Influence of functional asymmetry of the brain on sensitivity palmar surface of the fingers

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Influence of functional asymmetry of brain on sensitivity of palmar surface of fingers

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RESUME

Research results of changes in tactile sensitivity of palmar surface of the terminal phalanges of fingers for different types of functional asymmetry of the brain are presented.

Keywords: osteopathy, functional asymmetry of brain, lateralisation, tactile sensitivity, fingers.

SUMMARY

The article presents the results of a study of the dependence of the tactile sensitivity of the palmar surface of the terminal phalanges of the fingers in different variants of functional asymmetry of the brain.

Key words: osteopathy, functional asymmetry of the brain,lateralization, tactile sensitivity, fingers of the hand.

One of the fundamental features of the functioning of the human central nervous system, which also determines the specifics of labor activity, is determined by the functional asymmetry of the cerebral hemispheres. Despite the fact that the two halves of the brain work in a coordinated unity, one of the hemispheres has a dominant role in the implementation of many functions. The most noticeable manifestation of interhemispheric functional asymmetry is the predominant use of the right or left hand. Such lateralization manifests itself on the "leading" side of the body in the form of more developed fine motor skills of the fingers (for example, the ability to write) and greater muscle strength. Also, the functional specialization of the hemispheres was noted for the functions of speech, hearing, vision.

Lateralization of the brain does not manifest itself only at the functional level. The dominance of any hemisphere is also realized at the structural level: the dominant hemisphere is large in comparison with the size of the subdominant hemisphere [9, 10].

Functional asymmetry of the brain has an important clinical and

biosocial significance. This aspect is also interesting for us - osteopaths, since the sensory functions of the hands within the framework of osteopathic perception can also be largely determined by the interhemispheric lateralization of the brain.

The aim of this work was to identify the features of tactile perception of the palmar surface of the fingers on the dominant and subdominant sides of the body.

Materials and methods

The study group included 20 volunteers from among cadets-osteopaths of the initial stage of training at the Institute of Osteopathic Medicine, North-Western State Medical University named after I.I. Mechnikov. The number of men and women in the study group was equal. The distribution of the subjects in the age groups was as follows: 23–29 years old - 30%; 30–39 years old - 50%, 40–49 years old - 20%.

Clinical tests were used to determine the leading hemisphere of the brain:

1. Test one (T1): the subject was asked to interlace his fingers in "lock". The top thumb (right or left) defines the dominant side of the body.

2. Test two (T2): the subject crosses his arms. Hand on top indicates the dominant side of the body.

3. Test three (T3): the subject in a sitting position crosses his legs at the hips (position: "cross-legged"). The leg on top indicates the dominant side of the body.

4. Test the fourth (T4): determination of the dominant eye. Test well-known among chiropractors and osteopaths. The order of its implementation is as follows: the subject at a distance of 40-50 cm from his own nose (along the midline) sets a finger and looks at it with both eyes. After that, it alternately closes and opens the right and left eyes. The eye is dominant if, when it is opened and closed, the finger does not "move" from the midline to the side. On the side of the nondominant eye, there will be a significant “displacement” of the toe from its midline.

The tactile sensitivity of the palmar surface was investigated using the instrumental technique called IVIS (the name comes from the initial letters of the phrase: "study of vibration-induced sensitivity"). IVIS diagnostic technology is based on the hardware-software vibration complex (APVK) "IVIS" and the hardware-software photoplethysmographic complex (APFK) "Dialaz".

fingers hands

APVK "IVIS" is designed to create an objective control of tactile sensitivity (PM) of the palmar surface of the distal phalanges of the fingers (LPDFPR). The complex consists of peripheral and software parts. The peripheral part is represented by the MT6030 vibrodynamic speaker (manufacturer: OOO Kontrakt-Elektronika, Moscow).

The purpose of vibrodynamics is to generate and transmit mechanical vibrations. Mechanical vibrations arising in vibrodynamics

transferred to objects in contact with its surface. As a result, the object (read: investigated), to which mechanical vibrations were transmitted, itself becomes an emitter, that is, an oscillatory system.

Structurally, the vibrodynamic unit includes an inductor plate, to which mechanical vibrations are applied by the generator; the latter are perceived by a variety of skin receptors. The change in the intensity of the mechanical signal applied to the vibroplate makes it possible to determine the individual threshold values of kinesthetic perception.

White noise was used as an active mechanical signal fed to the vibrodynamic inductor. White noise is stationary noise, the spectral components of which are evenly distributed over the entire frequency range of a number of mechanical vibrations audible by the human ear (from 20 to 20,000 Hz).

The choice of precisely "white noise" as an inducing stimulus was dictated by the need to create poly-frequency mechanical vibrations, which is physiologically justified, since the receptor system of the skin has different thresholds for distinguishing between low- and high-frequency mechanical vibration signals, as well as high resolution for determining touch and pressure on the skin [8].

The definition of PM LPDFPR is that the distal phalanges of the fingers of the subject's hand are placed on the active part of the vibrodynamic device, which generates sound tracks of "white noise" of varying intensity.

For the study, several dozen sound files were created containing "white noise" of various intensities: in the range of values from -22.35 dB to -59 dB. The synthesis of the original file of "white noise" was performed using the BrainWave Generator program (v. 3.1, © Noromaa Solutions, 1998–2000), further processing of the original file with obtaining tracks of various intensities was performed using the WaveLab program (v. 3.0, © P. Gouter, 1994-1999).

For a quick and convenient selection of files of varying intensity, the software (interface) part of "IVIS" was created (v. 1.00, © E. Malinovsky, 2013).

The studies carried out made it possible to determine the different PM of the fingers in osteopaths and to rank the applied tracks according to the following categories:

1. Low PM: sensitivity to sound files with intensity in the range values -22.35 - -33.25 dB.
2. Average PM: sensitivity to sound files with intensity in range of values -34.25 to -46.8 dB.
3. High PM: sensitivity to sound files with intensity in range of values -47.8-59 dB.

To verify the information reported by the subjects in the process of determining the PM of their fingers, a system for determining autonomic activity based on the APFK "Dialaz" was used (v. 2.01, © R. Aitov, E. Malinovsky, 2006–2011).

The functioning of APFC "Dialaz" is based on the use of

photoplethysmograph. The technology of research and application of photoplethysmography is described in the article [7].

The methodology based on APFC "Dialaz" was tested in 2007. The results of its use made it possible to develop a method to eliminate the negative reactions of course laser therapy [2]. In addition, the APFK "Dialaz" in a series of studies in 2011 made it possible to optimize the use of osteopathic techniques in the treatment of patients with diseases of various parts of the spine [1, 4].

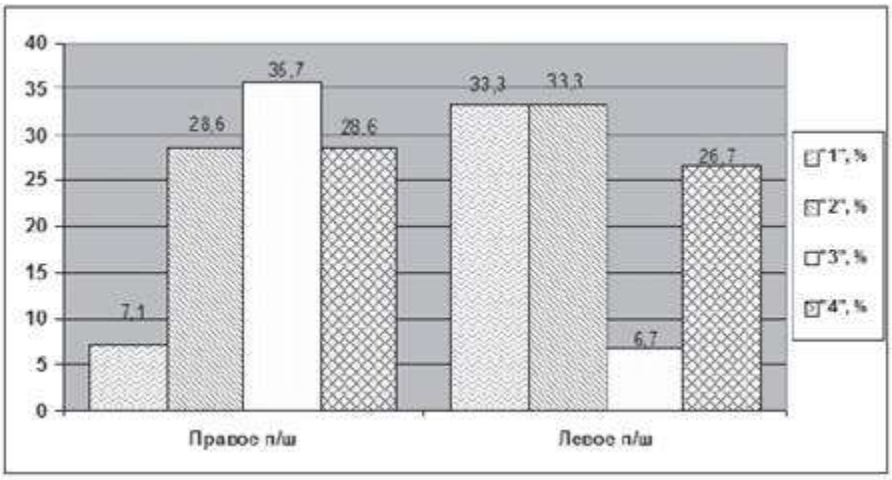
In this study, the ACPK "Dialaz" was used to verify the vibrational sensations that arose in osteopaths. The registration of the RIP served as an indicator of the vibrational sensation. RIP is the main quantitative indicator used in photoplethysmographic studies on the basis of Dialaz APFK. RIP is the result of a software-mathematical analysis of the dynamics of the amplitude and frequency of vasomotions in the skin microcirculation system. RIP values exceeding the range of 4–15% correspond to the empirically established state of rest of a waking person.

Research protocol vibration-induced PM LPDFPR was carried out as follows. Study of the initial PM LPDFPR using hardware-software complexes "Dialaz" and "IVIS" on 1–5 fingers. To determine the threshold values of PM, the selection of tracks was carried out in the direction from higher to lower intensity.

If in the process of vibration-induced RIP values of less than 4% or more than 15% were recorded for 2–4 seconds, this was regarded as a clear identification of the vibration signal by the investigated person. At the same time, any coincidence of the objective indicator of vibration sensation (according to the RIP value) and the subjective statement of the osteopath about the sensation of finger vibration was considered as a reliable tactile perception [5, 6].

Results and its discussion

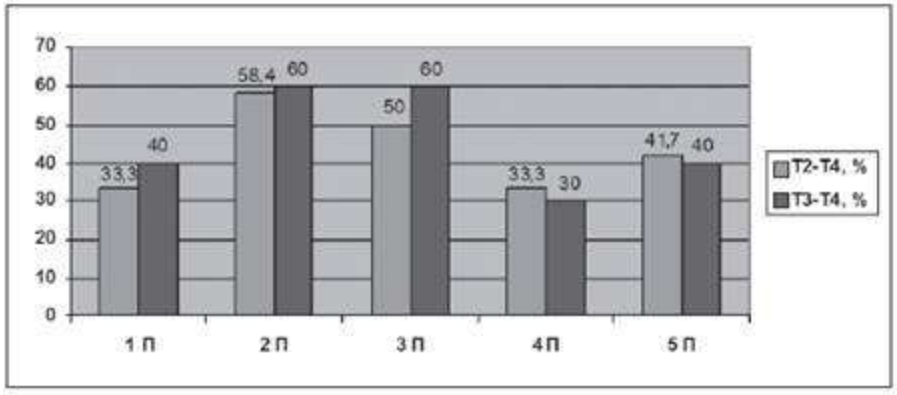
The used test methods for determining the dominant hemisphere of the brain had different results (Fig. 1). The initial parameters, on the basis of which the effectiveness of the above-described test methods was assessed, were the indicators obtained during IVIS.



Rice. 1. The results of determining the dominant hemisphere of the brain when using various test methods. Legend: "1" - test crossing fingers in a "lock", "2" - test of crossing arms, "3" - test of crossing legs, "4" - test for determining the dominant eye, "p / w" - hemisphere.

In the presence of different types of test methods, it is most advisable to take into account the results of those of them, the readings of which are identical. The study of this issue revealed the greatest coincidence of the results when combining tests T2 and T4 (60%), T3 and T4 (50%). The smallest number of matches was found when the T1 test was combined (30% or less). In this regard, it was decided not to use the T1 test when taking into account the results. In the study group, 31.3% were found among volunteers with right hemispheric lateralization and 68.7% with left hemispheric lateralization.

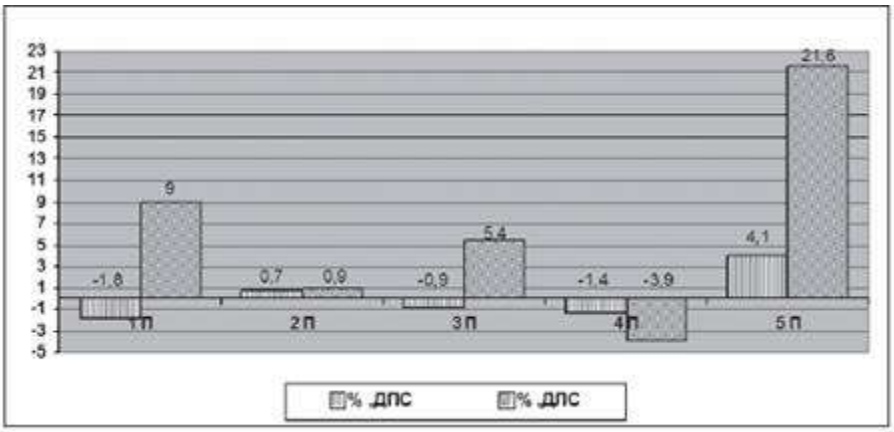
The use of T2-T4 and T3-T4 tests in combination with the study of PM on the palmar surface of the fingers according to the IVIS test system showed clear tendencies towards lateralization on 2 and 3 fingers (Fig. 2). Statistical study on the F-test (0.4) additionally indicates a more pronounced lateralization of the named fingers.



Rice. 2. Coincidence of tendencies towards lateralization of the cerebral hemispheres during

combining the T2-T4 and T3-T4 tests with the indicators of the IVIS test system.
Legend: "P" - finger, "1-5" - serial number of the finger, "T2", "T3",
"T4" - tests for determining the lateralization of the brain.

The study of the proportional prevalence of PM LPDFPR on the dominant side of the body shows a clear lateralization of the right hemisphere (Fig. 3). A statistical study of the coincidences of data by Pearson's t-test indicates a low degree of correlation: 0.7.



Rice. 3. Fractional differences in tactile sensitivity on the right and left dominant side of the body. Legend: DPS - share prevalence
CC on the dominant right side of the body, DLS - proportional prevalence of CC on dominant left side of the body.

conclusions

1. Sensory perception of the palmar surface of the terminal phalanges of the fingers within the framework of tactile sensitivity is determined by the right hemisphere of the brain.

2. More pronounced lateralization of the functional asymmetry of the head the brain manifests itself at the level of the 2nd and 3rd fingers. Diffusion of sensory functions is observed on the remaining fingers.

3. When determining the dominant hemisphere of the brain in the row of the clinical tests used, the test of “crossing the fingers” of the hands can be considered the least effective.

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Malinovsky, E.L. Influence of functional asymmetry of the brain on the sensitivity of the palmar surface of the fingers of the hand / E.L. Malinovsky, S.V. Novoseltsev // Traditional medicine. - 2013. - No. 3 (34). - P.24-27.

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