ANALYSIS DATA FOR DEVELOPMENT OF MULTIFUNCTIONAL COMPUTER-AIDED RHINOMANOMETER

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A scheme of modern multifunctional rhinomanometer is proposed. The role of main parameters (airflow, pressure, respiratory resistance and power of nasal airway) and diagnostic criteria for functional diagnostics of upper respiratory airway diseases are described. Principles of design and components of multifunctional rhinomanometer are discussed. Diagnostic possibilities of the rhinomanometer for evidence-based medicine conception are described.

Introduction. Statistical data give evidence of an increasing rate of upper respiratory airway diseases. Thus in the USA, chronic sinusitis has become the most widespread disease with its frequency of occurrence going ahead of cardiovascular and locomotorium diseases [1]. Diagnostics and treatment of such pathologies is essential because nasal breathing affects the entire functional condition of a human organism. Chronic upper respiratory airway diseases result in considerable reduction of patients' life quality. The modern concept of evidence-based medicine involves the use of examination methods based on facts and precise measurements. Therefore a priority task in diagnostics of upper respiratory airway diseases is the development of methods and devices for precise quantitative evaluation of nasal breathing [2-3].

Currently there are various instrumental methods of diagnostics of nose and paranasal sinuses diseases. Methods of intrascopic anatomic mapping based on direct visualization of airway structures (X-ray imaging, helical computed tomography) assist in evaluation of anatomic specifics of the region of interest, pathological changes, mass lesions. Functional methods, such as thermal visiography, scintigraphy, magnetic resonance imaging, use the distribution of temperature or other parameters to identify and localize e.g. inflammatory tissue. However the main task of the initial examination stage and the index of effectiveness of the applicable treatment is the acquisition of a precise quantitative evaluation of nasal breathing characteristics to objectify the clinical presentation of a disease and the extent to which the patient has difficulties with the breathing. The purpose of this paper is to classify the methods of functional diagnostics of nasal breathing and to substantiate the principal medical and technical requirements to a multifunctional rhinomanometer.

Classification of rhinomanometry methods. The nasal cavity plays an important role in producing aerodynamic resistance and ensures regulation of the volume and rate of airflow in respiratory airway [2-4]. The upper respiratory airway produces over 50% of the total respiratory passage resistance. Today the nasal breathing characteristics are evaluated using various types of rhinomanometers – devices for measurement of pressure differential and airflow in upper respiratory airway. The rhinomanometry methods are divided into the active ones which measure the parameters of physiological nasal breathing and the passive ones in which the measurement procedures are performed using the compressor-assisted artificial air blowing through the nasal cavity. The latter allow to rate the airflow parameters but are of low physiological nature reducing the relevance of the method. With respect to the location of pressure pickups, rhinomanometry is divided into the front rhinomanometry where the pickups are located at the nasal cavity inlet and the rear rhinomanometry where the pressure is measured at the nasal cavity inlet and outlet (in posterior naris area). The direct rhinomanometry methods are based on direct measurement of airflow and pressure differential in the nasal cavity and are most precise, yet with instrumental complexity. The indirect methods measure the minimal number of parameters to calculate the rest thus simplifying the measurement technique and the examination procedure but reducing the accuracy of diagnostics due to additional errors.

Establishment of the principal medical and technical requirements to the device. The analysis of the specified methods and respective devices for the designed multifunctional rhinomanometer is used as the basis for establishment of the principal medical and technical requirements and development of the functional and structural diagram and the procedure of examination. The arrangement of the device must ensure implementation of the active rear rhinomanometry method with direct measurement of airflow and pressure differential in the nasal cavity. Such arrangement provides the highest reliability of measurements. Nasal breathing parameters are determined during the air inlet. The device must include pressure pickups to evaluate the pressure differential at the nasal cavity inlet and outlet, an airflow sensor, and an additional pressure pickup to control the air outlet cycle. It is advisable to use a Venturi [5] nozzle as an airflow sensor which measures pressure in diffuser. This enables to use pressure pickups of the same type thus simplifying the development of schematic diagram of the device. The pressure pickup measurement range must be 0 to 50 kPa with a standard measurement error for such class of medical devices not exceeding 5 %. If analogue pickups are used, a 4-channel ADC must be selected with a quantization increment not exceeding 10 % of the pickup error and a sampling frequency of up to 500 Hz. The control software must be clearly separated at the system and user levels, provide output and storage of diagnostic data in digital and graphic form, and ensure protection against unauthorized (extralegal) access to the hardware setup and calibration data.

Conclusions and outlook. The designed multifunctional rhinomanometer must be capable to perform direct rear active rhinomanometry with the specified metrological characteristics and a capability to implement additional indirect methods of diagnostics of air conduction of upper respiratory airway when direct measurements cannot be done. The outlook for the work involves the hardware and software implementation of the complete device, its metrological attestation, development of patient examination technique to ensure repeatability of results and clear criteria for differential diagnostics of various diseases of upper respiratory airway.

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РАЗРАБОТКА ВИРТУАЛЬНОГО УЗ-СКАНЕРА КАК ИМИТАЦИОННОЙ ОБУЧАЮЩЕЙ СИСТЕМЫ

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This work is dedicated to the creation of a virtual ultrasonic scanner. It can be used to educate students to understand the physical meaning of the ultrasonic scan. The developed program has a friendly interface and easy to use. Advantage of this program is the possibility of quickly modify according to the modern requirements.

В современной системе образования актуальными являются вопросы связанные с обучением студентов-биомединженеров в высших учебных заведениях. Сегодня