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Muscle activity of the Lumbo-pelvic-hip complex in three isometric exercises using TRX ® rip trainer™

Actividad muscular del complejo Lumbo-Pelvis-Cadera en tres ejercicios isométricos usando TRX® rip trainer™

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Abstract. One of the tools currently used for strengthening the lumbo-pelvic-hip complex (LPHC) is the TRX ® Rip Trainer™. This device produces asymmetric destabilizing forces by means of an elastic resistance (ER) cord. This study aimed to compare the level of muscle activity of LPHC, during the performance of three isometric exercises using TRX ® Rip Trainer™. Twenty-two healthy, physically active men (mean age 23 ± 2.35 years) were evaluated during the performance of «Drag» (anterior), «Drive» (posterior) and «Stack» (rotation) isometrically resisted exercises, performed using TRX ® Rip Trainer ™. The muscle activity of longissimus, external oblique, gluteus medius, and biceps femoris was recorded by means of surface electromyography. There were differences regarding the side of the ER location in most of the evaluated muscles (p <.05). In addition, a Friedman test revealed differences between the exercises in relation to the evaluated muscle (*p*<.05). Usually, Stack exercise produces a higher level of activity in these muscles. The findings of this study describe the behavior of LPHC muscles during the use of TRX ® Rip Trainer ™.

Keywords: Isometric exercises; surface electromyography; lumbopelvic stabilization; elastic resistance; Lumbo-pelvic-hip complex.

Resumen. Una de las herramientas actualmente utilizadas para el fortalecimiento del complejo lumbo-pelvis-cadera (CLPC) es el TRX® Rip Trainer ™. Este dispositivo produce una fuerza desestabilizadora asimétrica por medio de un cordón de resistencia elástica (RE). Este estudio tuvo como objetivo comparar el nivel de actividad muscular de CLPC, durante la realización de tres ejercicios isométricos utilizando TRX® Rip Trainer ™. Veintidós hombres sanos, físicamente activos (edad media de 23 ± 2,35 años) se evaluaron durante la realización de los ejercicios de resistencia a la isometría «Drag» (anterior), «Drive» (posterior) y «Stack» (rotación), realizados con TRX® Rip Trainer ™. Mediante electromiografía de superficie, se registró la actividad muscular de longísimo, oblicuo externo, glúteo medio y bíceps femoral. Hubo diferencias en relación con el lado de la ubicación de RE, en la mayoría de los músculos evaluados (*p* <.05). Además, un test de Friedman reveló diferencias entre los ejercicios en relación con el músculo evaluado (*p* <.05). Por lo general, el ejercicio Stack produce un mayor nivel de actividad en estos músculos. Los resultados indicados en este estudio describen el comportamiento de los músculos CLPC durante el uso de TRX® Rip Trainer ™.

Palabras clave: ejercicios isométricos; electromiografía de superficie; estabilización lumbopélvica; resistencia elástica; complejo lumbo-pelvis-cadera.

Introduction

Core stability is the result of motor control and muscular endurance of the lumbo-pelvic-hip complex (LPHC) (Leetun, Ireland, Willson, Ballantyne, & Davis, 2004). The LPHC acts as a connection between the upper and lower extremities, contributing to the body movement through muscular activity which stabilizes the lumbar spine, pelvis and hip (Barwick, Smith, & Chuter, 2012; Chang, Slater, Corbett, Hart, & Hertel, 2016; Rivera, 2016; Shimamura et al., 2015; Washington, Gilmer, & Oliver, 2018). Although the importance of the role of deep local stabilizing muscles has been recognized, current research has focused on the more superficial global movers, due to their contribution to lumbopelvic segment stability (Bergmark, 1989; Chang, Slater, Corbett, Hart, & Hertel, 2017). However, the action of the hip muscles to maintain the stability of this segment is unclear.

It has been recognized that maintaining core stability reduces the likelihood of suffering from back pain and lower limb injuries (Borghuis, Hof, & Lemmink, 2008; Cinar-Medeni, Baltaci, Bayramlar, & Yanmis, 2015). Coulombe, Games, Neil, & Eberman (2017) indicate that within three months, core stability exercises are more effective than general exercises to decrease pain and increase the functional status in patients with low back pain. In athletes suffering from low back pain, the literature has been insufficient to affirm the effectiveness of the use of core stability exercises (Hibbs, Thompson, French, Wrigley, & Spears, 2008; Reed, Ford, Myer, & Hewett, 2012; Stuber, Bruno, Sajko, & Hayden, 2014). However, benefits for sports performance have been reported in this group (Behm, Drinkwater, Willardson, & Cowley, 2010; Butcher et al., 2007; Willardson, 2007).

Progression of exercises aimed at stabilizing the core begins with the isometric contraction of the muscles of the lumbar spine, pelvis and hip (McGill & Karpowicz, 2009). Therefore, it is recommended that a training or rehabilitation program should start with isometric exercises directed at the specific contraction of the muscles of the LPHC, and then progress towards more functional movements (Alvarez, Rial, Chulvi, Garcia, & Cortell, 2016; Bastida, Gómez-Carmona, Reche, Granero, & Pino, 2018; Bliss & Teeple, 2005; Javadian, Akbari, Talebi, Taghipour-Darzi, & Janmohammadi, 2015; Kennedy & Noh, 2011; Naclerio Ayllón, 2008).

There are multiple tools that facilitate the increase of specific contraction of the muscles of the LPHC, one of them is the elastic resistance (ER), because it can produce a force capable of destabilizing the trunk, which must be resisted by the person (Calatayud et al., 2015; McGill, Cannon, & Andersen, 2014). The ER contributes to muscular strengthening by means of loads that can be adjusted to individual intensity and that are carried out in different directions (Chen, Li, Chang, Huang, & Cheng, 2015). Calatayud et al. (2015), have analyzed that in addition to the postural condition, ER additionally increases the muscle activity of the LPHC. In addition, Aboodarda, Page, & Behm (2016), through a meta-analysis, have found that ER provides a muscular activation similar to isoinertial resistance, so it can be used as a tool for progressive resistance programs. Currently, the direction of the tension that must be resisted to produce greater muscular activity of the LPHC has not been estimated.

Using the principle of training with ER to increase the core stability, the commercial device TRX ® Rip Trainer™ was created, which was included in gyms as a tool aimed to provide dynamic stabilization of the LPHC and force to the upper extremities. By means of a lever bar and an elastic cable, this device provides an asymmetric or unilateral resistance that must be controlled by the person («What is TRX Rip Training?» Retrieved from https://www.trxtraining.com/rip-training). The exercises that are currently performed with this device are intended to resist the anterior, posterior and rotational tension. Because the elastic resistance generates a unilateral tension, this device will always produce a rotational resistance, which would generate an increase in the activation of the lumbopelvic muscles (Andersson, Grundstrom, & Thorstensson, 2002; Sugaya, Sakamoto, Nakazawa, & Wada, 2016). However, there are no studies describing muscle activity produced by an exercise performed with TRX® Rip Trainer ™. This information may be important because it could help direct the specific training of the LPHC muscles.

The purpose of this study was to compare the level of LPHC

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muscle activity during the execution of three isometric exercises using TRX ® Rip Trainer™. This study also assessed the activity of these muscles according to the location side of the ER. Thus, our hypothesis was that the greater the rotational tension that must be resisted, the greater the muscular activity of the LPHC.

Materials and Methods

Design

An observational, analytical, cross-sectional study was used.

Participant

Volunteers were selected among the college student community. The size of the sample was calculated using a GPower software (V.3.1.9.2, Düsseldorf, Germany), based on the values reported by Vinstrup et al. (2015) of the external oblique (left) when the elastic resistance vs machine were compared (54 ± 28.4; 77 ± 27.3; p = .0018), calculated at two tails with a value á = .05 and a power (1-â) = .95. The sample consisted of 22 healthy, physically active men with mean values ± standard deviation of 23 ± 2.35 years old; 1.73 ± .05 cm height; 70.96 ± 7.47 kg and a body mass index of 23.48 ± 2.38 kg/m^2. Participants who performed physical activity less than three times a week with a duration of less than 50 minutes, those who had a history of lumbar spine or hip surgery and those who presented with discomfort that prevented the exercise performance were excluded from the study.

Procedures

Participants were contacted by telephone or email two weeks prior to the evaluation. Participants were referred to the laboratory, where they were informed of the purpose and protocol of the study. Each participant freely signed an informed consent based on the declaration of Helsinki, according to the requirements of an ethics committee (Folio number: EK 1014). Then, each volunteer answered a questionnaire where the exclusion criteria were identified.

The volunteers were instructed by a certified instructor who explained them and showed them the correct execution of each exercise. The selection of the order of the exercises was randomly made in each assessment by means of a spreadsheet (Excel ® 2007). The participant performed a repetition for each exercise, where he had to maintain the position for 30 seconds to imitate a time of execution that is regularly used, which was observed by an evaluator. The participant rested two minutes between each exercise.

The TRX ® Rip Trainer ™ was used for the performance of the exercises. The description provided by the manufacturer consists of a metal bar of 1.1m in length, 18mm in diameter and an elastic cord that produces a resistance of 9.1kg. As a whole, this device has a weight of 1.8kg. A carabiner hook was placed on a wall, 1.25 m above the ground, where the resistance cord was fixed. The participants were placed at three meters from the carabiner hook to perform the exercises. Each exercise was performed both ipsilaterally and contralaterally alongside the muscle to be evaluated, since the device produces an asymmetric ER.

Description of exercises

«Drag»: The volunteer stood in front of the anchor point with his hands taking the center of the bar with the palms downwards. Then, he flexed his arms and elbows so that the bar was at his chest height, making a force opposite to the anterior tension caused by the device. (Figure 1A)

«Drive»: The volunteer was placed on his back facing to the anchorage point with his hands taking the center of the bar and the palms downwards. Then, he extended his arms at the level of the chest, making a force opposite to the posterior tension caused by the device. (Figure 1B)

«Stack»: The volunteer was placed alongside the anchor point with the hands taking the center of the bar with the palms towards the center of the body. Then, he performed a trunk rotation, so that one hand is at the ipsilateral hip level, while the other hand takes the bar in front of the trunk, making a force opposite to the rotation tension caused by the device. (Figure 1C)

In order to evaluate the muscular activity, a surface electromyogram was used (Bagnoli-16. Delsys. Boston. MA. USA). To reduce skin impedance, the area to be evaluated was prepared by shaving the surface hairs and cleaned with 95% denatured alcohol. The location of the electrodes was performed according to the SENIAM standard (Hermens, Freriks, Disselhorst-Klug, & Rau, 2000). Muscles of the lumbo-pelvic-hip complex were bilaterally evaluated. The shown data correspond to right-sided muscles, since a previous analysis did not identify any difference between the comparisons of muscle activity with the opposite side (Table, Appendix). The muscles evaluated were longissimus (LG), external oblique (EO), gluteus medius (GM) and biceps femoris (BF).

Table, Appendix:
Comparison of muscle activity on both sides, according to the tension of the exercise.

	Right Longissimus Median (IQR)	Left Longissimus Median (IQR)	*p* value	Right External Oblique Median (IQR)	Left External Oblique Median (IQR)	*p* value	Right Gluteus Medius Median (IQR)	Left Gluteus Medius Median (IQR)	*p* value	Right Biceps Femoris Median (IQR)	Left Biceps Femoris Median (IQR)	*p* value
Ipsilateral Drag	.55 (.31-.65)	.61 (.44-1.0)	.33	1.49 (.95-2.89)	1.26 (.39-2.57)	.09	.77 (.55-1.28)	.66 (.38-1.04)	.41	2.64 (1.93-3.23)	2.98 (1.79-3.72)	.37
Contralateral Drag	1.22 (.54-1.70)	1.41 (.81-1.60)	.37	1.33 (1.03-2.0)	1.5 (.97-2.20)	.86	.63 (.44-1.20)	.67 (.41-1.04)	.89	.30 (.22-.52)	.32 (.23-.51)	.47
Ipsilateral Drive	1.34 (.92-1.71)	1.33 (.86-1.69)	.86	1.05 (.81-1.49)	1.02 (.84-1.52)	.56	.68 (.55-1.04)	.80 (.41-1.38)	.34	.29 (.18-.53)	.38 (.23-.62)	.18
Contralateral Drive	.64 (.38-1.29)	.6 (.44-.85)	.31	1.68 (.99-2.46)	1.5 (.68-2.65)	.09	.85 (.43-1.65)	.76 (.55-1.11)	.56	2.71 (.20-3.84)	2.59 (.99-3.32)	.16
Ipsilateral Stack	2.97 (1.30-3.61)	2.51 (1.98-3.58)	.70	2.35 (1.67-3.18)	2.76 (2.13-4.83)	.17	.87 (.68-1.23)	.77 (.36-1.16)	.33	.38 (.26-.57)	.47 (.26-.65)	.16
Contralateral Stack	1.13 (.74-1.49)	.92 (.71-1.23)	.07	2.87 (1.17-4.73)	2.65 (1.47-5.02)	.72	1.39 (.78-2.20)	1.39 (.59-2.13)	1	4.36 (.67-5.73)	5.22 (1.86-6.45)	.38

Note: Data are expressed in millivolt.

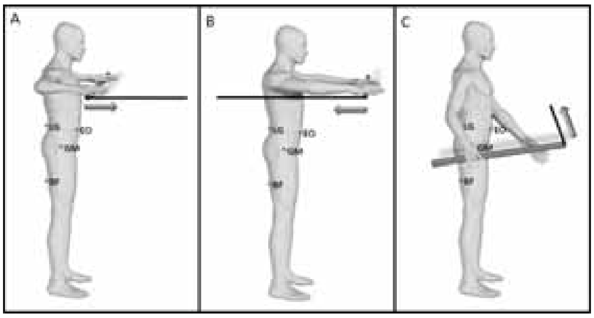

Figure 1
Scheme of the execution of the Exercises. A: Drag, B: Drive and C: Stack (for a better understanding, the picture shows the exercise with contralateral tension). The arrow indicates the direction of resistance to be maintained. The points indicate the location of the electrodes for longissimus (LG), external oblique (EO), gluteus medius (GM) and biceps femoris (BF).

Data processing

The signals obtained from the muscles were sampled with a sampling frequency of 1000Hz and captured using software (EMGworks 4.0 Acquisition. Delsys. Boston. MA. USA). Then, a computational macro was used (Igor Pro 6.37. WaveMetrics. OR. USA.), where the signal was loaded to be processed with a 4th order, low pass filter of 20 Hz. The analysis window included 30 seconds of the test. Thus, the muscle electrical activity was characterized as the average of the rectified signal, which was used as our outcome.

Statistical analyses

The distribution of the sample was determined using the D'Agostino & Pearson test, where a non-parametric distribution of the data was identified. Then, the muscle activity during the execution of each exercise with the ER located on the ipsilateral side versus the location of the ER on the contralateral side of the muscle was compared using the Wilcoxon test. In addition, a Friedman test was applied to each muscle, by comparing the three exercises according to the location of the ER in relation to the muscle to be evaluated, using the Dunn test as a posteriori test. The used level of significance was *p* <.05. The data were analyzed in the GraphPad Prism 5 software.

Results

The results are presented as medians and interquartile range.

When comparing the muscle activity during the execution of each exercise, with the ER located on the ipsilateral side versus the side contralateral to the muscle to be evaluated, LG shows significant differences in Drag (*p* = .016), Drive (*p* = .015) and Stack (*p* = .002), EO shows significant differences only in Drive (*p* = .014), GM only in Stack (*p* = .038) and BF in Drag (*p* <.001), Drive (*p* <.001) and Stack (*p* < .001). (Table 1)

Table 1.
Comparison of the muscular activity according to the location side of the elastic resistance during the execution of three exercises using TRX ® Rip Trainer ™. Data was expressed in milli Volt, in 22 volunteers. IQR: Interquartile range.
Note: Drag=Anterior tension; Drive=Posterior tension; Stack=Rotational tension

Exercise	Muscle	Elastic Resistance Side Ipsilateral *Median (IQR)*	 Contralateral *Median (IQR)*	*p* value
Drag	Longissimus	.55 (.31-0.65)	1.22 (.54-1.70)	.016*
	External Oblique	1.49 (.95-2.89)	1.33 (1.03-2.0)	.098
	Gluteus Medius	.77 (.55-1.28)	.63 (.44-1.20)	.795
	Biceps Femoris	2.64 (1.93-3.23)	.3 (.22-.52)	<.001***
Drive	Longissimus	1.34 (.92-1.71)	.64 (.38-1.29)	.015*
	External Oblique	1.05 (.81-1.49)	1.68 (.99-2.46)	.014*
	Gluteus Medius	.87 (.55-1.04)	.85 (.43-1.65)	.548
	Biceps Femoris	.29 (.18-0.53)	2.71 (2.20-3.84)	<.001***
Stack	Longissimus	2.97 (1.30-3.61)	1.13 (.74-1.49)	.002**
	External Oblique	2.35 (1.67-3.18)	2.87 (1.17-4.73)	.173
	Gluteus Medius	.87 (.68-1.23)	1.39 (.78-2.20)	.038*
	Biceps Femoris	.38 (.26-.57)	4.36 (.67-5.73)	<.001***

When comparing the performances of the three exercises by placing the ER on the ipsilateral side, LG has a higher level of activation in the Stack exercise than in the Drag (*p* <.001) and Drive (*p* <.05) exercises; EO has a higher activation level in Stack than in Drive (*p* <.05). When comparing the performances of the three exercises by placing the ER on the contralateral side, LG showed a higher level of activation in Stack than in Drive (*p* <.05); EO had a higher level of activation in Stack with respect to Drag (*p* <.01). (Figure 2)

When comparing the performances of the three exercises by placing the ER on the ipsilateral side, GM had no differences and BF had a higher level of activation in Drag with respect to Stack (*p* <.001) and Drive (*p* <.001). When comparing the performances of the three exercises by placing the ER on the contralateral side, GM showed a higher level of activation in Stack than in Drag (*p* <.05) and Drive (*p* <.05), and BF showed a higher level of activation in Stack in relation to Drag (*p* <.001) and a higher activation in Drive in relation to Drag (*p* <.001). (Figure 3)

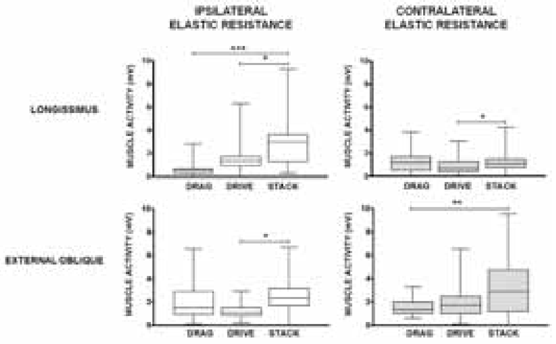

Figure 2.
Muscle activity in 22 volunteers of the Longissimus and External Oblique, during the execution of three exercises using TRX ® Rip Trainer ™, compared according to the location side of the elastic resistance. The box plot shows the median, IQR, and max/min values. (*=*p* <.05; **=*p* <.01; ***=*p* <.001)

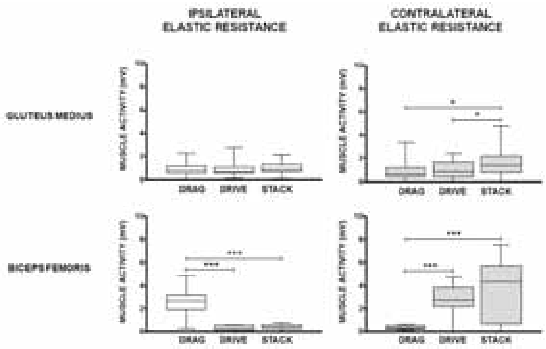

Figure 3.
Muscle activity in 22 volunteers of the Gluteus Medius and Biceps Femoris, during the execution of three exercises using TRX ® Rip Trainer ™, compared according to the location side of the elastic resistance. The box plot shows the median, IQR, and max/min values. (*=*p* <.05; ***=*p*<.001)

Discussion

The purpose of this study was to compare the level of LPHC muscle activity during the execution of three isometric exercises using TRX ® Rip Trainer™. Different muscle activation levels were observed when the exercises were compared according to the location of the ER and the direction of tension.

Location of the Elastic Resistance

The data obtained from our report suggest that the execution of each exercise should consider the ipsilateral or contralateral location of the ER provided by TRX ® Rip Trainer™, since a higher muscle activity can be generated from one side in relation to the opposite side.

The anterior tension produced by Drag exercise, generated a higher BF muscle activity when the ER was located on the ipsilateral side. This result is similar to that found in previous studies, which identified an increase in the activity of this muscle to control the anterior flexion of the trunk (M. H. Kim & Yoo, 2013; McGorry, Hsiang, Fathallah, & Clancy, 2001). On the other hand, this exercise produced greater LG muscle activity when the ER was on the opposite side. The level of activation observed in LG would be produced by the rotational component that generates the asymmetric resistance during the execution of Drag (Bankoff, Moraes, Salve, Lopes, & Ferrarezi, 2000; Sakamoto, Teixeira-Salmela, de Paula-Goulart, de Morais Faria, & Guimaraes, 2009).

In Drive, the posterior tension caused a higher LG activity when the ER is placed ipsilaterally to the muscle, whereas EO and BF increase their activity when the ER is located on the opposite side. Biomechanically, the anterior pull of ER in the upper body causes an external flexor moment of the trunk and hip, which must be counteracted by an extensor moment, which could lead to an increase in posterior muscle activity to maintain an upright position during the exercise (Aruin & Latash, 1995; Prior et al., 2014; Sundstrup et al., 2014). Possibly, this exercise also produces a greater force of rotation in relation to Drag, because the resistance is maintained from a position furthest from the body, which could explain the contralateral activation of the muscles (Nordin & Frankel, 2001; Vinstrup et al., 2015).

The rotational tension caused by Stack exercise showed a higher LG activity, when the ER was located ipsilaterally to the muscle. Lee, Coppieters, & Hodges (2005), identified that LG increases its activity with ipsilateral rotation and decreased with contralateral rotation. This is contrary to what was found in this study, because this exercise makes a force opposite to the rotation tension caused by the device, so that the activity of this muscle on the right side was greater when a rotation force was made towards the right side. On the other hand, Stack exercise increases the activity of GM and BF with the ER located on the contralateral side. The findings in this research could be associated with the synergistic action of these muscles to the rotational control of the hip, which in closed kinetic chain exercises would help the stability of the pelvis and trunk to resist a rotational force (Neumann, 2010).

Despite the differences between the ipsilateral and contralateral sides, it has not been demonstrated that training with this device improves the functional stability of the trunk. Kim Y, Kim J, & Yoon (2015), point out that the trunk stability function can improve regardless of the direction in which the core muscles are trained. Future reports may be aimed at identifying whether the use of TRX® Rip Trainer ™ improves the functional stability of the trunk.

Lumbopelvic Muscles

The result reveals that LG showed a higher level of activation during the rotational tension caused by the Stack when the exercises were performed by placing the ER on the ipsilateral side. On the other hand, when the ER was located on the contralateral side, Stack only produces a higher activity compared to Drag. The findings reported by Vinstrup et al. (2015) support our results for LG, because they indicate that rotational ER produces a higher activity of the spinal erector muscles when performing a bipedal exercise; they also mentioned that this position could produce a greater activity of the postural muscles since the hip is less fixed.

In relation to the results obtained in EO, this muscle showed a higher level of activation with Stack when compared to Drive, when the ER was located on the ipsilateral side. In contrast, when the ER was located on the contralateral side, this muscle showed a greater activity in Stack when compared to Drag. Previous reports reported that there were no effects on EO muscle activity when ER was compared with weight machines or free weights (Saeterbakken, Andersen, Kolnes, & Fimland, 2014; Vinstrup et al., 2015). However, these reports do not compare the activity of EO in relation to the direction of ER. The data obtained in the present study are related to previous reports that have identified that EO produces a higher muscle activity during trunk rotation (Andersson et al., 2002; Sugaya et al., 2016; Toren, 2001).

Hip Muscles

With respect to the data recorded in GM, Stack is the exercise that produces the most activity in this muscle when the ER is located on the contralateral side. Vinstrup et al. (2017), identified that high levels of GM activity can be achieved using ER in open kinetic chain exercises. However, these exercises are performed in decubitus positions and without a rotation component. There are few exercises that evaluate this muscle during the rotation of the trunk and it has been identified that the execution of exercises in bipedal position produces a greater GM activity compared to the lateral decubitus position (Macadam, Cronin, & Contreras, 2015). The findings reported in our research suggest that GM is activated in contralateral rotational force, possibly to help maintain lumbopelvic stability.

The data from this study suggest that BF increases its activity during the execution of isometric resistance exercises. On the one hand, when the ER is on the ipsilateral side, it was observed that this muscle shows a higher level of activation when it opposes the anterior tension produced by Drag. On the other hand, when ER is on the contralateral side of the electrode located in BF, Stack and Drive produce a higher activation level or, in other words, when the rotation component is higher. Generally, this muscle has been studied in various exercises during the phases of eccentric and concentric contraction of the lower limb, presenting high levels of activation in both phases (Bourne et al., 2018; Vinstrup et al., 2017). Jakobsen et al. (2014), mention that the hamstring rehabilitation exercise performed with elastic resistance induces the activity of these muscles in a similar way to when training machines are used. However, this work only reported the muscle activity of the hamstring during the knee flexion exercises. The data found in the present investigation allow to identify the behavior of BF when an asymmetric elastic tension is resisted isometrically, in order to avoid the rotation movement of the lumbopelvic segment.

Due to the high adherence of exercises with ER, this device could be used in training programs aimed at LPHC strengthening (Bergquist, Iversen, Mork, & Fimland, 2018; Calatayud et al., 2015; Medicine, 2009; Sundstrup, Jakobsen, Andersen, Jay, & Andersen, 2012; Vinstrup et al., 2017; Vinstrup et al., 2015). Andersen et al. (2010) point out that there is no difference between performing exercises using weights and asymmetric ER, concluding that both can be a good alternative in clinical practice. In addition, Aboodarda et al. (2016), suggest that ER provides similar prime mover, antagonist, assistant movers and stabilizer muscle activation as isoinertial resistance. The results of the study will be clinically relevant, not only for the researchers, but also for the trainers, therapists and the population in general, whose purpose is to improve the stability of the LPHC.

There are limitations in our study. This research only evaluated healthy young men, so the action of these exercises should be checked later in women, the elderly or individuals with altered control of the LPHC. In another aspect, the physical properties of TRX® Rip Trainer™ were not characterized; however, this commercial device was used as recommended by the manufacturer. Another limitation was that only one repetition of each exercise was evaluated to avoid fatigue of the participants, since a 30-second window was used for the analysis of the signal, in order to imitate a time of execution that is regularly used. Possibly, a greater number of repetitions during a shorter period of time could show the results better. No participant had previous experience in the use of this tool, so they were instructed by a certified instructor who explained and demonstrated to them the correct execution of each exercise. However, being easy exercises to perform, the lack of experience of the participants did not influence the results.

Conclusion

The activity of the LPHC muscles during the performance of isometric exercises using TRX® Rip Trainer™, depends on the direction of the muscle tension and on the side in which the ER is placed. Usually, Stack exercise produces a higher level of activity in these muscles, due to the greater rotational force that must be resisted.

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Conflict of interest: Valeria Soto currently works as Senior Instructor of TRX-Chile. This membership did not yet exist when the assessments of this study were carried out.

Disclaimer: The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of TRX company. Mention of commercial products does not constitute endorsement of the TRX company.

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