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OPTIMIZATION OF EARLY DIAGNOSIS OF INTERNAL DISORDERS OF THE TEMPOROMANDIBULAR JOINT

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ABOUT ARTICLE

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Abstract: Axiography is an objective method of examining the trajectory of the articular pathway, which allows us to assess the nature of the function in normal and functional disorders of the temporomandibular joint.To carry out the method of axiography, an Arcus digma axiograph (KaVo, Germany) was used, which was connected to a personal computer. Arcus digma (KaVo, Germany) is an electronic system for recording movements of the lower jaw, which allows for three-dimensional ultrasonic recording of movements of the lower jaw and registering angles to adjust the articulator to an individual function. An ultrasonic transmitter and a receiver mounted on a measuring arc were connected to the main device of the device. Data was saved directly during measurements on a connected computer, and the selection of workspaces and workflow management were carried out through the main device or using a pedal. The holder of the paraocclusive plug, which was fixed using Structur 2 SC (VOCO) to the vestibular surface of the teeth of the lower jaw, was connected to the transmitter. The selection of the required measuring program was carried out from the touch screen of the basic device. If necessary, all the measurements carried out could be reproduced in dynamic mode many times. All movements were performed while maintaining contact between the teeth of the upper and lower jaw. In this study, we used the proposed method of combined use of the Littmann electronic stethoscope and the Arcus digma axiograph (Fig.5) (innovation proposal No. 1600

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dated 11.02.2016, authors: Geletin P.N., Morozov V.G., Mishutin E.A., Ginali N.V., Karelina A.N.). the combined application of axiography and auscultation of the temporomandibular joint is as follows:

1. In preparation for the study, the doctor shows the patient what movements to make - slowly open and close his mouth (1 time for 15 seconds). At the same time, it is recommended that the patient repeat the movements several times, first with the help of a doctor, and then independently, so as not to make any mistakes already during the registration process.
2. In the computer program of the Littmann electronic stethoscope (3M ESPE), the "joint front view" mode is set and the patient is asked to slowly open his mouth after a beep from 1 time for 15 seconds. When a click or crepitation occurs, a computer program records the time of their occurrence, duration and intensity level (in dB).
3. At the same time, an axiogram of the movement of the lower jaw in the vertical plane (when opening and closing the mouth) and a phonogram of noises in the TMJ on the right are recorded.
4. The stethoscope sensor is installed on the outer surface of the zygomatic process near the tragus of the ear on the other side (left) and the technique of combined axiography and audio diagnostics using the Littmann electronic stethoscope (3M ESPE) is repeated. When a click or crepitation occurs, a computer program records the time of their occurrence and the intensity level (in dB).
5. At the same time, an axiogram, movements of the lower jaw in the vertical plane and a phonogram of noise in the TMJ on the left are recorded.
6. The axiograms and phonograms obtained during the study were stored in a computer database, the phonogram was converted into a wav sound file and analyzed using the computer program "Diagnosis of diseases of the temporomandibular joint" (certificate No. 2015662495, authors Mishutin E.A., Korshunova K.P., Geletin P.N.), then the data they were printed out for registration in the patient's medical history.
7. The diagnosis was made based on the analysis of axigrams (deviation of the trajectories of opening and closing the mouth from the norm in the sections of the axiogram corresponding to the

initial, middle and final phase of opening and closing the mouth and computer analysis of phonogram recordings according to the main characteristics of sound (sound strength and frequency) and the phase of opening and closing the mouth, in which sound phenomena occur.

8. The diagnosis was made based on the analysis of axigrams (deviation of the trajectories of opening and closing the mouth from the norm in the sections of the axiogram corresponding to the initial, middle and final phase of opening and closing the mouth and computer analysis of phonogram recordings according to the main characteristics of sound (sound strength and frequency) and the phase of opening and closing the mouth, in which sound phenomena occur.

INTRODUCTION

When The relevance of research. Electromyography (EMG) is the only objective and informative method of studying the functional state of the peripheral nervous system, the pathology of which occupies a leading place in the structure of neurological diseases [1]. Electromyographic studies make it possible not only to establish the nature of the disease, to carry out its topical diagnosis, but also to objectively monitor the effectiveness of treatment, predict the time and stages of recovery.

Automated systems for measuring and processing biomedical information using modern software tools significantly expand the diagnostic capabilities of modern medicine. This also applies to electromyography, a method of studying the neuromuscular system by registering the electrical potentials of muscles.

But, unfortunately, at this time, most domestic medical institutions cannot afford to purchase modern myographs due to their high cost. One of the solutions to this problem is to modernize the existing myographs of the previous generation by pairing them with personal computers equipped with specialized software.

In addition to relatively low costs, another advantage of this approach is the ability to expand the research package by creating additional software without changing the hardware of the system. It is the latter aspect that is taken as the basis of this work devoted to the creation of a software package for studying the frequency composition of electromyographic signals

In this regard, the needs of practical healthcare and research institutions for equipment for EMG research are very high. However, currently the domestic medical industry does not produce any certified mass-produced electromyograph. The cost of foreign devices makes them inaccessible even for specialized medical institutions.

At the same time, today, four-channel MG 440 myoscopes from Micromed[2], which are non-automated electromyographs of the previous generation, are successfully used at many clinical bases. Under the current conditions, the problem of upgrading such equipment by interfacing it with personal computers using specialized information input/output devices and subsequent processing of EMG information by special software is relevant. This approach is implemented in an automated system for the study of electromyographic signals, created on the basis of a serial MG 440 myoscope and an IBM PC-type PC connected by an interface module. This system was developed at the KHAI Engineering Bureau MHP [3]. However, its software did not allow the analysis of the frequency composition of electromyograms, which served as the basis for the development of a software package designed to study the spectral characteristics of EMG signals.

The purpose of the study

To develop a software package for studying the frequency composition of electromyographic signals of human skeletal muscles.

Tasks

To achieve the above research goal, the following tasks must be solved.

1. Based on the analysis of literature on methods of spectral analysis of digital signals in general and literature on spectral analysis of biosignals, in particular, choose the most informative method for studying the frequency composition of electromyographic signals.

2. To study the structure of the hardware and software of the complex "Automated human electromyographic signal research System" in order to use and improve it.

3. To develop a software package for studying the frequency composition of electromyographic signals.

4. Based on the spectral characteristics of electromyograms of human skeletal muscles obtained using the developed software, determine the main frequency ranges in normal and in a number of diseases of the neuromuscular apparatus in order to increase the diagnostic value of this research method.

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METHODS

To assess the prevalence and early detection of pathology of the temporomandibular joint, a screening study of 483 patients aged 14 to 25 years, students of school No. 33, was conducted. All patients were examined as part of a medical examination. A sample of patients who underwent dispensary examinations was analyzed, at the first stage clusters in the form of dental institutions were randomly selected. At the second stage, a simple random sample was performed. The required sample size was determined using the program Somrage 2 of the WinPepi 11.45 package (J.H. Abramson). The key parameters of the calculation are the following: the level of statistical significance - 5%; power - 80%; the minimum significant differences, values and prevalence of the main variables are established on the basis of literature data.

Computer technology, which appeared in the early 60s and rapidly increasing its power, made it possible to solve many scientific and engineering problems that could not previously be solved by analytical methods. By the mid-70s, a large number of algorithms for the numerical solution of such problems had been accumulated. Entire libraries of algorithms have been formed. These libraries are a collection of carefully tested and optimized algorithms developed over the years by the world's leading experts. They actually represent the current state of numerical methods for scientific and engineering purposes. With the advent of these libraries, it has also become necessary to provide the shortest possible access to this abundance of algorithms to a wide audience of engineers and scientists. As a matter of fact, the creation of the MATLAB language (abbreviated from MATrix LABoratory - matrix laboratory) was due to this need.

MATLAB has gained great popularity over the years, gradually moving from large computing systems to personal computers, and the program itself, along with all professional applications, has turned into a powerful system covering a wide range of scientific, engineering and economic applications.

MATLAB contains tools for:

Data collection

Data analysis and processing

Visualization and digital signal and image processing

Creation of algorithms and design

Modeling and simulation

Programming and application development

MATLAB performs a variety of computer tasks to support scientific and engineering work, ranging from data collection and analysis to application development. The MATLAB environment combines mathematical calculations, visualization and a powerful technical language. Built-in interfaces allow you to quickly access and extract data from external devices, files, external databases and programs. In addition, MATLAB allows you to integrate external procedures written in C, C++, Fortran, and Java with MATLAB applications.

Used by more than half a million users: in industry, government, academic and educational organizations, MATLAB has actually become the globally accepted standard for technical computing. MATLAB has a wide range of applications, including digital signal and image processing, control system design, natural sciences, finance and economics, and instrumentation. The open architecture makes it easy to use MATLAB and related products to explore data and quickly create competitive user tools.

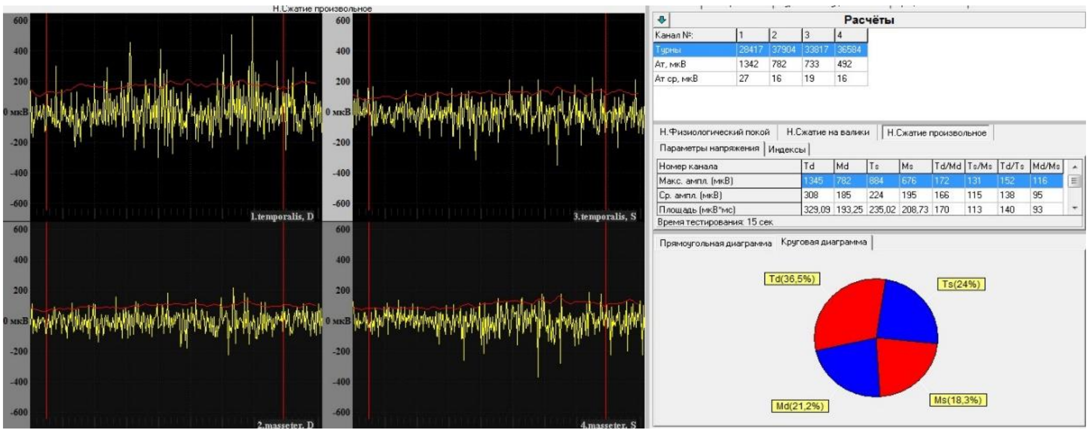
The study began by turning on the personal computer and after the operating system was loaded, the power toggle switch on the back panel of the electromyograph hardware unit was switched to the "|" position, after which the power indicator lit up. Disposable monopolar surface electrodes made of silver chloride with a diameter of 10 mm were used; the reference electrode was fixed on the wrist. To reduce the skin's resistance, it was pre-cleaned at the location of the electrodes with 70% alcohol, "Unigel" was used as a conductive substance and recorded after 5-6 minutes, allowing the gel to moisturize the skin surface well. The surface cup electrodes were fixed in the area of the motor points of the studied muscles using a Band-aid with an interelectrode distance of 1 cm (2 cm between the centers of the electrodes or 1 cm between their edges). During the recording of the electromyogram, the patient was in a sitting position without head support. Bioelectric signals from the muscle were transmitted via electrodes to a computer, where they were amplified, purified and visualized on a monitor screen in real time.

Then the software for working with the analyzer was launched: the parameters of electromyogram (EMG) registration were selected using drop-down lists such as "Sensitivity", "Scan", "lower (LF)" and "upper (HF)", "signal transmission frequencies", as well as the "volume" of the electromyogram sounding.

The specified parameters were changed during the signal registration process, then they went to the Settings menu and edited the required settings. The signal registration process was carried out according to pre-created or selected protocols. We used the Protocol menu. The screen is divided into 4 areas, the main one is the working area for displaying the recorded signal. It is divided into 4 registration channels according to the sides (right D and left S) and muscles (masticatory - Masseter and temporal - Temporalis), and there is a clear correspondence of these muscles to the channel numbers, which must be observed for correct mathematical processing.

On the right side there is an area of mathematical calculations divided into three components from top to bottom - the general EMG parameters for all channels, including the chewing graph, calculated values of indices and parameters of chewing (voltage), as well as the area of graphical representation of the results. They started working with the system by clicking on "Start" and started the monitoring process, to switch to recording mode and save the signal, they pressed "Register". Before recording each sample, a notification appears on the screen indicating which sample and how long it will be recorded. After recording the samples, an analysis was performed, which was carried out after marking "Tension" or "Chewing" in the "Viewing" section. This choice determines a different set of parameters in the table of indices and voltage parameters, then "Analysis" was pressed to display calculations of signal Spectra, Tour - amplitude analysis and a chewing graph.

For comparative analysis of samples, click "Sample ratio" and select samples for comparison in the window that appears. The graphical representation of the results of the table "Voltage parameters" was reflected in the form of rectangular and pie charts



Electromyography of patient K., born in 1995, with a diagnosis of internal disorders of the temporomandibular joints.

During the study, a record of the bioelectric activity of the chewing muscles was used in a state of physiological rest, with maximum compression of teeth with cotton pads and with arbitrary maximum compression of teeth. The procedure began with the study of the bioelectric activity of muscles in a state of relative physiological rest. Next, a standardized recording was performed with maximum volitional compression of 2 standard cotton pads with a diameter of 10 mm located on the border between the second premolars and the first molars symmetrically on both sides for 5 seconds. Muscle activity during compression was determined in millivolts for each muscle individually and the total for four.

Then the indicators of bioelectric activity of the muscles were analyzed with arbitrary volitional compression of the dentition in the usual occlusion. Electromyographic muscle activity was recorded for 5 seconds with maximum teeth compression. The patient was asked to clench his teeth as tightly as possible in the position of maximum contact between the upper and lower teeth and maintain this level of tension throughout the recording period.

The electroneuromyographic signals of paired muscles were compared using the index of symmetry of the masticatory muscles (ISM), the index of symmetry of the temporal muscles (ISM), the index of symmetry of the distribution of muscle activity (ISRMA). The following most informative indicators were also used for comparison and statistical analysis: the average amplitude of the masticatory and temporal muscles on the left and right, the area of muscle contraction, and the total potential.

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