European Journal of Physical Education and Sport Science
ISSN: 2501 - 1235
ISSN-L: 2501 - 1235
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.896961 Volume 3 | Issue 11 | 2017

ACUTE EFFECTS OF APPLIED LOCAL VIBRATION DURING FOAM ROLLER EXERCISES ON LOWER EXTREMITY EXPLOSIVE STRENGTH AND FLEXIBILITY PERFORMANCE

İsa Sağiroğlu[i]
Department of Coaching Education,
Trakya University, Edirne, Turkey

Abstract:
Self-myofascial releasing (SMR) exercises using foam roller equipment are thought to improve muscle performance. It is also known that local vibration (LV) exercises have been improving strength, power, and flexibility for a long time. However, there is a limited study that examines the effects of SMR exercises applied with LV on muscular performance. The purpose of this study is to investigate the effects of SMR applications using vibrating foam roller equipment on lower extremity explosive strength and flexibility in well-trained soccer players. Twenty-two well-trained male soccer players (mean age 22.13 ± 2.47 years, height 178 ± 4.92cm body weight 74.9 ± 3.93kg, training time 11.59 ± 1.14h / week) participated in two different exercise sessions (foam roller and foam roller+LV) with randomized crossover study design and 48-hour intervals. All athletes were tested for the Counter Movement Jump (CMJ) and sit-and-reach (S & R) flexibility test before and after both training sessions. When the results of the study were examined, both foam roller exercise and foam roller + LV exercise showed an increase in jump and flexibility performance ($p < 0.05$). However, no difference was observed between the applications when the data obtained from both applications were compared among themselves. As a result, foam roller exercises made with local vibration seemed to have the similar effect on jumping and flexibility performance compared to foam roller exercises only. Moreover, both foam roller and foam roller + LV exercises can be applied by athletes prior to training or competitions due to their positive effects on muscle performance.

Keywords: self-myofascial releasing, local vibration, vertical jump, flexibility, football

[i] Correspondence: email isagiroglu83@gmail.com

1. Introduction

Foam roller exercises have recently been used frequently by fitness coaches, sportive performance conditioners, and physiotherapists on athletes for pre-exercise warm-up or post-exercise cooling (Beardsley and Skarabot, 2015). In order to understand the mechanism of action of foam roller exercises, it is first necessary to know myofascial releasing (MR). MR is a broad term for manual therapy techniques applied by pressing to muscle and fascia (McKenney, Elder, Elder and Hutchins, 2013). Fascia is defined as a fibrous-colloidal tissue that is part of the body's blood pressure-force transmission system (Benjamin, 2009). One of the sub-branches of MR applications is the Self-Myofascial Releasing (SMR) technique. During the SMR applications, the athlete or the individual performs self-MR exercises using various tools. One of the most common tools used during SMR applications is foam roller equipment (Healey, Hatfield, Blanpied, Dorfman and Riebe, 2014, MacDonald et al., 2013, Coreya Peacock et al., 2015). Foam roller applications have many acute and chronic effects. The best known are acute and chronic increases in flexibility, reduction in muscle pain, modulation of autonomic nervous system activity and arterial and vascular endothelial function effects (Beardsley and Skarabot, 2015, MacDonald et al., 2013, Corey A Peacock et al., 2015, Sullivan and Silvey, 2013). Despite the many positive effects of SMR exercises, there is no clear consensus on the mechanisms of action. However, studies have concentrated on the mechanisms of action on the fascia, although not much clear information yet. Simmonds, Miller and Gemmell (2012) examined the mechanisms of SMR applications by separating them into mechanical and neurophysiological effects. Mechanical effects include thixotropy, piezoelectric, facial adhesions, cellular responses, myofascial trigger points and facial inflammation. Neurophysiological effects are on the Golgi tendon organ and mechanoreceptors.

On the other hand, it is stated that vibration exercises also cause an increase in strength, power, and flexibility in sportsmen (Dallas et al., 2015; Savelberg, Keizer and Meijer, 2007). Its use on sportsmen is particularly popular by fitness trainers and sportive performance coaches. Vibration exercises are applied in two ways; these are Local vibration (LV) and whole body vibration (WBV). While the vibration is applied indirectly to the target muscle during WBV, it is applied directly to the muscle during LV (Drummond et al. 2014). The vibration tool brings to the mechanical oscillation course, which can affect muscle spindle and Ia afferents, resulting in a change in the length of the muscular extrafusal fibrils. The response resulting from the activation of this vibrational afferent feedback mechanism is known as tonic vibration reflex (TVR) (M. Cardinale and Bosco, 2003).

In recent years, especially in the fitness industry, foam roller tools with vibration mechanism have begun to be used. The work done with this equipment aims to achieve acute and chronic maximum benefit in power and flexibility performance by combining the mechanical and neurophysiological effects of LV and SMR applications. However, when literature review is made, it cannot be seen that the combined use of LV and SMR exercises does not investigate the acute effects on flexibility and lower extremity explosive strength of soccer players.

The purpose of this study was to investigate the effects of foam roller and foam roller + LV applications by made with vibrating foam roller equipment on the explosive strength of the lower extremity. The hypothesis of this study was "the *acutely applied foam roller + LV on lower limb flexibility and explosive strength performance is more effective than the only application of foam roller applied acutely".*

2. Material and Methods

2.1 Participants

Twenty-two well-trained male soccer players (mean age 22.13 ± 2.47 years, height 178 ± 4.92cm body weight 74.9 ± 3.93kg, training time 11.59 ± 1.14s / week) were included in this study after signing the voluntary participatory proclamation form. The study inclusion criteria for the athletes were determined to have been exercising regularly for the past three months, exercising for at least eight hours per week and not having a lower extremity injury or surgical operation to affect the test results. In addition, they did not have any health problems such as diabetes, epilepsy, neurological or neuromuscular, which could prevent them from participating in the test protocols described in the details of the study. All sportsmen were banned from eating and drinking alcoholic beverages and strenuous physical activities containing caffeine and similar stimulants at least 24 hours before the test sessions.

2.2 Experimental Design

The athletes completed the study protocol on two different days at 48-hour intervals to avoid possible physiological, neurophysiological and fatigue factors during the study. A randomized crossover study design was used in the study protocol as a foam roller and foam roller + LV studies after a standard warm-up exercise. Working protocols were applied at the same time of day (13: 00-15: 00) to reduce the effects of circadian rhythm on the results of the study. In both working sessions used vibrating foam roller equipment (The Vyper Hyperice, USA). All sportsmen were given training exercises to teach the technique of foam roller exercises a week before starting work.

2.3 Warming Protocol

During this study, the athletes performed a general warm-up on a vertical bike (Monark Peak Bike, Sweden) with 74 watts (1.5 kg, 50 rpm) for five minutes prior to all applications.

2.4 Foam Roller and Foam Roller + LV Applications

After the athletes completed the standard warm-up protocol, they went to the jumping test 2 minutes later and they were the jumping by 3 counter movement jump at intervals of 15-second. After 30-second from the last jumping test, a 3 sit-and-reach test was performed with a 15-second interval and the average of the values was recorded. Foam roller exercises were performed immediately after the preliminary tests were completed. These exercises were applied in two sets with a 30-second interval for the muscles of hamstrings, quadriceps, gluteals and gastrocnemius respectively (Figure 1). During the application, the metronome was set to 40 beats per minute, so 10 repetitions (rolling) were performed for 30 seconds. In addition, while the vibrating feature of the vibrating foam roller equipment was kept closed only during the foam roller exercise, the vibration characteristic of the vibrating foam roller equipment during the foam roller + LV exercise was kept open as 38 Hz. which is the highest level. One minute after the exercises were completed, the jumping test was started again and the jumping test was carried out with 3 counter movement jump at 15 seconds intervals. After 30 seconds from the last jumping test, a 3 sit-and-reach test was performed with a 15-second interval and the average of the values was recorded.

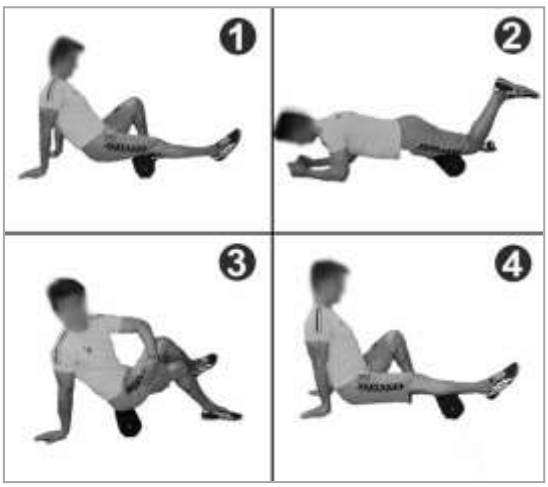

Figure 1: SMR exercises used in the study

2.5 Counter Movement Jump Test

In order to determine the lower extremity explosive force performances of the athletes, the counter movement jump test was carried out. During this test, the jump height of the athlete was determined with an accelerometer placed in the waist region of the athlete (Myotest Pro, Switzerland). The athlete immediately tried to jump as high as possible with hands on the waist as soon as he had squatted down so rapidly that the knee joint would be about 90 degrees.

2.6 Flexibility Test

The flexibility levels of the athletes were determined using a sit-and-reach test stand (Artı Med Turkey). The athlete was instructed by the test manager not to bend his knees during the test and after two seconds at the farthest point he could reach, the score was recorded.

2.7 Foam Roller Exercise Applications

1. Hamstrings; The athlete sat on the mat and the foam roller was placed just below his hip joint in such a way as to remain underneath. He lifted his hips up on his hands and rolled his foam roller equipment just above his knee joint, then back to the starting point, and so on again. His breathing was checked during the movement.
2. Quadriceps; The athletes laid face down on the mat and the foam roller was placed just below the hip joint. He raised up her hips as her arms would be on the mat and rolled his foam roller equipment right up the side of the patellas, then back to the starting point and thus completed again. His breathing was checked during the movement.
3. Gluteals; The athlete sat on the mat and the foam roller was placed just below the gluteus maximus muscle in such a way as to remain underneath. He rolled the foam roller equipment right underneath the gluteus maximus muscle, then back to the starting point, and so on again. His breathing was checked during the movement.
4. Gastrocnemius: The athlete sat on the mat and the foam roller was placed just below his knee joint in such a way as to remain underneath. He lifted up his hips on his hands and rolled the foam roller equipment right up to the ankle, then back to the starting point, and so on again. His breathing was checked during the movement.

2.8 Statistical analysis

IBM SPSS 20 package program was used for data analysis. Firstly, descriptive statistics of independent variables belong to athletes were made. Then, the Shapiro-Wilk Test was performed to understand if the data had a normal distribution. Independent Samples T Test was used for statistical evaluation between jump and flexibility data

obtained after two different applications. In addition, Paired Sample T Test was used for statistical evaluation between jump and flexibility data obtained before and after exercises. The confidence interval was accepted as 95% and the error margin of 5% constituted the alpha value. The cases where P value was smaller than the alpha value were accepted as significant ($p < 0,05$).

3. Results

Descriptive statistical values of the athletes participating in the study are shown in Table 1.

Table 1: Descriptive statistical values of the athletes participating in the study (n = 22)

	Average	**S.D.**
Age (years)	22,13	2,47
Length (cm)	178	4.92
BW (kg)	74,9	3,93
BMI ($m/^2$)	23,62	0,73
TT (h/ week)	11,59	1,14

BW: Body weight, BMI: Body mass index, TT: Training time, h: Hour

Table 2: Statistical data analysis (n = 22) of vertical jump and elasticity pretest-posttest values of the foam roller application

	Pretest		**Posttest**	
	Average	**S.D.**	**Average**	**S.D.**
Vertical jump (cm)	42,40	2,66	43,81*	2,80
Flexibility	8,40	2,97	9,59*	3,18

* Significant difference compared to pre-exercise $p < 0,05$ S.D: Standard deviation

In the examining the vertical jump and flexibility pre-test and post-test values of the foam roller application, it was showed a statistically significant increase in both vertical jump and flexibility performance when the values obtained after the application are compared with the values obtained before the application ($p < 0,05$).

Table 3: Statistical data analysis of vertical jump and elasticity pre-test and post-test values of Foam roller + LV application

	Pretest		**Posttest**	
	Average	**S.D.**	**Average**	**S.D.**
Vertical jump (cm)	42,54	2,57	44,63*	2,38
Flexibility	8,5	3,12	10,18*	2,78

*Significant difference compared to pre-exercise $p < 0,05$ S.D: Standard deviation

In the examining the vertical jump and elasticity pre-test and post-test values of Foam roller + LV application, it was showed a statistically significant increase in both vertical jump and flexibility performance when the values obtained after the application is compared with the values obtained before the application ($p < 0,05$).

Table 4: Statistical data analysis of vertical jump and elasticity values before Foam roller and Foam roller + LV applications

	Foam Roller		**Foam Roller+LV**	
	Average	**S.D.**	**Average**	**S.D.**
Vertical jump (cm)	42,40	2,66	42,54	2,57
Flexibility	8,40	2,97	8,50	3,12

S.D: Standard deviation

There was no statistically significant difference ($p > 0,05$) when the vertical jump and elasticity data obtained before both foam roller and foam roller + LV applications were examined.

Table 5: Statistical data analysis of vertical jump and elasticity values after Foam roller and Foam roller + LV applications

	Foam Roller		**Foam Roller+LV**	
	Average	**S.D.**	**Average**	**S.D.**
Vertical jump (cm)	43,81	2,80	44,63	2,38
Flexibility	9,59	3,18	10,18	2,78

S.D: Standard deviation

There was no statistically significant difference ($p > 0,05$) when the vertical jump and elasticity data obtained after both foam roller and foam roller + LV applications were examined.

4. Discussion

SMR exercises using Foam roller equipment are a technique that can be easily applied to reduce the tension on the soft tissue, fascia, tendons and muscles without decreasing the muscle performance, and to increase the range of motion of the joint. (Okamoto, Masuhara and Ikuta, 2014). For this reason, SMR exercises made with foam roller equipment among sportsmen are very popular. Local vibrational applications have also been used by athletes for many years to increase muscle strength and flexibility (M. Cardinale and Bosco, 2003). Recently a foam roller equipment has been developed which can be applied to both SMR and LV exercises at the same time. This is the first

study to investigate the effects of combined use of foam roller and local vibration (LV) on training lower extremity explosive strength and flexibility performance on trained soccer players.

There are contradictory results in the literature on the effects of SMR exercises. The most important reasons for these conflicting results can be as follows: the use of SMG equipment in different structures in studies, the lack of experience of the athletes in the practice, the inability to measure exactly the pressure applied to the soft tissue and variables such as application time and frequency. (Beardsley and Skarabot, 2015). In their study on 11 physically active athletes, C. A. Peacock, Krein, Silver, Sanders and KA (2014) compared the effects of dynamic warming and foam roller exercises applications on flexibility, power, strength, agility and speed performance. At the end of the study, it was explained that similar results were obtained in flexibility performance between the two applications, while the power, force, agility and speed performance after the foam roller application increased more than the dynamic warming session. Behara and Jacobson (2017) compared the effect of dynamic flexing with foam rollers application on hip flexibility, knee strength and vertical jump performance in a study on college league American footballers. According to the study results, there was no difference between the vertical jump and knee strength values before and after the application while the hip elasticity values were found to increase after both applications. Especially in studies where foam roller exercises are compared with static warming protocols, there is a lot of research to show that there is no reduction in power and strength performance as opposed to static flexing practice, although there is an increase in flexibility performance after foam roller exercises (Beardsley and Skarabot, 2015, MacDonald et al., 2013, Okamoto et al., 2014, Coreya Peacock et al., 2015, C. A. Peacock et al., 2014). This increase in flexibility performance after foam roller exercise may be due to a change in the thixotropic (liquid form) property of the fascia that surrounds the muscle (Paolini, 2010). Fascia is composed of colloidal materials and when exposed to mechanical stress or heat it softens and becomes more fluid, but when the stimulus disappears, it thickens again, its viscosity increases and becomes stiffer (Lindsay and Robertson, 2008). Siegmund, Barkley, Knapp and Peer (2014) reported that local vibration application improved waist and hamstring flexibility. Cronin, Nash and Whatman (2008) proposed three mechanisms to explain the benefits of LV application, a) an increase in pain threshold, b) an appropriate increase in temperature with an increase in blood flow, and c) beginning of tensioned muscle loosening. M Cardinale and Lim (2003) stated that low frequency is more reliable and effective in vibrational exercises. Also in his study, he suggested that the low frequency (20 Hz) increase the vertical jump performance while the high

frequency (40 Hz) reduces the vertical jump performance. Some studies, on the contrary, suggest that 50 Hz. frequency is more effective for vertical jump performance than frequency 20-35 Hz. In this study, the highest frequency (38 Hz) of the vibrating featured foam roller equipment was used.

When the results of this study were examined after both the foam roller exercise and the foam roller + LV exercise were found the increase in vertical bounce and flexibility performance. However, no difference was observed between the applications when the data obtained from both applications were compared among themselves. This result invalidates our hypothesis that the foam roller + LV application on the lower extremity explosive strength and flexibility performance may have different effects only from the application of the foam roller. The increase in elasticity obtained after both applications is similar to the literature. However, although vertical jump performance did not change in many studies, an increase in the vertical jump performance was obtained after both applications in this study.

In conclusion, foam roller and foam roller + LV exercises can be used to improve lower extremity explosive strength and flexibility performance in well-trained soccer players both before the competition and before the training. This work was done on well-trained footballers, and subsequent studies can be done using different SMR equipment on sedentary individuals.

References

1. Beardsley, C., & Skarabot, J. (2015). Effects of self-myofascial release: A systematic review. *J Bodyw Mov Ther, 19*(4), 747-758. doi:10.1016/j.jbmt.2015.08.007
2. Behara, B., & Jacobson, B. H. (2017). Acute Effects of Deep Tissue Foam Rolling and Dynamic Stretching on Muscular Strength, Power, and Flexibility in Division I Linemen. *J Strength Cond Res, 31*(4), 888-892. doi:10.1519/JSC.0000000000001051
3. Benjamin, M. (2009). The fascia of the limbs and back--a review. *J Anat, 214*(1), 1-18. doi:10.1111/j.1469-7580.2008.01011.x
4. Cardinale, M., & Bosco, C. (2003). The use of vibration as an exercise intervention. *Exercise and Sport Sciences Reviews, 31*(1), 3-7. doi: Doi 10.1097/00003677-200301000-00002
5. Cardinale, M., & Lim, J. (2003). The acute effects of two different whole body vibration frequencies on vertical jump performance. *Medicina Dello Sport, 56*(4), 287-292.

6. Cronin, J., Nash, M., & Whatman, C. (2008). The acute effects of hamstring stretching and vibration on dynamic knee joint range of motion and jump performance. *Phys Ther Sport, 9*(2), 89-96. doi:10.1016/j.ptsp.2008.01.003
7. Dallas, G., Paradisis, G., Kirialanis, P., Mellos, V., Argitaki, P., & Smirniotou, A. (2015). The acute effects of different training loads of whole body vibration on flexibility and explosive strength of lower limbs in divers. *Biol Sport, 32*(3), 235-241. doi:10.5604/20831862.1163373
8. Drummond, M. D., Couto, B. P., Augusto, I. G., Rodrigues, S. A., & Szmuchrowski, L. A. (2014). Effects of 12 weeks of dynamic strength training with local vibration. *Eur J Sport Sci, 14*(7), 695-702. doi:10.1080/17461391.2014.889757
9. Healey, K. C., Hatfield, D. L., Blanpied, P., Dorfman, L. R., & Riebe, D. (2014). The effects of myofascial release with foam rolling on performance. *The Journal of Strength & Conditioning Research, 28*(1), 61-68.
10. Lindsay, M., & Robertson, C. (2008). *Fascia: clinical applications for health and human performance*. Clifton Park, N.Y.: Delmar.
11. MacDonald, G. Z., Penney, M. D., Mullaley, M. E., Cuconato, A. L., Drake, C. D., Behm, D. G., & Button, D. C. (2013). An acute bout of self-myofascial release increases range of motion without a subsequent decrease in muscle activation or force. *The Journal of Strength & Conditioning Research, 27*(3), 812-821.
12. McKenney, K., Elder, A. S., Elder, C., & Hutchins, A. (2013). Myofascial Release as a Treatment for Orthopaedic Conditions: A Systematic Review. *Journal of Athletic Training, 48*(4), 522-527. doi:10.4085/1062-6050-48.3.17
13. Okamoto, T., Masuhara, M., & Ikuta, K. (2014). Acute effects of self-myofascial release using a foam roller on arterial function. *The Journal of Strength & Conditioning Research, 28*(1), 69-73.
14. Paolini, J. (2010). Therapeutic modalities: Review of myofascial release as an effective massage therapy technique. *IJATT, 14*(5).
15. Peacock, C. A., Krein, D. D., Antonio, J., Sanders, G. J., Silver, T. A., & Colas, M. (2015). Comparing acute bouts of sagittal plane progression foam rolling vs. frontal plane progression foam rolling. *The Journal of Strength & Conditioning Research, 29*(8), 2310-2315.
16. Peacock, C. A., Krein, D. D., Silver, T. A., Sanders, G. J., & KA, V. O. N. C. (2014). An Acute Bout of Self-Myofascial Release in the Form of Foam Rolling Improves Performance Testing. *Int J Exerc Sci, 7*(3), 202-211.
17. Peer, K. S., Barkley, J. E., & Knapp, D. M. (2009). The acute effects of local vibration therapy on ankle sprain and hamstring strain injuries. *Phys Sportsmed, 37*(4), 31-38. doi:10.3810/psm.2009.12.1739

18. Savelberg, H. H., Keizer, H. A., & Meijer, K. (2007). Whole-body vibration induced adaptation in knee extensors; consequences of initial strength, vibration frequency, and joint angle. *J Strength Cond Res, 21*(2), 589-593. doi:10.1519/R-20766.1
19. Siegmund, L. A., Barkley, J. E., Knapp, D., & Peer, K. S. (2014). Acute effects of local vibration with biomechanical muscle stimulation on low-back flexibility and perceived stiffness. *Athletic Training and Sports Health Care, 6*(1), 37-45.
20. Simmonds, N., Miller, P., & Gemmell, H. (2012). A theoretical framework for the role of fascia in manual therapy. *J Bodyw Mov Ther, 16*(1), 83-93. doi:10.1016/j.jbmt.2010.08.001
21. Sullivan, K., & Silvey, D. (2013). J., Button, DC, & Behm, DG (2013). Roller-massager application to the hamstrings increases sit-and-reach range of motion within five to ten seconds without performance impairments. *International Journal of Sports Physical Therapy, 8*(3), 228-236.