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Research Article / Araştırma Makalesi

Acute effect of percussion massage applied on quadriceps with Hypervolt device on range of motion and performance *

Kuadricepse Hypervolt cihazı ile uygulanan perküsyon masajının eklem hareket açıklığına ve performansa akut etkisi

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ABSTRACT

Objective: The aim of our study is to investigate the effect of percussion massage applied to the quadriceps muscle with a Hypervolt device on range of motion (ROM), jumping, agility and anaerobic performance.

Material and Methods: Total of 24 (41.7% female, 58.3% male) healthy individuals with mean age of 22.04±1.19 years participated in the study. A cross-randomization method with a 72-hour washout period was used throughout the study. Percussion massage (Hyperice, California, USA) was applied to the dominant quadriceps muscle of the participants lying in the supine position for 8 minutes at a frequency of 30 Hz using the flat head of the Hypervolt device. ROM, vertical jump, T Drill Test and Wingate anaerobic performance tests (WAnT) were evaluated.

Results: Hip flexion ROM of the participants increased significantly after percussion massage with Hypervolt (p=0.02). There was no significant difference in vertical jump and T Drill Test results and ROM measurements other than hip flexion after percussion massage with Hypervolt (p>0.05). WAnT results were found to be decreased (p<0.05).

Conclusion: While percussion massage device has positive effects on joint range of motion, they have no effect on jumping and agility performance. However, there was a decrease in anaerobic power output. Percussion devices such as Hypervolt which are utilized for warming up may reduce anaerobic performance.

Keywords: *Percussion, massage, power, range of motion*

ÖZ

Amaç: Çalışmamızın amacı; Hypervolt cihazı ile quadriceps kasına uygulanan perküsyon masajının eklem hareket açıklığı (EHA), sıçrama, çeviklik ve anaerobik performans üzerine etkisini araştırmaktır.

Gereç ve Yöntem: Çalışmaya yaş ortalaması 22,04±1,19 yıl olan toplam 24 (%41,7'i kadın, %58,3'ü erkek) sağlıklı birey katıldı. Araştırma boyunca, 72 saatlik arınma periyodu içeren çapraz randomizasyon usulü uygulandı.

Supin pozisyonda uzanan katılımcıların dominant kuadriceps kasına Hypervolt cihazının düz başlığı kullanılarak 8 dakika boyunca 30 Hz frekansta perküsyon masajı (Hyperice, Kaliforniya, ABD) uygulandı. Araştırma protokolünde; EHA, dikey sıçrama, T Drill Test ve Wingate Test ile anaerobik performans testlerinin (WAnT) sonuçları incelendi.

Bulgular: Katılımcıların, Hypervolt ile perküsyon masajı sonrasında kalça fleksiyon EHA'larının anlamlı olarak arttığı görüldü (p=0,02). Hypervolt ile perküsyon masajı uygulaması sonrası dikey sıçrama, T Drill Test ve kalça fleksiyonu dışındaki EHA sonuçlarında anlamlı değişiklik izlenmedi (p>0,05). WAnT sonuçlarında ise düşüş olduğu gözlendi (p<0,05).

Sonuç: Perküsyon masajı cihazının eklem hareket açıklığı üzerine olumlu etkileri bulunurken, sıçrama ve çeviklik performansına etkisi bulunamamıştır. Anaerobik güç çıkışında ise düşüş gözlenmiştir. Hypervolt gibi perküsyon cihazlarının ısınma amaçlı kullanımında anaerobik performansı düşürebileceği göz önünde bulundurulmalıdır.

Anahtar Sözcükler: *Perküsyon, masaj, güç, eklem hareket açıklığı*

INTRODUCTION

It has been observed that the use of percussion massage device (PMD) applications has increased in recent years, especially among the athlete populations (1). PMDs are used for warming up before activity, for recovery after activity, and for the treatment of myofascial problems (2). There are diverse types of PMDs (Hypervolt®, TheraGun®) that can be self-applied and by the therapist (1, 2). Although there are PMDs with various frequency ranges, these devices give positive myofascial results in the 5-300 Hz frequency range (2). PMDs have replaceable heads such as flat, round, bullet

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and fork that differ according to the area of massage application (2).

Traditional massage has positive effects on delayed onset muscle pain (DOMS) and acutely increases the range of motion (ROM) (3). On the other hand, traditional massage has no effect on fatigue and performance parameters such as strength, jump, sprint, endurance (3). Similar to traditional massage, PMD and vibrating foam rollers are also known to increase ROM (1, 4, 5) and have positive effects on DOMS (4-6). In several studies investigating the effects of PMDs on performance, no positive or negative effects on physical fitness components such as 'maximum voluntary contraction, muscle activation or force' have been observed (1, 5). PMDs were recommended for warming up before exercise since they did not have negative effects on muscle strength/power, while improved flexibility and decreased DOMS (1, 5).

Although there are few studies on the mechanism of action and clinical results of PMDs, its marketing and using are widespread (2). The acute effects of 5 minutes percussion massage with Hypervolt on the gastrocnemicus muscle were examined in an unique study published in a peer-reviewed journal by Kondrad et al.; no change was observed in plantar flexor maximum voluntary contraction (MVC) while ankle dorsiflexion ROM increased after percussion massage application (1).

The use of PMDs by coaches and athletes is common. It also appears that the marketing of PMDs is widespread. Considering that these devices are used by athletes and trainers for warming up before exercise/performance, it is important to reveal the effects of PMDs on other physical fitness components such as jumping, agility and anaerobic power.

We aimed to investigate the effect of 8-minute (min) percussion massage applied to the quadriceps muscle with the Hypervolt device on ROM, jumping, agility and Wingate anaerobic performance tests (WAnT).

MATERIALS and METHODS

Participants

Healthy male and female participants aged 20-25 participated in the study. Those with a history of lower extremity injury, neuromuscular disease, health problems that prevent them from performing the tests, and elite athletes were not included in the study. Minimally active individuals according to IPAQ were accepted for participation.

Ethical Aspect of the Study

The study was approved by the Clinical Researches Local Ethics Committee's decision no. 240, dated 13 July 2021. Participants were informed about percussion massage application and test procedures. Afterwards, the individuals who volunteered for the study were included in the study.

Design of the Study

A cross-over randomization method was used throughout the study (7). For this, the participants were subjected to two different application sequences: “Application A: PMD on day 1, control after 72 hours” and “Application B: control on day 1, PMD after 72 hours” (Table 1). The tests were repeated at the same time of the day with 72-hour intervals.

Table 1. Design of the study

Application A		
PMD (1st day)	**à**	**Control (After 72 hours)**
8 min. PMD application Warming up 1. ROM 2. Jump tests 3. T Drill Test 4. WAnT	Washout period: 72h	Warming up 1. ROM 2. Jump tests 3. T Drill Test 4. WAnT
Application B		
Control (1st day)	**à**	**PMD (After 72 hours)**
Warming up 1. ROM 2. Jump tests 3. T Drill Test 4. WAnT	Washout period: 72h	8 min. PMD application Warming up 1. ROM 2. Jump tests 3. T Drill Test 4. WAnT

PMD: percussion massage device, ROM: range of motion, WAnT: Wingate anaerobic performance test

Test Protocol

Application of PMD

Percussion massage was applied to the quadriceps muscle in the dominant extremities of the participants for 8 minutes while the participants were lying in the supine position. Referring to Konrad et al.'s study, we massaged four different parts of the quadriceps muscle for 2 minutes each (1). Massage was applied by the same researcher with a Hypervolt device (Hyperice, California, USA) at a frequency of 30 Hz. Number 1 flat head was used during the massage (Figure 1).

Figure 1. Hypervolt massage device and its different heads; 1: Flat, 2: Round, 3: Bullet, 4: Fork

The anterior thigh was divided into 4 longitudinal sections from medial (1st section) to lateral (4th section) and percussion massage was applied to each section for 2 minutes. The massage was started from the distal of the vastus medialis and directed longitudinally to the proximal in 20 seconds. Afterwards, it was directed distally again in 20 seconds (1). In this way, the vastus medialis obliquus was massaged for 2 minutes, then the second part of the quadriceps muscle was massaged. Afterwards, massages of the 3rd and 4th sections were performed, respectively. During the massage, the same intensity of pressure was applied to the skin of all participants.

After PMD application, ROM, jumping, agility, and WAnT were evaluated. Participants, who started the research protocol with this application repeated the tests without massage application after 72 hours and these are recorded as control tests.

Control Application

In the first evaluation of the participants, whose research protocol was started with this application, only the performance test was performed, and the tests were repeated 72 hours later, by performing the PMD application.

International Physical Activity Questionnaire (IPAQ)

The IPAQ was used to determine the physical activity status of the participants. The questionnaire consists of 4 sections and a total of 7 questions, including questions about physical activity performed for at least 10 minutes in the last 7 days. Turkish validity and reliability of the questionnaire was made by Karaca et al. (8).

Measurements

After a five-minute warm-up program at 60 bpm on a recumbent bicycle ergometer, the evaluations were performed in the following order: 1. ROM, 2. Jump tests, 3. T Drill Test, 4. WAnT. 3-minute rest periods were given between (9) all tests.

Joint Range of Motion

Joint range of motion measurements were performed by the same researcher with a metal goniometer (Baseline Stainless Steel Goniometer; Fabrication Enterprises Inc., Elmsford, NY, USA). Hip extension, knee flexion and knee extension measurements were performed in the prone position. On the other hand, hip flexion, ankle plantar flexion and ankle dorsiflexion measurements were performed in the supine position.

Jump Tests

The jump heights of the participants were evaluated with a vertical jump meter (TKK 5406, Takei, Japan) (10). The belt of the device was fixed just above the level of the crista iliaca and the participants performed their maximum jump. Two different jump tests; countermovement and squat jump tests were applied to the participants (11). Each jump test was performed 3 times and the highest score was recorded in cm.

T Drill Test

The agility of the participants was evaluated with the T Drill Test. All participants were given 3 test trials and their best scores were recorded in seconds (12).

Wingate Anaerobic Power Test (WAnT)

Anaerobic capacity tests of the participants were performed with a bicycle ergometer (Monark 894 E, Sweden). After the participant sat on the bike, the seat height was adjusted so that the knee was in full extension while the pedal was at the lowest level. The participant was asked to accelerate to the maximum pedaling speed without resistance. When the participant reached the maximum pedaling speed, they were asked to pedal for 30 seconds at maximum speed against the resistance (kg) corresponding to 7.5% of the predetermined participant's body weight (13). During the test, the participant was verbally encouraged to spin at maximum speed. After the test, the participant was allowed to cool down by pedaling for 2-3 minutes without resistance.

Statistical analysis

SPSS v.23 package program was used in the analysis of the data obtained by the cross-over randomization method. After examining the descriptive properties of the data, the conformity to the normal distribution was examined with

the Shapiro-Wilk test. Since it was determined that the data were normally distributed, difference analysis was performed with t-test in dependent groups. P value was considered significant at the 0.05 level. Data were presented as frequency (n), percent (%), mean ± standard deviation.

G-Power analysis

The adequacy of the results was determined by finding the Noncentrality parameter δ=3.46, Critical t=2.01, Df=46 and Power (1-β err prob)=0.92 in the post hoc power analysis (G*Power 3.1.9.6, Germany) performed by considering the WAnT results.

RESULTS

A total of 24 participants, 41.7% (n=10) women and 58.3% (n=14) men, were included in the study. Mean age of the volunteers was 22.04±1.19 years, body mass index was 21.40±1.86 kg/m^2, weekly exercise time was 136.67±49.98 minutes, IPAQ value was 1417.73±1357.86 MET/week. The right extremity of all participants was detected as dominant. 29.2% (n=7) of the participants were active smokers.

It was observed that the hip flexion ROM of the participants increased significantly after percussion massage with Hypervolt. No significant change was detected in other lower extremity ROM measurements. The lower extremity ROM values of the volunteers before the application and after percussion massage with Hypervolt to the quadriceps muscle in the dominant extremity are presented in Table 2.

Table 2. Lower extremity joint range of motion values after percussion massage

ROM	Non dominant	Dominant	After Percussion Massage - Dominant	*p* value
Hip flexion	114.33±10.12	113.88±8.74	116.67±8.55	**0.020***
Hip extension	23.08±6.26	23.79±7.13	22.71±6.54	0.207
Knee flexion	131.83±8.64	131.88±9.98	132.25±8.30	0.646
Knee extension	0±0	0±0	0±0	a
Ankle DF	16.54±5.40	18.63±5.06	19.67±4.32	0.205
Ankle PF	45.88±8.20	47.42±9.38	47.21±8.00	0.843

a: The p value could not be calculated because the mean and standard deviation were 0. *: p value is significant at the 0.05 level. ROM: Range of Motion, PF: plantar flexion, DF: dorsiflexion

After percussion massage with Hypervolt, no significant change was detected in the performance tests, jump tests and T Drill Test results. It was observed that there was a decrease in peak power, average power, and power drop in WanT test results after percussion massage with the Hypervolt device (Table 3-4).

Table 3. Jumping and agility test results after percussion massage

Tests	Control	After Percussion Massage	*p* value
Squat Jump (cm)	36.88±7.73	37.29±7.52	0.384
Counter Movement Jump (cm)	38.04±7.77	38.63±8.29	0.192
T Drill Test (sec)	14.47±1.53	14.12±2.05	0.129

*: p value is significant at the 0.05 level. sec: second.

Table 4. Wingate test results after percussion massage

WAnT	Control	After Percussion Massage	*p* value
Peak power (W)	456.57±137.81	414.05±122.51	**0.006***
Peak power (W/bw)	7.22±1.51	6.55±1.30	**0.008***
Average power (W)	330.47±89.19	313.94±86.15	**0.039***
Average power (W/bw) (W/kg)	5.24±0.92	4.99±0.93	0.056
Minimum power (W)	244.12±61.68	232.24±56.86	0.061
Minimum power (W/bw) (W/kg)	3.90±0.73	3.71±0.67	0.072
Power drop (W)	212.63±94.97	181.62±77.59	**0.018***
Power drop (W/bw) (W/kg)	3.32±1.24	2.83±0.97	**0.020***
Power drop (W/sec)	7.08±3.16	6.05±2.58	**0.018***
Power drop (W/sec/kg)	0.11±0.04	0.09±0.03	**0.020***
Power drop W percentage %	44.95±9.30	42.29±9.38	0.090
Fatigue index	44.89±9.40	42.34±9.29	0.104

*: p value is significant at the 0.05 level. WAnT: Wingate anaerobic performance test, W: watt, bw: body weight, sec: second, kg: kilogram

DISCUSSION

The aim of our study was to evaluate the acute effects of percussion massage applied to the quadriceps muscle with the Hypervolt device on ROM and athletic performance. The most important result of our study was the decrease in WAnT performance after percussion massage with the Hypervolt device. To the best of our knowledge, the effects of PMD on WAnT were evaluated for the second time in the literature (14) in our study. The effects of PMD on T Drill Test performance was evaluated for the first time with this study, and it was observed that percussion massage had no effect on agility evaluated with the T Drill Test. Similar to previous studies with PMDs (15-17), it was observed that percussion massage did not cause a significant change in jump performance. Additionally, similar to previous studies (1, 5), an increase in hip flexion ROM was observed after percussion massage with Hypervolt.

Monterio et al. observed an increase in hip flexion and extension passive ROMs following the application of foam roller massage to the quadriceps muscle (18). They applied the massage for 60 and 120 seconds and reported similar results, however positive effects of foam roller application on passive ROM disappeared in 30 minutes (18). We measured active ROM values in this study, as well but did not observe any significant difference in hip extension.

Lim et al. reported that ROM increased after vibratory foam roller application to the hamstring muscle, whereas no change was detected in vertical jump performance (19). Our

study revealed similar results in hip flexion ROM and jump performance.

Hypervolt percussion massage therapy, like foam roller, causes pressure and friction on the skin, muscle, and fascia in the applied area and may have an effect on reducing the tissue viscosity, so that the resistance to movement decreases (20). Romero-Moreleda et al., comparing vibratory and non-vibration foam rollers in their study, found that vibratory foam rollers improved passive hip extension better than non-vibration foam rollers (21). In the same study, both foam rollers were observed to increase active hip extension and knee flexion similarly (21). However, Cheatham et al. found that there was a similar increase in knee flexion ROM after foam roller application with and without vibration (4). Kondrad et al. reported an acute increase in ankle after a 5-minute massage of the gastrocnemicus muscle with Hypervolt device and they concluded that the decrease in muscle stiffness and changes in pain perception after PMD application were effective in increasing ROM (1). Contrary to these studies, an increase in hip flexion was observed in our study and no significant difference was observed in hip extension and knee flexion, which may be due to the difference in methodology.

In a case study written by Patel, it was shown that there was an increase in the sit and reach test after the application of a 5 minute percussion massage to the hamstring muscle with TheraGun device every day for a week (22). In the report presented by Guzman et al., it was shown that there was an increase in hip flexion and knee flexion ROM after a single session of massage application to the hamstring and quadriceps muscles with the TheraGun device (23).

As one of the most important results of our study, it was observed that there was a decrease in WAnT performance after percussion massage with the Hypervolt device. To our knowledge, there is only one study in the literature examining the effects of PMDs on WAnT performance (14). Virginia et al. found that the peak power in WAnT increased after 2 minutes of PMD application with TheraGun device compared to 2 minutes of foam roller application and control group (14). However, in our study, the duration of the percussion massage was 8 minutes, and WAnT was performed 20 minutes after the percussion massage. The differences in the duration of the percussion massage and the tests after the massage may have caused contrary results with Virginia et al.

Rusli's study had shown that Wingate Test performance increased after 5 minutes of dynamic stretching exercise and decreased after 10 minutes of dynamic stretching exercise (24). Similarly, we suggest that increasing the duration of PMD application may have a negative effect on test performance. The effects of PMD duration and the time gap between PMD application and WAnT should be investigated.

It was shown that the Wingate Test performance decreased after static stretching in the study by Miller (13). In another study, Hansen et al. reported that there was no change in WAnT after foam roller application in the control group, 30 sec, 60 sec and 90 sec groups (25). It has been mentioned in this study that foam roller application at increasing doses may decrease performance (25). In this context, it should be remembered that percussion massage with a Hypervolt device, like foam rollers, may also cause a decrease in anaerobic performance.

We observed that jump and T Drill Test performances did not change after percussion massage with Hypervolt. Similarly, Kujala et al. (2019), Peter et al. (2020) and Hernandez (2020) also showed that the jump performance did not change after PMD application (15-17). These studies revealed similar results with our study on jump performance.

The effect of PMD application on T Drill Test performance was evaluated for the first time in this study and it was presented that percussion massage applied to the quadriceps muscle had no effect on agility. Chen et al. evaluated the effects of dynamic stretching warm-up protocol and vibratory foam roller application on agility with the 505 agility test and found no difference between the two warm-up protocols (26).

First limitation of our study was the PMD application to quadriceps muscle in the dominant extremity with a single frequency (30 Hz). The effects of PMD on ROM, jump, T Drill Test and WAnT performance after application to both lower extremities need to be investigated. Secondly, the effects of PMD duration and time gap in WAnT performance should be evaluated in future studies.

CONCLUSION

Due to the positive effects of PMDs on flexibility and the widespread use of them for warming, it is important to reveal their effects on performance. Percussion massage did not revealed any effects on jumping performance. Likewise, T Drill Test performance did not change after percussion massage with the Hypervolt device. However, WAnT performance decreased following percussion massage.

Ethics Committee Approval / Etik Komite Onayı

This study was approved by the Suleyman Demirel University Faculty of Medicine Scientific Research Ethics Committee (approval number 240, date: 13.07.2021).

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

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