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Süspansiyon Egzersizlerinin Kassal Aktivasyonlar Üzerine Etkisi: Derleme

The Effect of Suspension Exercises on Muscular Activities: A Narrative Review

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ÖZ

Süspansiyon egzersizleri, geleneksel kuvvetlendirme egzersizlerine alternatif uygulanan, kapalı kinetik zincir egzersizlerinin stabil olmayan ortam ile birleştiği fonksiyonel egzersizlerdir. Süspansiyon egzersizlerinin kassal aktivasyonlar üzerine spesifik etkileri tam olarak bilinmemektedir. Bu nedenle bu derlemenin amacı, süspansiyon egzersizlerinde farklı kasların aktivasyonlarını geleneksel benzerleri ile karşılaştırmaktı. Bu amaçla, Ağustos 2022 tarihinde Medline (PubMed), Embase ve Cochrane Library veritabanları kullanılarak arama yapıldı. Süspansiyon egzersizlerinin kassal aktivasyonlara etkisini araştıran ve geleneksel benzerleri ile karşılaştıran çalışmalar derlemeye dahil edildi. 8 çalışma içleme kriterlerini sağladı. Süspansiyon egzersizleri, geleneksel egzersizlere kıyasla kas gruplarının çoğunda aktivasyonu arttırırken belirli kaslarda aktivasyon farklılığı gözlenmedi. Bu nedenle bireye özgü planlama yapılarak, optimal performans için geleneksel ve süspansiyon egzersizlerinin kombine kullanılması önemlidir.

Anahtar Kelimeler: Kas aktivasyonu, Süspansiyon eğitimi, Elektromiyografi.

ABSTRACT

Suspension exercises are functional exercises that combine closed kinetic chain exercises with an unstable environment as an alternative to traditional strengthening exercises. The specific effects of suspension exercises on muscular activities must be better understood. Therefore, this review aimed to compare the activities of different muscles in suspension exercises with their traditional counterparts. For this purpose, a search was conducted using the Medline (PubMed), Embase, and Cochrane Library databases in August 2022. Studies investigating the effect of suspension exercises on muscular activations and comparing them with their conventional counterparts were included in the review. Eight studies fulfilled the inclusion criteria. It was observed that suspension exercises increased activation in most muscle groups compared to conventional exercises, while there was no difference in activation in specific muscles. Therefore, it is essential to use a combination of traditional and suspension exercises for optimal performance with individualized planning.

Key words: Muscle activation, Suspension training, Electromyography.

1. INTRODUCTION

The largest and most effective parameter of injury prevention or post-injury rehabilitation programs is appropriate individualized strength training. However, more than traditional strengthening programs focusing on isolated muscle strengthening is required to provide the neuromuscular coordination necessary for optimal performance and strength development (1). Functional exercises, which include multi-planar and multi-joint exercises in which many muscle groups work in synergy, are based on coordinated strength, which allows the Central Nervous System to work more actively and develop good stabilization and strong motor patterns (2,3).

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Suspension exercises (SE) are functional exercises developed to enable individuals to work safely with their body weight, aiming to provide a high level of neuromuscular activation by combining closed kinetic chain exercises with an unstable environment (4).

Training with the suspension system allows exercising with the resistance of one's body weight (5) and aims to eliminate the overload of the osteoarticular system despite the applied load. Working in a closed kinetic chain makes it possible to limit and resist the shear force impacting the joints. Due to these properties, suspension systems are incredibly safe (6). In addition, affordability, ease of installation, and transportation make the device more appealing than conventional exercise equipment (7).

In suspension training, the hands or feet are usually suspended by being supported by a single anchor point, while the other end of the body is in contact with the ground (8). The instability provided by the device is due to a system of ropes with handles at the bottom that pivot around a single anchor point, acting as a pendulum (9). Suspension exercises can be performed at different intensities by changing the body position and the attachment point of the rope. When used for rehabilitation purposes, stable base support with a low percentage of body weight is preferred. In contrast, increasing instability and percentage of body weight are challenging for high-performance training (3).

With the frequent implementation of SE, the number of studies focusing on this exercise method's biomechanical and neuromuscular effects has increased in recent years. It has been reported that bodyweight exercises with a suspension system provide increased muscle activation, low compressive loading on the spine, increased performance, a potential increase in caloric expenditure, and cardiovascular improvements compared to conventional exercises (2,5,6,8).

The fact that SE is highly valuable in strength training in athletic performance and rehabilitation and that the specific effects of this new training method during exercise are not fully known creates confusion about the most effective strength training. Therefore, the main aim of this review is to contribute to the creation of the most effective rehabilitation program by compiling studies analyzing the effect of suspension exercises on muscle activities.

2. METHOD

Literature Review

In this narrative review, a literature search was conducted in "Medline (PubMed), Embase, and the Cochrane Library" in August 2022 to identify the effects of the suspension-based training program on muscle activity. Searches were made using “electromyography, suspension training, TRX, muscle activity” keywords. The articles were chosen by, first, reading the abstract; afterward, data were analyzed by reading the entire text via full-text resources. To undertake the study, we have collected information published about the effects of suspension devices on muscle activity over the last eight years (2013-2022). According to our results, eight clinical trial studies met the inclusion criteria.

2. RESULTS

Atkins et al. compared the neuromuscular activation of the erector spina, external oblique, and rectus abdominis muscles during static 'plank' exercise performed on suspension,

unstable floor (Swiss ball) and hard floor. Muscular activation was assessed by superficial electromyography (SEMG). In the study of 18 male elite youth swimmers, rectus abdominis activation was significantly higher during plank exercise on suspension than on the hard surface and Swiss ball. While there was no significant difference in erector spinae muscular activation between the three conditions, higher activation was found in external oblique muscular activation on a hard surface compared to other conditions. It was concluded that suspension training provides more intense activation of the anterior musculature, but the lateral and posterior muscles require higher stimulus levels (10).

Similarly, Bryne et al. examined the activation of the rectus abdominis, external oblique, rectus femoris, and serratus anterior muscles during variations of the 'plank' exercise. Twenty-one university students (10 females and 11 males) participated in the study. In the study in which muscle activations were recorded with superficial EMG, abdominal muscle activations were found to be higher during plank exercise performed in 3 different ways (arms on the rope, feet on the rope, arms and feet on the rope) with standard plank and TRX suspension rope compared to standard plank exercise in all three exercises performed with TRX rope. The study's results revealed that the instability stemming from the TRX suspension system significantly increased abdominal muscle activation. Although significant results were also noted in the rectus femoris and serratus anterior muscles, the difference could have been better in activation in the abdominal muscles. The study's results demonstrated that rectus abdominis and external oblique muscle activation increased as the participants progressed from average to suspended feet and arms (5).

Luk et al. examined the activations of rectus abdominis (RA), lumbar multifidus (LM), erector spinae (ES), rectus femoris (RF), gluteus maximus (GM) and biceps femoris (BF) muscles during variations of a supine bridge and prone bridge exercises in 43 healthy men. Muscle activations were evaluated in 6 conditions: the prone bridge on stable ground, a supine bridge on stable ground, a prone bridge with feet in suspension, a supine bridge with feet in suspension, a prone bridge with hands in suspension, supine bridge with hands in suspension. This study reported that supine bridge exercises on foot suspension provided higher activation in RA, RF, ES, LM and BF muscles than supine bridge exercises on hands suspension and a stable floor. RF, TES, and BF muscle activation were found to be higher during supine bridge exercise with hands in suspension than on a stable floor. Lower GM activation was found in supine bridge exercise with feet in suspension compared to supine bridge exercise with hands in suspension and stable floor. Therefore, if the target exercise muscle groups were RA and RF, Prone-Arm suspension was recommended. However, if the target exercise muscle groups were TES, LM and BF, Supine-Feet suspension was recommended (11).

Harris et al. evaluated pectoralis major, deltoid acromial, serratus anterior, obliques, rectus abdominis, gluteus maximus, erector spinae, middle trapezius and rhomboid muscle activations during four different exercises performed on suspension and a stable surface in a study involving 25 subjects (16 males, 9 females). Muscle activations were evaluated during four different exercises: bridge, push-up, inverted row, plank in suspension and on a stable floor. In that study, significantly increased activation was detected in at least one muscle during suspension exercises compared to standard floor exercises. It was concluded that suspended exercises significantly increased muscle activations compared to standard floor exercises. The results of this investigation demonstrated an increase in muscle activation of several upper

extremity and core muscles when exercises are implemented with a suspension trainer. Such increases in muscle activation during ST were particular to each specific exercise based on the position and load of the straps (12).

Krause et al. evaluated muscle activation around the hip and thigh during standard and suspended lunge exercises. For this purpose, 30 healthy participants (15 females and 15 males) were included in the study. In the study in which muscular activations were evaluated by electromyography (EMG), it was reported that suspended lunge exercise provided significantly higher activation in the hamstring, gluteus maximus, gluteus medius and adductor longus muscles compared to conventional lunge exercise but no significant change was detected in rectus femoris. This study concluded that the suspended lunge exercise was more demanding than the standard lunge exercise. Therefore, the suspended lunge can be regarded as a step up from the standard lunge (13).

Miller et al. investigated the myoelectric activity of the rectus femoris and gluteus maximus muscles during the traditional and suspension-based split squat exercise. The myoelectric activity was evaluated using EMG. In a study of 19 recreationally active individuals (10 females and 9 males), there was no difference observed between genders and in rectus femoris muscular activation, while gluteus maximus muscular activation increased significantly during the suspension-based split squat. Based on the findings of this study, suspension training is a suitable method for resistance exercise (14).

Calatayud et al. examined the EMG activation levels in 7 different muscles during push-up exercises performed with four different suspension systems including TRX system. 29 young, fit, male university students participated in the study. The participants performed the push-up exercise using four different suspension systems, including a TRX rope and the standard way without equipment. Regardless of design type, all suspension systems were highly effective, especially for high activation of the rectus abdominis of the lumbopelvic hip complex. The steady-state only produced high activation of the deltoid muscle. This study showed that maximum activation of the lumbopelvic hip complex occurred with suspension systems. It should be noted that further activation of the triceps, upper trapezius, lumbar erector spinae and rectus femoris can be achieved with more unstable suspension devices such as a pulley single anchor system. However, if further activation is sought for the anterior deltoid and clavicular pectoralis, it can be achieved with more stable conditions. In fact, a two-anchor parallel band system is the best option for increasing clavicular pectoralis muscle activation. At the same time, suspended push-ups have no additional advantage for increasing anterior deltoid muscle activity (9).

Snarr et al. examined the effect of push-up exercise on the activation of the pectoralis major, anterior deltoid, and triceps brachii muscles on suspension and standard floor. They included 21 healthy men and found statistically significant increased activation for all three muscles during a suspended push-up exercise compared to push-up exercise performed on a standard floor. In addition, previous research has indicated that altering the position of the hands during push-ups can lead to increased EMG output in the targeted muscles. In this study, the hands remained slightly wider than shoulder width throughout the push-up movement. Therefore, the suspended push-up resulted in a greater range of humeral motion compared to the push-up, resulting in increased EMG output in the selected glenohumeral musculature (15).

3. CONCLUSION

In the literature, there is a dominant view that suspension exercises provide higher muscular activation than traditional exercises and that higher muscular activation leads to greater strengthening effects and contributes more to performance improvement. In this review (14,16), after a detailed review of studies analyzing muscle activation during different suspension exercises, it was concluded that there were significant differences in muscle activation between suspension-based exercises and traditional exercises. Although suspension-based exercises increased activation in most muscle groups compared to conventional exercises, they did not produce activation differences in specific muscles. However, using different suspension devices and body position is also critical for muscular activations. Considering these factors, a targeted combination of traditional and suspension exercises can be performed for optimal performance. This way, it will be possible to plan training that increases neuromuscular control and motor responses specific to the individual.

Conflict of Interest Statement

The authors declare no conflicts of interest.

REFERENCES

1. DiStefano, L. J., DiStefano, M. J., Frank, B. S., Clark, M. A., Padua, D. A. (2013). Comparison of integrated and isolated training on performance measures and neuromuscular control. *J Strength Cond Res*, *27*(4), 1083-1090.
2. Jordan, S. L., Brinkman, B., Harris, S., Cole, T., Ortiz, A. (2022). Core musculature co contraction during suspension training exercises. *J Bodyw Mov Ther*, *30*, 82-88.
3. Pastucha, D., Filipcikova, R., Bezdickova, M., Blazkova, Z., Oborna, I., Brezinova, J. et al. (2012). Clinical anatomy aspects of functional 3D training–case study. *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub*, *156*(1), 63-9.
4. Fitness Anywhere, L. L. C. (2013). TRX suspension training course user's guide. *Fitness Anywhere LLC, San Francisco, Calif, USA*.
5. Byrne, J. M., Bishop, N. S., Caines, A. M., Crane, K. A., Feaver, A. M., Pearcey, G. E. (2014). Effect of using a suspension training system on muscle activation during the performance of a front plank exercise. *J Strength Cond Res*, *28*(11), 3049-3055.
6. Nowak, A., Morawiec, M., Gabrys, T., Nowak, Z., Szmatlan-Gabryś, U., Salcman, V. (2020). Effectiveness of resistance training with the use of a suspension system in patients after myocardial infarction. I*nt J Environ Res Public Health*, *17*(15), 5419.
7. Mok, N. W., Yeung, E. W., Cho, J. C., Hui, S. C., Liu, K. C., Pang, C. H. (2015). Core muscle activity during suspension exercises. *J Sci Med Sport*, *18*(2), 189-194.
8. Bettendorf, B. (2010). TRX suspension training bodyweight exercises: scientific foundations and practical applications. *San Francisco: Fitness Anywhere Inc*.
9. Calatayud, J., Borreani, S., Colado, J. C., Martín, F. F., Rogers, M. E., Behm, D. G. et al. (2014). Muscle activation during push-ups with different suspension training systems. *J Sports Sci Med*, *13*(3), 502.
10. Atkins, S. J., Bentley, I., Brooks, D., Burrows, M. P., Hurst, H. T., Sinclair, J. K. (2015). Electromyographic response of global abdominal stabilizers in response to stable-and unstable-base isometric exercise. *J Strength Cond Res*, *29*(6), 1609-1615.
11. Luk, J. T., Kwok, F. K., Ho, I. M., Wong, D. P. (2021). Acute responses of core muscle

activity during bridge exercises on the floor vs. the suspension system. *Int J Environ Res Public Health*, *18*(11), 5908.

12. Harris, S., Ruffin, E., Brewer, W., Ortiz, A. (2017). Muscle activation patterns during suspension training exercises. *Int J Sports Phys Ther*, *12*(1), 42.

13. Krause, D. A., Elliott, J. J., Fraboni, D. F., McWilliams, T. J., Rebhan, R. L., Hollman, J. H. (2018). Electromyography of the hip and thigh muscles during two variations of the lunge exercise: a cross-sectional study. *Int J Sports Phys Ther*, *13*(2), 137.

14. Miller, W. M., Barnes, J. T., Sofo, S. S., Wagganer, J. D. (2019). Comparison of myoelectric activity during a suspension-based and traditional split squat. *J Strength Cond Res*, *33*(12), 3236-3241.

15. Snarr, R. L., Esco, M. R. (2013). Electromyographic comparison of traditional and suspension push-ups. *J Hum Kinet*, *39*, 75.

16. Ayotte, N. W., Stetts, D. M., Keenan, G., Greenway, E. H. (2007). Electromyographical analysis of selected lower extremity muscles during 5 unilateral weight-bearing exercises. *J Orthop Sports Phys Ther, 37*(2), 48-55.