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The influence of percussion massage on knee's range of motion in two positions

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Abstract

Study aim: The practical application of vibration stimuli is increasingly observed in physiotherapy and sports. The aim of the study was to investigate the effects of local vibration on knee-joint range of motion (ROM) improvement among male American football players.

Materials and methods: The study consisted of 31 participants (age 22.9 ± 4.3), divided by knee injury (KI) history and nKI (no knee injury). The intervention involved the use of vibration on parts of the quadriceps muscle with a 10-second vibration and 5-second intermission protocol. ROM measurements were conducted in the prone position (PrP) before the intervention, immediately after, and after 10 minutes, as well as in the half-kneeling position (HkP) before and immediately after.

Results: Knee ROM increased immediately after ($p < 0.001$) and 10 minutes after ($p < 0.05$) the intervention in nKI in the PrP, and there was a statistically significant improvement in the HkP ($p < 0.001$). There was no significant interaction between ROM in PrP and knee injury ($F_{2,58} = 8.562$; $p < 0.001$), but there were significant differences in the ROM before (KI: 133.9° ± 6.26°; nKI: 144° ± 4.06°), immediately after (KI: 137.3° ± 6.98°; nKI: 145.9° ± 4.64°), and 10 minutes after (KI: 136.7° ± 6.75°; nKI: 145.6° ± 4.5°) the intervention. There was no significant interaction between ROM measurement in HkP and knee injury. There was a statistically significant difference in ROM ($F_{1,29} = 33.76$; $p < 0.001$) before (KI: 141.4° ± 7.66°; nKI: 146.4° ± 7.17°) and immediately after (KI: 145.3° ± 8.22°; nKI: 150.2° ± 6.32°) the intervention in the HkP.

Conclusions: Local vibration may increase knee ROM by improving soft tissue elasticity.

Keywords: Knee joint – Massage therapy – Percussion – Vibration massage – MedicGunPro

Introduction

Widespread use of vibration in rehabilitation has been observed in recent years [17]. Data show vibration to be an effective therapeutic stimulus, which carries beneficial effects in treating the pain of various etiological origins. Two types of vibration therapy may be distinguished based on their effect range: whole body vibration (WBV) and local body vibration (LBV) [7]. Numerous studies have indicated WBV therapy to be an effective form of neuromuscular training, which can aid the rehabilitation process [12].

Recently, the growing popularity of handheld vibration massage devices, mimicking the classic massage technique (tapotement), has been noted [19]. Data confirm the effectiveness of applying local vibration for preventing delayed onset muscle soreness (DOMS), treating pressure ulcers, and voice regeneration [18]. Local vibration may also be used as complementary treatment of spasticity [16]. However, data on the influence of local vibration massage on muscle strength and ROM are inadequate [1]. The current research applies local vibration called percussion therapy [12], whose stimuli reach deep tissues according to Cochrane [4]. In percussion therapy, each hit penetrates deeper than typical vibrations do, facilitating blood supply increase, and reducing lactic acid as well as muscle soreness and stiffness [3]. A great advantage of percussion therapy devices is their mobility and accessibility [10]. The ease of use and compact size of the percussion therapy devices allow for independent treatment, without the involvement of a physiotherapist or a massage therapist, which seems to be convenient for both athletes and amateurs [13]. Percussion vibrations stimulate reflex muscle contractions when applied to the muscle tendon or muscle belly. Such a neuromuscular response is referred to as the tonic vibration reflex (TVR) [8]. The TVR is mediated by both mono – and polysynaptic pathways [5]; however, its effects on increasing soft tissue

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elasticity remain unclear. The study aims to investigate how locally applied vibration affects changes in the range of motion in the knee joints affected by percussion vibration [9].

Material and methods

The study was approved by the institution's ethics commission. Written consent was obtained from all study participants. The inclusion criteria included: age between sixteen and thirty-five years, at least three training sessions per week as nonprofessional athletes, male gender. Participants were recruited to the research by a medical doctor. Exclusion criteria included: female gender, age below 16 and above 35 years of age, contraindications for vibration application. Finally, the sample consisted of 31 participants. The subjects were divided into two groups in accordance with the knee joint injury history. The first group (aged 23.1 ± 4.6) was composed of men with prior history of knee joint injury (knee injury – KI), and group 2 (aged 22.46 ± 4.2) was composed of men with no history of knee joint injury (no knee injury – nKI). Detailed anthropometric characteristics are presented in Table 1.

Table 1. Group anthropometric characteristics

	Knee injury (KI)	No knee injury (nKI)
n	18	13
Age [years]	23.1 ± 4.6	22.46 ± 4.2
Body mass [kg]	82.9 ± 11.6	78.4 ± 12
Body hight [cm]	181,9 ± 7.2	182.1 ± 6.4

The range of motion (ROM) of the knee joint was tested using a handheld standard goniometer (Saehan 15 cm goniometer). The measurements were taken in two positions: the prone position and the half-kneeling position. The passive ROM was taken in accordance with proper measurement practice, with the goniometer placed laterally and the axis of the goniometer pointing in the middle of the knee joint. The stationary arm of the goniometer was placed parallel to the femur and pointing into the trochanter major and the moving arm parallel to the tibia and pointing into the lateral malleolus. The measurement was taken by the same researcher, at three instances: before the intervention, immediately after, and 10 minutes after the intervention in the prone position (PrP) with the pelvis in a neutral position. Additionally, two measurements of the ROM were performed before and immediately after the intervention in a half-kneeling (HkP) position. Vibration therapy was performed with the MedicGunPro device, characterized by interchangeable heads (x6) – bifurcated, point, flat round, trapezoidal and wavy. The soft, round tip was used in all interventions.

The vibration stimulus was applied locally to the quadriceps muscle of the thigh with the participant in a supine position. The massager was applied four times to the three superficial heads of the quadriceps muscle: on the medial head (vastus medialis – VM), the straight head (rectus femoris – RF) and the lateral head (vastus lateralis – VL). In the KI group the vibration was applied to the affected limb, and in the nKI to the dominant limb, as self-reported by the participant of the study.

The vibration was applied using the protocol of 10 s vibration on the muscle insertion with a 5 s break, 10 s of vibration on the muscle origin with a 5 s break, then 20 s on the origin and insertion with 5 s breaks between applications. For each of the three parts of the quadriceps, the procedure was repeated four times. The frequency of the vibration remained at 30 Hz with 10 mm amplitude. The method was developed following the device manual and preexisting research on vibration's impact on elasticity [14].

The statistical analysis was conducted using the STATISTICA (v.13) program. The distributions of the data were assessed using the Shapiro-Wilk test. Variance homogeneity was tested using Levene's test. Simple one-way ANOVA was performed. To assess the interaction an ANOVA test for repeated measures and Bonferroni's post-hoc tests were performed. The level of statistical significance was $p < 0.05$.

Results

The analysis showed statistically significant differences in the knee flexion range of motion (ROM) before and immediately after the treatment ($p = 0.002$), and before and 10 minutes after the intervention ($p = 0.011$) in the PrP. Statistically significant differences were also found before and immediately after treatment intervention in knee ROM tested in HkP ($p < 0.001$).

Moreover, participants were divided into two groups in accordance with knee joint injury history. Analysis showed significant differences between groups in ROM of the knee joint before ($p < 0.001$), immediately after ($p < 0.001$), and 10 minutes after the intervention ($p < 0.001$). Furthermore, no statistically significant differences between groups were found in knee flexion ROM in the HkP position before and immediately after treatment ($p < 0.001$). The results of the above analysis are presented in Table 2.

Furthermore, the analysis did not show a significant interaction between ROM MEASUREMENT IN PrP x KNEE INJURY ($F_{2,58} = 0.662$; $p = 0.52$). The analysis showed a statistically significant difference between the ROM before, immediately after, and 10 minutes after the intervention ($F_{2,58} = 8.562$; $p = 0.0006$). The highest ROM value was observed in PrP immediately after the intervention. Post-hoc tests showed differences between ROM before (138.13° ± 7.39°) and immediately after (140.94° ± 7.41°)

Table 2. Differences between groups in range of motion of the knee joint

Range of Motion	Knee injury (KI, n = 18)	No knee injury (nKI, n = 13)	p
before in PrP	133.9 ± 6.26	144 ± 4.06	<0.001
immediately after in PrP	137.3 ± 6.98	145.9 ± 4.64	<0.001
10 min after in PrP	136.7 ± 6.75	145.6 ± 4.5	<0.001
HkP before	141.4 ± 7.66	146.4 ± 7.17	0.079
HkP after	145.3 ± 8.22	150.2 ± 6.32	0.084

therapy (p = 0.0004) and before and 10 minutes after (140.42° ± 7.36°) the intervention (p = 0.004).

There was no significant interaction between ROM MEASUREMENT IN HALF-KNEELING × KNEE INJURY ($F_{1,29}$ = 0.002; p = 0.961) despite higher ROM values after the intervention. The statistical analysis showed statistically significantly higher knee ROM values after the intervention (147.32° ± 7.76°) in comparison to before (143.51° ± 7.75°) the massage in HkP ($F_{1,29}$ = 33.757; p < 0.001).

Discussion

The current research had one main aim: to inquire into the effects of percussion massage on muscle elasticity. Finding that local vibration, according to the Kinsner protocol [11], was able to improve soft tissue elasticity was thought-provoking.

The current research applied selective vibration on three heads of the quadriceps, starting from the tendon muscle parts, where most vibration-receiving receptors are located, according to Pope and De Freitas [15]. The improvement in soft tissue elasticity has been observed in both the current research and the work by Kinser et al. [11], possibly indicating the effectiveness of local vibration.

The presented results are in congruence with results obtained by Konrad et al. [11], who investigated the effects of percussion massage on flexibility and muscle strength [12]. The current study utilized a soft head for percussion massage, like one used in the research by Kondrad et al. [12]. No vibration parameters are provided by the author; however, it is stated that vibration parameter selection is a decisive factor in the effects of therapy.

The current research used the MedicGunPro percussion massage device to apply vibration to the quadriceps, while research by Cheatham, Stull, and Kolber [3] compared the effects of vibration application utilizing a roller with vibration. The research compared the influence of classic rolling and rolling with vibration on the range of motion in the knee joint, as well as the pressure pain threshold (PTT) of the quadriceps muscle. Both of the studies examined sportsmen. Each roller intervention lasted for 2 min in total, with no vibration parameters specified by the author. The improvement observed in the ROM in the other works [3, 11, 12] could be explained by thixotropic effects. In all four works, vibration led to an increased range of motion within their experimental groups. Rolling, percussion massage, and stretching create pressure and friction on the treated area, possibly leading to less drag by affecting the viscosity and density of the fluids. In addition, another factor that may contribute to the obtained effects involves the effects on neuromuscular spindles and other mechanoreceptors transmitting stimuli [6].

The entire study group achieved a greater ROM upon applying the MedicGunPro massager to the quadriceps muscle. A statistically significant improvement in ROM of the knee joint was observed in all subjects following the application of the vibration. The forward lying position ROM improvement was maintained for 10 minutes upon therapy completion. The improvement observed in the HkP position proved to be the most statistically significant.

Due to the impact of vibrations on the neurophysiological mechanism, in the second stage of the research, the subjects were divided into two groups [2], distinguished by knee joint injury history. Group 1 consisted of individuals with prior knee joint injury history, while members of group 2 had no history of knee joint injury. One of the main objectives of the current research was to find out whether vibration would affect the knee joint to the extent observed in tissues with no trauma history. The results indicated that the knee flexion ROM increased statistically significantly in both groups, upon the vibration being applied. Percussion massage therapy proved more effective in group 1, composed of players with knee joint injury history. A statistically significant difference was found between groups in terms of the PrP. It could be assumed that such a difference is possible due to increased tissue tension among those who suffered a knee joint injury. The application of vibrations reduced tension in the surrounding tissues, allowing for an increase of ROM. Additionally, the effect of knee joint ROM increase was noted in the measurement that occurred 10 minutes after therapy completion. The ROM improvement was statistically significant in both groups; however, in the first group, the improvement was greater. In the HkP position, the flexion ROM in the examined joint increased in both groups.

In terms of future directions, it would be interesting to investigate the influence of local vibration on the explosive force. In further research, it would be interesting to confirm the beneficial effects of vibration on flexibility, with no reduction of explosive force, allowing for the introduction of vibration massage to the warm-up regimen for flexibility level optimization [17]. Further, most percussion massage devices are equipped with several heads. In future studies, it would be interesting to investigate the differences in the performance of individual tips [15].

Conflict of interest: Authors state no conflict of interest.

References

1. Barati K., Esfandiari E., Kamyab M., Takamjani I.E., Atlasi R., Parnianpour M., Yazdi H., ShahaIi S., Bidari S. (2021) The effect of local muscle vibration on clinical and biomechanical parameters in people with knee osteoarthritis: A systematic review. *Med. J. Islam Repub. Iran*, 35: 1–9. DOI: 10.47176/MJIRI.35.124
2. Blackburn T., Padua D.A., Pietrosimone B., Schwartz T.A., Spang J.T., Goodwin J.S., Dewig D.R., Johnston C.D. (2021) Vibration improves gait biomechanics linked to posttraumatic knee osteoarthritis following anterior cruciate ligament injury. *J. Orthop. Res*., 39: 1113–1122. DOI: 10.1002/jor.24821
3. Cheatham S. W., Stull K. R. and Kolber M. J. (2019) Comparison of a vibration roller and a nonvibration roller intervention on knee range of motion and pressure pain threshold: A randomized controlled trial. *J. Sport Rehabil*., 28: 39–45. DOI: 10.1123/jsr.2017-0164
4. Cochrane D. J. (2011) The Potential Neural Mechanisms of Acute Indirect Vibration. *J. Sports Sci. Med*., 10(1): 19–30.
5. Fallon J.B., Macefield V.G. (2007) Vibration sensitivity of human muscle spindles and Golgi tendon organs. *Muscle Nerve*, 36: 21–29. DOI: 10.1002/mus.20796
6. Furness N.D., Phillips A., Gallacher S., Beazley J.C.S., Evans J.P., Toms A.D., Thomas W., Smith C.D. (2018) Vibration therapy versus standard treatment for tennis elbow: A randomized controlled study. *J. Orthop. Surg.* (Hong Kong), 26(3): 2309499018792744:. DOI: 10.1177/2309499018792744
7. Germann D., El Bouse A., Shnier J., Abdelkader N., Kazemi M. (2018) Effects of local vibration therapy on various performance parameters: a narrative literature review. *J. Can. Chiropr. Assoc*., 62: 170.
8. Goebel R.T., Kleinöder H., Yue Z., Gosh R., Mester J. (2015) Effect of Segment-Body Vibration on Strength Parameters. *Sports Med. Open*, 1(1): 14. DOI: 10.1186/S40798-015-0022-Z
9. Guo J., Li L., Gong Y., Zhu R., Xu J., Zou J., Chen X. (2017) Massage Alleviates Delayed Onset Muscle Soreness after Strenuous Exercise: A Systematic Review and Meta-Analysis. *Front. Physiol*., 8: 747. DOI: 10.3389/FPHYS.2017.00747
10. Kessler N.J., Lockard M.M., Fischer J. (2020) Whole body vibration improves symptoms of diabetic peripheral neuropathy. *J. Bodyw. Mov. Ther*., 24: 1–3. DOI: 10.1016/j.jbmt.2020.01.004
11. Kinser A.M., Ramsey M.W., O'Bryant H.S., Ayres C.A., Sands W.A., Stone M.H. (2008) Vibration and stretching effects on flexibility and explosive strength in young gymnasts. *Med. Sci. Sports Exerc*., 40: 133–140. DOI: 10.1249/MSS.0B013E3181586B13
12. Konrad A., Glashüttner C., Reiner M.M., Bernsteiner D., Tilp M. (2020) The Acute Effects of a Percussive Massage Treatment with a Hypervolt Device on Plantar Flexor Muscles' Range of Motion and Performance. *J. Sports Sci. Med*., 19(4): 690-694.
13. Kröger S., Watkins B. (2021) Muscle spindle function in healthy and diseased muscle. *Skeletal Muscle,* 11:3. 1–13. DOI: 10.1186/s13395-020-00258-x
14. Kurt C. (2015) Alternative to traditional stretching methods for flexibility enhancement in well-trained combat athletes: local vibration versus whole-body vibration. *Biol. Sport*., 32: 225. DOI: 10.5604/20831862.1150305
15. Pope Z.K., DeFreitas J.M. (2015) The effects of acute and prolonged muscle vibration on the function of the muscle spindle's reflex arc. *Somatosens. Mot. Res*., 32: 254–261. DOI: 10.3109/08990220.2015.1091770
16. Saquetto M., Carvalho V., Silva C., Conceição C., Gomes-Neto M. (2015) The effects of whole body vibration on mobility and balance in children with cerebral palsy: a systematic review with meta-analysis. *J. Musculoskelet. Neuronal. Interact*., 15(2): 137-144.
17. Sierra-Guzmán R., Jiménez-Diaz F., Ramírez C., Esteban P., Abián-Vicén J. (2018) Whole-Body–Vibration Training and Balance in Recreational Athletes With Chronic Ankle Instability. *J. Athl. Train*., 53(4): 355-363. DOI: 10.4085/1062-6050-547-16
18. Urbaniak M., Milańczyk A., Smoter M., Zarzycki A., Mroczek D., Kawczyński A. (2015) The effect of deep tissue massage therapy on delayed onset muscle soreness of the lower extremity in karatekas – a preliminary study. *J. Combat Sports Martial Arts*, 6: 7–13. DOI: 10.5604/20815735.1174225
19. Weigel E.J. (2014) Effects of Vibration Massage on Doms, Using a Car Buffer. https://musclerestoration.com/wp-content/uploads/2013/03/Effects-of-Vibration-Massage-on-DOMS-Using-a-Car-Buffer-1.pdf (Accessed January 2023).

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