



RELATIONSHIP BETWEEN FUNCTIONAL LATERALITY AND ELECTROMYOGRAPHIC MUSCLE ACTIVITY - A PILOT STUDY

Grzegorz Zielinski¹, Marta Suwala², Michał Ginszt², Katarzyna Lipa¹, Jacek Szkutnik³

1. Medical Students' Research Association, Chair and Department of Rehabilitation, Medical University of Lublin, Poland
2. Chair and Department of Rehabilitation, Physiotherapy and Balneotherapy, Medical University of Lublin, Poland
3. Department of Functional Masticatory Disorders, Medical University of Lublin, Poland

#Corresponding author: Marta Suwala, e-mail: marta.suwala@umlub.pl, Chair and Department of Rehabilitation, Magnoliowa 2 St, p.o. box 20-143 Lublin, Poland, phone number: +48501656011

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ABSTRACT

Human brain consists of two hemispheres which are a harmonized centre of the nervous system. Despite their integration there are some differences between their functioning in the area of motor activity, emotions, visual-spatial function, and speech. Functional asymmetry in the area of motor activity may have an influence on heavier functional burdening of dominant side, thus influencing distribution of muscular tension. The aim of the study was to determine connection of one-sided lateralization with a change in muscular activity of masticatory apparatus muscles and a group of flexors and extensors of an arm. 36 adult women (average age 22 ± 2 years old), in whom no functional disorders of temporomandibular joints were diagnosed, took part in the study. In order to determine lateralization, a questionnaire prepared by the researchers and an interview were used. Using these, 13 women were qualified to study group of one-sided lateralization (right: eye, ear, upper limb, lower limb). In order to assess muscular activity of masseter and temporal muscles, BioEMG III electromyograph was used. Pressure pain threshold in area of trapezius muscle and in a group of flexors and extensors of an arm was determined based on digital algometre FDIX. Statistical analysis was made with Mann-Whitney U test. Despite statistically significant differences, electromyographic examination showed higher bioelectric activity of right temporal muscle and left masseter muscle. Lower pressure pain threshold was observed in the left trapezius muscle, the flexors on the right and the extensors on the left side. Statistical significance was determined to be 0.05. Muscular tension and pressure pain threshold do not seem to be connected with lateralization, however, in order to confirm this issue, further studies on a bigger group of people are needed.

BACKGROUND

First studies on functioning of brain hemispheres have their beginnings already in 19th century. At that time, thesis about left hemisphere being dominant in all functions was stated. Only in 70s and 80s of 20th century there was a sudden development of studies on hemispheric asymmetry [1]. Currently, it is known that brain hemispheres have functional asymmetry expressed in the area of visual-spatial functioning, speech, emotions and essentially in motor activity. Hemispheric dominance may be determined as important advantage in functioning during certain activities. The term lateralization is connected with the term of hemispheric specialization. Lateralization may be one-sided (preference of only one side: right eye, ear, limbs) or crossed (e.g. preference of right eye, right ear, left hand and right leg) [2].

Undoubtedly, lateralization has an influence on proper muscular tension and reception of proprioceptive stimuli which bring proper motor schemata of the body [3]. Lateralization occurs at the age of about 10 [2, 3]. After that time, till the end of their lives, people use preferred receptors and limbs. For years researchers have wondered whether such functioning has an influence on muscular tension. However, results of studies are not consistent [9-15]. The aim of the study was to determine connection between one-sided lateralization and a change in muscle activity of masticatory apparatus, as well as a change of pressure pain threshold on trapezius muscle and a group of arm flexors and extensors.

MATERIAL AND METHODS

The study was conducted on 36 healthy women aged 22 (± 2). To perform research, which were conducted according to rules of Declaration of Helsinki, an approval of the Bioethics Committee of Medical University in Lublin was obtained (KE-0254/331/2015). All examined women were informed about the aim and course of the study and consented voluntarily and consciously.

The study was conducted with the use of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TDM) questionnaire [4]. Study group consisted of people describing their medical condition as excellent and very good, in whom no disorders of temporomandibular joints or non-specific physical symptoms (positions connected with included or non-included pain) were diagnosed [4]. Next stage of the study was to determine lateralization with the use of a questionnaire developed by the researchers, which consisted of 11 multiple choice questions, and an interview created based on studies and papers of J. Skibska [1], A. Stepień [2], and A. Paczkowska et al. [3]. During the interview a dominant eye, leg, and arm were determined. On this basis 13 women with one-sided lateralization (right: eye, ear, upper and lower limb) were eventually qualified to the study group. Muscular activity of masseter and temporal muscles was determined with the use of 8-channel electromyograph BioEG III connected with BioPAK measuring system. Surface electromyography (sEMG) was conducted according to the criteria of sEMG examination procedures [5, 6]. All

examinations were performed in the morning hours to decrease influence of daily change in bioelectric muscle activity.

Before placing electrodes, the skin was cleaned with the use of 90% ethyl alcohol solution. Disposable round Ag/AgCl electrodes of 30 mm diameter and 16mm conductive surface were used for examination. Surface electrodes were placed in accordance with muscle fibers: frontal part of temporal muscles and surface part of masseter muscles on the right and left side. Reference electrode was placed on the skin covering spinous process of the 7th cervical vertebra (C7). Before sEMG examination, an interference test was conducted. Examined person was sitting on a dentist's chair: trunk was in a perpendicular position to the floor, lower limbs were straightened and placed collaterally, the head was leaned back on the headrest. Muscle activity was measured at rest for 10 seconds.

Level of pressure pain threshold (PPT) was determined within the area of descending part of trapezius muscle, and group of arm flexors and extensors with the use of digital algometre FDIX. Places to assess pain threshold on descending part of trapezius muscle were determined based on methodology described by Moloney and Witney [7]. There were 3 measurements on each side. PPT of the group of arm flexors and extensors was determined according to most common localization of myofascial trigger points (TrPs) with respect to paper of P. Richter and E. Hebggen [8]. 2 measurements on every muscle group were conducted on both sides.

STATISTICAL METHODS

To conduct statistical analysis IBM SPSS STATISTICS 21 software was used. For statistical analysis researchers used with Mann-Whitney U test. Differences were considered as statistically significant if the level of significance was lower than 0.05.

RESULTS

Difference in bioelectric activity of frontal part of temporal muscles and surface of masseter muscles, as well as PPT value of trapezius muscle and a group of arm flexors and extensors between left and right side was not statistically significant ($p > 0.05$) (Table 1, 2).

Despite of the lack of significant statistical differences, electromyographic examination showed higher bioelectric activity of right temporal muscle and left masseter muscle. Lower PPT was observed within trapezius muscle and the group of left extensors and the group of right flexors. (Table 1, 2).

DISCUSSION

The aim of the study was to determine connection between one-sided lateralization, a change in activity of masticatory apparatus muscles, and a change of pressure pain threshold of trapezius muscle and group of arm flexors and extensors. Similar results of research concerning muscle activity with the use of sEMG and PPT were also observed in studies of A. Szapala et al. [9] which were conducted on flexors and extensors of the

trunk and assessed abdominal rectus and erector spinae muscles with the use of sEMG. Szapaly et al. stated that there were no significant differences in bioelectric signal between left and right side in both studied muscle groups. Also in work of C. Davies et al. [10], there was observed that lateralization has no connection with functioning of muscles with regard to maximal tension and relaxation time between dominant and non-dominant side of the body. Abovementioned results are consistent with results of bioelectrical activity of masticatory apparatus muscles in abovementioned study. P. Pauli et al. [11] in their research on PPT occurrence depending on dominant side, came to conclusions that PPT values were not connected with lateralization. It is also consistent with results published in this study.

In opposition to abovementioned studies there is a work of M. Konieczny [12]. He conducted his research with the use of sEMG and high-speed camera in order to determine differences in muscle functioning: the triceps brachii and pectoral muscles while throwing. In the results, he stressed functionally significant asymmetry between both upper limbs. Difference between studies described in this paper may be connected with sex, age, and level of physical activity of the studied people. In the research of M. Konieczny, studied people were boys aged 12 who were sport oriented- baseball, and in abovementioned study studied people were women aged 22 who were not doing any specific sport regularly. One of the latest research concerning lateralization reports that there are differences in functioning of muscles in dominant and non-dominant limb. Research was conducted by T. Oyama and A. Sako [13] who studied cooperation of biceps and triceps brachii muscles in arm stabilization. Results obtained from sEMG and examination of arm movement indicate higher compressing in non-dominant arm. Significant differences in functioning of dominant and non-dominant limb were also shown in research of M. Tanaka et al. [14]. They noticed that the average time to obtain peak tension was significantly lower in dominant limb than in non-dominant one. They also observed that fatigue indicator in dominant limb was considerably higher. However, the research was conducted on a small group of subjects -10 people. Similar conclusions were drawn by W. Niu et al. [15]. He carried out a study in which 16 adult people were jumping from a platform at 3 different heights (0.32 m, 0.52 m, 0.72 m). The action of muscles (tibialis anterior and gastrocnemius) during landing was observed with the use of sEMG. Higher sEMG amplitudes before and after landing in non-dominant limb were observed.

Observed differences between results in particular publications may stem not only from studies on different muscle groups, but also from the use of different functional tasks to assess muscle activity. In order to unambiguously determine the influence of lateralization on muscle activity and pressure pain threshold, further research on bigger groups of people are recommended.

CONCLUSIONS

1. Muscle tension and pressure pain threshold do not seem to be connected with lateralization.

2. To confirm this thesis, further research on bigger groups of people are indicated.

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TAB. 1. sEMG AVERAGE ACTIVITY OF TEMPORAL MUSCLES AT REST (TA) AND MASSETER MUSCLES (MM) AT DOMINANT SIDE - RIGHT (1) AND AT THE OTHER SIDE - LEFT (2).

Muscle group	n	Average activity sEMG (µV)	SD	Z	p
TA (1)	13	2.97	2.13		
TA (2)	13	2.73	2.17	-0.487	0.626
MM (1)	13	2.72	2.04	-0.333	0.739
MM (2)	13	3.05	4.10		

TAB. 2. AVERAGE VALUE OF PRESSURE PAIN THRESHOLD (PPT) OF TRAPEZIUS MUSCLE (TRAP), GROUP OF ARM FLEXORS MUSCLES (ZG), AND GROUP OF ARM EXTENSORS (PR) AT DOMINANT SIDE - RIGHT (1) AND AT THE OTHER SIDE - LEFT (2).

Muscle group	n	Average PPT value (kg)	SD	Z	p
TRAP (1)	13	4.66	1.17		
TRAP (2)	13	4.11	1.25	-1.154	0.264
ZG (1)	13	4.43	1.26		
ZG (2)	13	4.87	1.47	-1.334	0.186
PR (1)	13	3.67	1.21	-0.564	0.579
PR (2)	13	3.77	1.27		



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