THE POSSIBILITIES OF USING REMOTE INFRARED THERMOGRAPHY TO DIAGNOSE AND DETERMINE THE EFFECTIVENESS OF THE TREATMENT OF CERTAIN ENT ORGANS DISEASES

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At the present level of medicine development the problem of early diagnostics of various pathological conditions remains an urgent task. To solve it we use radiography, CT, MRI, ultrasound and many other methods in medical practice. However, many of them are feasible only in powerful multi-profile hospitals. They have a high cost, are not safe for the patients and staff. In this connection, the search for new diagnostic methods which would be devoid of these drawbacks is practicable and meets the requirements of medicine.

In this regard, it is of great interest to study the infrared radiation of the human body as a promising diagnostic method. It is known that the tissues and human body in general radiate electromagnetic waves in a wide frequency range: infrared, millimeter and centimeter. But it is also known that 85% of the radiated energy is in the infrared range. For the first time in the practice of medicine infrared radiation as thermal imaging diagnostics was applied by Canadian surgeon M. Lawson in 1956. He used military night vision device for the early diagnostics of breast cancer. The reliability of such breast cancer diagnostics was, especially in the early stages, 60-70%. Then there was a rapid introduction of this diagnostic method in neurosurgery, maxillofacial surgery, vascular surgery, otorhinolaryngology. And, this diagnostic method compared with other widely used methods has certain advantages. When compared with CT, MRI, ultrasound and DITG the following effects were revealed:

Comparison of Radiation Diagnosis Techniques

Indicator	CT	MRI	Ultrasound	DITG
Health Hazard	Radiation Exposure	Stillness (up to 25 min), Noise	Very low	Absolute absence
Contraindications	Pregnancy	Electronic devices in the body,presence of metal objects	Burns, frostbite	Absent
Simultaneous examination of all organs and systems	Impossible		Possible	
Determination of tissues and body reactivity	Impossible		Possible	
Determination of inflammatory process area	Impossible	Possible		
Opportunity to survey the skin	Impossible			Possible

(by L.G Rosenfeld et al, 2006)

Thus, the thermal imaging method for the diagnosis of pathological processes is inexpensive, non-invasive, high-informative and totally harmless. In most cases it is used for primary diagnosis and its results complement other techniques data.

However, in recent years the introduction of infrared remote thermo diagnostics method is mainly limited by lack of modern equipment. There are four generations of thermal imagers.

The first generation of thermal imaging systems, which appeared in the 60s of the twentieth century, was created on the basis of optical-mechanical scanning systems with a single-element photodetector.

In thermography of the second generation, for work in the range of 8-12 microns, the scanning with a certain number of photo detectors is most commonly used.

In thermal imaging systems of the third-generation multi-element photo detector arrays in the mode of "instant view" are used: thermal image is created by projecting the image of the survey area on the matrix photo detector followed by an electronic information readout and presentation of thermogram on the personal computer screen. In general, in modern thermography, the number of elements, which are in the matrix, represents the image quality and makes 65000-70000.

In thermal imaging systems of the fourth-generation multi-element matrix uncooled microbolometer detectors are used. On the whole, in modern thermography the number of elements that are in the matrix presents the quality of the image and makes 65000-70000 (for refrigerated matrix photo detectors) and 100000 – 500000 (for uncooled microbolometer matrices).

At the end of the twentieth century in Ukraine together with Russia, a prototype model of third generation thermograph was created. It is a modern, high-performance diagnostic apparatus.

However, when used in practice several shortcomings were identified. Most importantly, for its work cooling factor (liquid nitrogen) is needed. The resolving power and photodetector chromaticity can be increased, and be more sensitive. Therefore, in recent years the Physical-Technical Institute of Low Temperatures of the NAS of Ukraine (Kharkiv), a new series of thermographs (more than 10 different models) enabling to solve many tasks of thermal diagnostics was created. They have been tested in studies of patients' skin thermotopography in Medial Radiology Institute named after S.P.Grigoriev NAMSU(Kharkov, Ukraine), Hospitals of Chicago University (USA), Kharkiv Regional Clinical Oncology Center (Kharkiv, Ukraine), ENT clinics of Kharkiv National Medical University (Ukraine). The study involved more than 100 patients with cancer and inflammatory diseases of ENT organs. On the slide the interface of the main page of the matrix thermograph is shown.

Feature of the matrix thermograph created in PTILT NASU, is a high temperature sensitivity of up to± 0,6ºC., and, most importantly, the measurement was carried out at room temperature without the use of liquid nitrogen. The survey was carried out in the office with the terms of microclimate, relevant to requirements of accurate clinical thermodiagnostics. Patients were examined in the frontal, sagittal and oblique projections. In each projection there were made several thermograms to improve accuracy and minimize random error.

Designed thermograph was used in two main ways: to diagnose the disease and to monitor the effectiveness of disease treatment.

The examination found that the normal temperature distribution on the human body surface is symmetrical, the difference in the rate is not more than 0.2 – 0.4°C. Therefore, the main method of disease diagnostics is to reveal violations of thermal symmetry.

A survey of ENT cancer patients found that any malignant tumor in each projection is identified as hyperthermic structure with gradient "tumor-surrounding tissue" from 0.5 to 7°C. Gradient does not depend on the histological structure of tumors, but is determined by the depth of the tumor focus, vascularization of the tumor and surrounding tissue, thickness of subcutaneous cellular tissue. Thermographic image of the tumor, as a rule, exceeds the visually determined during operation (or CT, MRI) boundaries of the neoplasm. This led to the introduction of the concept of "tumor field" – the area between the perimeter of an infrared and visual image of the tumor. There is a test, which enables to differentiate between benign and malignant tumors. For malignant neoplasms it is characteristic a higher skin temperature above the tumor 30-40 min after intravenous injection of 20 ml of 40% glucose solution up to 0.8-2°C.

Diagnosis of inflammatory processes of ENT organs using thermography is also a sensitive diagnostic test. It is very important that thermoassimmetry in symmetric parts can be fixed almost immediately with the appearance of clinical symptoms. At the same time we get infrared image, which reflects not only thermoimage of "problem area", but also a quantitative temperature curve of each individual point. Points, from which we want to get thermoinformation, can be folded in a variety of configurations (curves, straight lines, oblique lines).

This objective information can be displayed in the form of graphs. And the comparison of the graphs on the symmetric parts of the body skin will speak about the presence or absence of inflammation.

Another direction of enhancing the implementation of thermodiagnostics into practicalcare health care is a statement of the effectiveness of treatment (conservative or surgical) and, accordingly, the dynamics of the clinical picture of the disease. It is primarily thermoassimetry of respective zones and values of these areas. The second, and more important is the dynamics of the temperature at similar points, time recorded during treatment.

Based on this information it is possible to get a large and specific amount of information that will answer the main question: adequacy of the conducted treatment.

In general, it should be noted that infrared thermography is a new old diagnostic method that has a great future and can be applied successfully in practical health care.

Perspective unsolved issues need to include the following problems:

1 To improve, certify and replicate cheap thermographs of Ukrainian production.
2 To develop and improve methods of processing thermal images and the construction of mathematical models to determine the temperatures of different bodies at different depths.

ВОЗМОЖНОСТИ ПРЕМЕНИЯ ИНФРАКРАСНОЙ ТЕРМОГРАФИИ В ДИАГНОСТИКЕ И ОЦЕНКЕ ЭФФЕКТИВНОСТИ ЛЕЧЕНИЯ ЗАБОЛЕВАНИЙ ЛОР ОРГАНОВ

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На современном уровне развития медицины проблема ранней диагностики различных патологических состояний остается актуальной задачей. Для ее решения мы используем рентгенографию, КТ, МРТ, УЗИ и многие другие методы диагностики. Тем не менее, не во всех медицинских учреждениях имеется такое оборудование. Они имеют высокую стоимость, являются не безопасными для пациентов и персонала. В связи с этим, поиск новых методов диагностики, которые были бы лишены этих недостатков, является необходимым и отвечает требованиям медицины.

Ключевые слова: инфракрасная термография, ранняя диагностика, оториноларингология