



Original Article

The effect of a scalp massage on stress hormone, blood pressure, and heart rate of healthy female

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Abstract. [Purpose] A scalp massage was conducted on female office workers divided into a 15 minute group and 25 minute group and its effect on stress hormone, blood pressure and heart rate was analyzed in order to provide a theoretical rationale to apply scalp massage as stress therapy. [Subjects and Methods] A scalp massage was applied to 34 female office workers twice a week for a total of 10 weeks; the subjects were classified into 15 min., 25 min. and control groups, and their stress hormone levels, blood pressure and heart rate were evaluated. [Results] Significant differences in norepinephrine, cortisol and blood pressure (SBP & DBP) were found in terms of interaction by time interval and between groups. [Conclusion] As a result of applying scalp massage to female office workers for 15 and 25 minutes, positive effects were observed on stress hormone, blood pressure and heart rate. Therefore, scalp massage can be used for stress control with no spatial or time limit.

Key words: Massage, Stress hormone, Blood pressure

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INTRODUCTION

The use of female human resources is highlighted as an important factor in the aging Korean society, especially as married women have started entering the labour market. In addition, a wide range of fields utilize female labour and the distribution ratio of women in each field is increasing, with female participation in social and economic activities reaching 50.2% in 2013, 51.3% in 2014 and 51.8% in 2015¹⁾. Office jobs in particular are experiencing a greater influx of female resources than any other area, accompanied by the risk of various diseases due to poor working posture and environments, long-term use of computers, task over-load, mental stress, etc²⁾. The stress that female office workers experience in the male-centred organizational culture in Korea seems to have more significant implications³⁾.

In general, moderate stress plays a positive role in physical and mental vitality while achievement motivation elicits feelings of tension. However, undue stress caused by task over-load might have negative effects on the mind and body, for example, personal anxiety, reduced concentration, loss of drive to work, stress-related diseases, etc. It might also have direct or indirect negative effects on organizational performance, for example, occurrence of negligent accidents, expansion of healthcare expenses, a decrease in productivity and loss of employment⁴⁾. Thus, a stress therapy program with easy applicability during busy business hours can improve the health of female office workers. One of the easily applicable stress therapy options, in terms of time and space, is massage. Not only does it have therapeutic effects on various bodily functions including the nervous, musculoskeletal, cardiovascular and integumentary systems, it is also recognized as a type of aerohydrotherapy as it helps to promote local and general circulation, increases immunologic function, optimizes natural healing ability and helps maintain body balance and harmony. Massage is the oldest method used to resolve tiredness in

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the mind and body, and can treat and prevent illness⁵). Massage on the neck muscles extends the range of cervical spine rotation⁷) and improves neck flexor muscles⁸). In addition, massage after total knee arthroplasty decreases pain and increases the diarthrodial range⁹). In the current study, 10 to 20 minutes were determined to be appropriate for a scalp massage⁶). As mentioned above, massage has positive effects on muscles. In addition to the extension of diarthrodial range, it influences stress hormones (epinephrine and norepinephrine), which can trigger the activation of sympathetic nerves such as an increase in heart rate, contraction of blood vessels and muscle tension, as well as circulation throughout the body via blood¹⁰). Thus, massage has been confirmed to have positive effects on changes in hormones^{11, 12}), blood pressure^{13, 14}) and heart rate¹⁵). This study was performed to provide a theoretical rationale for the application of massage as stress therapy in female office workers. With the goal of improving health and quality of life, this study is based on the analysis of the effects of massage on stress hormones, including blood pressure and heart rate.

SUBJECTS AND METHODS

The target population of this study was female office workers; 20–49 year old female office workers at 3 institutions located in City G were randomly recruited as an accessible population. A total of 34 subjects participated. 11 were placed in Experimental (Exp) group (I), 11 in Experimental (Exp) group (II) and 12 in the Control group; their physical features are provided in Table 1.

This study was approved by the Ethics Committee at Dongguk University of Korea and written consent to participate in the study was obtained from all of the subjects in accordance with the Declaration of Helsinki.

Scalp massage was performed for 15 minutes/session for Exp (I) and 25 minutes/session for Exp (II), twice a week, for a total of 20 times over 10 weeks in both groups. The scalp massage room was maintained at a humidity of 40–60% and a temperature of 26–27°C. The investigator trained one sub-investigator with scalp care experience on the necessity and purpose of this study in order to maintain the accuracy and validity of experimental procedures. The sub-investigator performed the scalp massage under the supervision of the investigator. Details of the program are presented in Table 2.

Blood collection to measure the levels of stress hormones (epinephrine, norepinephrine and cortisol) was performed in the subjects following at least 12 hours of fasting. The collected blood was centrifuged for 10 minutes at 3,000 rpm using a centrifuge (Model HC-16A, Korea); the post-centrifugal plasma was stored at –73 °C and referred to Laboratory N for hemanalysis. Blood collection was conducted before the first scalp massage and at 9 am the following day. Blood was also collected after 10 weeks in the same manner. Blood pressure was measured before the first scalp massage and after 10 weeks, for a total of two times, using a mercury sphygmomanometer (OMRON HEM-770A, Japan). The blood pressure was measured after at least 10 minutes of rest. The mean value of the 2 measurements was used as the average blood pressure. The subjects' heart rates were also measured before the program and after 10 weeks at a stable status using the Sport Tester PE 3000 (Polar Electro Co. Finland); each measurement was conducted for 5 minutes and the mean value of the 2 measurements was used as the heart rate. The program SPSS (Ver 20.0) was used for data processing. The mean and standard deviations were used for elementary statistics. The primary effect and interaction effect on the time interval and between groups were evaluated using a two-way repeated ANOVA, and a post-Hoc test was conducted using the Duncan test. The statistical significance level was set as $p < 0.05$.

RESULTS

In total, there were 34 subjects in this study. A scalp massage was performed for 15 minutes/session for Exp (I) and 25 minutes/session for Exp (II), for 10 weeks. Scalp massage was not performed in the Control group. There was no significant difference in the time interval and interactions between groups for epinephrine ($p > 0.05$). However, there were significant differences in the time interval and interactions between groups for norepinephrine and cortisol. In an assay of primary effects caused by the time interval, significant differences were found among epinephrine, norepinephrine and cortisol, leading to a meaningful difference in Exp (II) for epinephrine in the post-hoc test as well as in Exp (I) and Exp (II) for norepinephrine and cortisol with prior and post-hoc tests. Significant differences between groups were also found for norepinephrine and cortisol, leading to meaningful differences between Exp (I) and the Control group and between Exp (II) and the Control group for both norepinephrine and cortisol (Table 3).

There was a significant difference in systolic blood pressure and diastolic blood pressure in terms of the interaction effect between time intervals and by group. In an assay of primary effects caused by time intervals, a significant difference was found in systolic blood pressure and diastolic blood pressure, leading to a meaningful difference in Exp (I) and Exp (II) for both systolic blood pressure and diastolic blood pressure with prior and post-hoc tests. A significant difference between groups was also found for systolic blood pressure and diastolic blood pressure, leading to a meaningful difference between Exp (I) and the Control group and between Exp (II) and the Control group for both systolic blood pressure and diastolic blood pressure (Table 4).

For heart rate, there was no significant difference in terms of interaction between time interval and by group ($p > 0.05$). Additionally, no significant difference in the primary effect caused by time intervals and between groups was found ($p > 0.05$) (Table 4).

Table 1. Physical characteristics of the subjects

	Age (years)	Height (cm)	Weight (kg)
Exp (I) (n=11)	42.6 ± 2.0	158.1 ± 3.1	59.2 ± 4.5
Exp (II) (n=11)	43.1 ± 1.8	158.1 ± 2.3	59.1 ± 1.2
Cont (n=12)	42.6 ± 1.7	158.0 ± 1.2	58.9 ± 1.2

Exp: experimental group, Cont: control group

Table 2. Scalp massage program for 10 weeks

Weeks	Order	Time		Contents	Frequency
		Exp (I)	Exp (II)		
	Warm-up	3 min	2 min	Stretching before massage	
				· Massage in shoulder (3 times)	
				· Compression by a thumb	
				· Compression by a wrist	
				· Grasp and squeeze by a finger	
				· Champi	
				· Compression under down [ed: unclear]	
				· Massage in neck	
				· Grasp and pull down in the muscle of neck	
				· Massage under the larynx	
1-10	Main program	19 min	11 min	· Massage in the occiput	2 times /week
				· Massage in a zig-zag	
				· Wave exercise	
				· Flip by a finger	
				· Effeirage by a finger	
				· Tapotement by a finger	
				· Pull up a hair	
				· Grasp up by head	
				· Rolling and massage a circle in the temples of one's head	
				· Massage in a ear	
				· Massage a hole in a face	
	Cool-down	3 min	2 min	stretching after massage	

Table 3. The influence of stress hormones according to group by 10 weeks, before and after

Variables	Pre massage			Post massage		
	Exp (I)	Exp (II)	Cont	Exp (I)	Exp (II)	Cont
Epinephrine	263.8 ± 63.1	254.0 ± 7.9	262.9 ± 60.1	212.4 ± 37.0	222.6 ± 33.1**	254.1 ± 35.4
Norepinephrine	751.6 ± 92.5	680.5 ± 110.2	739.1 ± 117.8	450.0 ± 127.9 ^a	499.5 ± 126.2 ^{ab}	655.1 ± 189.3
Cortisol	23.4 ± 2.7	24.2 ± 3.8	24.6 ± 2.9	16.3 ± 2.0 ^a	15.3 ± 2.2 ^{ab}	23.9 ± 1.8

Values are expressed as mean ± SD, *p<0.05, **p<0.01: Significance different between pre and post massage

^aSignificance different between Exp (I) and Cont, ^bSignificance different between Exp (II) and Cont**Table 4.** The influence of blood pressure and Heart rate according to group by 10 weeks, before and after

Variables	Pre massage			Post massage		
	Exp (I)	Exp (II)	Cont	Exp (I)	Exp (II)	Cont
Systolic blood pressure	157.6 ± 3.7	150.1 ± 2.9	152.5 ± 2.1	139.8 ± 3.0 ^a	135.4 ± 1.7 ^{ab}	147.4 ± 1.8
Diastolic blood pressure	99.9 ± 3.6	95.9 ± 2.0	101.8 ± 2.2	89.6 ^a ± 2.6	84.8 ± 2.4 ^{ab}	98.9 ± 2.0
Heart rate	80.0 ± 7.2	81.1 ± 9.1	81.5 ± 2.2	73.3 ± 7.1	77.1 ± 12.8	80.1 ± 2.9

Values are expressed as mean ± SD, *p<0.05, **p<0.01: Significance different between pre and post massage

^aSignificance different between Exp (I) and Cont, ^bSignificance different between Exp (II) and Cont

DISCUSSION

There are two different neuroendocrine systems associated with stress: one is the sympathetic system-adrenal medulla axis involved in the secretion of epinephrine and norepinephrine and the other is the hypothalamus-pituitary-adrenal medulla (HPA) axis involved in the secretion of cortisol¹⁶⁾. The physiological effect of massage in general can be divided into a relaxation effect and a stimulation effect. The relaxation effect involves hypothalamic reactions associated with the decline of sympathetic system activity and an increase in parasympathetic system activity. There are two types of stimulation effects: one is reflexive and the other is mechanical. The reflex effect is refreshing and relaxing due to delivering stimulation at the cutaneous peripheral nerve to the cerebrum. Peripheral cutaneous stimulation promotes circulation through stimulation of the parasympathetic nerve, relaxation of muscles and extension of capillary vessels. Ultimately, massage reduces sympathetic nerve activity while increasing parasympathetic nerve activity¹⁷⁾. In this study, 15-minute and 25-minute scalp massages had a significant effect on norepinephrine and cortisol while the 25-minute scalp massage had a significant effect on epinephrine. This suggests that a scalp massage decreases the activation of the sympathetic nerve while increasing the activation of the parasympathetic nerve, resulting in a decrease in the secretion of norepinephrine and cortisol, or in other words, stabilization of hormone levels. However, only in the case of the 25-minute scalp massage was there a significant difference in the level of epinephrine. After exposure to stress, the levels of epinephrine and norepinephrine change rapidly. This seems to be caused by either personal sensitivity differences and time variance¹⁸⁾ or as a result of personal differences between subjects and time variance. In addition, the study demonstrated that the levels of epinephrine were unpredictable and could increase in uncontrolled noise environments¹⁹⁾. Thus, reactions to stress can differ according to different stress characteristics.

A previous study demonstrated that the low frequency (LF) sympathetic nerve activity marker significantly decreased whereas the high frequency (HF) parasympathetic nerve activity marker significantly increased after 15 minutes of scalp massage²⁰⁾. Another study demonstrated the effects of a 20 minute scalp massage on norepinephrine and cortisol²¹⁾. The results of our study were in agreement with these existing studies, suggesting that a >15 minute scalp massage has a positive effect on stress hormones.

The results also suggested that stress increases cardiac output and blood pressure by influencing the sympathetic nerve, resulting in the increase of peripheral blood pressure by epinephrine, leading to the relaxation of blood vessels and increased blood flow rate in the liver, heart muscles and brain tissues. In addition, norepinephrine is known to cause vasoconstriction, increase blood pressure, general peripheral resistance²²⁾, and pulse due to rising blood cortisol concentration levels during mental stress.

There was a significant decrease in both systolic and diastolic blood pressure after 15 and 25 minute scalp massages, which seems to be a result of the stabilization of hormone levels caused by an increase in the activation of sympathetic nerves and parasympathetic nerves and the subsequent decrease in the concentration of norepinephrine and cortisol hormone. This is probably because the scalp massage promoted blood circulation, resulting in a positive effect on the neck muscles and the relaxation of blood vessels^{7, 8)}. After performing scalp massage in adults at the normotensive or prehypertensive stage, blood pressure was found to have decreased significantly²³⁾. Additionally, 4 weeks of massage at work was shown to significantly decrease strain and blood pressure¹⁴⁾.

Under the control of the autonomic nervous system, the heart rate increases when the reaction of the sympathetic nerve system is accentuated. In this study, the heart rate did not seem to decrease significantly despite a decrease in the level of norepinephrine and cortisol hormones controlling the sympathetic nerve system. However, the heart rate showed a tendency to drop slightly. In a previous study involving carotid sinus massage in aged subjects, blood pressure and heart rate were shown to decrease²⁴⁾ and a significant decrease in heart rate was confirmed after 45–60 minutes of muscle massage in middle aged men and female performed at different intensities²⁵⁾. In a study using massage (at moderate and mild intensity) and a vibrator, massage treatment at moderate intensity was shown to significantly reduce the heart rate²⁶⁾. These differences from the existing study might be because massage in this study was not performed frequently (twice a week) and the intensity was relatively mild. In general, only the heart rate did not show a significant difference and the scalp massage had positive effects in terms of hormones and blood pressure.

We recommend active utilization of a scalp massage program with no spatial or time limits in female office workers, as the use of a scalp massage lasting 15 minutes or less as a stress control program could have a positive effect. Furthermore, better results are expected in future studies if the intensity of the massage is varied while considering the physical condition of the subjects.

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