COMPARISON OF DIFFERENT SPORTS TRAINING METHODS ON MUSCLE PLASTICITY

COMPARAÇÃO DE DIFERENTES MÉTODOS DE TREINAMENTO ESPORTIVO SOBRE A PLASTICIDADE MUSCULAR

COMPARACIÓN DE DIFERENTES MÉTODOS DE ENTRENAMIENTO DEPORTIVO SOBRE LA PLASTICIDAD MUSCULAR

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ABSTRACT

Introduction: Different loads and volumes in resistance training is the most effective way to muscle hypertrophy stimulation in rehabilitation. Adding different stability planes to balance training will increase the intensity of muscle activation, causing an enhanced exercise load. It is theorized that unstable stimuli in the support environment increased central excitability, improving the ability to mobilize muscle fiber contraction. However, the intensity of this relationship is not clarified. Objective: Investigate how to balance exercise training improves CORE muscle plasticity and the central nervous system. Methods: A total of 36 undergraduate and graduate students were recruited to participate in this experiment. Two movements with bridge exercise were selected for maximal muscle endurance testing. Electromyographic data of the CORE muscles were captured and compared at all execution phases. Results: There was no interaction between the stabilization plane and cognitive tasks. The main effects of the low bridge and high bridge movements on erector spinae muscle activation were 28.88 and 2.06. The main effects of cognitive tasks were 0.33 and 7.88, and the interaction effect was 0.89 0.31. Conclusion: Exercise training can increase capillaries in muscles, increase the cross-sectional area of myofibrils, change the proportion of different types of myofibrils, and increase muscle strength. ***Evidence Level II; Therapeutic Studies – Investigating the results.***

Keywords: Resistance Training; Cell Plasticity; Postural Balance.

RESUMO

Introdução: O treinamento de resistência com diferentes cargas e volumes é a maneira mais eficaz de estimular a hipertrofia muscular na reabilitação. Adicionar diferentes planos de estabilidade ao treinamento equilíbrio aumentará o grau de ativação muscular, causando um aumento na carga de exercícios. Teoriza-se que estímulos instáveis no ambiente de suporte levam ao aumento da excitabilidade central, melhorando a capacidade de mobilizar a contração das fibras musculares. Porém, ainda não sabemos a intensidade dessa relação. Objetivo: Investigar como o treinamento de exercícios com equilíbrio melhora a plasticidade muscular do CORE e o sistema nervoso central. Métodos: Um total de 36 graduandos e pós-graduandos foram recrutados para participar deste experimento. Dois movimentos com exercício ponte foram selecionados para o teste de máxima resistência muscular. Os dados eletromiográficos da musculatura do CORE foram capturados e comparados em todas as fases de execução. Resultados: Não houve interação entre o plano de estabilização e as tarefas cognitivas. Os principais efeitos dos movimentos de ponte baixa e ponte alta na ativação do músculo eretor da espinha foram 28,88 e 2,06, os principais efeitos das tarefas cognitivas foram 0,33 e 7,88, e o efeito de interação foi 0,89 e 0,31. Conclusão: O treinamento de exercícios pode aumentar os capilares nos músculos, aumentar a área transversal das miofibrilas, alterar a proporção de diferentes tipos de miofibrilas e aumentar a força muscular. ***Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.***

Descritores: *Treinamento de Força; Plasticidade Celular; Equilíbrio Postural.*

RESUMEN

Introducción: El entrenamiento de resistencia con diferentes cargas y volúmenes es la forma más eficaz de estimular la hipertrofia muscular en la rehabilitación. Añadir diferentes planos de estabilidad al entrenamiento de equilibrio aumentará el grado de activación muscular, provocando un aumento de la carga del ejercicio. Se teoriza que los estímulos inestables en el entorno de apoyo conducen a un aumento de la excitabilidad central, mejorando la capacidad de movilizar la contracción de las fibras musculares. Sin embargo, aún no conocemos la intensidad de esta relación. Objetivo: Investigar cómo el entrenamiento de ejercicios de equilibrio mejora la plasticidad muscular del CORE y del sistema nervioso central. Métodos: Se reclutó a un total de 36 estudiantes de grado y posgrado para participar en este experimento. Se seleccionaron dos movimientos con ejercicio de puente para la prueba de resistencia muscular máxima. Se capturaron los datos electromiográficos de los músculos del CORE y se compararon en todas las fases de la ejecución. Resultados: No hubo interacción entre el plano de estabilización y las tareas cognitivas. Los efectos principales de los movimientos de puente bajo y puente alto sobre la activación de los músculos erectores de la columna vertebral fueron de 28,88 y 2,06, los efectos principales de las tareas cognitivas fueron de 0,33 y 7,88, y el efecto de interacción fue de 0,89 y 0,31. Conclusión: El entrenamiento con ejercicios puede *aumentar los capilares en los músculos, incrementar el área transversal de las miofibrillas, cambiar la proporción de los diferentes tipos de miofibrillas y aumentar la fuerza muscular.* ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Entrenamiento de Fuerza; Plasticidad de la Célula; Equilibrio Postural.*

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INTRODUCTION

The structure and function of biological systems have a certain degree of plasticity. From an evolutionary perspective, the biological system will change after receiving specific stimuli for a long time, in order to maintain the balance of metabolism in the body, make individuals better adapt to environmental changes. These stimuli include physical activity, disease, metabolic status, aging and drugs, etc.[1] Muscle plasticity and brain plasticity are two important aspects of biological system plasticity. In recent years, there have been many studies on sports training and muscle and brain plasticity, it helps to understand how exercise training changes the muscles and nervous system. One of the main characteristics of muscle plasticity is the specificity of adaptation to specific stimuli.[2] Local tissue hypoxia, the degree of weight bearing and the number of muscle contractions are the main factors affecting muscle plasticity. Environmental factors can change the size and type of myofibrils, restriction of physical activity has many adverse effects on the individual's musculoskeletal system. Long-term bed rest will reduce muscle volume and strength and myofibril size.[3] For ethical and safety reasons, there are not many studies on the relationship between muscle plasticity and brain plasticity in humans, these studies mainly reveal the relationship between the two indirectly by observing the electrophysiological changes before and after exercise training.[4] The existing literature shows that, strength training does not affect the corticospinal excitability or the nerve conduction performance of peripheral motor pathways.[5] In the early stage of sports training, changes in behavior mainly reflect changes in the muscular nervous system, rather than a change in muscle structure. In response to this research question, Henning L et al. found that, atrophy of muscle apraxia reduces the maximum tonic contraction force/muscle cross-sectional area (P0/CSA). This means that compared to the cross-sectional area of the muscle, the decrease in muscle strength is more obvious.[6]

METHOD

Research methods

1. Research object

At the end of this study, a total of 36 undergraduates and research subjects were recruited to participate in this experiment, all subjects are college boys, aged between 21-25 years old. Inclusion criteria: Healthy male; Able to successfully complete the test actions selected in this experiment; the dominant hand is the right hand.

2. Exclusion criteria: Chronic low back pain occurred in the past 3 months; There was spinal disease, such as mandatory spondylitis, etc.; Past medical history of lumbar surgery; Persons with mental retardation; Have cerebrovascular disease; Have a history of mental illness; Alcoholics; Recently receiving regular core sports training; Professional athletes. Those who possess any of the above criteria will be excluded.[7]

Selection of core training actions

Choose the two actions of the lower bridge and the upper bridge, using a two-factor internal design of plane (2) × cognitive load (3), a total of 12 task combinations. In order to balance the errors caused by the sequence, the task sequence is randomly selected, each task lasts for 15s. In the dual task, the researcher reads out the calculation problem at the same time the action starts, the subject gave the next question after reporting the answer, if the answer is more than 5 seconds, go directly to the next question. In the non-calculating task, ask the subjects to pay attention to their actions, rest for 2 minutes between each task group.

Select muscles and attach electric film

Uniformly select the dominant multifidus and erector spinae, electrodes are attached to the right multifidus, erector spinae, rectus abdominis and external oblique muscles. Before attaching the electrodes, the subjects were asked to stretch the waist and abdomen muscles and brisk walking for five minutes to warm up. Then perform skin treatment, shave the body hair in the area where the EMG is applied, and wipe the skin with fine sandpaper and 75% medical alcohol, clean the skin epidermis, and attach electrode pads to each target muscle as required.[8]

Maximum muscle resistance test (MVC)

In order to standardize the EMG results, before the test, collect the EMG of each muscle with the maximum force of resistance to contraction for 5 seconds, repeat each action twice, with an interval of 2 minutes, take the maximum value of the two times as the calibration value, the specific operation is as follows: Rectus abdominis: Subject lies supine, with hips and knees flexed, put your hands around your chest, and then complete a 45° abdominal curl on your torso, at the same time, another person stood on both shoulders and applied resistance manually, and the subject resisted with the greatest effort. Abdominal external oblique muscle: The same position as above, the left torso rotates to the right while completing the curling, the other person applied resistance on the left shoulder, and the subject resisted with the greatest effort. Erector spinae and multifidus: The subject is in a prone position, and both lower limbs are fixed with a fixing strap, the subject did his best to lift the torso, while the other person applied resistance on both shoulder blades with both hands.[9]

RESULTS

The effect of different stabilization planes and cognitive tasks on the erector spinae RMS in the prone bridge motion

There is no interaction between the stable plane and cognitive tasks (P=0.40). There is a main effect of the plane (P<0.001), comparison between the same tasks, the level of muscle activation on unstable planes is higher than that on stable planes; There is no main effect of cognitive tasks (P=0.73). Comparing cognitive tasks, there is no significant difference between the three tasks under the stable plane (P=0.21), there was no significant difference between the three tasks in the unstable plane (P=0.87), and the cognitive task had no significant effect on muscles. (Table 1)

Table 1. Different cognitive tasks and the degree of activation of erector spinae in different planes in the prone bridge movement.

Cognitive task/plane	Stable plane	Unstable plane	Plane main effect	Cognitive task main effect	Interaction effect
			F	F	F
No task	4.02±1.21	4.88±1.56	28.88	0.33	0.89
Simple task	3.85±1.22	4.99±1.45			
Complex task	4.11±1.36	4.62±1.52			

The effect of different stabilization planes and cognitive tasks on the RMS of multifidus muscle in the prone bridge motion

There is no interaction between the stable plane and cognitive tasks (P=0.41). There is a plane main effect (P<0.001), in comparison between the same tasks, the activation of the unstable plane is significantly increased than that of the stable plane. There is no main effect of cognitive tasks (P=0.95). The difference between the three tasks of the stable plane is not significant (P=0.63), there was no significant difference between the three tasks in the unstable plane (P=0.58), and the effect of cognitive tasks on muscles was not significant. (Table 2)

The influence of different stabilization planes and cognitive tasks on the erector spinae RMS in the inverted bridge movement

There is no interaction effect between the stable plane and cognitive tasks (P=0.77). The unstable plane is more activated than the stable plane, but it is not significant (P=0.16), there is a main effect of cognitive tasks (P=0.001), as the difficulty of the task increases, muscle activation shows a decreasing trend, in the stable plane, complex tasks are significantly reduced compared with no tasks (P=0.006), the reduction of simple tasks is more significant than that of no tasks (P=0.002), the difference between complex tasks and simple tasks is not significant (P=0.26); The overall difference between the three tasks in the unstable plane was not significant (P=0.09). Comparing separately, the difference of complex tasks is more significant than that of no tasks (P=0.001), the difference between simple tasks and no tasks was not significant (P=0.30), and the difference between simple tasks and no tasks was not significant (P=0.32). (Figure 1)

The influence of different stability planes and cognitive tasks on the RMS of multifidus muscle in the inverted bridge movement

There is an interaction between the stable plane and cognitive tasks (P=0.02). There is no main effect between the planes (P=0.93), and the difference between the two planes is not significant. There is a main effect between the cognitive task planes (P<0.001), stable plane, the difference between the above three tasks is significant (P<0.001), as the difficulty of the task increases, it shows a decreasing trend. Simple tasks are significantly reduced compared with no tasks (P=0.001), the reduction of complex tasks is different than that of no tasks (P<0.001), and the difference between complex tasks and simple tasks is not significant (P=0.36); On the unstable plane, there are differences between the three tasks (P<0.001). The decline of complex tasks is more significant than that of no tasks (P=0.002). Complicated tasks are different from simple tasks (P=0.006), and the difference between simple tasks and complex tasks is not significant (P=0.56). (Figure 2)

Table 2. Different cognitive tasks and activation levels of multifidus muscles in different planes in the prone bridge movement.

Cognitive task/plane	Stable plane	Unstable plane	Plane main effect	Cognitive task main effect	Interaction effect
			F	F	F
No task	3.21±1.33	4.07±1.79	23.05	0.04	0.89
Simple task	3.23±1.49	3.91±1.61			
Complex task	2.99±1.49	3.79±1.66			

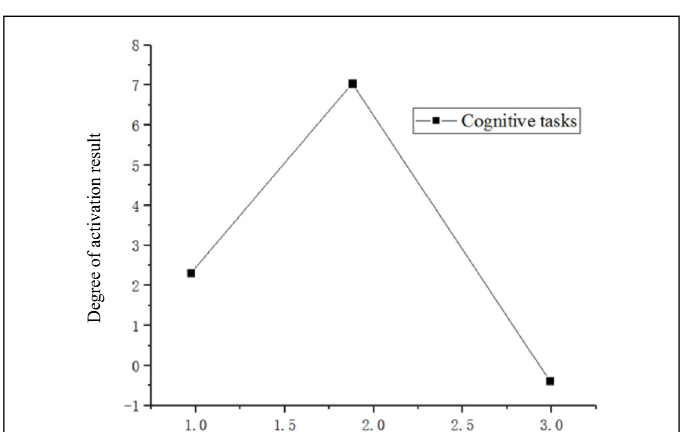

Figure 1. The results of different cognitive tasks and the activation degree of erector spinae in different planes in the supine bridge movement.

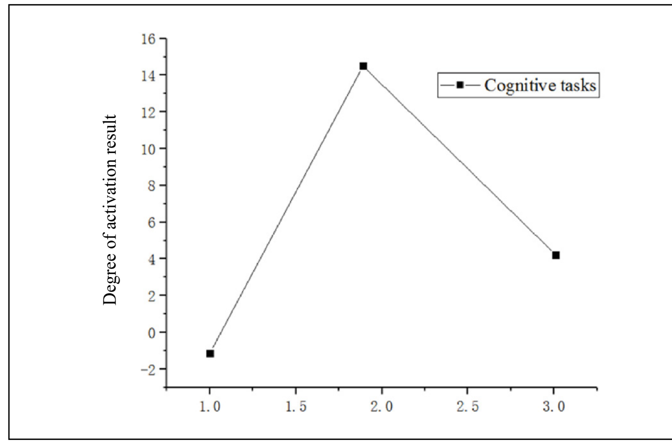

Figure 2. The results of different cognitive tasks and multifidus activation in different planes in the supine bridge movement.

DISCUSSION

The upward and downward bridge movements are commonly used rehabilitation training methods, during exercise, the waist and abdomen muscles are required to resist the gravitational load formed by the trunk while maintaining the neutral state of the spine. Adding different stability planes to core stability training will increase the degree of muscle activation, causes an increase in exercise load. The compressibility and instability of the Swiss ball can increase the difficulty of training and recruit more muscles to participate.[10] It is theorized that unstable support environment stimuli lead to increased central excitability, in turn, the ability to mobilize muscle fiber contraction is improved. In addition, the Swiss ball will make the body's center of gravity constantly change, in order to maintain balance, will continue to adjust it, so extra work is added to control posture stability, Swiss ball training increases exercise load, under unstable conditions, muscle activation will be higher, consistent with previous research results. The Swiss ball has the characteristics of rich forms, and different training difficulties can be changed on the Swiss ball. As the difficulty level of cognitive tasks increases, erector spinae, the activation of the multifidus muscle decreases, moreover, the decline of complex cognitive tasks is more significant than that of no cognitive tasks. In this case, attention is distracted by the computing task, causes the signal of the main muscles of the trunk to decrease in the core stability training.

CONCLUSION

The article selects two actions, the downward bridge and the upward bridge, a two-factor internal design of plane (2)×cognitive load (3) was adopted, and there were 12 task combinations in total. Perform the maximum muscle resistance test on it, using an unstable plane will increase the degree of muscle activation, after joining a cognitive task, the activation of muscle groups will decrease.

All authors declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: The author made significant contributions to this manuscript. HX: writing and performing surgeries; data analysis and performing surgeries; article review and intellectual concept of the article.

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