least of hip extension, and thereby an increase in IAP results in the enhancement of MVC torque of hip extension.

One of the ways for changing IAP during a given task is to control lung volume by changing breathing state. The diaphragm contraction intensity is proportional to the lung volume (i.e., depth of inspiration) (Depalo et al. 2004; Hodges et al. 2001) and plays a significant role in producing high IAP. Indeed, IAP has been shown to vary with breathing state and lung volume (Hagins et al. 2004; Kawabata et al. 2010; McGill et al. 1990; Miyamoto et al. 1999). Therefore, to test the aforementioned hypothesis, we investigated IAP and torque during hip extension and flexion MVC tasks in three different breath-hold conditions. If IAP has a causal effect on hip extension MVC torque, then the increased IAP via changing breath-hold conditions should result in the enhancement of hip extension MVC torque.

Methods

Subjects

Twelve healthy young males voluntarily participated in this study (22.7 ± 2.1 years, 1.71 ± 0.02 m, 67.7 ± 5.8 kg; means ± SDs). All subjects were physically active and regularly participated in recreational sports (≥ 30 min day^{-1}, ≥ 2 days week^{-1}), but none of the subjects had been involved in any type of systematized physical training programs. None had any musculoskeletal injuries in the back or lower extremity within 12 months prior to the experiments. The subjects were asked to refrain from strenuous exercise and unfamiliar physical activities for 24 h prior to the start of a test. Before participation, all subjects were fully informed of the purpose and procedures of this study and possible risks of the measurements. Written informed consent was obtained from all subjects. All subjects visited the laboratory to become familiar with MVC tasks before the start of test. This study was approved by the local ethics committee and performed in accordance with the Declaration of Helsinki.

Experimental setup and procedure

For the purpose of normalization for the activation levels of the rectus abdominis (RA), oblique external (OE), oblique internal (OI), erector spinae (ES) during hip extension and flexion (see below), first the subjects perform MVCs of trunk flexion, trunk rotation, lateral flexion, and trunk extension. Surface electromyogram (EMG) signals were obtained from the RA, OE, OI and ES during the MVC tasks. Each task was performed twice for 5 s with maximal effort against manual resistance, in accordance with the procedure used in previous studies (Maeo et al. 2013; Tayashiki et al. 2016a, b), with 2–3 min intervals between the trials. Subsequently, the subjects lay supine on a dynamometer (CON-TREX MJ, PHYSIOMED, Germany) bed with their right hip and knee flexed at 90° (anatomical position: 0°) in accordance with our prior studies (Usui et al. 2016; Tayashiki et al. 2017). The lever arm of the dynamometer was attached to the right thigh. The rotation axis of the hip was aligned with that of the dynamometer. The torso, pelvis, and left thigh were tightly secured to the bed with non-elastic belts to prevent extraneous movement. The shoulders were firmly held with pads to prevent the body from moving toward the head during the measurements. To obtain EMG signal of the biceps femoris (BF) for the purpose of normalization, the subjects performed knee flexion MVC for 5 s twice.

After the completion of the aforementioned tasks, a familiarization session consisting of submaximal and MVCs of hip extension or hip flexion was performed. We have adopted hip flexion MVC task to elucidate whether IAP has a causal effect specifically on hip extension MVC torque. Following a rest period of at least 3 min, the subjects performed hip extension or flexion MVC in the following three breath-hold conditions: (1) inspiring fully prior to the MVC and holding the breath during the task (inspiratory condition), (2) expiring fully prior to the MVC and holding the breath during the task (expiratory condition), and (3) breathing normally prior to the MVC and holding the breath during the task (normal condition). The orders of tasks and conditions were randomized across the subjects. The subjects were asked to concentrate only on performing hip extension or flexion MVCs without paying attention to the abdominal and back muscles. In each condition of both hip extension and flexion MVC tasks, measurements were conducted twice with an interval of at least 3 min between the trials. Additional trial was allowed if the difference in the maximal torque between the two trials for each task was more than 5%. The two trials with $<5\%$ difference were used for further analyses. The repeatability of torque measurement was confirmed in our recent studies (Usui et al. 2016; Tayashiki et al. 2017).

Measurements

IAP was measured using a sterilizing pressure transducer (MPC-500, Millar Instruments, USA) placed in the rectum, about 15 cm from the anus as described in earlier studies (Tayashiki et al. 2016a). Prior to the measurement, the pressure transducer was calibrated by a transducer control unit (TCB-500, Millar Instruments, USA). McCarthy (1982) demonstrated that the pressure measured using a transducer inserted into the rectum (i.e., 10 cm or more from the anus) corresponded to that using a transducer inserted into the abdominal cavity. The repeatability of IAP measurement was confirmed in our recent study (Tayashiki et al. 2016b).

EMG signals of RA, OE, OI, ES, BF, and GM were obtained by pre-amplified surface electrodes (electrode shape: parallel-bar, inter-electrode distance: 10 mm; DE-2.1, DELSYS, USA) with band-pass filtering between 20 and 450 Hz (Gain: × 1000; Bagnoli 8 EMG System, DELSYS, USA) on the right side of the body. The reference electrode was placed on the right ulnar styloid process. After appropriate skin preparation to reduce the skin impedance, the electrodes were placed over each muscle. The electrodes sites were 3 cm lateral to the umbilicus for the RA, halfway between the crest of the anterior superior iliac spine and the lower edge of ribs above the anterior super iliac spine for the OE, below the OE electrodes and superior to the inguinal ligament for the OI, 2 cm lateral to the L_3 spinous process for the ES, halfway between the trochanter and the sacral vertebrae for the GM, halfway of the thigh length (the distance from the greater trochanter to lateral joint space of knee joint) for the BF (Iida et al. 2011; Tayashiki et al. 2016a). The repeatability of EMG measurement for RA, OE, OI, and ES was also confirmed in our previous study (Tayashiki et al. 2016b).

Data analyses

The IAP, torque, and EMG signals were simultaneously recorded by a personal computer via a 16-bit A/D converter (PowerLab 16/35, ADInstruments, Australia). Figure 1 shows examples of hip extension torque, IAP, and EMG signals during hip extension MVC. These data were analyzed using data analysis software (LabChart version 7, ADInstruments, Australia). The IAP during each MVC was determined as the change from the baseline (value at rest) to the value at the time at which the maximal torque was attained (Tayashiki et al. 2016a, b). All EMG signals were high-pass filtered at 20 Hz to remove the artifacts (Hof 2009; Tayashiki et al. 2016a) and full wave rectified. For the subsequent EMG data analysis, we checked that there were no cardiac electrical artifacts in the trunk muscles' signals. For the trunk flexion, trunk rotation, lateral flexion, trunk extension, and knee flexion tasks, the average amplitude value of rectified EMG signal (AEMG) during the middle 3 s of maximal effort (5 s) was calculated for each muscle. For the hip extension and flexion MVC tasks, the AEMG value for each muscle was determined over a 500-ms window centered on the time at which the maximal torque was attained. The average value across the two trials in each MVC was used for further analyses. For each of RA, OE, OI, and ES, the highest AEMG value among the trunk flexion, trunk rotation, lateral flexion, and trunk extension was used as EMGmax. For BF, the highest AEMG value across hip extension MVC in normal condition and knee flexion task was used as EMGmax. For GM, the AEMG of hip extension MVC in normal condition was referred as EMGmax. The AEMG for each muscle during

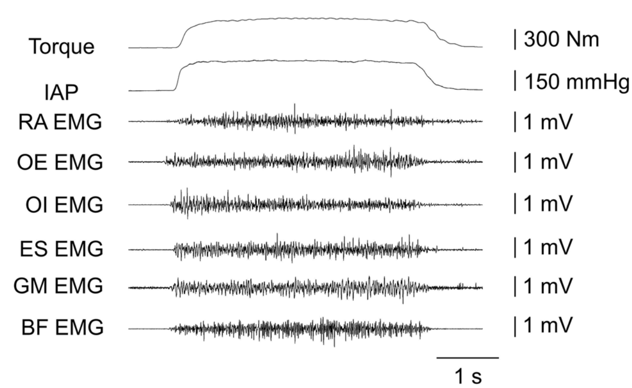

Fig. 1 Typical examples of raw data on torque, intra-abdominal pressure (IAP), and electromyograms (EMGs) of the rectus abdominis (RA), oblique external (OE), oblique internal (OI), erector spinae (ES), gluteus maximus (GM), and biceps femoris (BF) during maximal voluntary isometric hip extension

hip extension and flexion MVCs in each breath-hold condition was expressed as the value relative to EMGmax (%EMGmax).

Statistical analysis

Based on the data of our preliminary results ($n = 5$), priori power analyses with an assumed type 1 error of 0.05 and a statistical power of 80% were conducted to find statistically significant difference in IAP during hip extension MVC between conditions and to find statistically significant correlation between IAP and hip extension MVC torque in each condition. The critical sample sizes were estimated to be seven and eight subjects, respectively. Thus, 12 subjects were recruited to account for possible attrition.

The results are presented as mean ± SDs. Shapiro–Wilk test was used to check and confirm the normal distributions of the all variables except for %EMGmax of GM in normal condition (the values are 100 in all subjects). Paired Student's *t* test was used to examine the difference in MVC torque and IAP between two measurements. Intra-class coefficient (ICC) and confidence interval (CI) were calculated for MVC torque and IAP. In addition, coefficient of variation (CV) and standard error of measurement (SEM) for MVC torque and IAP were calculated. A one-way (three breath-hold conditions) repeated measure analysis of variance (ANOVA) followed by post hoc comparisons (Bonferroni) was used to test the differences in the measurement values between the three conditions. When a significant main effect was found, effect size (r) was also reported with a P value to express the magnitude of the difference between the conditions. Pearson product–moment correlation coefficients were calculated to determine the relationships between the MVC torque (dependent variable) and IAP (independent variable) during hip extension and flexion MVCs in the three conditions. Significance level was accepted at $P < 0.05$. All statistical analyses were performed using SPSS software (version 22.0, IBM Corp, USA).

Results

Repeatability

For MVC torque, paired Student's *t* tests revealed no significant difference between the two measurements. The ICC, CV, and SEM for MVC torque were 0.999 (CI 0.998–0.999), 1.3%, and 3.8 N m, respectively. For IAP, paired Student's *t* tests revealed no significant difference between the two measurements. The ICC, CV, and SEM for IAP were 0.945 (CI 0.914–0.965), 8.3%, and 11.1 mmHg, respectively.

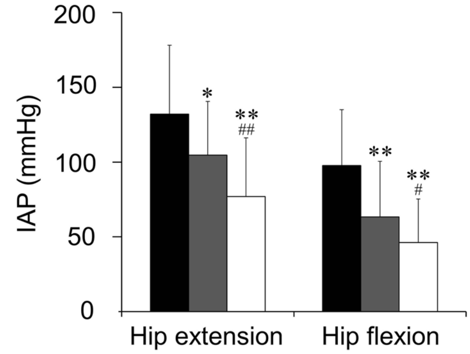

Fig. 2 Intra-abdominal pressure (IAP) in inspiratory condition (black closed bar), normal condition (gray closed bar), and expiratory condition (open bar) during maximal voluntary isometric hip extension (left) and flexion (right). Values are expressed as mean ± SD. Asterisks (* and **) indicate a significant ($P < 0.05$ and 0.01, respectively) difference from the inspiratory condition. Number signs (# and ##) indicate a significant ($P < 0.05$ and 0.01, respectively) difference from the normal condition

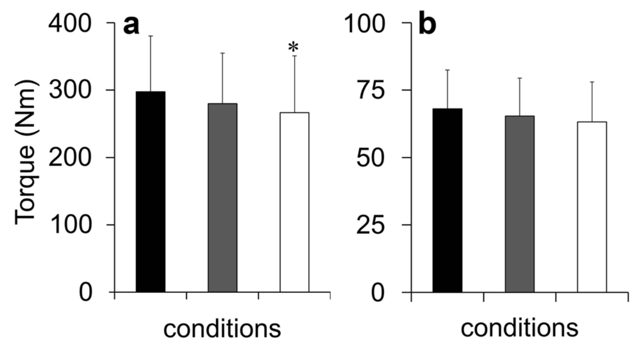

Fig. 3 Maximal torque in inspiratory condition (black closed bar), normal condition (gray closed bar), and expiratory condition (open bar) during maximal voluntary isometric hip extension (**a**) and flexion (**b**). Values are expressed as mean ± SD. An asterisk (*) indicates a significant ($P < 0.05$) difference from the inspiratory condition

Hip extension task

A significant main effect was found in the IAP during hip extension MVC ($F = 24.277$, $P < 0.001$, partial $\eta^2 = 0.688$). The IAP during hip extension MVC was significantly greater in inspiratory condition (132.0 ± 46.1 mmHg) than in normal (104.6 ± 35.9 mmHg) ($P = 0.013$, $r = 0.61$) and expiratory conditions (77.0 ± 39.1 mmHg) ($P < 0.001$, $r = 0.80$) and also greater in normal condition than in expiratory condition ($P = 0.007$, $r = 0.64$) (Fig. 2). For hip extension MVC torque, a significant main effect was found ($F = 5.486$, $P = 0.012$, partial $\eta^2 = 0.333$). The hip extension MVC torque was significantly greater in inspiratory (297.7 ± 82.7 N m) than in expiratory condition (266.4 ± 84.5 N m) ($P = 0.019$, $r = 0.58$) (Fig. 3). The IAP during hip extension MVC was significantly correlated with hip extension MVC torque in each of normal ($r=0.716$, $P=0.009$) and expiratory ($r=0.728$, $P=0.007$) conditions. A similar tendency was observed in inspiratory condition although not reaching statistical significance ($r=0.560$, $P=0.058$) (Fig. 4).

For %EMGmax during hip extension MVC, a significant main effect was found in GM ($F=3.812$, $P=0.038$, partial $\eta^2=0.257$) (Table 1). Post hoc analysis revealed that no significant difference was found between the three conditions ($P=0.104$–0.665, $r=0.27$–0.46). There were no significant main effects in the other muscles ($F=0.077$–3.742, $P=0.066$–0.827, partial $\eta^2=0.007$–0.254).

Hip flexion task

A significant main effect was found in the IAP during hip flexion MVC ($F=34.560$, $P<0.001$, partial $\eta^2=0.759$). The IAP during hip flexion MVC was significantly higher in inspiratory condition (97.8 ± 37.3 mmHg) than in normal (63.4 ± 37.2 mmHg) ($P=0.001$, $r=0.76$) and expiratory conditions (46.2 ± 29.1 mmHg) (P < 0.001, $r=0.82$) and also greater in normal condition than in expiratory condition ($P=0.014$, $r=0.60$) (Fig. 2). For hip flexion MVC torque, there was no significant main effect ($F=1.399$, $P=0.268$, partial $\eta^2=0.113$) (Fig. 3). The IAP during hip flexion MVC was not significantly correlated with the hip flexion MVC torque in each condition ($r=-0.200$–0.038, $P=0.534$–0.908) (Fig. 4).

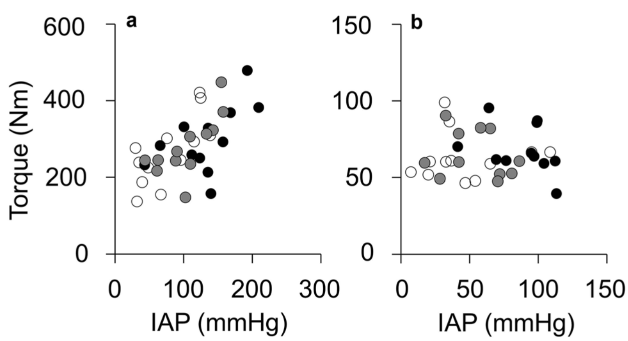

Fig. 4 Relationships between maximal torque and intra-abdominal pressure (IAP) during maximal voluntary isometric hip extension (**a**) and flexion (**b**) in inspiratory condition (black closed circle), normal condition (gray closed circle), and expiratory condition (open circle)

For %EMGmax during hip flexion MVC, significant main effect was found in each of RA ($F=12.741$, $P=0.002$, partial $\eta^2=0.537$) and OE ($F=7.722$, $P=0.003$, partial $\eta^2=0.412$). Post hoc analysis revealed that %EMGmax values for RA and OE during hip flexion MVC were significantly higher in inspiratory condition than in the other conditions ($P=0.006$–0.033, $r=0.55$–0.65), respectively. There were no significant main effects in the other muscles ($F=0.072$–3.050, $P=0.068$–0.845, partial $\eta^2=0.007$–0.217) (Table 2).

Discussion

The main findings obtained here were that (1) the breathing states during MVCs influenced both IAP and MVC torque in hip extension task, and (2) the significant associations between MVC torque and IAP were found in hip extension task. These results support our hypothesis that IAP has a positive causal effect on hip extension MVC torque.

In the present study, hip extension MVC torque in inspiratory condition is significantly higher than that in expiratory condition, whereas hip flexion MVC torque was not different among the three breath-hold conditions (Fig. 3). To the best of our knowledge, this study is the first to demonstrate the effects of breathing states on hip extension and flexion MVC torque, in relation with changes in IAP. It has been revealed that IAP is associated with hip extension MVC torque, but not with hip flexion MVC torque (Tayashiki et al. 2017). This was further confirmed by the present study even when controlling breathing state during the MVC tasks (Fig. 4). Moreover, an 8-week abdominal bracing training improved both maximal IAP during abdominal bracing and hip

Table 1 Descriptive data on %EMGmax for each muscle during maximal voluntary isometric hip extension task

	Inspiratory condition	Normal condition	Expiratory condition	ANOVA	
				P value	Partial η^2
RA	5.6 ± 3.9	7.8 ± 6.9	8.2 ± 6.2	0.139	0.164
OE	13.4 ± 8.9	14.7 ± 9.4	12.6 ± 10.0	0.430	0.074
OI	32.9 ± 19.9	33.2 ± 20.4	34.3 ± 22.6	0.827	0.007
ES	44.6 ± 15.5	38.1 ± 10.5	37.8 ± 8.0	0.066	0.254
GM	121.0 ± 28.8	100.0 ± 0.0	110.5 ± 27.0	0.038*	0.257
BF	93.5 ± 24.3	87.1 ± 21.6	88.0 ± 26.5	0.386	0.083

Values are expressed as mean ± SD

BF biceps femoris, *ES* erector spinae, *GM* gluteus maximus, *OE* oblique external, *OI* oblique internal, *RA* rectus abdominis

*Significant main effect ($P<0.05$) was found in the %EMGmax for the muscle

Table 2 Descriptive data on %EMGmax for each muscle during maximal voluntary isometric hip flexion task

Muscles	Inspiratory condition	Normal condition	Expiratory condition	ANOVA	
				P value	Partial η^2
RA	48.3 ± 18.1	34.7 ± 13.1	35.3 ± 15.2	0.002*	0.537
OE	73.0 ± 22.3	61.3 ± 21.2	60.3 ± 19.4	0.003*	0.412
OI	76.6 ± 50.2	69.0 ± 52.0	62.7 ± 41.8	0.150	0.159
ES	10.0 ± 4.7	9.4 ± 4.7	10.6 ± 4.4	0.417	0.076
GM	28.0 ± 25.5	29.1 ± 27.4	27.7 ± 18.7	0.845	0.007
BF	23.1 ± 13.1	23.7 ± 17.5	16.6 ± 13.0	0.068	0.217

Values are expressed as mean ± SD

BF biceps femoris, *ES* erector spinae, *GM* gluteus maximus, *OE* oblique external, *OI* oblique internal, *RA* rectus abdominis

*Significant main effect ($P < 0.05$) was found in the %EMGmax for the muscle

extension MVC torque, but not MVC torque of knee extension (Tayashiki et al. 2016a), hip flexion, and knee flexion (unpublished data). Taking together with the previous and present findings, we can conclude that an increase in IAP has a direct and causal effect to specifically improve hip extension MVC torque.

In contrast to the current results, previous studies have reported that an increase in IAP did not result in the corresponding change in maximal lifting force (Hagins et al. 2006; McGill et al. 1990). For example, Hagins et al. (2006) failed to find a significant difference in maximal lifting force between inspiratory and expiratory conditions despite IAP being significantly greater in inspiratory condition than in expiratory condition. The discrepancy between the present and previous findings might be attributed to the relatively small change in IAP in the study of Hagins et al. (2006). The difference in IAP between inspiratory and expiratory conditions is considerably lower in the previous study (Δ = 19.9 mmHg) than in the present study (Δ = 55.0 mmHg). The present study showed that there was no significant difference in hip extension MVC torque between normal and inspiratory or expiratory conditions although the differences in IAP were significant between normal and inspiratory (Δ = 27.4 mmHg) or expiratory conditions (Δ = 27.7 mmHg). Taken together, a sufficient increase in IAP might be needed to improve hip extension torque and performance involving hip extension such as lifting and running. As another possibility for the discrepancy between the present and previous findings, the difference in the task used might be involved. The prior studies (Hagins et al. 2006; McGill et al. 1990) have used a multi-joint lifting task, in which knee extension, trunk extension, and hip extension are involved. At present, however, it is yet unknown whether IAP can improve knee extension MVC torque. Thus, further researches are warranted to clarify whether a sufficient increase in IAP can lead to an enhancement of muscle strength developed during other single- (e.g., knee extension) and multi-joint movements (e.g., lifting).

As a potential mechanism for the causal effect of IAP on hip extension MVC torque, an action of IAP for the torque production might be involved. It has been suggested that extension torque is caused by the pressure acting on the diaphragm and pelvic floor (i.e., IAP) (Miyamoto et al. 1999; Stokes et al. 2010; Tayashiki et al. 20016a). Additionally, some studies suggest that activities of abdominal muscles such as the transverse abdominis and OI, which are needed to produce IAP, can generate lateral forces transmitted to the lumbodorsal fascia, causing trunk/hip extension (Cholewicki et al. 1999; McGill et al. 1990). Another possible mechanism is the effect of breathing state on agonistic muscle activities of limbs (Ikeda et al. 2009; Li and Laskin 2006; Li and Yasuda 2007). However, the effect of breathing state on muscle activities as well as torque development might be task- and muscle-dependent. For example, forced expiration enhanced finger flexors activities and maximal finger flexion force (Li and Laskin 2006) but did not affect maximal lifting force (Hagins et al. 2006). In the current results, all muscles analyzed had no significant differences in %EMGmax during hip extension MVC among the three conditions. This result rules out the possibility that breathing state influenced agonistic muscle activities during the prescribed MVC tasks. The examination of the precise mechanism for the causal effect of IAP on hip extension MVC torque is a very interesting research topic, but it requires a more appropriate research design.

In terms of practical relevance, core stability training has been reported to improve physical performance such as sprint running and jump (Jamison et al. 2012; Prieske et al. 2016; Sharma et al. 2012). To date, the precise mechanism underlying the improvements remains unclear. However, taking the present findings together with the previous finding that an 8-wk abdominal bracing training increased maximal IAP and hip extension MVC torque (Tayashiki et al. 2016a), it may be assumed that the possible increase in IAP, induced by core stability training, would play an important role for improving physical performance involving hip extension such as sprint running and jumping.

In summary, the current study for the first time demonstrated that breathing state during MVCs influenced both IAP and MVC torque in hip extension task but only IAP in hip flexion task. In addition, the significant associations between IAP and MVC torque were found only in hip extension. The current findings indicate that IAP has a positive causal effect on hip extension MVC torque and that a sufficient increase in IAP directly leads to an enhancement of hip extension MVC torque.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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