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JUSTIFICATION OF THERMOGENIC RESPONSE TO THE GROWTH OF SKIN TUMORS

Researchers: Alexander Sepper, M.D., Ph.D., Anthony Piana, D.C., FPACT

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Abstract
Screening for Skin Cancer using thermal imaging has been sought after by many thermologists. This study uncovers research performed in the former Soviet Union in the diagnosis of skin cancer. An attempt to not only screening for the existence of a skin lesion was made, but also to classify as malignant.

Conclusion
The detection of skin tumors was e" ectively identified in 98.6%of the subjects. The ability to di" erentiate malignant versus benign tumors was 86.3% The use for the identification and diagnosis of skin tumor pathology is accurate to use adjectively for general skin cancer identification.

Discussion
The day when every dermatologist has a small compact digital thermal camera should not be far o" . Since every suspect skin lesion can not be sent for biopsy, the use of thermal imaging in a clinical setting is paramount.

Clinical and experimental research in oncology and thermal imaging found that the formation of thermogenic response to growth of skin tumors is mainly due to two factors: convective heat transfer by skin blood vessels and conductivity of tissue layers. Since the layer of subcutaneous fat tissue has prominent “shielding” properties to infrared radiation, the primary role in the transfer of heat from the tumors beneath the skin has a convective transmission. In regard of thermal imaging study of superficial tumors in addition to registering thermogenic manifestations of convective reaction it is possible to analyze the “true” temperatures of tumors.

Morphological studies of skin tumors identified a number of areas differing in intensity of the microvasculature:

I - necrotic area without vascularization,
II - semi-necrotic area with few capillaries,
III - area of stable microcirculation,
IV - border zone penetrating and contacting with normal tissues, and
V - area of normal tissue.

It is clear that the character of thermogenic skin reaction will depend on the grade of microcirculatory processes. Zones of necrotic changes and poor vascularization will be presented on thermograms as hypothermic local entities which are transferred to the periphery into the isothermal background of surrounding tissues with normal microcirculation. At the same time, it should be noted that the detection of the mentioned hypothermic zones may depend on the size and extent (area) of tumors and formation of necrotic hypo-circulation processes. In cases of their non-significant grade, local hypothermia may not be detected. But the formation of the thermovisual structure of the superficially located tumors, as has been observed, also depends on their geometrical shape. In objects of hemispherical shape with a curved surface the process of thermoemission is outperforming the thermoemission of objects with a straight (flat) surface. In this regard, tumors protruding above the

surface of the skin may be presented as localized hypothermic formations. Tumors with flattened shape in absence of large necrotic areas are identified on thermograms as foci of increased thermogenic activity. In many cases, around tumors, or inside themselves the secondary inflammatory process associated with a sharp increase in the thermogenic activity of tissues may develop. In such cases the thermovisual structure of the skin has a contrast character of hypothermic local areas surrounded with hyperthermic perifocal zones of different lengths reflecting the severity of the inflammatory reaction. Often the marked hyperthermia "covers" the low thermogenic activity of tumor sites themselves. There are observations when with morphologically proven absence of inflammatory changes in neoplasms there are defined zones of enhanced thermogenic activity on thermograms and in case of malignant nature of the tumor the intensity of infrared luminescence is considerably expressed. Evidently in such cases there is a reactive increase in infrared emission of surrounding tissue intact when the temperature increases in response to atypical metabolic and circulatory processes.

Criteria for Qualitative Analysis of Thermal Information: the nature of the thermal structure is visually assessed. The presence of atypical foci of increased or decreased luminosity and perifocal thermal formations, their shape, homogeneity, dimensions and outlines are determined.

Criteria for Quantitative Analysis of Thermal Information:

1) The ratio of the perimeters of atypical thermal areas on the thermograms and tumors themselves – P1
2) The ratio of the perimeters of perifocal reactive zones on thermograms with those around the tumors in patients – P2
3) The value of temperature difference of "Local Thermal Area - Intact Tissue Zone" – T1
4) The value of temperature difference of "Perifocal Thermal Area - Intact Tissue Zone" – T2

The data of thermal analysis and thermovisual diagnostics are compared with the results of clinical and laboratory studies and in the case of surgical treatment are verified by histological analysis of the surgical specimens.

GLYCEMIC LOADING PROCEDURE

Patients are studied before and 30 minutes after intravenous administration of 20 grams of a 40 percent solution of glucose, taking into account the history of diabetes and blood glucose levels.

THERMOSEMIOLOGY OF SKIN NEOPLASMS

BENIGN TUMORS

Type	Qualitative Analysis of Thermal Information	Quantitative Analysis of Thermal Information
IA	Before glycemic load: the formation of various forms of atypical local hypothermic areas with variable size and homogeneity, quite clearly contoured on a relatively isothermal background of the surrounding tissues. After glycemic load thermal characteristics do not change.	P1 = 1 : 1 T1 = 1.0-1.5^{O}C
IB	Before glycemic load: the formation of various forms of atypical local hypothermic areas with variable size and homogeneity, surrounded with non-homogenous hyperthermic zones turning into the isothermal background of the surrounding tissues.	P1 = 1:1 P2 = 1:1 T1 = 1.0-1.5^{O}C T2 = 2.0-2.5^{O}C (if perifocal inflammation is present); +1.0-1.5 (in case of reactive hypertermia). After glycemic load the ratio of P2 can change to 1.5:1
II	Before glycemic load: the formation of homogeneous clearly contoured atypical localized areas of increase thermogenic activity that are detected on the relatively isothermal background of surrounding tissues. After glycemic load thermal characteristics do not change.	P1 = 1:1 T1 = +0.5-1.0^{O}C

MALIGNANT TUMORS

Type	Qualitative Analysis of Thermal Information	Quantitative Analysis of Thermal Information
IA	Before glycemic load: the formation of non-homogeneous clearly contoured atypical localized areas of increased thermogenic activity that are detected on the relatively isothermal background of surrounding tissues.	P1 = 1.5 : 1 T1 = +1.3-1.6^{O}C After glycemic load the ratio of P2 can increase to 2:1; T1 to +1.5-2.0^{o}C
IB	Before glycemic load: marked hyperthermic local areas are surrounded with perifocal zones of enhanced infrared emission	P1 = 1.5:1 P2 = 2:1 T1 = 1.0-1.5^{O}C T2 = +2.5-3.0^{O}C After glycemic load the ratio of P2 can change to 2.5:1, T1 to +1.5-2.0^{O}C, T2 to +2.9-3.3^{O}C
II	Formation of atypical areas of irregular non-homogeneous decrease of thermogenic activity surrounded by perifocal zones of hyperthermia	P1 = 1:1 P2 = 1.5:1 T2 = +2.5-3.0^{O}C After glycemic load the ratio of P2 can change to 5.5:1, T2 to ++3.2-3.5^{O}C
PS	In addition to these types it is possible to obtain characteristic for melanoma thermostructure - the presence of atypical hyperthermic area and the formation of hyperthermic perifocal zone in the form of a “flame” with the top forwarded to the proximal direction of the limb	P1 = 1.5 : 1 P2 = 2.5:1 T1 = +3.5-5.0^{O}C T2 = +2.5-3.0^{O}C Test of glycemic load usually increases these numbers

DISCUSSION

The shown above figures are based on an analysis of 376 thermograms of patients with benign and malignant tumors of the skin. According to our data the efficiency of the method of thermal imaging in the detection of skin tumors was 98.6% and in the differential diagnosis of benign and malignant nature of the disease in 86.3%. The erroneous conclusions of the differential diagnosis are accounted for false-positive results. This is primarily due to the similarity of qualitative indicators of thermographic types of benign and malignant forms of skin tumors. In this regard, for the implementation of thermal differential diagnosis, we have to first be guided by quantitative criteria of thermoinformation analysis. In addition, it is important to use the application of active thermography techniques with the test the glycemic load.

The formulation of thermal imaging diagnosis requires comparison of the infrared data with the results of clinical and laboratory observations.