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Effects of abdominal belts on intra-abdominal pressure, intra-muscular pressure in the erector spinae muscles and myoelectrical activities of trunk muscles

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Abstract

Objective. To evaluate the effects of abdominal belts on lifting performance, muscle activation, intra-abdominal pressure and intra-muscular pressure of the erector spinae muscles.

Design. Simultaneous measurement of intra-abdominal pressure, intra-muscular pressure of the erector spinae muscles was performed during the Valsalva maneuver and some isometric lift exertions.

Background. While several hypotheses have been suggested regarding the biomechanics of belts and performance has been found to increase when lifting with belts, very little is known about the modulating effects on trunk stiffness. At present, there is no reason to believe that spine tolerance to loads increases with belts.

Methods. An abdominal belt designed for weightlifting was used. Intra-abdominal pressure, intra-muscular pressure of the erector spinae muscles and myoelectric activities of trunk muscles (erector spinae, rectus abdominis and external oblique) were measured simultaneously during the Valsalva maneuver as well as three types of isometric lifting exertions (arm, leg and torso lift). A paired *t*-test was used to analyze for statistical differences between the two conditions (without-belt and with-belt) in intra-abdominal pressure, intra-muscular pressure of the erector spinae muscles and in the integrated EMG of the trunk muscles.

Results. Intra-muscular pressure of the erector spinae muscles increased significantly by wearing the abdominal belt during Valsalva maneuvers and during maximum isometric lifting exertions, while maximum isometric lifting capacity and peak intra-abdominal pressure were not affected. Integrated EMG of rectus abdominis increased significantly by wearing the abdominal belt during Valsalva maneuvers (after full inspiration) and during isometric leg lifting.

Conclusions. Wearing abdominal belts raises intra-muscular pressure of the erector spinae muscles and appears to stiffen the trunk. Assuming that increased intra-muscular pressure of the erector spinae muscles stabilizes the lumbar spine, wearing abdominal belts may contribute to the stabilization during lifting exertions.

Relevance

The data presented in this study lead to a new concept that an abdominal belt may help to raise intra-muscular pressure of the erector spinae muscles and stiffen the trunk by increasing the activation of the rectus abdominis muscle.

Keywords: Abdominal belt; Lumbar spine; Intra-abdominal pressure; Intra-muscular pressure; Erector spinae; Lifting; Isometric

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1. Introduction

Lifting over exertion is linked to low-back pain. Some believe that wearing an abdominal belt is effective in preventing low-back injuries, although there is no conclusive proof [1,2]; in fact some evidence suggests the contrary. Some competitive weightlifters never perform maximum heavy liftings without wearing abdominal belts. In some industrial sectors, a variety of abdominal belts have become more widely used by manual handling workers [1,2]. Why do

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they wear abdominal belts when they perform liftings? What is the benefit of wearing belts during lifting tasks? At present, the biomechanical effect of the belts is controversial and there exist few reliable guidelines for prescribing the belts for manual handling workers [1,2]. However, given the suggestion that trunk stiffness may be affected by belt wearing [3], we were motivated to examine this possibility.

Firstly, we should define the 'abdominal belt' in this paper. Abdominal belts are not lumbar corsets which are often prescribed by orthopedists, but rather are those commonly used in competitive weightlifting. Most abdominal belts are made of leather, so they do not stretch easily. Abdominal belts are not as wide as lumbar corsets. During weightlifting, the width of abdominal belts is fixed by regulations, which is 6 cm in the front and 10 cm in the back.

Many researchers had tried to examine the effect and mechanisms of various abdominal belts in various ways [3–13]. For example, in some studies, intra-abdominal pressure (IAP), activity or strength of trunk muscles, lifting capacities, lifting motions and endurance were analyzed as parameters. However, the major biomechanical concern of most studies has been on the effect of belts on IAP during performances [4–8]. Specifically, belts are believed to provide stability to the lumbar spine through increases in IAP [4–6]. Classically, IAP was believed to relieve compressive load on the lumbar spine, as was stated by Bartelink [14] and Morris [15]. Furthermore, they suggested that IAP may contribute to spinal extensor moment by exerting a hydraulic force upon the diaphragm which acts anterior to the spine. Harman et al. [4] and Lander et al. [5,6] suggested that wearing a weight-belt contributed to the stabilization of the spine from observations that wearing the weight-belt raised the IAP during lifting. However, recent developments question this notion of the effect of IAP [16–18]. Over 20 years after the report of Bartelink [14] and Morris et al. [15], Nachemson et al. [16] observed that voluntary pressurization of the abdomen increased the intradiscal pressure of the lumbar spine rather than decreasing it, presumably a result of abdominal wall musculature activity. McGill [17] suggested that the theory of IAP as a significant mechanism in the reduction of disc loading has been overemphasized. Krag [18] noted that higher IAP during voluntary Valsalva maneuvers was accompanied with increased low-back electromyographic (EMG) activity. These issues raise some doubt that IAP relieves the compressive force acting on the lumbar spine. One unique theory was reported by Gracovetsky [19] that a high IAP pushes the lumbodorsal fascia away and this would increase the efficiency of the fascia as a contribution for longitudinal tension and an element for extending the spine. However, McGill and Norman [20] reported, using mathematical models, the potential of the lumbodorsal facsia to contribute significant extensor moment has been overestimated. Thus, the function of the IAP on the stability of the spine is controversial and debatable.

In another attempt to determine any effect of abdominal belts, McGill et al. used a new parameter-passive stiffness of the lumbar torso [3]. He reported that wearing the belt stiffened the torso about the lateral bending and axial rotation axes of the trunk. According to our survey among weightlifters in Japan [11], the majority of the lifters perceived enhanced stability and stiffness in their backs when they used the belts during lifting. Such feelings of stability and stiffness perceived by the weightlifters combined with the previous work on stiffness motivated this study. It was thought that the passive stiffness of the torso may be reflected in the intra-muscular pressure in the erector spinae (IMP-ES), which we previously reported, contributed to stabilization of the flexible spine against external forces [21]. Our specific purpose in the present study was to provide a clue to understanding the effect of the belts by measuring IMP-ES, simultaneously with IAP, lifting capacity and activities of trunk muscles. We paid particular attention to IMP-ES, because to our knowledge researchers have not yet analyzed the effect of the belts in the light of IMP-ES.

In this study, we examined the effect of the belts during maximum Valsalva maneuver and maximum isometric lifting tasks. We know many weightlifters perform heavy lifts with their breadth held. Sometimes a partial Valsalva is performed during maximum lifting exertions. However, controversy still exists about the amount of load relief that the Valsalva can provide. When we wear an abdominal belt, we feel externally compressed. If we perform the Valsalva with the belt, we feel much more compression and sometimes a feeling of security is perceived. Our intention to use Valsalva was to analyze the state when we feel compression and a feeling of security (during wearing the belt) objectively by some parameters, which was not evaluated in previous studies. We chose isometric lifting as a lifting condition for the following reasons. In dynamic lifts, differences in lifting speed, lifting posture and multi-joint motion would be brought about and these factors would make the comparison between with-belt and without-belt conditions complicated. We supposed isometric lift could minimize the differences in the lifting posture among subjects and between the two belt conditions (without-belt and with-belt).

2. Methods

2.1. Subjects

Seven healthy male volunteers (age 24–36) without low-back pain participated in this study. Their body masses ranged from 57 kg to 78 kg (mean, 70 kg) and their height ranged from 163 cm to 180 cm (mean, 175 cm). None of the 7 subjects was a trained weightlifter, although they regularly participated in some sports activities.

2.2. Abdominal belt

An abdominal belt made of three layers of leather (such as those worn by weightlifters) was used in this study. The width of the belt was 6 cm in the front and 10 cm in the back. The thickness of the belt was 7 mm. Subjects were encouraged to familiarize themselves with the belt before the experiments. The belt was cinched around their abdomen as tightly as possible, while taking care not to bring a feeling of discomfort at resting condition or during lifting procedures. As a consequence, the external compression by the abdominal belt provided a feeling of security and stability to all the subjects during each performance. The tension of the belt was not measured objectively in this study.

2.3. LIDO Lift system

A LIDO Lift system (Loredan Biomedical, Davis, CA, USA) was used to analyze lifting capacity and motion (either an isometric lift, isokinetic lift and isoinertial lift). High reliability of the LIDO Lift system was verified by Shibata et al. [22].

2.4. Experiment

2.4.1. Experiment 1

The subjects stood upright and performed the maximum Valsalva maneuver for 3 s both without-belt (WOB) and with-belt conditions (WB). In addition, the Valsalva was performed with breath held after full expiration; secondly, after full inspiration.

2.4.2. Experiment 2

The subjects performed three types of maximum isometric lifting exertions designed by Chaffin [23] (arm lift, leg lift and torso lift) (Fig. 1), for 5 s, using the LIDO Lift system under both WOB and WB conditions. Isometric lifting allows no joint motion during the performance. During the leg lifts, the subjects bent their knees to approximately 45° and gripped a T-handle in their hand, with their spines in a neutral posture. The height of the grip was adjusted to the height of their knees. In the torso liftings, the subjects bent their backs with their knees extended and gripped the T-handle at the height of their knees.

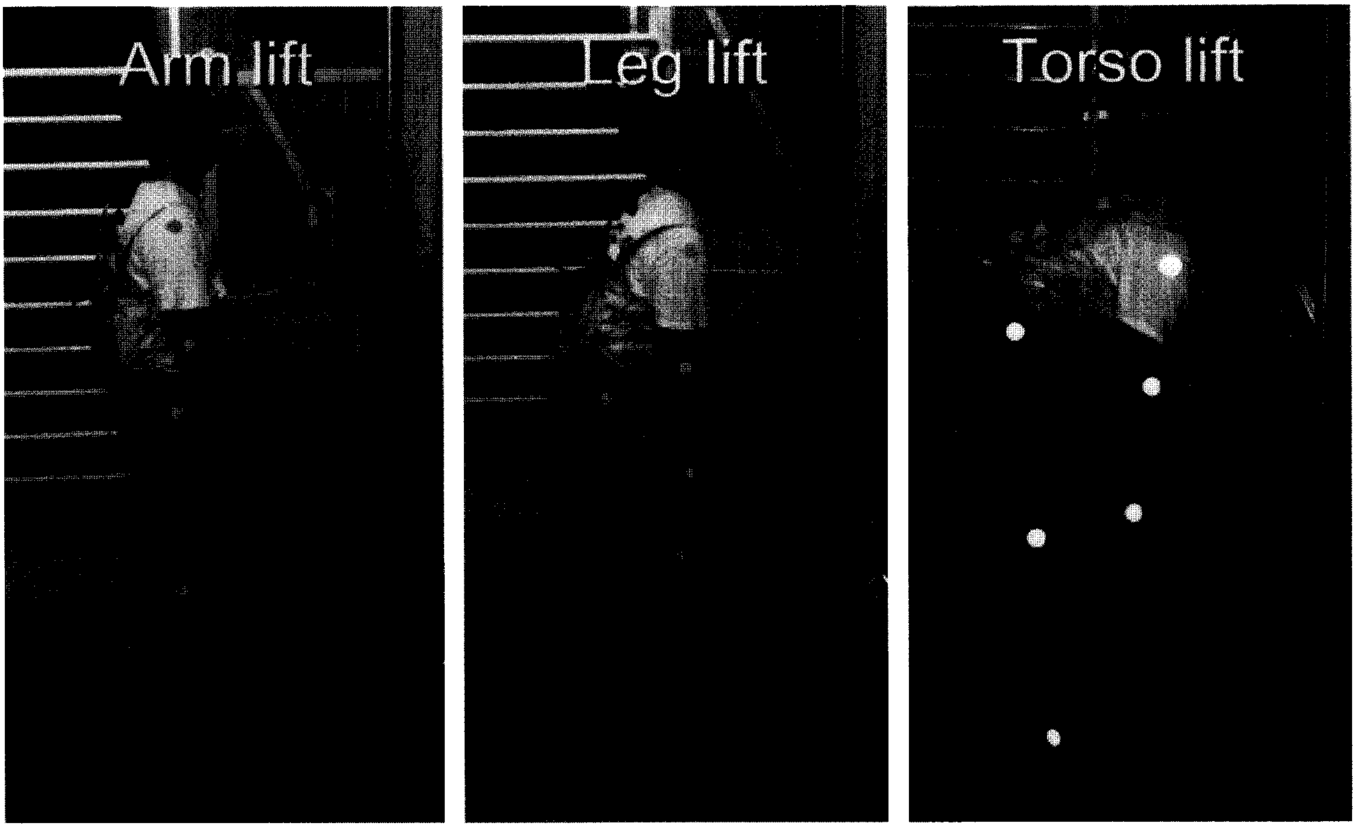

Fig. 1. Three types of isometric liftings (using the LIDO Lift system) were performed in this study. Left to right: arm lift, leg lift and torso lift.

2.5. Measurement of IAP, IMP-ES, myoelectric activities of trunk muscles and lifting force

In experiments 1 and 2, IAP, IMP-ES and myoelectric signals of trunk muscles were recorded simultaneously.

IAP was measured with a pressure-sensitive transducer (Keller, Winterthur, Switzerland) placed intrarectally, 15 cm from the anus. The pressure-sensitive transducer was covered with a balloon made of rubber. When necessary, the subjects were given an enema before measurements. Nordin et al. measured intra-abdominal pressure simultaneously with a wireless radio pill and two wire-connected pressure transducers introduced orally and rectally, respectively [24]. In their study, it was reported that an acceptable correspondence was found in wave forms of the generated pressure curves in time and shape.

IMP-ES was measured by means of the microcapillary infusion technique, reported by Styf et al. [25,26]. The procedure for introducing the pressure recording catheter was as follows [21]. The skin and subcutaneous tissue were anesthetized 3 cm laterally from the midline at the level of the third lumbar spinosus process with 5 ml of 1% Lidocaine (Fujisawa, Tokyo, Japan). Under sterile conditions, a sharp inner needle within an outer plastic tube of the Medikit set (Medikit, Tokyo, Japan) was inserted medially through the skin, at an angle of 30° from the plane of the skin. It passed the lumbodorsal fascia and stopped at 3 cm deep from the fascia in the erector spinae muscle. Care was taken for the cutting plane of the inner needle to be parallel to the fibers of the lumbodorsal fascia in order to minimize its damage. Then the inner needle was exchanged for a 30 cm catheter of 1.2 mm outer diameter which was filled with saline, while the outer plastic tube remained. After confirming the tip of the catheter resided into the erector spinae muscle, the outer tube was removed. The IMP measurement point at L3 was covered by the belt. However, care was taken that the belt should not cover nor apply compression to the catheter for the measurement of the IMP in the ES. The catheter was connected to the pressure-sensitive transducer. The infusion device of the system consisted of a rubber bag (infusion pump) containing 50 ml of saline connected to a microcapillary device (Shurefuser A, Nipro, Osaka, Japan). The microcapillary device was connected to the transducer line via a three-way stop-cock. During experiments, saline was infused at a constant rate of 0.7 ml per hour. Each pressure-sensitive transducer (for IAP and IMP-ES) was connected to an amplifier (Model BPM-100, Unique Medical, Tokyo, Japan).

Myoelectric signals of trunk muscles (the erector spinae; ES, the external oblique; EO, the rectus abdominis; RA) were recorded with bipolar surface electrodes, placed in bilateral pairs in the standing upright position during the Valsalva and in each lifting posture during isometric lifting exertions (Fig. 1). On the back a pair of electrodes was placed on the erector spinae muscles, 4 cm from the midline at the L4 level. Orientation was made by palpating the lower edge of the spinosus processus of the third lumbar spine. A pair of electrodes was placed over the rectus abdominis muscles just below the umbilicus level and over the oblique abdominal muscles, 3 cm superior and anterior to the iliac spines. The electrodes for rectus abdominis and external oblique were placed to avoid the coverage of the belt. However, the electrodes for erector spinae muscle were partially covered by the belt. The EMG signals were recorded at the sampling rate of 500 Hz. Then the signals were amplified, filtered (20–500 Hz), rectified and integrated for the duration of 2 s during the experiments. The 2 s for integration was determined carefully to include the time at which both peak IAP and IMP-ES appeared and not to miss the peak activity of any muscle. To compare the integrated EMG (IEMG) between two conditions (without-belt, with-belt), the IEMG data were normalized. The maximum IEMG value recorded during isometric trunk flexion, extension or twisting tasks was used as the normalization constant.

In the second experiment, lifting force was measured with a force sensor built in to the LIDO Lift system. All signals were A/D converted at 500 Hz by a personal computer (NEC, Tokyo, Japan) using wave analyzing software (Bimutas system, Kissei Comtech, Matsumoto, Japan). Statistical analysis between two conditions (WOB: without-belt, WB: with-belt) was performed using paired *t*-tests.

3. Results

In experiments 1 and 2, resting IAP and IMP-ES just before the exercise, peak IAP and IMP-ES during the exercise and maximum increase in IAP and IMP-ES were measured (Fig. 2) and compared between the two belt conditions.

3.1. Experiment 1

The resting IAP, the peak IAP and the maximum increase in IAP did not change significantly by wearing the belt in the Valsalva maneuvers, both with full expiration and inspiration (Tables 1 and 2). On the other hand, both maximum IMP-ES and increase of IMP-ES demonstrated a significant increase by wearing the belt in the Valsalva maneuvers, both with full expiration and inspiration (Fig. 3(A,B), Tables 1 and 2). In the Valsalva after inspiration, integrated EMG (IEMG) of RA increased significantly by wearing

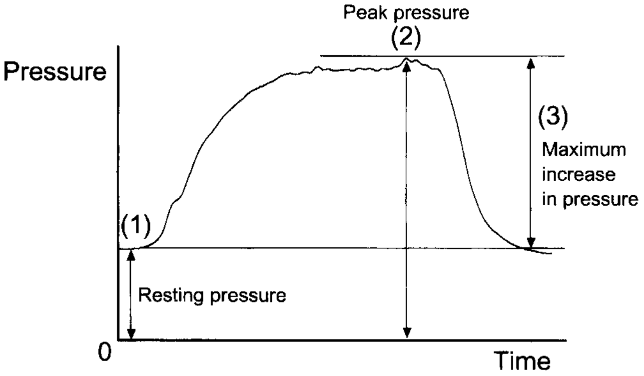

Fig. 2. A sample curve which indicates a change in pressure (representing IAP or IMP-ES) with the passage of time and the method for collecting data in each experiment. Resting pressure (1) at the beginning of the exercise and peak pressure, (2) during the exercise were measured. The difference between the resting pressure and the peak pressure was referred to maximum increase in pressure (3).

the belt (Fig. 5, Table 2). No significant changes were observed in IEMG of ES and EO (Fig. 5, Table 2).

3.2. Experiment 2

We did not particularly instruct the subjects to lift with breath held; however, all of them performed their maximum isometric lift with their breath held. We made it sure that isometric lifting tests were performed under the same breathing conditions in the two belt conditions. Isometric lifting capacity (peak force) was not significantly affected by wearing the belt in the three types of lifting (Tables 2 and 3). Neither peak IAP nor maximum increase in IAP was affected significantly by wearing the belt (Tables 1 and 2). On the other hand, resting IMP-ES, maximum IMP-ES and maximum increase of IMP-ES demonstrated a significant increase by wearing the belts (except for the maximum increase in IMP in the arm lift) (Fig. 4(A–C), Tables 1 and 2). In the leg lift, IEMG of RA

Table 1
Maximum increase in intra-abdominal pressure (IAP) and intra-muscular pressure in the erector spinae muscle (IMP-ES) during the Valsalva maneuver and three types of maximum isometric lifting ($n = 7$)

	Maximum increase in IAP (mmHg)		Maximum increase in IMP-ES (mmHg)	
	Without-belt	With-belt	Without-belt	With-belt
Valsalva maneuver (after full expiration)	55.8 (17.6)	64.0 (23.7)	47.3 (22.3)**	74.2 (19.1)**
Valsalva maneuver (after full inspiration)	72.0 (24.6)	80.2 (17.0)	53.9 (28.0)**	105.5 (20.7)**
Isometric arm lift	47.1 (20.8)	47.7 (17.0)	59.0 (34.2)	68.9 (36.4)
Isometric leg lift	59.5 (14.1)	59.8 (23.6)	58.9 (59.0)*	110.7 (31.0)*
Isometric torso lift	53.1 (23.9)	53.7 (32.3)	114.9 (48.9)**	248.5 (94.0)**

Averages and SD (in parentheses) are shown. When the belt is worn, maximum increase in IMP-ES was significantly higher in the Valsalva maneuver, isometric leg lifting and isometric torso lifting.
*$p<0.05$; **$p<0.01$.

Table 2
Percentage changes in peak force (only in lifting), IAP, IMP-ES and integrated EMG of the trunk muscles due to lifting with an abdominal belt with the without-belt condition as a base ($n = 7$)

	Peak force	IAP		IMP-ES		IEMG		
		Peak	Maximum increase	Peak	Maximum increase	RA	EO	ES
Valsalva (after full expiration)	—	10	16	59*	83**	19	18	−13
Valsalva (after full inspiration)	—	20	29	106***	133**	43**	−16	22
Isometric arm lift	−2	4	4	50*	31	10	−16	12
Isometric leg lift	2	−3	−3	182*	222*	54*	−14	18
Isometric torso lift	2	−4	−5	127**	136**	5	−30	17

The rectus abdominis muscle showed significant increase in its activation in the Valsalva and isometric leg lifting. RA: rectus abdominis muscle, EO: external oblique muscle, ES: erector spinae muscle.
*$p<0.05$, **$p<0.01$, ***$p<0.001$.

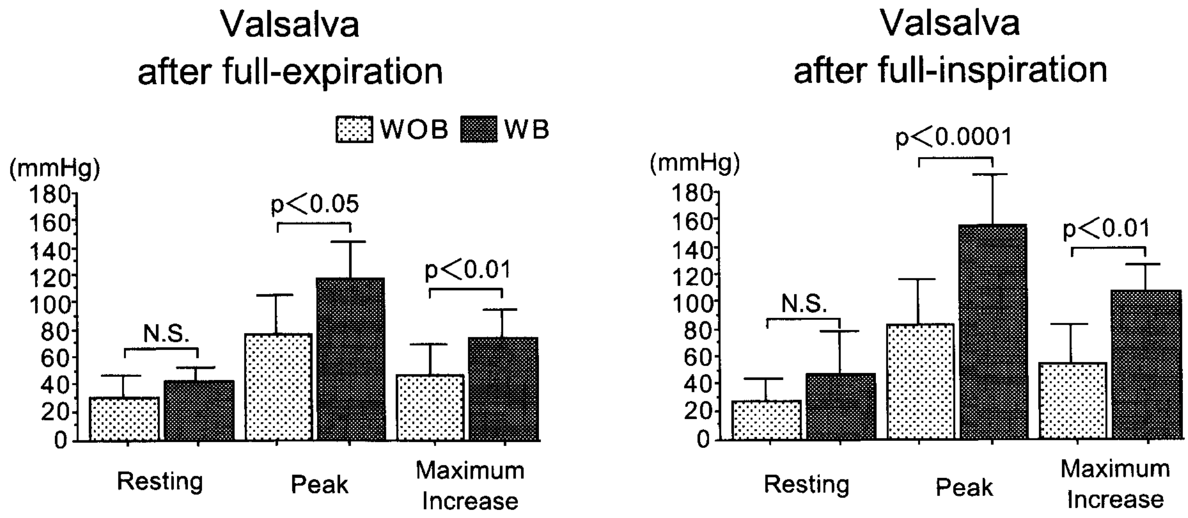

Fig. 3. The effect of the abdominal belt on IMP-ES during the Valsalva maneuver. Graphs show means and SD of the resting IMP-ES, the peak IMP-ES and maximum increase of the IMP-ES during the Valsalva maneuver ($n = 7$): (A) the Valsalva maneuver after full expiration; (B) the Valsalva maneuver after full inspiration. WOB: without-belt conditions, WB: with-belt conditions

Table 3
Mean and SD (in parentheses) of peak force in three types of isometric liftings are shown ($n = 7$); peak force demonstrated no significant difference between the two belt conditions in three types of isometric liftings (WOB: without-belt conditions, WB: with-belt conditions)

	Peak force (lbs)	
	Without-belt	With-belt
Isometric arm lift	67.2 (12.2)	66.0 (13.9)
Isometric leg lift	131.9 (40.3)	134.8 (45.4)
Isometric torson lift	129.2 (23.4)	131.0 (36.5)

increased significantly by wearing the belt (Fig. 5, Table 2). No significant changes were observed in IEMG of ES and EO (Fig. 5, Table 2).

4. Discussion

While several hypotheses regarding the action of belts have been suggested, we focused on the modulation of stiffness of the trunk in the present study. IAP, IMP-ES and trunk muscle activity were measured simultaneously during the Valsalva maneuver as well as three types of isometric lifting exertions to evaluate of the effect of an abdominal belt, which, as far as we

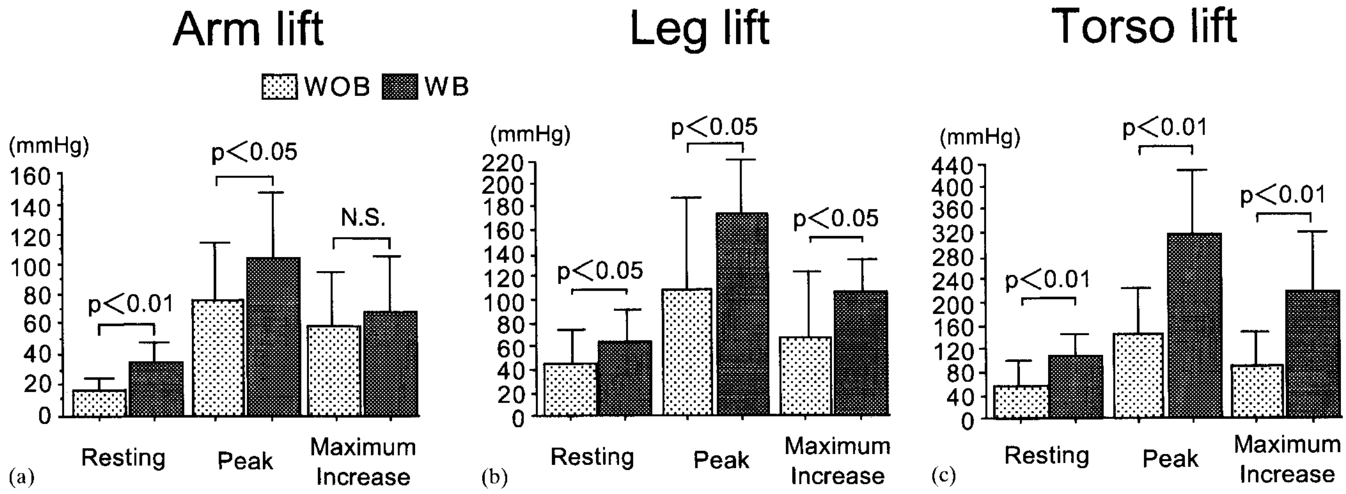

Fig. 4. The effect of the abdominal belt on IMP-ES during three types of isometric liftings: (A) arm lift, (B) leg lift, (C) torso lift. Graphs show means and SD of the resting IMP-ES, the peak IMP-ES and maximum increase of the IMP-ES during three types of isometric liftings ($n = 7$). WOB: without-belt conditions, WB: with-belt conditions.

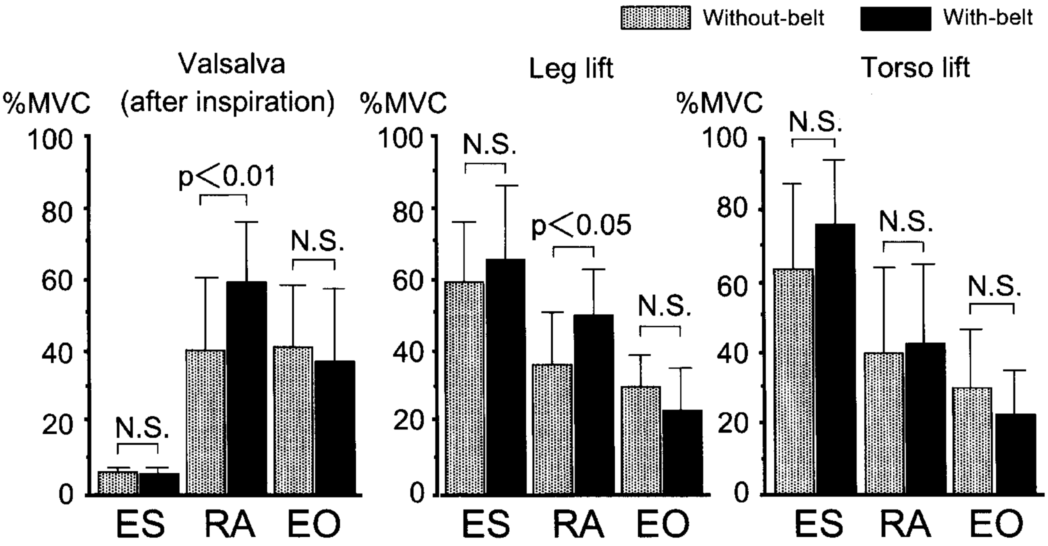

Fig. 5. Comparison of integrated EMG of trunk muscles (ES: erector spinae, RA: rectus abdominis, EO: external oblique) between the two belt conditions, in the Valsalva maneuver (after inspiration), isometric leg lifting and isometric torso lifting ($n = 7$). Integrated EMG was normalized to a %MVC (maximum voluntary contraction) of each muscle.

know, had never been attempted. We chose isometric lifting as a lifting condition because, we supposed, it could minimize the differences in the lifting posture among subjects in the two belt conditions (without-belt and with-belt).

Because the electrodes for ES were partially covered by the belt, there might be some artifact in the measured myoelectric activities of ES. However, we observed very little difference in myoelectric activities in ES with the external compression by the belt which was partially covering the electrodes. The differences were smaller than those that occurred upon repetition of the same tasks and were not significant in each subject. Lantz and Schults [27] also reported the same result on the compression on the electrodes by an orthosis.

Two findings are important in the results of the present study. One is that IMP-ES was increased significantly by wearing the belt, while IAP was not increased significantly. One of the possible explanations for it may be that the abdominal cavity can expand to some extent, while the compartment of the erector spinae muscle cannot expand because of the presence of the firm lumbodorsal fascia. The other finding is that the activation of the rectus abdominis muscle was increased in the Valsalva maneuver (after full inspiration) and isometric leg lifting. McGill et al. [7] reported that the activation of the rectus abdominis was significantly increased during lifting by wearing a competition lifting belt, although no explanation was proposed. The rectus abdominis contracts, shortens its length and moves a little forward in a usual way. In the presence of the belt, which presses the middle portion of the rectus abdominis, the rectus abdominis needs more intense contraction to shorten its length and move a little forward than in without-belt condition. In our experiments, in the Valsalva and isometric leg lifting, a greater EMG signal in the rectus abdominis was observed. We suppose that the presence of the belt acted as a resistance to the rectus abdominus. We also suppose that the excessive energy that was required was spent increasing the tension of the belt, which applied an external compression on the back. The EMG signal in the erector spinae showed no significant differences between the two belt conditions. This may be because of the difference of muscle form of the rectus abdominis and the erector spinae. The belt did not seem to act as a resistance to the erector spinae. During maximum lifting, each subject would contract the ES fully and this may cause the nonsignificant difference.

The hypothesis we have about the biomechanics of the belt on the horizontal plane is as follows (Fig. 6): when the belt is tightened around the abdomen and prevents the anterior protrusion of abdominal wall, the belt works as a resistance against the contraction of the rectus abdominis muscle. In this condition, the subject can perform more intense voluntary contraction of the rectus abdominis muscle than usual. This is probably the reason for increased activity of the rectus abdominis during wearing the belt. The contracted rectus abdominis pushes the belt forward while the posterior part of the belt applies compression to the extensor compartment of the lumbar spine. This compression probably stiffens the extensor compartment of the lumbar spine. Increased IMP observed in our study may be one of the consequences of this compression. McGill et al. [3] reported that passive stiffness of the

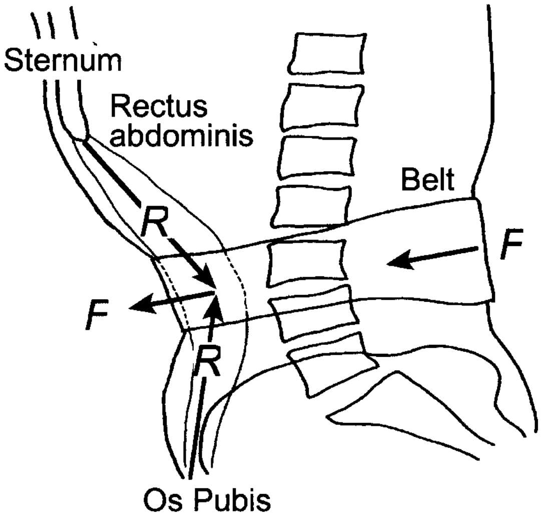

Fig. 6. The hypothesis about the biomechanics of abdominal belts. When the belt is tightened around the abdomen and prevents the anterior protrusion of abdominal wall, the belt can work as a resistance against the contraction of the rectus abdominis muscle. The force produced by the contraction of the rectus abdominis (arrow R) partly changes its direction to push the belt forward (arrow F) and apply compression to the extensor compartment of the lumbar spine.

torso was elevated by wearing an abdominal belt. Our result may seem to support his theory. In this hypothesis, when the activation of the rectus abdominis is increased, IMP-ES is elevated. Of course, the contraction of the erector spinae may also be one of the factors of elevating IMP-ES. Assuming that increased IMP-ES stabilizes the lumbar spine, wearing abdominal belts may contribute to the stabilization during Valsalva maneuvers and maximum lifting exertions. Based on the result of the present study, we don't intend to assert that increased IMP, which was achieved by wearing the belt, stabilizes the spine. Further study is needed to evaluate the stabilizing effect of the belt on the lumbar spine.

In the present study, IAP was not elevated significantly by wearing an abdominal belt. This result differs from the studies of Harman et al. [14], Lander et al. [5,6] and McGill et al. [7] in which IAP was increased significantly by wearing the belt. This may be due to differences in the lifting condition and selection of subjects. In their studies, IAP was measured and compared while lifting the same weight isoinertially in two conditions (without-belt and with-belt). We would like to make it clear that the design of our study is not to compare IAP and IMP during creating the same (isometric) lifting force between the two conditions, but to compare IAP and IMP during maximum (isometric) lifting exertions. There exist two different factors, that is, lifting styles (isoinertial or isometric) and levels of lifting exertions (submaximum or maximum). These are important points to distinguish the method of our study from those of previous studies [4–7]. In the studies of Harman et al. [4], Lander et al. [5,6] and McGill et al. [7], the subjects in their studies included skilled weightlifters, whereas none of the subjects in the present study was a weightlifter. According to our survey among weightlifters in Japan [11], the majority of the lifters answered that it requires experience to get a positive effect from wearing abdominal belts to perform lifts. The authors suppose that, if increased IAP is one of the benefits obtained by wearing the belt as was stated in some previous studies and creating high IAP with the belt is something that needs some experience [11], the 7 subjects in our study might not have sufficient experience although they provided average isometric lifting capacity compared with Japanese young male database [19]. In addition, the number of the subjects in our study is only 7, which seems to be very small. There may not be sufficient statistical power. We recognize that these several limitations restrict the relevance of the data reported here. We do not intend to state that the increase in IAP is always nonsignificant by wearing abdominal belts in all kinds of lifting styles. Further study is required to analyze IAP and IMP-ES in various lifting tasks and in various subjects.

Some would expect that lifting capacity should increase by wearing the belt. However, in the present study, isometric lifting capacity was not changed by wearing an abdominal belt. The result was the same in our previous study [8] for a larger number of subjects (38 male subjects; the same belt, used in the present study, was used). Reyna et al. [12] also obtained the same result. She reported that isoinertial lifting capacity and selected trunk muscle strengths were not changed significantly by a lumbar support belt.

The result of this study is something new and interesting. To prove our hypothesis about the biomechanics of the belt on the horizontal plane, further study is required to evaluate the effect of the belts on the motions of abdominal wall during Valsalva maneuvers and lifting tasks. Ongoing research in our laboratory focuses upon evaluations of CT-scanned images of the trunk to assess the effect of the belt [28]. Perhaps future findings will support the fact that wearing the belts raise IMP-ES and provide stability on the lumbar spine. We hope these findings will contribute to establishing more reliable guidelines for prescribing abdominal belts to manual workers.

5. Conclusions

In Valsalva maneuver and maximum isometric lifting tasks, wearing the abdominal belt significantly increased the intra-muscular pressure of the erector spinae muscle. On the other hand, maximum isometric lifting capacity and peak intra-abdominal pressure were not affected by wearing the belts. Integrated electromyogram of rectus abdominis muscles increased significantly by wearing the abdominal belt in Valsalva maneuver and isometric leg lifting. Wearing the weight-belts raised the IMP and were supposed to stiffen the trunk. Thus, the belts may contribute to the stabilization of the lumbar spine. Measurement of intra-muscular pressure of the lumbar back muscles might be a useful new method for obtaining a greater knowledge about the effectiveness of abdominal belts.

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