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Influence of the quality of sleep on the masticatory muscle activity - a pilot study

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Conflict of interest

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Key words: sEMG, sleep, anterior temporalis, masseter muscle

ABSTRACT

Introduction: Modern literature indicates an uptrend in the occurrence of sleep disorders. Currently, about 30-40% of adults are suffering from sleep disorders, which makes them one of the most common health problems of the population.

The aim of the study: The determination of the quality of sleep on the muscle tension of the masticatory apparatus.

Methods and materials: 27 adults volunteered to take part in the study. After the application of the exclusion criteria, 12 women (with an average age of 23 ± 1 year) have qualified. They were subsequently divided into two equal groups, in accordance with the guidelines of the Pittsburgh questionnaire: six women with a below 6 point result - high quality of sleep and six women with an over 6 point result (or higher) - low quality of sleep. Electromyographic activity of the anterior temporalis (TA) and masseter muscle (MM) was evaluated in resting mandibular position. Based on the electromyographic results, the values of the asymmetry indexes of the muscles of the masticatory apparatus muscles were calculated. The U Mann-Whitney test has been used for the statistical analysis, with the significance level of 0,05.

Results: There were no significant differences in resting activity of the anterior temporalis, masseter muscles and the asymmetry index of the anterior temporalis between groups ($p > 0,05$). There was the significant difference in the asymmetry index of masseter muscles between groups ($p < 0,05$).

Conclusions: The quality of sleep has no significant influence on the resting activity of masticatory muscles. The influence of the quality of sleep on the asymmetry index should be the object of further research. In order to verify this conclusion, the research should be carried out on a larger group of people.

INTRODUCTION

Sleep problems are a very broad term, which encapsulates deficits in the quantity as well as the quality of sleep. All of the problems, which influence the continuity of sleep, are labeled as sleep disorders, which can be a result of several factors beginning with the lifestyle, environmental factors and even insomnia and other medical conditions. The effects of the lack of or the insufficiency of sleep can have short as well as long-term health consequences (1).

When it comes to the short-term consequences of sleep disorders among healthy adults, we can enumerate: an increased sensitivity to stress, somatic pain, lowered quality of life, emotional and mood disorders as well as the impairment of the cognitive function of memory and efficiency (2). In the age group labeled as teenagers, the consequences of the lack of sleep are visible in the lowered educational results and risk taking as well as psychosocial health (3). Among children, however, behavioral problems start to be visible with the addition of cognitive impairments (4). Long-term consequences of the lack of sleep encapsulate high blood pressure, dyslipidaemia, cardiovascular diseases, weight problems, metabolic syndrome, type II diabetes and colorectal cancer (5). Therefore, it can be stated that sleeping disorders can have a significant influence on the decrease of the quality of the life of children and youth and the development of many systemic diseases (cardiovascular, gastrointestinal) (6). The research on the subject of the quality of sleep indicates an uptrend when it comes to the occurrence of sleep disorders. Currently, about 30-40% of adults are suffering from sleep disorders, which makes them one of the most common health problems of the population (1). Among the risk factors, when it comes to the occurrence sleeping disorders - organism functioning disorders, difficult financial situation, depression, myofascial pain in the face area, and low level of education can be listed. Research indicates that the vast majority of people who suffer from the lowered quality of sleep are women, regardless of the race, climatic zone. Moreover, difficulties in falling asleep are connected

with the aging process, even though the literature shows that a growing percentage of young people suffer from sleeping disorders. In the USA 13% of adolescents suffer from severe insomnia and problems with sleep occur among children between the age of 10 and 15 (7).

The aim of this work is to establish the influence of the quality of sleep measured by the Pittsburgh questionnaire on the stationary activity and asymmetry index of the muscles of the masticatory apparatus - the front part of the temporal muscle and the surface part of the masseter.

MATERIALS AND METHODS

The study group consisted of 27 women, invited to take part in a pilot study, the aim of which was the determination of the quality of sleep on the muscle tension of the masticatory apparatus. All of the women were clinically examined in accordance with the protocol of Research diagnostic criteria for temporomandibular disorders (RDC/TMD) (8).

The study was conducted in accordance with the guidelines of the Declaration of Helsinki as well as with the consent of the Bioethics Committee of the Medical University of Lublin (KE-0254/73/2017). The people subjected to the study were informed about the aim of the study in question as well as being fully aware of the possibility of resignation at any given moment.

The following exclusion criteria have been adapted to the study: facial cranium injuries, neurological and psychological disorders, pregnancy, insomnia treatment, functional impairment of the masticatory apparatus.

After the application of the criteria listed above, 12 out of 27 women (with an average age of 23 ± 1 year) have qualified. Based on the Pittsburgh questionnaire of the quality of sleep (Pittsburgh Sleep Quality Index - PSQI) they were divided into a control group of 6 women (with an average PSQI score of 3) and a study group of 6 women (with an average PSQI score of 18). The PSQI questionnaire consists of ten points, which determine: the time it takes to fall asleep, the quantity of sleeping hours and it establishes the factors, which cause sleep disturbances as well as the sleeping habits of the test subject. In accordance with the recommendations of the authors of the questionnaire depending on the PSQI score, people who took part in the study were divided into the categories of good (below 6 points) and bad sleepers (6 or more points) (9).

The research was conducted during the morning hours (from 9 to 11 a.m.) in order to decrease the influence of the daily change in the bioelectric muscle dynamics. Every woman was prepared for the examination in the following manner: the skin of the test subject was cleansed with 90% ethyl alcohol solution and the jewellery from the head and neck area was removed. The test subject was seated in the dentist chair with the head placed on the headrest. In this position - disposable, round Ag/AgCl electrodes with a 30 mm diameter and a 16 mm conductive surface (SORIMEX, Poland) were placed. The placement of the electrodes within the muscle fibers of the anterior temporalis (TA) and the masseter muscle (MM) was in accordance with Ferrario et al. (10). The reference electrode was placed on the forehead in accordance with Venegas et al. (11). For this particular study, an 8-channel surface electromyography (sEMG) device (BioEMG IIITM) with BioPak Measurement System software was used (BioResearch Associates, Inc. Milwaukee, WI, USA). Before the examination, a disturbance test was carried out. The patients were asked to close their eyes and not to swallow their saliva. During that time, the resting activity of TA and MM was recorded on the left and right side in accordance with Wieczorek et al. (12).

Based on the results, the asymmetry index (AsI) was calculated using the formula below, where RMS means root means square:

$$\text{AsI} = (\text{RMS}_{\text{right}} - \text{RMS}_{\text{left}}) / (\text{RMS}_{\text{right}} + \text{RMS}_{\text{left}}) \times 100$$

The value of the index will vary between +100 and -100. The positive value will stand for a bigger input from the muscles on the right side, whereas the negative value will indicate a bigger input from the muscles on the left side. The results which equal 0 indicate muscle equity between the right and left side (13).

The comparison of the bioelectric data and asymmetry index results was conducted using the IBM SPSS STATISTICS 21 software. Bearing in mind the pilot nature of the study a nonparametric U Mann-Whitney test was applied. The differences would be taken into consideration as statistically significant if the p-values (test probability) were lower than the estimated significance level ($p < 0.05$).

RESULTS

The average bioelectric activity of the TA muscles among the control group was equal to 2,357 μV and among the study group 2,414 μV . The activity of MM muscles among the control group was equal to 1,574 μV and among the study group 1,814 μV . There were no significant statistical differences in the comparison of the average bioelectric activity of the masticatory muscles (TA, MM) between the groups ($p > 0,05$), as shown in table 1.

Among the control group, the average AsI of the TA muscles was equal to -1,62 and among the study group -16,106. There were no significant statistical differences in the comparison of the average AsI of the TA muscles between the groups ($p > 0,05$). Among the control group, the average AsI of MM muscles was equal to -6,262 and among the study group +11,206. There were significant differences observed in the comparison of the average AsI of MM muscles between the groups ($p > 0,05$), as shown in table 1.

Table1. Cumulative data of the study - results of the bioelectric activity and asymmetry indexes of anterior temporalis and masseter muscles

* statistically significant difference ($p < 0,05$)

	n	average bioelectric activity TA	p	average bioelectric activity MM	p	AsI TA	p	AsI MM	p
study group	6	2,414 μV	1	1,814 μV	0,15	-16,106	0,749	11,206	0,037*
control group	6	2,357 μV		1,574 μV		-1,62		-6,262	

DISCUSSION

Sleep disorders are becoming a more frequent reason for visiting family doctors. According to the study, carried out by the Center for Public Opinion Research (CBOS) from the year 1996 frequent and persistent difficulties with falling asleep apply 24% of general respondents (19% male i 28% female) with 5% of people up to 24 years of age, whereas 42% over 65 years of age (14). The review of the literature from the last 10 years indicates an increase in the occurrence of insomnia among young adults. Sleep disorders affect up to 60% of people below 25 years of age (14). Despite the research conducted on the subject of sleep disorders and even with the separation and establishment of the improper sleep hygiene as its main cause, the researchers still have not managed to establish all of the mechanisms, which are responsible for triggering insomnia (11). It is certain however that, some of the sleep disorders can result in clinical symptoms of many diseases.

The aim of our study was to establish the influence of the quality of sleep, with the use of PSQI questionnaire on the bioelectric stationary activity of the temporal and masseter muscles. The average bioelectric activity of the temporal and masseter muscles among the study group was slightly different than in the control group, but the result was not statistically relevant ($p > 0,05$). The comparison of the asymmetry index of the temporal muscle in both groups also did not provide a relevant statistical outcome ($p > 0,05\%$). Whereas the comparison of the asymmetry index results when it comes to masseter muscles was indeed statistically significant ($p < 0,05\%$). To date, there are a scarce number of studies when it comes to establishing the influence of psychological disorders on the tension of muscles. In literature we can find references to the influence of depression on stationary muscle activity of the masticatory apparatus, which also suggest that among people suffering from disorders connected with depression - no increased tension of the masseter muscles was observed (15), which is in accordance with the review of literature conducted by Więckiewicz et al. (16). Severe depression, depressive bipolar disorders or dysthymic disorders will not affect the occurrence of migraines or headaches related to muscle tension (17). All of the research shows that we still cannot determine a causal connection between the pain of the masseter, increased muscle tension, psychological states, and conditions of a person, which would confirm the research, in which there was no influence of sleeping disorders on the masticatory muscles activity.

Among other, most frequently examined clinical symptoms, visible among people with sleep disorders we can point to the myofascial pain syndrome (18). The research conducted by Rener-Sitar et al. which uses Research diagnostic criteria for temporomandibular disorders (RDC/TMD) and the quality of sleep indicator of Pittsburgh (PSQI) point to the lack of significant differences in the average PQSI results between men and women of black or white race and among people with or without higher education. A minor influence on the sleep quality (SQ) was observed when it came to the age of the test subjects, but the results were not statistically relevant ($p > 0,05$). An influence which is more significant than socio-demographic factors were the diagnosis of the I axis and RDC/TMD, it was proven that the psychological factors are the most significant when it comes to impairing the quality of sleep (19).

Despite a large number of studies of the influence of pain on the quality of sleep, the literary review does not provide an unequivocal standpoint on the case of whether sleep disturbances are a cause or a result of pain symptoms. The research of Quartana et al. indicates that the increase of the symptoms of insomnia resulted in the increase of pain in the following (20), whereas the research of Yatani et al. suggests that the pain is the cause of the decrease of the quality of sleep (21). The review of the literature of Uhlig et al. indicates that the correlation of the primary headaches including migraines and tensional headaches and sleep disorders - but he highly specifies the bidirectionality of this correlation. However, bearing in mind that not all of the research applied to the standardized diagnostic criteria the exact and detailed comparison is impossible (22).

It is a well-known fact, that the reaction of the musculoskeletal system on pain stimuli is the increased muscle tension or particular defensive reflexes (23). Therefore can be suggested that the facial skeleton pain, tensional headaches and migraines will result in an increased tension of the temporal and masseter muscles. This hypothesis, however, is not in accordance with the conducted research. Therefore, to prove the influence of psychological disorders with the inclusion of sleep disorders on the masticatory muscles activity, further studies have to be conducted.

CONCLUSIONS

- The quality of sleep has no significant influence on the bioelectric activity of the masticatory muscles.
- The influence of the quality of sleep on the asymmetry index should be the subject of further studies.
- In order to verify these conclusions, further studies need to be conducted on a larger group of test subjects.

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