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REVIEW ARTICLE

Effects of vibration and local vibration therapy

Vibrasyon ve lokal vibrasyon terapisinin etkileri

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Abstract

Vibration is a mechanical stimulus characterized by oscillatory movements, possessing parameters such as amplitude, frequency, and power. It is examined in two different forms: local and whole-body vibration. Vibration applications assist in enhancing postural control by triggering the tonic vibration reflex through alpha motor neurons and muscle spindle activity. Local vibration is a physiotherapy method that aims to provide targeted muscle stimulation by delivering vibratory stimulation to a specific muscle or muscle tendon via a mechanical device. Additionally, when applied to the antagonist muscle of a spastic muscle through the reciprocal inhibition mechanism, it increases the motor excitability of the antagonist muscle while reducing the excitability of the spastic muscle. The application of vibration to musculoskeletal structures induces muscle contraction, known as the tonic vibration reflex. The Ia afferent discharges generated by the activation of muscle spindles can modulate intracortical inhibition by altering the excitability of the corticospinal pathway. Through this mechanism, vibration is employed in neurorehabilitation for various purposes, including facilitating muscle contraction, providing proprioceptive input, reducing spasticity, and enhancing neuromuscular performance and proprioception. The tonic vibration reflex depends on several factors, particularly vibration frequency. It has been demonstrated that low frequencies aid in muscle relaxation, whereas specific frequency ranges trigger the tonic vibration reflex. The aim of this study is to pioneer a more effective application of vibration therapy.

Keywords: Vibration, local vibration, therapeutic effect.

Özet

Vibrasyon, amplitüd, frekans ve güç parametrelerine sahip, salınım hareketleriyle karakterize edilen mekanik bir uyarıdır. Lokal ve tüm vücut vibrasyon olarak iki farklı şekilde incelenmektedir. Vibrasyon uygulamaları, alfa motor nöronlar ve kas iğciği aktivitesi yoluyla tonik vibrasyon refleksini tetikleyerek postüral kontrolü geliştirmeye yardımcı olur. Lokal vibrasyon, mekanik bir cihaz aracılığıyla belirli bir kasa veya kas tendonuna titreşim uyarımı göndererek hedeflenen kasta stimülasyon sağlamayı amaçlayan bir fizyoterapi yöntemidir. Aynı zamanda resiprokal inhibisyon mekanizması ile spastik kasın antagonist kasına uygulandığında, antagonist kasın motor uyarılabilirliğini artırırken spastik kasın uyarılabilirliğini azaltmaktadır. Vibrasyonun muskulotendinöz yapılara uygulanması, tonik vibrasyon refleksi adı verilen kas kasılmasına neden olur. Kas iğciklerinin aktive edilmesiyle oluşan Ia afferent deşarjlar, kortikospinal yolun uyarılabilirliğini değiştirerek intrakortikal inhibisyonu yönetebilir. Bu mekanizma sayesinde nörorehabilitasyon alanında kas kontraksiyonunu fasilite etmek, proprioseptif girdi oluşturmak, spastisiteyi azaltmak, nöromusküler performansı ve propriosepsiyonu artırmak gibi çeşitli amaçlarla kullanılmaktadır. Tonik vibrasyon refleksi, başta vibrasyon frekansı olmak üzere çeşitli faktörlere bağlıdır. Düşük frekansların kas gevşemesine yardımcı olduğu, belirli frekans aralıklarının ise tonik vibrasyon refleksini tetiklediği gösterilmiştir. Bu çalışmanın amacı vibrasyon tedavisinin daha etkili bir şekilde uygulanmasına öncülük etmektir.

Anahtar Kelimeler: Vibrasyon, lokal vibrasyon, terapötik etki.

INTRODUCTION

Local vibration is a physiotherapy method applied to specific muscles or tendons via mechanical devices, targeting muscle stimulation (1). Additionally, when applied to the antagonist muscle of a spastic muscle through the reciprocal inhibition mechanism, it can balance motor excitability and reduce spasticity (2). Vibration applied to musculoskeletal structures triggers muscle contraction, known as the tonic vibration reflex (3). This process regulates intracortical inhibition by modifying the excitability of the corticospinal pathway through Ia afferent discharges (4). In neurorehabilitation, vibration is utilized to facilitate muscle contraction, provide proprioceptive input, reduce spasticity, and enhance neuromuscular performance (5). The tonic vibration reflex depends on several factors, primarily vibration frequency. It has been demonstrated that low frequencies promote muscle relaxation, whereas specific frequency ranges trigger the tonic vibration reflex (6). This study aims to examine the neurophysiological effects of vibration, its role in the tonic vibration reflex, and its applications in neurorehabilitation.

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GENERAL EFFECTS OF VIBRATION THERAPY

The findings of this study support the positive effects of vibration on the muscular and nervous systems. It has been observed that both local and whole-body vibration applications improve postural control by triggering the tonic vibration reflex through alpha motor neurons and muscle spindle activity (7). Local vibration has been shown to enhance muscle activity by providing vibratory stimulation to the targeted muscle or tendon, suggesting its potential as an effective method in the neuro-rehabilitation process (1). Furthermore, through the reciprocal inhibition mechanism, vibration applied to the antagonist muscle of a spastic muscle has been demonstrated to reduce spasticity by restoring balance between the muscles (2). The application of vibration to musculoskeletal structures has been found to increase muscle contraction via the tonic vibration reflex and improve neuromuscular performance by modulating the excitability of the corticospinal pathway (4). In line with these findings, it has been concluded that vibration applications offer numerous benefits in neurorehabilitation, such as facilitating muscle contraction, providing proprioceptive input, reducing spasticity, and enhancing motor control. Specifically, it has been shown that certain frequency ranges support muscle activation by triggering the tonic vibration reflex, while low frequencies assist in muscle relaxation (6).

Vibration-Muscle Spindle

Vibration applied to the tendon or directly to the muscle tissue results in a significant increase in muscle spindle activity. Two distinct studies conducted in 1976 revealed that local vibration with a frequency range of 20-220 Hz. and an amplitude of 1.5 mm, applied to the gastrocnemius, tibialis anterior, peroneus longus, and extensor digitorum longus muscles, increased muscle spindle activation. In both studies, it was observed that the response and discharge rates of muscle spindle endings increased in parallel with the increasing vibration frequencies. These findings indicate that vibration frequency is a factor that directly affects the activation and discharge rate of muscle spindle endings. In a similar study conducted in 1998, local vibration applied to the distal tendons of the extensor digitorum longus and lateral peroneal muscles for 30 seconds at an amplitude of 0.5 mm and a frequency of 80 Hz resulted in a significant increase in the discharge rate of muscle spindle primary endings. These findings suggest that muscle spindle endings and motor unit functional responses can be enhanced through vibration applications, which can improve neuromuscular responses of muscles. It is understood that vibration strengthens muscle performance and the response to stimuli by increasing muscle spindle activation, making it an effective tool in physical performance and rehabilitation processes (8).

Effect on Muscle Performance

In traditional resistance training, external weights are used in addition to body weight to increase exercise intensity. The strengthening effects of vibration applications are based on one of Sir Isaac Newton's laws of motion, Force = Mass x Acceleration (F = M x A). According to this principle, to induce a change in force, either mass or acceleration must be altered. Unlike traditional resistance training methods, vibration devices generate greater force by increasing the existing acceleration through sinusoidal vibrations, rather than increasing the applied mass (9). The mechanical oscillations of vibration cause changes in the length of muscle-tendon complexes, regulated by the stretch reflex and defined by sensory receptors, which modulate muscle contractions during reflexive muscle activity (10). High-frequency vibration (80-100 Hz. for local vibration, 35-45 Hz. for whole-body vibration) has been found to be more effective than lower frequencies in enhancing muscle activity (11). Recent studies have suggested that vibration applications could be an alternative modality to exercise (12).

Effect of Vibration on Proprioception

Sensory receptors play a critical role in the perception of proprioception. The primary receptors involved in the perception of proprioception in muscles are muscle spindles and Golgi tendon organs. Afferent signals related to position sense and movement perception originate from the muscle spindles. These afferents are activated during muscle elongation and when the muscle spindle is stretched. Group Ia afferents found in muscle spindles are particularly sensitive to changes in speed, especially in the limbs, while group II afferents are involved in transmitting position information. The activation of

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muscle spindles increases with the stretching of the muscle. For position sense to be perceived accurately, sufficient signaling from the muscles on both surfaces of the joint is necessary during position and movement. This process is essential for the proper functioning of proprioceptive perception. When vibration is applied to the tendon of a muscle, it can ensure adequate activation of the muscle spindle, allowing for the detection of positional changes in the joint. The effect of vibration on the muscle spindle can enhance the precise perception of joint positions, which plays a crucial role in movement control and proprioceptive perception. These mechanisms can be effectively utilized, particularly in rehabilitation processes, to improve coordination between muscles and enhance the monitoring of joint movements (13). Pollock et al. (2011) did not observe a significant increase in position sense at 30, 60, and 80 degrees of knee flexion immediately after 5x1 minute of whole-body vibration (30 Hz) in healthy young individuals (14).

Vibration-Motor Unit

During vibration application, muscle fiber activation occurs due to the effect of alpha motor neurons and muscle spindle activity, a process referred to as the tonic vibration reflex. Studies have shown that vibration increases motor unit firing and discharge rates by enhancing the tonic vibration reflex and muscle spindle activation. These findings demonstrate the potential of vibration to enhance neuromuscular responses in muscles. This effect may strengthen muscle performance and the response to stimuli (1). Following the application of local vibration with a frequency of 150 Hz and an amplitude of 1.5 mm to the triceps tendon, an increase in motor unit firing rate and EMG activity was observed in fatigued muscles, accompanied by the tonic vibration reflex (15).

Vibration and Neuromuscular Performance

Vibration devices operate based on a different principle compared to traditional devices. Conventional devices typically generate force by increasing the applied mass, whereas vibration devices enhance the existing acceleration through sinusoidal vibrations. This allows to produce higher force. The advantage of vibration devices is that they make force production more effective by increasing acceleration through vibrations. This method leads to more efficient outcomes compared to traditional devices and creates a stronger impact on muscles, thereby facilitating improved performance (14). The elongation of muscle-tendon complexes, regulated through the stretch reflex and sensed by sensory receptors, occurs via the mechanical oscillations induced by vibration (10).

Vibration and Its Hormonal Effects

Studies in the literature have shown that vibration applications, through the repetitive muscle contractions they induce, elicit various responses in the endocrine system and metabolism. It has been demonstrated that vibration applied directly to the muscle increases the levels of testosterone and growth hormone in the body's circulation, while cortisol levels decrease (16). Additionally, some studies have reported an increase in norepinephrine levels following vibration application, with no observed changes in other hormone levels. These findings indicate that vibration has a significant impact on muscles and hormones and can modulate certain physiological responses in the body. However, it is emphasized that further research is needed to determine how these changes are sustained over time and to explore the long-term effects of such applications (17).

Vibration and Bone Density

Vibration application to increase bone density was first utilized by NASA for astronauts traveling to space. The purpose of using vibration in astronauts was not only to enhance bone density but also to strengthen the musculoskeletal system by leveraging the effects of high gravitational forces. The literature supports the idea that vibration increases bone density and reduces the risk of fractures. While various hypotheses exist to explain how vibration increases bone density, the most widely accepted explanation is that vibration signals are transmitted into bone tissue, activating mechanosensors, which in turn increase bone density. Studies have identified that vibration with frequencies ranging from 12-40 Hz, amplitudes of 0.7-5 mm, and gravitational acceleration forces of 0.1-10 g are optimal for enhancing bone density (18).

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Vibration and Flexibility

The application of vibration, resulting in the relaxation of tense muscles, suggests that vibration may enhance flexibility. A vibration application with a frequency of 30 Hz and an amplitude of 4 mm has been observed to induce the Busy Line Phenomenon, where activation in group Ia fibers and stretching effects occur simultaneously (19). Vibration applied to the Golgi tendon organ leads to the inhibition of group 1b fibers in antagonist muscles. Another theory regarding flexibility suggests that vibration increases the pain threshold and reduces pain sensitivity, thereby improving flexibility. Furthermore, local vibration applications are believed to enhance peripheral circulation and body temperature, which in turn reduces muscle tension (20).

Vibration and Spasticity

Vibration applications have become an alternative method effectively used in the management of spasticity due to their anti-spasticity effects. Studies on spasticity involving whole-body vibration have shown a reduction in spasticity according to the Modified Ashworth Scale. A whole-body vibration application with a frequency of 12 Hz. and an amplitude of 4 mm, applied for 20 minutes, did not induce electrophysiological changes but was found to reduce spasticity according to the Modified Ashworth Scale (21). Local vibration applications have demonstrated more objective positive effects on spasticity compared to whole-body vibration. A local vibration application at a frequency of 50 Hz. to the antagonist muscle of spasticity has been reported to regulate the Hmax/Mmax ratio, which is increased by spasticity in the muscle (22).

Vibration and Pain

Lau and Nosaka (2011) applied local vibration therapy (VT) at a frequency of 65 Hz for 6 minutes to the elbow flexors of sedentary but healthy male individuals following ten sets of six repeated eccentric exercises. As a result, compared to the control group, a significant reduction in the Visual Analog Scale (VAS) scores were observed in the vibration group, although no statistically significant difference was found in terms of pressure pain threshold (23). Cochrane (2017) reported that in physically active males, vibration therapy (VT) at a frequency of 120 Hz, applied for 15 minutes in continuous mode to the biceps brachii muscle using the Myovolt™ device, significantly reduced the pressure pain threshold 48 and 72 hours after eccentric exercise (24).

Vibration and Neuroplasticity

Environmental stimuli can lead to structural and functional changes in organs and tissues throughout life. These changes are particularly evident in the brain, where plastic properties that are sensitive to changes persist from early development through aging (25). This process is known as neuroplasticity, which is defined as the capacity of the central nervous system to promote neurogenesis and connections in response to psychological, physiological, and environmental factors (26). In this context, neuroplasticity is associated with an increase in the production of neurotrophins, which induce changes in the growth and differentiation of cell signals. Vibration therapies, in recent years, have garnered increasing interest as a safe and well-tolerated neuromodulation (NIBS) technique that can recondition dysfunctional cerebral structures and pathways related to stroke, while also promoting long-term motor recovery. The basic concept of these applications lies in the strong proprioceptive stimulus provided by muscle vibration. Proprioceptive stimuli are important signals that help us perceive the movement and position of our body. High-frequency, low-amplitude repeated applications of vibration can modulate the brain's motor and somatosensory structures, resulting in changes in synaptic reactivity. This modulation can lead to neuroplastic changes in the brain, facilitating the reorganization of damaged motor pathways and cerebral structures after a stroke. High-frequency vibrations can contribute to the long-term reorganization of synaptic pathways in the brain, thereby accelerating neurological recovery. The reorganization of synaptic pathways improves the brain's ability to control various motor and sensory functions. This process plays a key role in motor recovery and can help individuals regain functional abilities. Studies have shown that vibration therapies contribute not only to the modulation of motor pathways but also to the modulation of somatosensory structures. Therefore, not only muscle movements but also other important functions, such as body position and environmental perception, can be improved. The neuroplastic effects provided by vibration through

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changes in synaptic reactivity support the recovery of motor functions after stroke, demonstrating that these techniques can be an effective tool in long-term recovery processes. Additionally, research suggests that the long-term effects of such neuromodulation applications contribute to maintaining improvements in motor functions in daily life. Due to their low side effect profile, vibration therapies offer a safe and effective recovery process, making them a valuable option in stroke rehabilitation and neurological recovery. In conclusion, vibration therapies are an effective neuromodulation technique that can accelerate neurological recovery by enhancing communication between the brain and muscles and can facilitate the long-term recovery of motor functions. This may become an important therapeutic tool in motor recovery processes following a stroke (27).

THE HARMFUL EFFECTS OF VIBRATION

When applied correctly, this method does not pose any safety concerns; however, when it coincides with the body's natural vibration frequency, known as the resonance frequency, negative effects such as cardiovascular reactions, headaches, and even epileptic seizures may occur in some cases. The resonance frequencies of organs in the human body generally range from 2 to 12 Hz. Vibrations corresponding to this frequency range can impact the normal function of the organs, leading to unwanted side effects in individuals. In particular, when high-frequency vibrations overlap with the natural resonance frequencies of the organs, the effects on the body may become more pronounced. Therefore, an important consideration during vibration applications is ensuring that the applied frequency does not align with the body's resonance frequencies. Otherwise, excessive stimulation of the organs could occur, potentially leading to negative consequences. To avoid such side effects, vibration frequencies should be carefully selected, and applications should be tailored to the individual's health condition and specific needs (28).

CONCLUSION

In conclusion, local vibration has been demonstrated to be an effective physiotherapy method for stimulating specific muscles or tendons and balancing motor excitability. Its ability to trigger the tonic vibration reflex and regulate corticospinal excitability underscores its crucial role in neuromuscular function modulation. Given its proven benefits in facilitating muscle contraction, alleviating delayed-onset muscle soreness, providing proprioceptive input, and enhancing neuromuscular performance, local vibration emerges as a valuable tool in neurorehabilitation. The findings of this study further support the potential of vibration therapy in optimizing motor control and promoting functional recovery. Future research will facilitate the investigation of pain mitigation following muscle pain treatment protocols.

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References

1. Murillo N, Valls-Sole J, Vidal J, Opisso E, Medina J, Kumru H. Focal vibration in neurorehabilitation. Eur J Phys Rehabil Med. 2014;50(2):231-42.
2. Desmedt J. Mechanisms of vibration-induced inhibition or potentiation: tonic vibration reflex and vibration paradox in man. Adv Neurol. 1983; 39:671-83.
3. Eklund G, Hagbarth KE. Normal variability of tonic vibration reflexes in man. Exp Neurol. 1966;16(1):80-92.
4. Roll J, Vedel J, Ribot E. Alteration of proprioceptive messages induced by tendon vibration in man: a microneurographic study. Exp Brain Res. 1989;76(1):213-22.
5. Steyvers M, Levin O, Van Baelen M, Swinnen SP. Corticospinal excitability changes following prolonged muscle tendon vibration. Neuroreport. 2003;14(15):2001-4.
6. Homma S. Integral pattern of coding during tonic vibration reflex. 1972.

Turk J Clin Res. 2025;1(1):34-39
https://doi.org/10.63909/1453004

7. Cardinale M, Wakeling J. Whole body vibration exercise: are vibrations good for you? Br J Sports Med. 2005;39(9):585-9.
8. Ribot-Ciscar E, Rossi-Durand C, Roll J-P. Muscle spindle activity following muscle tendon vibration in man. Neurosci Lett. 1998;258(3):147-50.
9. Park SY, Son WM, Kwon OS. Effects of whole body vibration training on body composition, skeletal muscle strength, and cardiovascular health. J Exerc Rehabil. 2015;11(6):289.
10. Cardinale M, Bosco C. The use of vibration as an exercise intervention. Exerc Sport Sci Rev. 2003;31(1):3-7.
11. Hazell TJ, Jakobi JM, Kenno KA. The effects of whole-body vibration on upper-and lower-body EMG during static and dynamic contractions. Appl Physiol Nutr Metab. 2007;32(6):1156-63.
12. Cheng CF, Cheng KH, Lee YM, Huang HW, Kuo YH, Lee HJ. Improvement in running economy after 8 weeks of whole-body vibration training. J Strength Cond Res. 2012;26(12):3349-57.
13. De Gail P, Lance J, Neilson P. Differential effects on tonic and phasic reflex mechanisms produced by vibration of muscles in man. J Neurol Neurosurg Psychiatry. 1966;29(1):1-11.
14. Pollock RD, Provan S, Martin FC, Newham DJ. The effects of whole body vibration on balance, joint position sense and cutaneous sensation. Eur J Appl Physiol. 2011;111(12):3069-77.
15. Griffin L, Garland S, Ivanova T, Gossen E. Muscle vibration sustains motor unit firing rate during submaximal isometric fatigue in humans. J Physiol. 2001;535(3):929-36.
16. Bongiovanni L, Hagbarth K. Tonic vibration reflexes elicited during fatigue from maximal voluntary contractions in man. J Physiol. 1990;423(1):1-14.
17. Di Loreto C, Ranchelli A, Lucidi P, Murdolo G, Parlanti N, De Cicco A, et al. Effects of whole-body vibration exercise on the endocrine system of healthy men. J Endocrinol Invest. 2004;27(4):323-7.
18. Gusi N, Raimundo A, Leal A. Low-frequency vibratory exercise reduces the risk of bone fracture more than walking: a randomized controlled trial. BMC Musculoskelet Disord. 2006;7:92.
19. Sands WA, McNeal JR, Stone MH, Russell EM, Jemni M. Flexibility enhancement with vibration: acute and long-term. Med Sci Sports Exerc. 2006;38(4):720-5.
20. Gerodimos V, Zafeiridis A, Karatrantou K, Vasilopoulou T, Chanou K, Pispirikou E. The acute effects of different whole-body vibration amplitudes and frequencies on flexibility and vertical jumping performance. J Sci Med Sport. 2010;13(4):438-43.
21. Chan KS, Liu CW, Chen TW, Weng MC, Huang MH, Chen CH. Effects of a single session of whole body vibration on ankle plantarflexion spasticity and gait performance in patients with chronic stroke: a randomized controlled trial. Clin Rehabil. 2012;26(12):1087-95.
22. Murillo N, Kumru H, Vidal-Samso J, Benito J, Medina J, Navarro X, et al. Decrease of spasticity with muscle vibration in patients with spinal cord injury. Clin Neurophysiol. 2011;122(6):1183-9.
23. Lau WY, Nosaka K. Effect of vibration treatment on symptoms associated with eccentric exercise-induced muscle damage. Am J Phys Med Rehabil. 2011;90(8):648-57.
24. Cochrane DJ. Effectiveness of using wearable vibration therapy to alleviate muscle soreness. Eur J Appl Physiol. 2017;117(3):501-9.
25. Güneş M, Kavak M. Aerobik ve dirençli egzersiz eğitiminin nöroplastisite üzerine etkisi. In: Akkaya R, editor. Fizyoterapide güncel yaklaşımlar. Ankara: Bridge Yayınları; 2024. p. 95-122.
26. Gulyaeva NV. Molecular mechanisms of neuroplasticity: an expanding universe. Biochemistry (Mosc). 2017;82(3):237-42.
27. Vigano A, Celletti C, Giuliani G, Jannini TB, Marenco F, Maestrini I, et al. Focused muscle vibration (fMV) for motor recovery after stroke: induction of multi-site neuroplasticity, timing of intervention, clinical approaches, and expectations from a narrative review. Vibration. 2017;6(3):40.
28. Vry J, Schubert IJ, Semler O, Haug V, Schönau E, Kirschner J. Whole-body vibration training in children with Duchenne muscular dystrophy and spinal muscular atrophy. Eur J Paediatr Neurol. 2014;18(2):140-9.