GIORNATE ROMANE DI TERMOGRAFIA

An international meeting, devoted to thermography and called « Giornate Romane di Termografia » was held in Rome, from December 2nd - 3rd, 1977.

The meeting was organized by G. GUALDI, Radiology Professor at the University of Rome, and also by A. ASCARELLI, L. LALLANI, M. GUALDI and F. TAORMINA.

Many people, from the whole of Italy, took part in the assembly attracted above all by the interdisciplinary character of the various themes treated.

The present indications of thermography in breast, osteo-articular and head and neck pathology were dealt with.

Chairmen of the meeting were: G. MARCOZZI (Rome); G. CARDINALI (Ancona); D. GIGANTE (Rome).

« Acta-Thermographica » has pleasure in publishing the summaries of the papers presented at « Giornáte Romane di Termografia ».

A - Thermography in breast diseases

M. GAUTHERIE (Strasbourg), A. ASCARELLI (Rome)

Technical and semeiological notes on breast thermography and thermographic prognoses of mammary carcinoma

The task of thermography which, within the framework of breast pathology, can study the thermal cutaneous distribution and its qualitative and Quantitative variations was discussed. The correct technique in executing a thermograph was briefly described and then the types of standardised vascularization were detailed. Elementary thermographical signs were discussed in order to connect them to the thermographic classification. Dr. Gauthere then went on to illustrate the concept of pre-therapeutic prognoses which should condition, after fixing the thermographic classification, the choice of treatment capable of giving the maximum chances of survival to the patient. Thermography, with its classification, provides an indirect evaluation of the rate of growth of the neoplasm. This affirmation is supported, as has emerged from the considerable literature on the subject, by three parameters. These are the specific heat of the cancerous tissue and the doubling time of the tumour, connected to the metabolic heat potential. On the basis of these a prognostic classification, Q, can be established with the five thermological divisions (QO to Q4). Also the correlations between clinical classification, thermographic classification, and diagnostic classifi. cation were related. Furthermore, the subject of surveillance of the neoplasm after radiation treatment was dealt with, as was the possible role of thermography in complete sterilizations of neoplasma, in relapses, and in unsuccessful sterilizations.

A. RACANELLI (Bari)

Contact thermographic semeiology of the breast

According to the speaker the vascularization of the breast represented in T.C. can be classified in the following manner: 1. External pedunculus; formed by branches of the external mammary artery and of the lower scapular artery. 2. Internal pedunculus; formed by branches of the internal mammary artery. 3. Median pedunculus; formed by the internal branch of the acromio-thoracic artery. Furthermore, there are two physiological anastomoses to be considered: a) the «upper communicant » between the external breast and the internal breast: b) « the ueriareolar circulation », evaluated more easily - during pregnancy and lactation. The normal thermographic map reveals: a) constant elements; b) variable elements according to age and genital function. A) The constant elements are, the confines of the breast and the nipple. The confines - information from the area of appendage of the breast to the thoracic wall is thermographically represented by a blue-violet colour. The nipple remains cold and appears as a black or slightly brown hole. B) The variable elements are, mammary vascularization and glandular perenchyma. Mammary vascularization is represented by vascular pedunculi; it appears as a mesh network of threads with sharp, linear images of green-blue-violet colour. The glandular aerenchvma is dark brown-green in colour according to the thickness and heat of the fundus. The linear image of vascularization becomes almost a caricature in the premenstrual period, pregnancy, lactation, and during hormone treatment.

P. FRIEDLI (Zurich)

Evaluation of high-resolution thermograms by on-line digital mapping and colour coding

The speaker described a computer assisted system which has been developed to achieve a more objective diagnostic interoretation of thermograms: With this system, temperature, instead of being displayed on the basis of a grey scale whose differences in tone are difficult to read, is given decisive quantitative indices. The infra-red signal from a thermograph is digitized on-line and stored in a computer disk. Simultaneously the image data is processed digitally and transferred into a 64-k x 16-bit Mos colour display unit memory. The thermogram is displayed on a colour monitor on the basis of a 512 x 512 or 256 x 512 and 15 colours; each colour represents a previously fixed temperature. The computer can identify in 2.5 secs. certain pathologic indications in the-temperature pattern. They are then shown graphically and by quantitative indices. 7 thermograms may be recorded on a disk and the digitized thermograms are transferred to a magnetic tape to that the images can be referred to at any time. This method-simplifies the objective identification of a suspicious breast thermogram, for example, and the advantage of being able to store the image allows for a comparison of images in surveillance examinations.

R. **AMALRIC** (Marseilles)

Telethermography and breast cancer: indi, cations and limitations

The speaker referred to a clinical, thermographic and mammographic study of 2226 breast carcinomas. The thermograms from this study were divided into five categories of progressive significance: new information was gained on two types of suspected vascularization (Th 3) whose thermal gradient was 2.5 °C., and on two aspects of vascular disorder (Th 4) whose thermal gradient was 3°C. The percentage of indubitablv positive thermograms (Th4 and-Th5) was 70%; that of suspect images (Th 3), 20%; and that of false negatives (Th 1 and Th 2), only 9%. These percentages vary considerably in relation to the clinical local dimensions of the tumour and false negatives can appear in 30% of tumours of small dimensions. However. the radio clinical dimensions show that, in these same types, the possibility of error is much higher; if considered se-, parately, it is 40% in clinical tests and 25% in mammographic tests. Under these circumstances, only a combined diagnosis (clinical, thermographic, radiographic and cytological) is capable of providing a sufficientlv sure diagnosis. Using the combined method the possibilites of diagnostic errors are considerablv reduced. Also. the false positives of infra-red "thermography do not rise above 10% thus rendering valid this method in the diagnosis of breast tumours.

L. MARIEL (Paris)

Contact thermography: indications and limits in the diagnosis of breast cancers

The speaker reminded the audience that contact thermography, uses the fact that ester crystals of the cholesterol change colour with the temperature. They form a thermal image of the breast. Thanks to cooling off tests only the vessels of high caloric strength will be selected. Cancers with weak thermogenesis have little or no thermal translation, and this would explain the negative results: 20% in Tl and 15% in T2. Cancers of high thermogenesis should have a wealth of thermal signs indicating the PEV. All intermediate temperatures exist between these two extremes. Thus, to the diagnostic value of contact thermography is added a prognostic value. Dr. Marie1 concluded that thermographv is the indispensable complement to mammography in correcting the margin of error in this method.

A. **ROMANINI** (Rome)

Thermography as a method of evaluating the efficacy of oncological therapy

The speaker examined the strategy to be followed in evaluating the condition of patients with malign tumours and in cases where there is a high risk of the tumour spreading. After having valued the biological activity of the tumour, with the aid of tests involving a dosage of alfafetoprotein and CEA, he found that the role of thermography is to indicate the metabolic and mitotic activity correlated to the evolution. On the one hand, thermographic information enables an early diagnosis of cutaneous and osseous metastases during staging, and on the other, it permits an instrumental verification of a suspected lesion observed in the course of follow-up. THV monitoring carried out in conditions that may be replated, and with the use of a specimen sample. can indicate to what extent recurring lesions 'are sensitive to chemical and endocrine-therapeutical study. The speaker concluded by recalling that telethermography is on a level with other radiographic and scintigraphic methods in defining where, and to what size area, radiation treatment must be applied.

R. AMALRIC (Marseilles)

Thermographic policy in breast cancer

The speaker reported that it is necessary to select those parameters which are measurable

objectively in order to define the value of dynamic telethermography (DTT) of breast disorders. Dr. Amalric went on to say that in the first analytical phase four points must be taken into consideration: vascularization, the gradient of the local thermal increase (hot spot), the temperature of the breast as a whole (full hvnerthermia). and. finally, the more or less regular aspect 'of the thermal margins of the breast (edge sign). On the basis of irregularities in these parameters four signs justifying suspicion and four criteria indicating malignancy can be ascertained. The four suspicious signs are: asymmetrical hypervascularization, a hot spot higher in temperature than 2.5 "C., a hyperthermia of whole breast of 2°C., and the alteration of the thermal outlines of the. breast. However, the criteria indicating malignancy consist of anarchic vascularisation, -a hot-spot higher than 3°C., a whole breast hvnerthermia higher than 2°C., and a diffused alteration in the thermal outlines. The speaker thus concluded that the classification of breast thermograms may be expressed in 5 groups: Group I: Normal thermograms (Th 1). Group 2: Thermograms of benign types (Th2). Group 3: Suspect thermograms (Th3). Group 4: Thermograms with a criterion of malignancy (Th4). Group 5: Thermograms with more criteria of malignancy (Th 5).

C. **VALDAGNI** (Trento)

The case-finding of mammary carcinoma

The speaker began by referring to the fact that a large number of foreign authors, with the exception of the French, attribute a secondary role to thermography in the early diagnosis of breast carcinoma; in fact, the Americans consider mammography the most important test in the diagnosis of breast tumours. Dr. Valdagni, considers that thermography ought to be included, not only amongst normal exams carried out in the staging of breast cancer (clinical tests, mammography and eventual biopsy), but also as a method of control of high-risk patients in the tumor centres. The sneaker then specified that he was referring to women with positive case histories in their families, to those who have alreadv been operated on for breast cancer, or to those afflicted, in whatever manner, by benign neoplasms, the most important of these being fibrocystic mastopathy. The advantage of this diagnostic test is the low cost of the procedure, the small amount of time involved in carrying out the test, the fact that the test can be reneated at short intervals, the good diagnostic results which have been statistically confirmed, and finally, a not irrelevant detail, the success with which this method has been met by the female public.

B - Thermography in head and neck diseases

V. **SBARBARO** (Verona)

Telethermography in cerebra-vascular insufficiency

The sneaker maintained that the value of thermography in the diagnosis of cerebra-vascular insufficiency is considerable; this method can be used as a screening test prior to angiography. In stenoses or carotid occlusions with compensatory circulation between the branches of the external carotid and those of the inner carotid, thermography can provide three suggestive pathognomanic signs: the presence of an internal, superorbital cool triangle: an upper external frontal hyperthermia through the overloading of the frontal compensatory artery; and, sometimes, a hypothermia at the internal corner of the orbit. In concluding, Dr. Sbarbaro warned that in occludent lesions of long-standing, in stenoses of modest size, as in sub-ophthalmic lesions, thermographic tests can prove to be false. The advantages of this new non-traumatic method, which complements angiography and ultra-sonic studies, are that it is non-invasive and there is a lack of contraindications of any kind.

J. **ROBERT** (Nancy)

The value of thermography in the diagnosis of complaints of the thyroid gland

The sneaker had taken more than 1000 thermographs of subjects suspected of having a thyroid complaint. The results of these were comnared with results obtained from ultrasonic echotomography and, above all, from scintigraphy. The results obtained by the speaker were as follows: hypothyroids are not accompanied by any thermographic anomaly. Goitres with no thyroid malfunctioning are accompanied by a hyperthermic anomaly of an inconstant nature. Hyperthyroids nearly always indicate straight forward hyperthermia. In the maioritv of cases. toxic adenomas are accompanied by a "localized hyperthermia. However, the interest of thermography lies, above all, in the aid it provides in the diagnosis of cold scintigraphic nodules. Thyroid cancers provoke a localized hyperthermia in approximately one out of every two cases. Other cold nodules which correspond to cysts, benign adenomas, and thyreonodules, are accompanied by isothermia or hypothermia in approximately 80% of cases.

G. CENNAMO (Naples)

Ocular pathology

The speaker was in complete agreement that thermography represents a complementary diagnostic technique of considerable use in the study of phlogistic, endocrine and neoplastic pathology. He went on to say that benign tumours (of the eye-ball and of the orbit) and exophthalmia of endocrine type reveal themselves through thermography as cool areas. Inflammations and the maioritv of malignant tumours. or vascular malformations, show up as hot areas. The thermal gradient in these cases is higher than 2.5 "C., whilst in venous malformations and acute phlogistic processes, the hyperthermal areas of the orbit appear localized and well-defined; in malignant tumours, that is, uveal melanomas and retinoblastomas. the whole orbit is considerably hyperthermal. 'A malignant neoplasma may demonstrate hypothermic zones which correspond to areas of cystic, or plainly necrotic degeneration.

C - Thermography in osteo-articular diseases

E. F. J. RING (Bath)

Thermography in rheumatoid arthritis

The inflammatory changes in arthritic joints are well demonstrated by infra-red thermography. However, the technique is of limited value unless it can be used to monitor the disease. By standardised technique a clear distinction can be made between normal, osteoarthritic and rheumatoid arthritic peripheral joints. By adopting a fixed temperature scale and colour code, changes in heat distribution can be visually compared. A more useful technique uses the temperature distribution from a given area for a system of quantitation, called the Thermographic Index. This index is low in normal joints and raised by inflammation. For monitoring the individual response to anti-inflammatory-drugs this technique is entirelv objective. It is particularlv useful for the evaluation" of new drugs, in trials "against established preparations. Anti-rheumatic drugs with higher toxicity risks, can be monitored for their anti-inflammatory progress. By using this objective system of numbers, important observations on drug dose, and local response can be recorded. For example, there are statistical differences in the time course of response to oral non steroid anti-inflammatorv drugs: larger ioints showing a slower fall in T. index than small joints in the first weeks of treatment. Results from drug trials which include an analgesic washout period, or cross-over design, will be clearly affected by this response factor. While thermography can be described as a diagnostic aid in arthritis, its principle value lies in treatment assessment. In this respect it is the only non invasive and objective technique currently available to the rheumatologist.

B. TALIA (Modena)

Lesions of the intra-operative carpal tunnel

The intra-operative thermographic data indicates the important role of the ischemic and compressive factors in the carpal tunnel syndrome. In fact, during the investigation, it is possible to view. bv means of thermography. a segment of the median nerve which constantly and significantly hypothermal (At - 1 °C) in comparison with the proximal and distal segments which can also become noticeably hypothermal. The hypothermia corresponds to the stenosis and thickening part of the nerve, whilst the possible hyperthermic areas. both proximal and distal. are always related 'to particular topical conditions in the circulation. Sometimes one can notice the anastomic circulations between on the one hand, the superficial palmar arch and the radial artery, and on the other between the ulnar artery either alone or with the median artery. This thermographic information is of great use in deciding what surgical procedure to adopt.

E. F. J. RING (Bath)

Thermography in Paget's disease

The speaker related that Osteitis Deformans, Pa-.get's disease. is a disease of the skeletal svstem frequently overlooked. In a percentage of cases, and in certain geonrauhical locations. higher incidence of a more acurate form of the disease is reported. Bone pain and local rise in temperature are the two main symptoms. Complications may lead to fractures, and even cardiac failure. Much research interest has been shown in the treatment of these cases. One of the most successful is a relatively new drug. Thvrocalcitonin. The speaker and his department studying a group'of 20 patients in long term treatment with differing forms of this drug. They have found that the degree of involvement in the tibia makes this an ideal site for surface temperature measurements. Higher temperatures have also been recorded from the forehead, and spine, where this disease is active. They have used the Thermographic Index to quantitate disease activity, and the response to Calcitonin. It has been shown that the rapid fall in temperature on commencing treatment is associated with pain relief. Similarly, a rising Ther-

mographic. Index usually precedes clinical relapse by several weeks. Comparison of different dose regimes with porcine and salmon preparations of the drug have shown the latter to be more potent in equivalent dose. Thermography has proved of value in the fundamental problems associated with Paget's disease, aiding clinical assessment in the control of calcitonin therapy.

L. ACCIARRI (Verona)

Thermography in the atrophy of Sudeck-Léricheof the hand

Because of its anatomy, the hand is particularly suitable for thermographic examination. Thermographic patterns may be modified by alterations of vascular, nervous or osteo-articular origin. Amongst these latter Dr. Acciarri examined Sudeck atrophy concluding that in connection with thermographic pattern (hyperthermia or hypothermia), the patients who respond to calcitonine treatment can be recognised from the start. In fact in the majority of Sudeck (75%) thermography shows a diffused hyperthermia of the hand. In 81% of these cases treatment with calcitonine leads to a clinical cure and to the normalisation of the thermographic pattern. In the remaining cases the thermographic pattern is characterised by hypothermia of the hjured hand. None of these cases, listed by Dr. Acciarri, responded to calcitonine treatment. The speaker concluded with a number of pathogenic considerations on Sudeck disease.

D - Thermography in skin diseases

M. CRISTOFOLINI (Trento)

The biological problem of the melanoma

According to the speaker thermography daily assumes a more determinative role in differentiating melanomas from nevi and other neoplasmas. including seborrhoeic verrucas. fibroma cutis; basocellular epithelioimas, and angiocheratomies. Dr. Cristofolini related that the primary malignant melanoma presents hyperthermia in the maioritv of cases (88.9%). whilst nevi eresent hypothermia mostly' (92.5%); that is, with the exception of those cases complicated by a phlogistic process of folliculose nature. Thermography proves to be most useful for the dynamic study of neoplasmas in as much as the level of local infiltration can be documented, as can the presence of a post-operative relapse caused bv a metastatic dispersion, even at a distance from the original centre. The speaker concluded that thermography supplies prognostic data regarding the way in which hyperthermia of the melanoma seems proportional to the degree of differentiation of the reproductive activity and the invasive capacity of the same tumorous form. The locality of the surgically removed melanoma is initially hyperthermic, but becomes, in time, hypothermic; and the persistence of a hot spot indicates a local relapse.

R. AMALRIC (Marseilles)

Thermography of the melanoma

Its completely non traumatic character has made of telethermogranhv a diagnostic method of prime importance in the diagnoses of malign melanomas which have to be kept from any kind of trauma. A thermographic test provides information. not onlv on the neowlasia but also on the adjacent area: "the tributary regions, the lymph nodes, the lymphatic system. The thermographic test consists of 3 stages. 1. A study of the primary tumour and visualization of the abnormallv hyperthermic zone, precise topographical localization, evaluation of its extension in connection with the clinically palpable lesion, a description of the surroundings of the warm zone and a reading of the thermal gradient. 2. A study of the satellite lymph nodes. 3. A study of the lymphatic system with the aim of revealing wossible metastases clinically unsuspected. The-melanomas turn out to be hyperthermic 8 times out of 10. The 20% of false-negatives always result in **the** ulcerated types. Also a metastatic adenopathy turns out to be hyperthermic in 80% of cases: the false negatives are due to the presence of a considerable fattv laver which hinders the transmission of infra-red rays towards the skin. On the other hand, benign cutaneous melanomas have a false thermal reading in only 6% of cases. More often than **not this** is caused by a super-infection with a regular peripheral aredla. Thermography provides considerable information on the extension of the tumoral lesion: often the tumour awpears very much more extensive than had been indicated bv clinical examination. It is, therefore, precious information leading to the adoption of a more suitable therapeutic treatment. Thermography also offers essential information on the evolution of the neoplasia. In 10% of cases a particular thermonrawhic aspect has been noticed: a hyperthermic-renewal of the tumour, decentralized, extended towards the radix of the joint, and visualization of the lymphatic draining system. This particular aspect has been called the « thermal flame ». It is indeterminable if this image is to be attributed to inflammatory causes, lymphatic invasion or to both of these situations. However, the prognosis connected with this image

is not auspicious since all the patients in whom it was present died within the 18 months following its appearance. On the other hand, there do exist malign melanomas which are thermograprically cool but have a better prognosis. Dr. Amalric concluded his lecture by affirming that telethermography contributes in the following manner to the treatment of melanomas: it furnishes precise limits for surgical or radio therapeutical intervention, it allows the warm zone to be totally determined, the penalty for not determining the whole of the warm zone being a relapse at the edges. And, above all, it allows the post-therapeutic surveillance of the treated area, of the metastasized lymph nodes, and of the metastases distant from their place of origin.

E - Thermography in vascular and gynecological diseases

L. Acciarri (Verona)

Thermography in angiopathy of the hand from vibrating tools

The author spoke on 25 workers affected by Raynaud phenomenon caused by the use of vibrating tools, studied by Thermography and photoplethismography. In these cases the problem is to make evident the vascular lesion. These are the results: in standard conditions thermography is clearly alterated in 54% of the cases, with a great hypothermia of the hand. In the same patients photoplethismography was altered only in 24%. The results of photoplethismography can be improved with the cooling test; however this is painful for the patient. Also this cooling test, using: thermography. can be used only in the cases of normal thermopraghic pattern in basal state. The sneaker concluded bv pointing out the importance of thermographic 'data also from the forensic or insurance point of view.

L. Acciarri (Verona)

Thermography in the traumatic hand

In traumatic pathology of the hand, bound to either vascular or nervous lesions, thermographie data can be very important, above all from the prognostic point of view. In traumatic vascular lesions, thermography gives information on collateral circulation, and then on the possibility of the survival of ischemic territory; furthermore thermography can recognize the most important complications (thrombosis or cycatricial stenosis) which must be treated by surgical intervention. In traumatic nervous section, thermography gives important informations on nervous regeneration. In normal regeneration 4 characteristic phases are seen (hyperthermic phase; hypothermic phase; thermic amputation phase and stabilization phase). In abnormal regeneration thermographic evolution stops at the 2nd phase, and the thermic amputation phase is missed. Thus thermography, enables us to recognize immediately, before any other method used today, the cases which must be operated on again, reducing further complications.

L. **Acciarri** (Verona)

Thermography in the lower leg arterial diseases

The sneaker referred the results of thermograehic examinations in 80 cases of arterial occlusion: either unilateral or bilateral. After having defined the normal thermographic pattern of the lower leg the speaker dealt at length with the pathological pattern. At the level of- the thigh and the Knee (the sectors which can be most easily surgically treated). this is represented bv hvnerthermic areas which 'reflect superficial collateral circulation. The collateral circulation is easily recognizable in the unilateral occlusions. On the other hand with thermography there are difficulties in identifying bilateral occlusions. Dr. Acciarri therefore dealt with the clinical value of thermography basing his report on the thermonranhic modifications produced in patients after a-tiredness-test. The results of the tiredness-test were confirmed bv the clinical evolution of 30 patients tested "after one year. This comparative study allows us to prooose a thermonrauhic protocol for therapeutic indications: 1) Negative thermography before and after the tiredness-test. The therapeutic orientation could be medical. 2) Thermography always nositive before and after the tiredness-test. The therapeutic orientation could be surgical. 3) Positive thermography only after tiredness-test. The therapeutic orientation is more difficult. All clinical and instrumental data must be utilised.

A. **Racanelli** (Bari)

Contact thermography in physio-pathology of the placenta

The speaker, after illustrating the technique of T.C. in the obstetrico-gynaecological field, described the experiences obtained in the clinical field. Her lecture was based on the results obtained from 405 cases of normal and abnormal pregnancies, between the 24th and 42nd weeks of gestation, which were subjected to investigation by T.C. In the majority of cases the thermographic surveys were carried out in «normal » conditions or in « vasculodynamic « conditions after a ra-

pid intravenous administration of ß mimetic. (I mg. of chlorhydric Rithodrine). Dr. Racanelli found that T.C. proved itself a valid technique by: 1. Localizing the zone of appendage of the placenta. It was, thus, possible to a) make a differential diagnosis between the previa placenta and the unexpected abruptio placentae; b) to carry out amniocentesis without risks. 2. Evaluating the function of the spaces between the villi bv means of a dynamic test, with ß mimetic, in case's of materno-fetal suffering (pregnancy toxaemia. diabetes, hypertension, Rh isoimmunization). 3. Watching the haematic hypoperfusion of the placenta in labour during childbirth.

F - Thermography in ecology

G. M. LECHI (Milan)

Thermal infra-red in remote sensing techniques in enviromental quality control

The use of thermal infra-red and its capabilities and limitations in environment aualitv control was described by the speaker. He went on to show that infra-red thermal surveys are valid in hydrology, agriculture and forestry, geology and soil surface control. Because it is a remote sensing technique it cannot be fully understood without an in-depth knowledge of the laws of electromagnetic radiant energy. On thermographs of surfaces the variations in the grey or coloured tones is not an indication of different temperatures, but a measure of the radiant power. Usually thermographs are obtained from scanning used either slowly or fast, according to whether they are to give an actual time image or not. The thermographs consist of an ordered group of scan lines which are generated by the electric signals transmitted from the detector. These signals allow a thermal image of the surface of the object to be viewed on a monitor. Examples were" provided of the technique when used to follow the thermal behaviour of the crater of Vulcano and the area adjacent to it; on to calculate the amount of fresh water coming into the sea from a freshwater spring upwelling in the sea near Cefalu, **Sicily**: or to calculate-to what extent some rice fields were affected by a disease. In the latter case, the diseased area had a different temperature from the healthy area and this was translated into different colours on the thermogram. An infra-red thermal survey was also carried out to study the discharge and currents in the Venetian lagoon.

LITERATURE IN THERMOGRAPHY

by M. GAUTHERIE

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