Influence of neck and back massage on the synchronicity of electrical brain activity

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Abstract. Due to busy working or learning schedules, people spend a lot of time in a sitting, motionless position, which could cause tension neck syndrome and promote other harmful consequences. Massage has been used for health support for many decades. However, there are a lot of different types of massages with different physiological effects, and our knowledge remains pure regarding the biological mechanisms of massage benefits. The question of the influence of massage on functional brain state attracts scientific interest as massage is an available and attractive health-supporting tool. Particular types of massage had been found to reduce frontal brain activity, but others were associated with the activation of certain brain regions. In our study, we aimed to evaluate the impact of combined general and point massage of the cervical-collar area on the electrical activity of the brain in terms of its synchronicity in healthy young subjects. Through cross-correlation analysis of EEG before and after massage, we found that massage of the cervical-collar area increased the synchronicity of electrical activity between the central and frontal regions during resting state with closed eyes and decreased the synchronicity between the central and occipital brain areas during resting state with opened eyes, which allows us to suggest that this type of massage optimizes functional brain state.

1 Introduction

The cervical-collar region is a vulnerable part of the body in terms of neck muscle susceptibility to excess tension, spasm, and deterioration of head black circulation, which is explained by the anatomical localization of the neck [1]. Disturbances in its innervation or blood supply lead to serious consequences for the health of the entire organism. After all, the dorsal cervical spine is involved not only in the innervation of the arms but also in the blood supply to the brain. Therefore, the cervical-collar region is closely related to headache development, which can now be observed in many people [2] and might be caused by a passive lifestyle, excessive exposure to different gadgets when students and employers spend a lot of time in front of the computer, and physical inactivity that is essential for triggering troubles with the functional state of the back and neck. Among them

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are muscle cramps, surges in blood pressure, breathing problems, and fluctuations in various other vital functions of the body [1–3].

In this regard, it is important to utilize effective and safe prophylactic measures to prevent health issues associated with a forced sedentary lifestyle. Massage has been used for health support for many decades [4]. The question of the influence of massage on functional brain function is of scientific interest as it is an available and attractive health-supporting tool. When massaging the cervical-collar area, tension in the cervical and shoulder muscles is relieved, and pain in this area disappears. Massage serves as an effective means for osteochondrosis and neuralgia prevention and treatment [5], for improving blood circulation, venous and lymphatic outflow, relieving neck muscle spasms, normalizing sleep, improving emotional state, and helping cope with migraines and dizziness [6–10]. However, there are a lot of different types of massages with different physiological effects, and our knowledge remains pure regarding the biological mechanisms of massage benefits and objective biomarkers of its efficiency [7]. Particular types of massage have been found to reduce frontal brain activity [8], increase activity of the pleasure-related left anterior cingulate cortex [9], which is concerned with relaxation, but also activate certain brain regions [5].

In our study, we aimed to evaluate the impact of combined general and point massage of the cervical-collar area on the electrical activity of the brain in terms of its synchronicity in healthy young subjects.

2 Materials and Methods

2.1 Participants

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. We involved volunteer healthy young males (20 subjects) and 20 females (20 subjects) in the age of 20 to 25.

2.2 EEG record and massage procedure and EEG analysis

The electroencephalogram of the brain was recorded using the 21-chanal Neuronspectr-4 EEG device (Neurosoft, Ivanovo, Russia). For EEG registration, the international system “10-20” was applied. We used following EEG electrode pairs of leads: frontal lobe - Fp1, Fp2, temporal - T3, T4, central - C3, C4, occipital - O1, O2. We performed cross-correlation analysis for the following interhemispheric pairs of leads: FP1-C3, FP2-C4, C3-O1, C4-O2, FP1-T3, FP2-T4, T3-O1, T4-O2.

Background rest EEG with closed eyes and then with opened eyes was recorded for 3 minutes for each state. Then 20 minutes of combined general and point massage. Then again recording the EEG with closed (3 minutes) and opened (3 minutes) eyes. The sapling rate was 512 Hz. Previously, all EEG records were cleaned from artifacts semi-automatically (with the help of EEG device software). The cross-correlation coefficient was calculated as the measure of synchronicity of electrical activity in different brain regions [10] automatically with the help of EEG device software. The cross-correlation coefficient was calculated for each state: background rest EEG with closed eyes and with opened eyes before massage session EEG with closed (3 minutes) and opened (3 minutes) eyes after the massage.

2.3 Statistical analysis

For a comparative statistical analysis of the interhemispheric EEG synchronously before and after massage and for analysis of the effect of left-right hemispheric laterality as well as the sex effect, a two-way repeated measures ANOVA with within-subject factors (laterality and condition: before-after massage) and between-subject factor sex was utilized. All date presented as the mean and standard deviation (SD). P-value <0.05 was considered as statistical significant. For statistical analysis, we used the Statistical Package for the Social Sciences (IBM SPSS, V.21).

3 Results and Discussion

Repeated measures did not reveal a main effect for either the between-subjects factor sex or the inter-subjects factor laterality, as well as their interaction with each other or with the condition (pre-post massage) factor. However, repeated measures revealed the main inter-subject effect condition (pre-post massage). As there was no difference in EEG cross-correlation coefficients (R) between males and females, we present data for the hole sample in resting states with closed (Table 1) and opened (Table 2) eyes before and after massage. As it is seen from Table 1 and Table 2, after massage, synchronicity between the frontal and central regions of the left hemisphere in the resting state with closed eyes increased ($F=6.41$, $p=0.001$). Whereas after massage synchronicity between central and occipital regions of the right hemisphere in the resting state with opened eyes decreased ($F=6.37$, $p=0.01$).

Table 1. Cross-correlation coefficients between interhemispheric pairs of leads in the resting state with closed eyes before and after massage

Pairs of leads	Before/after massage	R	SD	P-value
FP1-C3	before	0,157	0,089	0,008
	after	0,220	0,034	
FP2-C4	before	0,207	0,072	0,797
	after	0,2122	0,069	
C3-O1	before	0,156	0,079	0,774
	after	0,160	0,083	
C4-O2	before	0,182	0,100	0,535
	after	0,167	0,084	
FP1-T3	before	0,173	0,063	0,488
	after	0,188	0,082	
FP2-T4	before	0,190	0,053	0,920
	after	0,188	0,087	
T3-O1	before	0,174	0,084	0,175
	after	0,204	0,063	
T4-O2	before	0,205	0,112	0,970
	after	0,205	0,101	

Table 2. Cross-correlation coefficients between interhemispheric pairs of leads in the resting state with opened eyes before and after massage

Pairs of leads	Before/after massage	R	SD	P-value
FP1-C3	before	0,166	0,063	0,664
	after	0,178	0,0913	
FP2-C4	before	0,168	0,0828	0,964
	after	0,169	0,073	
C3-O1	before	0,210	0,090	0,117
	after	0,170	0,112	
C4-O2	before	0,240	0,089	0,013
	after	0,188	0,131	
FP1-T3	before	0,152	0,065	0,745
	after	0,160	0,071	
FP2-T4	before	0,157	0,046	0,968
	after	0,158	0,066	
T3-O1	before	0,213	0,093	0,662
	after	0,202	0,110	
T4-O2	before	0,250	0,110	0,103
	after	0,213	0,136	

Thus, we observe that ricing correlations in electrical activity in the anterior regions of the cortex during rest conditions with closed eyes could reflect the diminishing inhibitory cortico-fugal descending influences from the cortex to subcortical strictures. Under such circumstances, the cortex is less active, more passively follows the rhythms produced by subcortical structures, and expresses more synchronicity in electrical activity [10]. At the same time, we reviled that synchronicity between the central and occipital brain areas which is responsible for the sensory visual perception [11] during restring state with opened eyes dropped in compere with similar condition before massage. This finding could reflect that the brain cortex become more reactive as an effect of massage which produces normalizing influence on the functional brain station.

Conclusion

On the basis of cross-correlation analysis of the EEG, we found that combined general and point massage of the cervical-collar area increases the synchronicity of electrical activity between the central and frontal regions during restring state with closed eyes and decreases the synchronicity between the central and occipital brain areas during restring state with opened eyes, which allows us to suggest that this type of massage optimizes functional brain state.

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