Artery Research
Vol. 26(4); December (2020), pp. 219–222
DOI: https://doi.org/10.2991/artres.k.200615.001; ISSN 1872-9312; eISSN 1876-4401
https://www.atlantis-press.com/journals/artres

Research Article

Acute Effects of Self-myofascial Release using a Foam Roller on Arterial Stiffness in Healthy Young Adults

Sascha Ketelhut[1,*], Martin Möhle[1,2], Kuno Hottenrott[1,2]

[1]Institute of Sports Science, Martin-Luther-University Halle-Wittenberg
[2]Institute for Performance Diagnostics and Health Promotion, Martin-Luther-University Halle-Wittenberg

ARTICLE INFO

Article History

Received 09 February 2020
Accepted 10 June 2020

Keywords

Self-myofascial release
foam roller
arterial stiffness
hemodynamic parameters

ABSTRACT

This study aimed to investigate whether a single bout of Self-myofascial Release (SMR) has a beneficial effect on peripheral and central Blood Pressure (BP) and different parameters of arterial stiffness. Twenty nine healthy male recreational athletes (26.1 ± 2.9 years, BMI 23.4 ± 1.5 kg/m^2) completed an instructed SMR using a foam roller. Peripheral and central BP and different parameters of arterial stiffness were measured noninvasively before SMR and at different time points (t1, t15, t30) during a subsequent 30-min recovery phase. There was a significant decrease in both systolic (t15, −2.36 ± 4.45 mmHg, p = 0.05; t30, −4.01 ± 4.47 mmHg, p = 0.003) and diastolic (t30, −2.45 ± 5.45 mmHg, p = 0.025) peripheral pressure during the recovery phase after SMR. Regarding central BP, only systolic pressure showed a significant decrease (t30, −3.64 ± 5.83 mmHg, p = 0.003). Mean arterial pressure (t15, −1.91 ± 3.36, p = 0.03; t30, −3.05 ± 2.88 mmHg, p < 0.001), augmentation pressure (t30, −1.60 ± 2.40 mmHg, p = 0.009), peripheral resistance (t30, −0.09 ± 0.10 s* mmHg/ml, p < 0.001), and stiffness index β0 (t30, −0.33 ± 0.55, p = 0.021) were significantly reduced after SMR. No significant changes were determined for reflection coefficient, augmentation index, cardiac output, and heart rate, respectively. SMR showed effects on peripheral and central BP and different parameters of arterial stiffness in healthy young adults.

HIGHLIGHTS

- A single bout of self-myofascial release confers favourable cardiovascular benefits.
- Self-myofascial release induces mechanical stress to the vascular system.
- Effects on vascular function is comparable to the effects after a bout of exercise.

1. INTRODUCTION

Recent studies have shown that apart from aerobic exercise, other interventions like massage therapy and stretching exercises may induce positive effects not only on wellbeing but moreover on cardiovascular health. A meta-analysis from Liao et al. [1] found positive effects of massage therapy on systolic and diastolic Blood Pressure (BP) in patients with hypertension or prehypertension. Furthermore, a systematic review involving subjects with essential hypertension concluded that a combination of massage therapy and antihypertensive medication is more effective than antihypertensive medication alone in lowering BP [2].

Studies assessing the effects of regular static stretching suggest that short-term regular stretching induces significant reductions in arterial stiffness and blood pressure [3,4]. A study from Yamato et al. [5] showed acute effects of static stretching on arterial stiffness in healthy young adults. It is argued that the mechanical stress applied to the vessels by either stretching exercises or the compression during massage therapy can induce hemodynamic responses [6–9].

In recent years Self-myofascial Release (SMR) has evolved as a manual therapy combining massage-like compressive loading and stretching techniques into one exercise routine. SMR refers to a form of manual therapy that applies mechanical compression (often using a foam roller) to the muscle and fascia to manipulate the myofascial system and improve flexibility. This therapy has emerged and is highly regarded within the rehabilitation and fitness settings. SMR is commonly applied as a therapeutic, post-exercise technique aiming to accelerate recovery or as a pre-exercise technique targeting to improve subsequent mobility and performance. A systematic review suggests that SMR has positive effects on joint range of motion, reduces perceived pain after intense bouts of exercise, and enhances recovery [10]. In a recent study, SMR has been shown to positively affect sympathovagal balance and peripheral BP for 30 min post-intervention [11], thus emphasizing its

*Corresponding author. Email: sascha.ketelhut@gmail.com
Peer review under responsibility of the Association for Research into Arterial Structure and Physiology
Data availability statement: The data that support the findings of this study are available from the corresponding author, [SK], upon reasonable request.

potential cardiovascular protective effect. To the best of our knowledge, no prior studies have examined the effects of SMR on central hemodynamics. Therefore, the present study aimed to evaluate the immediate effects of SMR on peripheral and central BP and different parameters of arterial stiffness.

2. MATERIALS AND METHODS

2.1. Subjects and Study Design

Twenty nine healthy male subjects (aged 26.1 ± 2.9 years, BMI 23.4 ± 1.5 kg/m^2) were randomly selected and included in the experimental study (Table 1). All participants were normotensive (BP < 140/90 mmHg), recreationally active, non-smokers, and free of overt cardiovascular disease. All participants have not stretched regularly for at least 1 year and had none or only limited experience with SMR.

Each participant was informed about the purpose and course of the study and gave verbal and written consent. The study was conducted in accordance with the Guidelines for Good Clinical Practice and was in line with the Helsinki Declaration on the use of human subjects for research.

The study design consisted of a baseline examination where relevant parameters were obtained, followed by a SMR intervention lasting 35 min and a subsequent resting period. During the seated rest, the relevant parameters were assessed in the first (t1), 15th (t15), and 30th (t30) min after SMR.

2.2. Self-myofascial Release

The subjects were instructed through a SMR procedure utilizing a commercially available foam roller (BLACKROLL®, Bottighofen, Schweiz; diameter: 15 cm; length: 30 cm). The protocol targeted the quadriceps region, the hamstring region, the gluteal region, the calf region, as well as the thoracic and lumbar region. The subjects performed seven different exercises, which required them to roll the targeted muscle groups back and forth over the foam roller working the entire surface area. An investigator gave continuous feedback to guarantee the correct form and rhythm. For each exercise, two sets lasting 60 s with 10 repetitions were performed. Subjects were instructed to execute the rolling in a smooth and controlled manner to a metronome cadence. Each set was separated by 60 s of rest. During the rest, the subjects either rolled the bi-lateral extremity (for exercises of the lower extremities) or passively rested (for exercises of the upper and lower back). Each technique was performed bi-laterally (for exercises of the lower extremities) with the body prone on the floor. The intensity was adjusted by using the bodyweight to apply pressure to the soft tissues during the rolling motion. Legs and arms not engaged in the technique were used to offset weight as required. The participants were instructed to apply a pressure that provokes a bearable pain (a score of 7–8 on a pain scale where one represented no pain at all and 10 represented the maximum pain that can be tolerated) in the targeted muscles and tissues.

Table 1 | Subject's characteristics

Items	M ± SD
Age (years)	26.1 ± 2.9
Height (cm)	178.2 ± 4.3
Weight (kg)	74.8 ± 5.6
Body mass index (kg/m^2)	23.4 ± 1.5
Peripheral blood pressure (mmHg)	120.8 ± 6.9/71.7 ± 7.7

Values are means ± SD.

2.3. Experimental Measures

All measurements were performed by the same study staff member under standardized conditions using the same devices. All participants were instructed to refrain from caffeine, alcohol, excessive physical activity, and static or dynamic stretching 12 h before testing. Furthermore, subjects were asked to fast for 3 h preceding the test.

Body mass and height were registered using a stadiometer and a scale (Tanita BC-545, IL, USA), respectively. Peripheral and central BP, Mean Arterial Pressure (MAP), Heart Rate (HR), Cardiac Output (CO) Augmentation Pressure (AP), Augmentation Index (Alx), Reflection Coefficient (RC), and Peripheral Resistance (PR) were determined noninvasively using Mobil-O-Graph® (24h PWA monitor, I.E.M., Stolberg, Germany, calibration MAD-c2), a clinically validated device for hemodynamic measurements [12]. Furthermore, we computed the aortic stiffness index $\beta 0$ [13,14].

Measurements were performed during a 15-min seated rest in a quiet, temperature-controlled room (22 ± 0.6°C). The measurements were repeated during a subsequent 30-min post-exercise recovery.

Custom-fit arm cuffs were used with the right arm extended and placed on a customized arm-support so that the heart and the pressure cuff were at the same level.

2.4. Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics 23.0 (SPSS, Chicago, IL, USA). All data were statistically checked for normality. The Levene test was used to check the homogeneity of variance. To test comparisons between baseline and different time points during and after the SMR, repeated measurement ANOVAs were performed. Bonferroni post hoc analyses were performed to examine pairwise mean differences. Data are expressed as mean ± 1 Standard Deviation (SD). The level of statistical significance was considered $p < 0.05$.

3. RESULTS

Subjects' characteristics are presented in Table 1. According to the ESH/ESC Guidelines [15], all the participants had normal BP values at baseline.

After an initial increase (t1, $p > 0.05$), there was a significant decrease in both peripheral (t15, −2.36 ± 4.45 mmHg, $p = 0.05$; t30, −4.01 ± 4.47 mmHg, $p = 0.003$) and central (t30, −3.64 ± 5.83 mmHg, $p = 0.003$) systolic BP (Table 2) relative to baseline. Regarding diastolic BP there only was a significant reduction in peripheral pressure (t30, −2.45 ± 5.45 mmHg, $p = 0.025$) 30 min after the SMR (Table 2).

Table 2 | Effects of self-myofascial release on different outcomes

Outcomes	Measurement time points			
	Pre-exercise	**1′**	**15′**	**30′**
pSBP (mmHg)	120.81 ± 6.89	121.72 ± 9.35*	118.45 ± 7.81*	117.21 ± 8.54**
pDBP (mmHg)	71.66 ± 7.70	72.45 ± 8.56	70.45 ± 8.65	69.21 ± 9.06*
cSBP (mmHg)	106.16 ± 7.64	108.24 ± 8.31*	105.14 ± 7.39	102.52 ± 7.41**
cDBP (mmHg)	72.98 ± 7.87	74.00 ± 8.48	71.79 ± 8.95	72.00 ± 9.56
MAP (mmHg)	94.19 ± 7.70	94.79 ± 7.57	92.28 ± 7.09*	91.14 ± 7.13***
HR (bpm)	63.48 ± 8.64	65.66 ± 9.78	62.34 ± 8.62	61.00 ± 7.89
CO (L/min)	5.62 ± 0.58	5.27 ± 0.76	5.46 ± 0.98	5.44 ± 0.96
AP (mmHg)	4.76 ± 2.23	5.79 ± 5.25	3.90 ± 2.19	3.16 ± 1.40**
AIx (%)	12.29 ± 6.89	14.79 ± 10.76	10.14 ± 5.99	9.55 ± 5.52
RC (%)	51.00 ± 10.92	52.03 ± 12.19	50.38 ± 11.06	47.72 ± 11.79
PR (s*mmHg/ml)	1.04 ± 0.13	1.11 ± 0.16	0.99 ± 0.19	0.94 ± 0.14***
β0	5.96 ± 0.75	5.90 ± 0.93	5.81 ± 0.87	5.63 ± 0.69*

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ difference from baseline. Parameters before (pre-exercise) and after (1′, 15′, 30′) self-myofascial release. Values are mean ± SD. pSBP, peripheral systolic blood pressure; pDBP, peripheral diastolic blood pressure; cSBP, central systolic blood pressure; cDBP, central diastolic blood pressure; β0, stiffness index β.

Mean arterial pressure (t15, −1.91 ± 3.36, $p = 0.03$; t30, −3.05 ± 2.88 mmHg, $p < 0.001$), AP (t30, −1.60 ± 2.40 mmHg, $p = 0.009$), PR (t30, −0.09 ± 0.10 s*mmHg/ml, $p < 0.001$), and β0 (t30, −0.33 ± 0.55, $p = 0.021$) were significantly reduced after SMR. No significant changes were determined for RC, AIx, CO, and HR, respectively.

4. DISCUSSION

The primary finding of this study was that SMR using a foam roller was effective in reducing peripheral and central BP and different parameters of arterial stiffness in a subsequent resting period.

The effects on peripheral BP are consistent with a recent study by Lastova et al. [11] who also found a significant reduction in systolic (≈3 mmHg) and diastolic (≈2 mmHg) BP 30 min after SMR using a foam roller.

Emerging evidence now suggests that apart from peripheral BP, parameters of arterial stiffness like central BP, AIx, AP, and PR are more strongly associated with preclinical organ damage and are better related to future cardiovascular events [16,17].

To the best of our knowledge, there are no data on the effects of SMR on central BP, AIx, AP, and PR. The detected reduction in central BP, after the SMR is comparable to the effects seen 30 min after a bout of moderate continuous exercise or high-intensity interval training [18,19]. Furthermore, the SMR led to a significant reduction in AP, PR, and stiffness index β0. The effects of SMR on parameters of arterial stiffness are comparable to the responses seen after a bout of aerobic exercise [20,21] and may translate into a significant cardiovascular risk reduction [22].

The present study does not provide information on the exact mechanism responsible for the results. However, it seems likely that the mechanical stress induced by the foam roller resulted in NO-dependent vasodilatation, which is reflected by the detected changes in β0, AP, and PR. This is supported by the results of Okamoto et al. [23], who investigated vascular endothelial function in 10 healthy young adults after a similar session of SMR. The authors found that plasma NO concentration was significantly increased 30 min after the SMR session.

4.1. Limitations

There are some limitations to the current study that have to be discussed. First, the sample size of 29 participants is relatively small. Furthermore, we did not include a control group in this study as subjects served as their own controls. In this concern, we used the 15-min resting phase as a control condition. As hemodynamic measurements are known to plateau after resting for 10 min [24], we would argue that a longer (e.g., 30 min) control condition is not necessary.

Additionally, only healthy young male subjects were recruited, thus the results cannot be extrapolated to other populations. Furthermore, the results are limited to the specific SMR protocol applied in the present study. It is possible that different protocols applying other techniques and exercises and targeting different muscle groups may have different effects. Finally, we only investigated the effects of a single bout of SMR. Further investigations assessing the long-term effects of SMR are warranted and may reveal whether the immediate effects could be accumulated.

5. CONCLUSION

In summary, the results of the present study suggest that a single bout of SMR confers favorable cardiovascular benefits in healthy normotensive subjects. It is assumed that SMR induces similar mechanical stress to the vascular system as massage therapy and stretching exercises, leading to short-term improvements in hemodynamic parameters.

Future research should address if successive exposure to such immediate responses would possibly lead to chronic adaptations similar to regular, moderate aerobic exercise, massage therapy, and static stretching.

CONFLICTS OF INTEREST

The authors declare they have no conflicts of interest. The results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

AUTHORS' CONTRIBUTION

KH and SK conceived the original idea and supervised the project. KH, SK and MM designed the study. SK and MM performed the measurements and planned and supervised the intervention program. SK and MM processed the experimental data, performed the analysis, drafted the manuscript, and designed the figures. KH aided in interpreting the results and worked on the manuscript. All authors provided critical feedback and helped shape the research, analysis, and manuscript.

FUNDING

No competing financial interests exist. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. BLACKROLL AG (Bottighofen, Schweiz) funded the foam rollers. The funders had no role in the study design, data collection, and analysis or preparation of the article.

ACKNOWLEDGMENTS

We would like to thank all the participants without whom this study would not have been possible. We also thank BLACKROLL AG (Bottighofen, Schweiz), who provided the foam rollers.

REFERENCES

[1] Liao IC, Chen SL, Wang MY, Tsai PS. Effects of massage on blood pressure in patients with hypertension and prehypertension: a meta-analysis of randomized controlled trials. J Cardiovasc Nurs 2016;31:73–83.

[2] Xiong XJ, Li SJ, Zhang YQ. Massage therapy for essential hypertension: a systematic review. J Hum Hypertens 2015;29:143–51.

[3] Nishiwaki M, Yonemura H, Kurobe K, Matsumoto N. Four weeks of regular static stretching reduces arterial stiffness in middle-aged men. Springerplus 2015;4:555.

[4] Wong A, Figueroa A. Eight weeks of stretching training reduces aortic wave reflection magnitude and blood pressure in obese postmenopausal women. J Hum Hypertens 2014;28:246–50.

[5] Yamato Y, Hasegawa N, Sato K, Hamaoka T, Ogoh S, Iemitsu M. Acute effect of static stretching exercise on arterial stiffness in healthy young adults. Am J Phys Med Rehabil 2016;95:764–70.

[6] Lu X, Kassab GS. Integrins mediate mechanical compression–induced endothelium-dependent vasodilation through endothelial nitric oxide pathway. J Gen Physiol 2015;146:221–32.

[7] Kuebler WM, Uhlig U, Goldmann T, Schael G, Kerem A, Exner K, et al. Stretch activates nitric oxide production in pulmonary vascular endothelial cells *in situ*. Am J Respir Crit Care Med 2003;168:1391–8.

[8] Awolesi MA, Sessa WC, Sumpio BE. Cyclic strain upregulates nitric oxide synthase in cultured bovine aortic endothelial cells. J Clin Invest 1995;96:1449–54.

[9] Lansman JB, Hallam TJ, Rink TJ. Single stretch-activated ion channels in vascular endothelial cells as mechanotransducers? Nature 1987;325:811–13.

[10] Beardsley C, Škarabot J. Effects of self-myofascial release: a systematic review. J Bodyw Mov Ther 2015;19:747–58.

[11] Lastova K, Nordvall M, Walters-Edwards M, Allnutt A, Wong A. Cardiac autonomic and blood pressure responses to an acute foam rolling session. J Strength Cond Res 2018;32:2825–30.

[12] Franssen PML, Imholz BPM. Evaluation of the Mobil-O-Graph new generation ABPM device using the ESH criteria. Blood Press Monit 2010;15:229–31.

[13] Desjardins MP, Sidibé A, Fortier C, Mac-Way F, De Serres S, Larivière R, et al. Impact of kidney transplantation on aortic stiffness and aortic stiffness index β0. J Hypertens 2019;37:1521–8.

[14] Spronck B, Avolio AP, Tan I, Butlin M, Reesink KD, Delhaas T. Arterial stiffness index beta and cardio-ankle vascular index inherently depend on blood pressure but can be readily corrected. J Hypertens 2017;35:98–104.

[15] Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Böhm M, et al. 2013 ESH/ESC guidelines for the management of arterial hypertension: the Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Eur Heart J 2013;34:2159–219.

[16] Kucerová J, Filipovský J, Staessen JA, Cwynar M, Wojciechowska W, Stolarz K, et al. Arterial characteristics in normotensive offspring of parents with or without a history of hypertension. Am J Hypertens 2006;19:264–9.

[17] Kollias A, Lagou S, Zeniodi ME, Boubouchairopoulou N, Stergiou GS. Association of central versus brachial blood pressure with target-organ damage: systematic review and meta-analysis. Hypertension 2016;67:183–90.

[18] Milatz F, Ketelhut S, Ketelhut RG. Favorable effect of aerobic exercise on arterial pressure and aortic pulse wave velocity during stress testing. Eur J Vasc Med 2015;44:271–6.

[19] Ketelhut S, Milatz F, Heise W, Ketelhut RG. Influence of a high-intensity interval training session on peripheral and central blood pressure at rest and during stress testing in healthy individuals. Eur J Vasc Med 2016;45:373–7.

[20] Heffernan KS, Collier SR, Kelly EE, Jae SY, Fernhall B. Arterial stiffness and baroreflex sensitivity following bouts of aerobic and resistance exercise. Int J Sports Med 2007;28:197–203.

[21] Wang H, Zhang T, Zhu W, Wu H, Yan S. Acute effects of continuous and interval low-intensity exercise on arterial stiffness in healthy young men. Eur J Appl Physiol 2014;114:1385–92.

[22] Vlachopoulos C, Aznaouridis K, O'Rourke MF, Safar ME, Baou K, Stefanadis C. Prediction of cardiovascular events and all-cause mortality with central hemodynamics: a systematic review and meta-analysis. Eur Heart J 2010;31:1865–71.

[23] Okamoto T, Masuhara M, Ikuta K. Acute effects of self-myofascial release using a foam roller on arterial function. J Strength Cond Res 2014;28:69–73.

[24] van der Wel MC, Buunk IE, van Weel C, Thien TABM, Bakx JC. A novel approach to office blood pressure measurement: 30-minute office blood pressure vs daytime ambulatory blood pressure. Ann Fam Med 2011;9:128–35.