# THE VINCENZO MUTO MEMORIAL FIRST NATIONAL CONGRESS OF THE ITALIAN SOCIETY OF THERMOGRAPHY

From the 18th to the 19th of May, 1976, the First National Congress of Italian Society of Thermography was held in Trieste, at the Adriatico Hotel, on the beautiful gulf at Grignano beach. President of the Congress was doctor L. Fogher, Head of the Tumour Center of Trieste. Doctor Fogher's perfect organization with the help of english and french thermographers, assured good working conditions for the 200 Congress members (most italian radiologists and oncologists). So Acta Thermographica believes advisable to publish the summaries of papers presented at the Congress.


Dr. FOGHER introduces the Congress at the Opening Cerimony.

VINCENZO MUTO, M.D.
1919-1976

Suddenly, before the Congress, a great loss struck the Italian Society of Thermography: one of the promoters of the Society, doctor Vincenzo Muto, died in his native town, Naples. Doctor V. Muto was Head of the Radiological Department of the National Institute for Cancer Diseases in Naples and he was interested particularly in thermography. The members of the Italian Society of Thermography were very grieved at the death, not only of an influential expert, but of a very humane friend. The Management Committee decided to honour Doctor Vincenzo Muto dedicating to his memory the 1" National Congress of the Italian Society of Thermography.

J. M. SPITALIER **and** R. AMALRIC (Cancer Institute, Marseilles, France)

## Thermography and strategy in oncology

Dynamic Tele-Thermography (DTT) represents the most recent advance, currently at our disposal, in the field of medical thermography. At its name indicate:

- it is a *non invasive method* of investigation picking up at a distance electromagnetic infra red emission from the tegument;
- it makes use of *high speed cameras* with quantic detector translating the infra red emission into black and white and color immages, in an instant manner, which may guide other investigative procedures.

A thtrmographic pioneer, R.N. Lawson (Montreal), demonstrated that the *breast carcinoma is a heat producing neoplasm,* and did so by means of intra tumoral temparature measurements (average 36.5" Celsius, arterial blood 34.3, venous blood 35.4). Ch. Gros (Strasbourg) had measured breast cancer thermogenesis and found a range of values between 0.015 and 0.075 Watt/cm$^3$. The rate of cancer growth is directly proportional to this thermogenesis. *Blood warms up at the tumor site.* A continuous thermal exange chain must be present between tumor and camera (Table I), which implies that:

- the tumor emits a thermal message,
- the thermal message is transmitted towards the tegument (reasonable depth of tumor, conducting intermediate tissues without excess of fat, veins draining towards superficial planes),
- the thermal message is reemitted outwards by the tegument in the form of infra red radiation (ulceration, crusts, phaneres, sudation may considerably decrease skin surface emissivity),
- the thermal message is picked up by the high speed camera which processes it and converts it into a visual image through controlled manipulations of position, sensitivity, definition, speed and isotherms.

Tab. I. **Cutaneous thermographic manifestations of tumours * .**

| | *Gradient* | *Surface* |
|---|---|---|
| Depth | ↘ | |
| Volume | = | ↗ |

* According to G. F.,Pistolesi and Al., the gradient of thermogenic subcutaneous tumour is: conversly proportional to its depth and directly proportional to its volume.

Objective parameters for the interpretation of thermograms include: pattern of cutaneous vascularisation, presence or absence of hot spots, circunscribed or diffuse pattern of hyperthermia, distorsions of the thermal profile of the organ under examination. Abnormalities suggesting breast neoplasm are listed in Table II.

Tab. II. **Thermographic abnormalities types of tumours *.**

| | *Suspicious types* | *Malignant types* |
|---|---|---|
| Hypervascularization | Asymetric | Anarchic |
| Hot spot | < 2,5°C | ⩾ 2,5°C |
| Global hyperthermia | 2°C | > 2 °C |
| Profile distorsion | Limited | Extended |

* According to our analytic stage of thermograms studies.

Thermal increments of the abnormally hot areas are measured with reference to the temperature of the surrounding skin (A,), the symetric skin (A,), and/or a well known isothermal area (Ad: mid xiphoïd area, for instance.

Our initial experience of 1,000 consecutive cases of confirmed breast cancers determined our choice of 2.5°C as a significant thermal gradient (with many false positives below and many false negatives above).

We classifly thermograms in 5 categories of increasing diagnostic severity (Table III).

Equipped with such device, working on well defined parameters and strictly classified data, the

Tab. III. **Diagnostic categories of increasing severity *.**

| | |
|---|---|
| TH1 | = normal thermogram |
| TH2 | = abnormal thermogram of a benign type |
| TH3 | = doubtful or suspicious thermogram (with one sign of suspicion) |
| TIH4 | = thermogram of a malignant type (with several suspicious signs and/or one malignant sign) |
| TH5 | = thermogram of a malignant type (with several malignant signs) |

* According to our synthetic stage of thermograms studies.

oncologist has a new way to approach diagnosis, prognosis, and treatment of breast cancer.

## A) DIAGNOSIS OF CLINICAL AND OCCULT NEOPLASMS

1) **Screening of breast cancer.** DTT has been used for mass screening for breast carcinoma - D. Melander (Stockholm): L. Rocchi (Cesena) -. From 1968 to 1972, 6 authors screened 26,653 women with a total yield of 186 carcinomas, i.e. 7‰; 27% of which at a preclinical stage. DTT is a very fast method in mass screening - W. B. Hobbins (Wisconsin) -. By similar means, Ph. Strax's yield in New York is 14‰.

Added to other diagnostic methods, DTT narrows the gap between diagnostic and treatment of breast cancer; it has significantly improved, we think the quality and utility of diagnosis in the patients who have come to us sometimes for' simple breast pains.

Out of 1,878 first breast cancers seen with DTT between June 1970 and December 1975, thermography detected 19 non palpable neoplasms (1%) and 169 neoplasms with clinical and/or radiological benign appearances (9%).

We screen systematically the opposite breast following treatment of the side involved and after. In this manner, we have observed opposite side involvement in 3.5% of the cases 10% of which occult) at the time of the primary treatment and in 6,5% of the cases (15% of which occult) in the 3 years following treatment.

These data demonstrate the role of DTT in detecting occult lesions of the other breast. In such cases DTT gives direction for further classical investigations.

**2) Early diagnosis of other malignancies.** a) *Small size breast cancer:* out of 1,165 breast carcinoms 5 cm or less in diameter (Tl and T2 categories in UICC classification) 148 had normal or benign type thermograms, amounting 13% falses negatives. DTT fails to pick up l/3 of carcinomas measuring less than 2 cm in diameter, indicating the necessity of a combined approach (P.E., radiography, needle biopsy,. . .) for the identification of small breast cancer.

b) *Malignant melanomas of the skin and eye:* angiomas and malignant melanomas are the most heat producing tumors of the skin, with 8/10 positives on a series of 77 cases of primary malignant melanomas. When the diagnosis of a skin naevus is questionable, DTT may enlighten the physician as to the real nature of the lesion and appropriate therapeutic approach.

*c) Uterine cervix carcinomas and dysplasias:* DTT on mucosae surfaces shows that even small cervical carcinoma produce heat: 2 carcinomas in situ were in that way. The severity of dysplasias seems to correlate with their thermal emission in a series of 90 cases. DTT seems to have a place in the combined approach and follow up of epithelial lesions of the uterine cervix in high risk women.

d) *Primary malignant tumors of bone and soft tissues:* where good thermal connections exist between skin and bone, DTT can be used to detect primary malignant bone tumors. It offers practical advantages in children and can be easely repeated. In cases of bone pains, without X ray evidence of tumor, DTT may provide a convenient way to watch a lesion and guide further appropriate studies.

## B) STAGING

Here again the use of DTT in breast cancer can be extended to other types of tumors.

1) **Local extension.** Most of the time, thermal disease extends beyond the clinically and radiologically evident disease. DTT may draw the physicians's attention to some peripheral parts of the main lesions where he will palpate subcutaneous invasion. The surgeon will also look for secondary disease suggested by DTT in the operative specimens, as we have seen in breast carcinomas, malignant melanomas and sarcomas.

**2) Multifocal disease.** 40% of adenocarcinomas of the breast present with several hot spots on thermograms, and there are similar findings in primary tumors of bone, soft tissues, thyroid.

3) **Nodal involvement.** Fat surrounding regional lymph nodes interfers with thermography, with great value of positive images. DTT is moderated helpful in axillary and neck lesions, but will indicate distant cutaneous lymphatic permeations, such as in transit metastases of malignant melanomas of the limbs, some of which are palpable and some not.

**4) Bilaterality.** Apparently unilateral involvement of paired organs requires full examination of the controlateral organ, at high risk demonstrat-

ed by the cancerization of the first side. In patients with breast cancer we know the radiological, thermal and clinical birth date of the controlateral lesion, with an average 18 months lay between radio-thermal and clinical abnormalities.

**5) Distant metastases.** Skin, subcutaneous metastases as well as deeply seated ones, when their thermal message is able to reach the skin surface, can be located by **DTT.** In spite of its depth, vertebral body involvement is demonstrable, mainly through the spinous processes adjacent to skin surface, live bone being a good thermal conductor. We suggest that *initial examination and follow up* include *rachis and total body thermography.*

**DTT** has a role in the diagnosis and staging of many neoplasia despite 5 to 30% of false negatives and 10 to 20% of false positives, because it brings up original data. However it must be used concomitantly with other classical investigating methods.

## C) ASSESSMENT OF BIOLOGICAL BEHAVIOUR OF CANCER

*The severity of a cancer is related to its rate of growth more than its size at the time of diagnosis and treatment.* An old large slow growing tumor is by far less threatening than a recently appeared fast growing smaller one. Assuming that heat production of a neoplasm parallels its growth rate, one may use **DTT** as a *speed tele measure for some cancers,* and as a prognosis parameter.

**1) Fast growing breast cancers. 10 to 20% show** indication of rapid growth such as oedema, inflammation of skin or evident acute carcinomatous mastitis. They show typical thermograms with gradients higher than average and abnormaly extended thermal disease. Sometimes DTT solitarely gives the alarm.

Table IV represents 4 thermovisual patterns of breast cancers evolutive phases. The cases have a significantly worse prognosis. In our current study the ratio of *failure in the 3 years following curative treatments for operable breast carcinomas* correlates with the gradients:

for $\Delta \geq 4°C$ : 19/25 = 76%
for $\Delta \leq 2°C$ : 4/20 = 20%
(with p=0.001)

**2) Slow growing breast cancers.** DTT false negative confirmed breast cancer relates to deep location, small volume, over lying fat, non emissive over lying skin, or (as in 5% of our 1,878 cases) decreasde thermogenesis with slow rate of growth. Longer follow up will inform us on the signification of such findings. None of them have show lethal generalization after up to 6 years of observation.

**3) Scirrhous forms with late acceleration. l/3 of** reputedly slow growing scirrhous breast cancers is in evolutive phase by DDT. Patients often become after a change in the behaviour of their up to then resting disease and present with hotter thermograms. Those thermographic flare up may account for the disappointing treatment of some of those scirrhous, the easy going reputation of which should be reconsidered. Here again, DTT is useful in revealing a change in the biological behaviour of **some** neoplasms.

**4) Malignant melanomas of the skin.** Two patterns of DTT can be encountered: well circumscribed hot spot, corresponding to palpable tumor, on one hand; on the other, hot areas extending proximally beyond the clinical disease, creating a centripetal lengthened ellipse, the « *flame sign »:* these are regulfarly associated with 100% mortality within 1 year.

Prognosis cancer may be made easier by DTT: higher thermal rise, extends of thermal abnormality beyond clinically recognizable disease, centripetal flame, all of those suggest a guarded prognosis. In a more theorical field, insights into the biological energy of cancers.

## D) THERAPEUTIC DEDUCTIONS

DTT may help the physician to decide upon the appropriate therapeutic modalities and to assess their results.

**1) Choice of therapeutic modalities.** Radiotherapy and surgery depend much, in their practical realisation, upon the traditions of each oncological school. However thermograms should be taken into account in defining fields of irradiation and areas to be resected.

We have chosen to do so, aware of the insuffi ciencies of thermography used alone, but believing that it points out to significant pathologic

Tab. **IV. Categories of growth rate of breast cancers ***

| | |
|---|---|
| PEV 0 = gradient 5°C<br>PEV 1 = gradient 5°C | + hot area $\leq$ 2 quadrants |
| PEV 2 = gradient 4°C | + 2 quadrants < hot area < 4 quadrants |
| PEV 3 = gradient 3°C | +hot area $\geq$ 4 quadrants |

*** According to our thermo-clinical studies. PEV 0: possible slow** growing cancer. PEV 1, 2 and 3: fast growing cancers.

changes. *We draw the +2°C isotherm under thermoscopy* where it exists on the tegument overlying breast cancer, malignancies of skin, soft tissues, bone, nodes. This area is included in the irradiation and resection fields and is often added in the classical planings.

The results of this *thermovisual definition of targets* will be analized in due course, but we already believe in a lower rate of local recurrence following radiotherapy, more specifically with electron beam, when this approach is used.

It also helps the surgeon resecting areas of secondary X rays injuries and plays a role in reconstructive surgery by marking out vascular pedicules, in drawing and transplanting flaps, in following up grafts.

2) Choice of therapeutic strategy. Radiotherapy, resections, lymphadenectomy require technical perfection for success. Success also demands a proper chronology of the modalities used for treatment. DTT may help to choosing the modality of primary treatment: a large cold cancer may be operated initially, a smaller hot ont may do better following primary radiotherapy. In fact we sug gest that chemotherapy and/or radiotherapy be used whenever clinical or thermal evidence of rapid growth exists.

3) **Follow** up. Following curative treatment, DTT may be performed at regular intervals for detecting recurrence and metastatic disease as well as new neoplasms.

Following curative radiotherapy with conservative aims of operable breast cancers, DTT shows a thermal tide withdrawing slowly (18 months and over), with 70% cooled down at 3 years. Failure correlates with persistance of the abnormal patterns or flare up after improvment. Radiotherapic breast presents with a moderatly and persistantly stable abnormal medium patterns.

DTT will also help in assessoring the effects of chemotherapeutic and endocrine management of cancers, providing objective data of response.

*

We shall admit in conclusion to the failure of thermography to detect deep seated malignancies (such as respiratory and digestive tracts). We remain however convinced of its indication in the diagnosis, prognosis, therapuetic management and follow up of many cancers.

We are particularly conscious of the value of DTT in basic research on the behaviour of malignant neoplasms, with original data at clinician disposal. *It seems to us that the concept* of *energy production by cancers brings in a new dimension to the whole conception of malignant disease.*

## 1st Round Table: *Thermography in extra-mammary tumours*

Moderator: A. Toti (Ferrara, Italy)

### INTRODUCTION

The thrust of this Round Table was to discuss the value and limitations of thermography in extra-mammary tumours. Specialists in various fields presented not only their own work but that of other colleagues in Italy. The following sectors were represented: thyroid, bone, orbit, lymph nodes, skin and salivary glands thermography. At this time, there are a great number of dispersed thermography case studies which need not only be interpreted, but organized into an easily understood, reliable diagnostic discipline. There is no doubt that thermography is an extremely objective, instrumental diagnostic procedure, but there is still space for technical improvements, and with these advances we should realize our goal.

A. Ghisolfi (Pavia, Italy)

### The thermographic investigation of vascular, inflammatory, and neoplastic lesions of the orbit

In our Ophtalmic Clinic we have made use of telethermovision for more than 2 years and have performed more than one thousand examinations on patients complaining of ophtalmologic disturbances. It is the specific purpose of this report to give our results obtained in the orbital pathology of inflammatory, pseudo-inflammatory, vascular and neoplastic nature. Examining the characteristics of the normal orbit, it is useful to recall that hyperthermia is always accentuated medially and in the upper-internal angle either due to the course of the angular vessels or because these are the

deepest zones and therefore much less ventilated. Hyperthermic areas are also individualized in the most external side of the orbit, the superciliary region, the superior and inferior orbit, and the nasion. The thermogram of the face may be modified by all of the various pathologies of the orbit since its contents, being external with respect to the osseous structures, radiates its thermic activity towards the cutaneous area, and so it is possible to make an evaluation that is impossible for the other endocranial structures. From a thermographic point of view, we classify the exophthalmias as follows: a) *Accentuated kypertkermia* (the rise in temperature must always exceed 4°C): we include in this group exophthalmias which are secondary to inflammatory processes, tumours and vascular anomalies and malignant richly vascularized neoplasms. b) *Hypertkermia* (the rise in temperature varies from 2 to 4°C): we consider in this group those which are secondary to inflammatory pseudo-tumours or modestly vascularized neoplasms. *c) Hypothermia* in which we include the exophthalmias secondary to endocrinopathies, benign tumours such as lipoma, osteoma, neurofibroma, dermoid cysts. Considering our study, we believe we have good reason to state that thermography is a very effective help in the diagnostic research of diseases of the orbit being a very inoffensive and easy examination. Thermography should be performed before the traditional tests such as carotidography, orbital phlebography, scintigraphy, ecography, Emi-scanner, etc.

L. ACCIARRI (Verona, Italy)

## Thermography of parotid tumours

The thermographic pattern of the parotid region under normal conditions is characterized by temperature values that are either tendentially or decidedly hot. The hot parotid zone is delimited in front, above, and behind by the cold zones of the cheek, the ear, and the hair respectively. It continues downwards into an almost constantly hot band that corresponds to the external jugular vein. Normal anatomical variations of the region lead to a variety of thermographic patterns but all within rather definite limits. Numerous pathological conditions can modify the thermographic appearance of the parotid region, either by an increase or decrease in its temperature. Space occupying lesions of the parotid gland are characterized by thermograms that vary in relation to the malignancy or non-malignancy of the tumour. a) Benign space occupying lesions (cysts, lipomas, etc.), at sialography, present narrowing or displacement of ducts without structural involvement. Thermographically, when they are small they do not modify the metabolism or displace the vessels enough to modify the normal thermogram. When they are larger, however, they present a pattern of more or less marked hypothermia in relation to the extension of non functioning parenchyma. b) Mixed tumours of the parotid gland always present a pattern of slight hyperthermia, with a thermic gradient between 1 and 2°C. c) The most elevated hyperthermias, with a thermic gradient greater than 2°C in comparison with the healthy side, are seen with malignant tumours and are related to the marked metabolic and vascular disarrangement. Sialography shows the irregularity of the parotid ducts. Problems of differential diagnosis arise from inflammatory processes of the salivary glands: acute forms are always hyperthermic. Chronic forms give variable patterns usually with normal or cool temperatures. Collagen diseases in the inflammatory phase yield hot temperature patterns. In the scleroatrophic phase however they appear markedly hypothermic. Thus with space occupying lesions thermography can furnish information for differential diagnosis while sialography shows only a nonspecific empty area in the glandular parenchyma. Infact, benign forms are cold, mixed tumours are hot, and malignancies present the hotest values in the space occupying lesions. This last finding may be very useful in deciding on surgical treatment.

G. VIGANOTTI (Milan, Italy)

## Tumours of the thyroid

At this time the diagnosis of thyroid malignancy is often questionable, especially with regard to nodules with low or absent $I^{131}$ uptake (clinically doubtful). In order to establish better diagnostic criteria the National Tumour Institute of Milan, in collaboration with other institutions (Radiology Institute of the University of Ferrara) is carring out thermographic evaluation of all cool

**Tab. I. Histologically controlled cases of National Tumour Institute, Milan.**

| *Disease* | *Number of cases* |
|---|---|
| Malignant tumours. | 22 |
| Benign tumours | 105 |
| Thyroiditis | 2 |
| Hodgkin | 1 |
| T. B. | 1 |

thyroid nodules. The examinations have been performed in air-conditioned, thermostatic environments (20°C and 50% relative humidity) with the patient located at the shortest possible distance from the thermograph. Pictures were taken in black and white, and color, for the most accurate possible determination of the thermic gradient. The thermographic positivity has been evaluated at 1.5°C for the cases studied with the Aga Thermograph and 2°C for those studied with thermograph Barnes M. I. B. model. In Table I the cases subjected to thermography at N. T. I. of Milan are reported. These cases were also histologically controlled. Table II, which concerns benign forms, points out a high false positive rate. Table III (malignant tumours) demonstrates that the number of cool or hypothermic tumours is relatively low.

Hodgkin's and T. B. localization have been found to be normothermic. Thvroiditis has a thermic gradient between 1.5°C and 2°C. In three cases laterocervical metastases have resulted hyperthermic. The results of the Radiology Institute of Fcrrara University are reported in table IV.

Prom the above data we may make some considerations. Thermography presents a high rate of diagnostic accuracy in malignancy, but also a high rate of false positives. Occasionally, in our experience, it has been the only method which enable us to suspect a malignancy. If these data will be supported by wider surveys, thermography may become a popular diagnostic method in thyroid pathology; however, one to its built-in limitations, it must be associated with the clinical examination and radioisotopic techniques.

Tab. II. **Thermographic patterns in benign tumours.**

| *Tkermographic patterns* | *Number* of cases |
|---|---|
| Hypothermic | 4 (3.8%) |
| Normothermic | 25 (23.8%) |
| Hyperthermic 0.5-1.4°C | 54 (51.5%) |
| Hyperthermic 1.5-2°C | 22 (20.9%) |
| Total | 105 (100%) |

Tab. III. **Tbermographic patterns in malignant tumours.**

| *Thermographic patterns* | *Number of cases* |
|---|---|
| Normothermic | 2 (9.1%) |
| Hyperthermic 0.5-1.5°C | 2 (9.1%) |
| Hyperthermic >1.5°C | 18 (81.8%) |
| Total | 22 (100%) |

Tab. IV. **Correlation between clinico-pathologic and thermographic data of 36 nodular lesions of thyroid (Institute of Radiology, University of Ferrara).**

| *Clinico-pathologic diagnosis* | *Number* of *cases* | *Tkermographic patterns* | |
|---|---|---|---|
| | | *normal* | *abnormul (>2°C)* |
| Benign nodule | 16 | 14 | 2 |
| TSH non-dependent nodule | 3 | — | 3 |
| Malignant nodules | 7 | 3 | 4 |
| Multiple nodules | 7 | 6 | 1 |
| Acute thyroiditis | 2 | — | 2 |
| Other pathologies | 1 | 1 | — |
| Total | 36 | 24 | 12 |

S. D. BIANCHI (Torino, Italy)

## The value of thermography in the investigation of lymphoma

Damage to superficial lymph nodes is often one of the earliest clinical signs of lymphoma and skin sites are by no means rare. « Surface » manifestations of this kind are obvious candidates for thermographic investigation. In addition, there is probably a similarity between the metabolism of lymphomatous tissues and that of frankly neoplastic processes, where the typical alteration of cell metabolism is the cause of hyperthermia and opens the way to thermographic detection. These considerations, therefore, suggested that thermography might reasonably offer a rapid and, above all, non-invasive method of establishing an early and sufficiently reliable differential diagnosis in cases where the only clinical sign is a superficial adenopathy. 15 patients with Hodgkin's disease and 13 with other forms of lymphoma were examined with an Aga Thermovision 680. The axillary and inguinal nodes have not been much used due to « masking » and hence false results owing to the presence of hair. On the other hand, complication of the thermographic picture on the part of large hyperthermic vessels in the vicinity has made interpretation difficult in the case of supraclavicular and laterocervical sites. Our findings in this small series make it clear that lymphomatous tissues are hyperthermic. In some cases, comparison between the subsequent course of the clinical and thermographic pictures suggested that a relationship might be discernible between temperature changes, the treatment modality, and, possibly, the clinical stage. Hyperthermia cannot yet be classed as a sufficiently reliable parameter for the diagnosis of lymphoma, though it can usefully be employed to monitor the ongoing picture and the effect of treatment, particularly radiation therapy. For example, the failure of a site to cool after such treatment, once a reasonable time during which hyperthermia caused by inflammation may be expected to have relapsed, can be seen as a sign of reactivation of the site. It is this feature of thermography that points to its utility in day - to - day practice for the surveillance of lymphomas. Its absolute innocuousness and relatively simple technical requirements render it both a quick and manageable form of examination that can be repeated indefinitely. Were the results of research on a wider scale to show that other elements of semeiological value are present in thermographic findings, the examination would prove a useful adjunct to the instrumental methods of diagnosis already known.

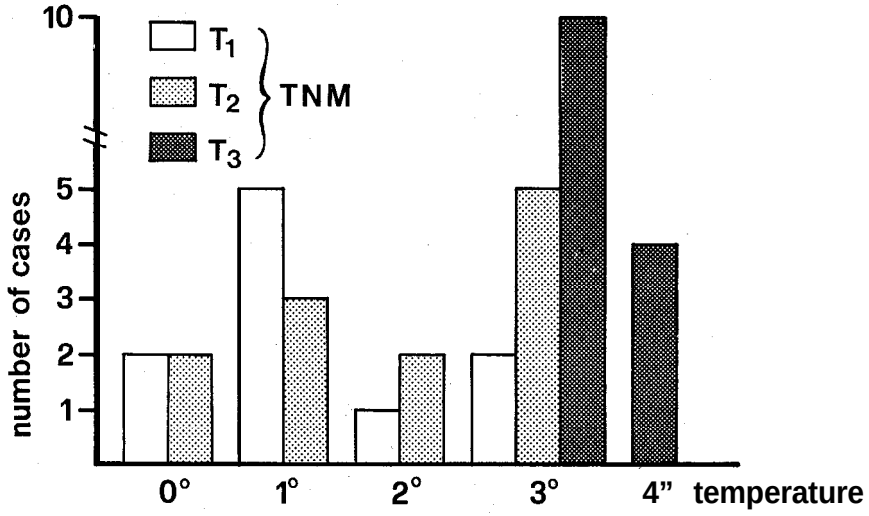
M. CRISTOFOLINI (Trento, Italy)

## Diagnostic value of thermography in the differential diagnosis of malignant melanomas

The purpose of this work is to verify the validity of thermography in the differential diagnosis of primary cutaneous melanomas, nevi, and pigmental cutaneous carcinomas. Hypothetically it should be possible to correlate thermographic data with the morphologic and/or clinical characteristics of skin neoplasias in order to determine not only the type but also the biological beha-

Tab. I. **Diagnostic value of thermography.**

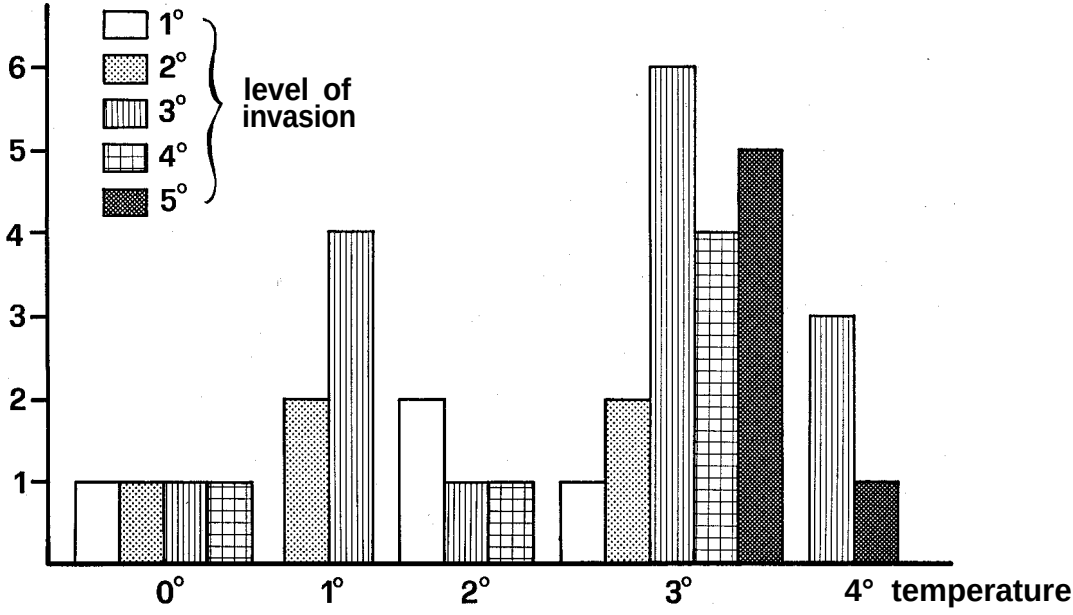
| *Type of tumour* | *Number of cases* | *Thermographic patterns* | |
|---|---|---|---|
| | | *Hypo- and normothermic* | *Hypcrthermic* |
| **Skin tumours, not nevi, simulating melanomas** | 67 | **56** | **11** |
| Pyogcnic granulomas | *10* | **4** | **6** |
| Seborroic warts | **7** | **7** | **-** |
| Angiokeratomas | **2** | **2** | **-** |
| Thrombosed capillary haemangiomas | **5** | **5** | **-** |
| Dermatofibromas | **20** | **18** | **2** |
| Pigmented basal cell tumours | **23** | **20** | **3** |
| **Nevi** | **148** | **137** | **11** |
| **Primary malignant melanomas** | **36** | **4** | **32** |




Graph 1. Prognostic value of thermography.

viour of the tumours. Consequently thermograms would not only be « diagnostically » significant, but also « dynamically » significant because they would document the level of infiltration, or diffusion and the presence of a relapse or of metastases and thus they would be able to guide the therapy according to the evolution of the tumour.

The thermograms were performed with a Bofors IR Mark 3. 148 nevi, 36 primary cutaneous malignant melanomas, 47 melanoma metastases and 67 cutaneous neoplasias (10 pyogenic granulomas, 7 seborroic warts, 2 angiokeratomas, 5 thrombosed capillary haemangiomas, 20 dermatofibromas, 23 basal-cell tumours) were examined. Due to the




Graph 2. Thermography as a guide in therapy. Hyperthermia correlates best with the level of invasion of the melanoma. When it goes beyond the third level not only excision of the neoplasia but also of the regional lymphnodes become necessary.

pigmentation and/or the clinical aspect, the differential diagnosis with melanoma was problematic. The thermographic data of these growths were compared with certain clinical and morphologic characteristics in order to note any correlations. The sites of the 71 melanoma operations were repeatedly examined by thermography to demonstrate any possible recurrence. Primary malignant cutaneous melanomas are mostly hyperthermic (88.9%), while nevi are almost always hypothermic (92.5%), unless complicated by folliculitis underneath, in which case they are « hot ». The remaining cutaneous neoplasias which can simulate melanoma (seborroic wart, basal cell tumour, dermatofibroma, angiokeratoma, thrombosed haemangioma) are cold or isothermic. Due to these facts thermography assumes a determinant rôle in the differentiation of malignant melanoma from nevi, and from the remaining cutaneous neoplasias. This is the « *diagnostic value* » of thermography (Table I). « *Prognostic* value » of thermography: the hyperthermia of malignant melanoma seems to correlate with the clinical classification according to TMN, which is a direct expression of the clinical character and therefore the prognosis of the tumour (Graph *1). Thermography as a guide in therapy :* since the clinical state (TNM) is also determined by the degree of infiltration, thermography can be a guide to regional nodal spread requiring, therefore, the extending of the surgical excision (Graph *2). Thermographic control of melanoma evolution:* thermography permits the observation of the biological conduct of the melanoma both in the case of recurrences after excision and in the lymphonode, and cutaneous metastases which are usually hyperthermic. The sites of previous excision of malignant melanoma are initially usually hyperthermic. Later they appear cold. They stay hot only if a recurrence of the tumour is present (Table II A). In metastases to lymph nodes the hyperthermia is proportional to the extension of the proliferation. Cold thermograms correspond to very small metastases with limited involvment of the lymph node tissue (Table II B).

Tab. II A. **Thermographic control of melanoma evolution. Follow-up thermography at the site of previous melanoma excision.**

| *Period of time* | *Number of cases* | *Thermographic patterns* | |
|---|---|---|---|
| | | *Hypo- and normothermic* | *Hyperthermic* |
| < 1 year | 10 | 2 | 2 |
| > 1 year | 11 | 9 | 2 |

Tab. II B. **Thermography of malignant melanoma metastases.**

| *Site of the metastases* | *Number of cases* | *Thermographic patterns* | |
|---|---|---|---|
| | | *Hypo- and normothermic* | *Hyperthermic* |
| Skin | 33 | 4 | 29 |
| Lymph nodes | 14 | 4 | 10 |
| Total | 47 | 8 | 39 |

A. GRISOTTI (Milan, Italy)

## Non-melanotic cutaneous tumours

Telethermography in the case of cutaneous epitheliomas is equivocal rather than distinctly differentiating them from melanomas which are in the great majority of cases hyperthermic. Basal cell carcinoma is generally hypo- or isothermic and only rarely presents a slight increase in temperature with respect to the adjacent zones.

Thermography has great diagnostic value in

differentiating between pigmented basal cell tumours, which are « cold », and melanomas which present hyperthermic, flame type phenomena. Spinocellular epitheliomas are also generally hypothermic especially if they are ulcerated. At times, however, they can present a hyperthermic halo which is an expression of peritumoral infiltration - notably in diffuse and invasive forms. Certain rapid growing spinocellular epitheliomas with precocious local and regional nodal invasion give frequent « hot » thermographic responses. This differentiates them from the majority of cases. Since the increased production of heat in malignant tumours is closely connected to the metabolic activity of the neoplastic cell, thermography represents a simple innocuous and worth-while means of cellular grading and prognosis. Lastly, it is important to underline the value of thermography in the follow-up of epitheliomas after surgery or radiological therapy.

N. CELLINI (Roma, Italy)

## Skelatal tumours

After more than ten years since its first employ ment (Gershon-Cohen 1965), the rôle of thermography, in the study of primary and secondary skelatal neoplasms is not at all established. It is certain that bone is one of the best conductors of infrared radiation and that its depth, compared with the cutaneous surface, does not compromise the emission capacity (Melki 1973). Nevertheless, in 1973, Dr. Lamarque's group (Montpellier) affirmed that, in his experience, thermography does not substantially add any new element compared with traditional radiology. On this matter, our cases include mainly bone lesions following mammary carcinoma, and I do thank Dr. G. Viganotti (Tumors Center Milan) for having provided me with the results of his experiences concerning infantile and youthful primary bone neoplasms. Precocious diagnosis of primary and secondary bone tumours, as in other kinds of neoplasms, is still difficult, and therefore, close co-operation among radiologist, specialist in nuclear medicine and histopathologist is considered necessary by all. As far as therapy is concerned, especially if surgical or radiant, it is extremely important to be able to define carefully the actual dimension of the neoplasm. Lastly, any method permitting monitoring of the tumour's evolution, once treatment has been carried out, is particularly useful. Regarding these three aims, the direct or contrastographic radiographic investigation presents, due to its own nature, some limitations while bone scintigraphy, even if it allows a metabolic and therefore dynamic control of neoplasm, has its limitations in its undetailed description, which makes a differential diagnosis difficult. The results obtained by thermographic investigation, are not very different from the radioisotopic ones, even if, for instance, some Authors assert the possibility of a thermographic differential diagnosis among primary, malignant and benign bone tumours. Malignant tumours would have a thermic gradient of at least 4°C and a characteristic pathological circulation while in benign bone tumours the thermic gradient would not exceed 2°C and there would not be a pathological circulation. Between primary malignant tumours and singular bone metastases one may note that the pathological hyperthermy would not exceed 2,5°C in the later. The problem of the « characteristic » thermic gradient (4°C, 2°C) and the percentage of controlled, positive histological diagnoses is still rather controversial. With this in mind, the group of the colleagues of the Tumours Institute of Milan, tend to check thermographic reliability comparing the extension of the hyperthermic area with the dimensions of the tumours established by other methods. They are also trying to determine if thermography is useful for therapeutical programming and control of patients who underwent chemoradiotherapy. Thus far eighteen cases of limb tumour in young people between 6 and 19 years, have been studied. This type of case gives a relatively better possibility of determination. In all cases, a very high hyperthermic degree was observed (only in one case, the gradient was+ 1°C) indipendent of the tumour's dimensions. Generally, the hyperthermic area (focus and pathologic circulation) was more expanded than the radiographic determination. In three cases, a control was carried out some time after radiochemotherapy and negativization of the thermo graphic table, in accordance with metastases the radiological and clinical diagnosis, was observed. As far as bone metastases are concerned, especially the osteolitic ones, it is well known that radiological positivization is observed only when more than 50% of the calcium has been removed (Babaiantz 1974). Intertrabecular metastases only cause displacement of the medula without modifying the calcificated bone tissue (Schinz). Many Authors, both in Italy (Lovisatti) and abroad (Melander, Amalric, Melki) have tried to analyze the possibilities and advantages offered by thermography, alone or associated to scintigraphy usually with Technetium phosphate. According to the experience

of these authors, with whom we agree, pathological hyperthermy is generally not very intense (0.5-2.5 degrees), yet, the opinions on thermography employement, in this field, are very discordant. In 1969, Lovisatti did not find any case of exact diagnosis in 17 patients studied. In 1972, Amalric, in 90 cases studied, reported 85% positivity. Last by, in 1973, Melki, on 92 patients, spoke of 74% exact diagnosis by thermography alone, that rose to 97% associating thermography to scintigraphy. This last result seems to show the way for the employement of this method. Its greatest merit is its easiness of execution and repetition, even if, unfortunately, just like scintigraphy, it is not able to give a « characteristic » diagnosis. In conclusion, we believe that thermography has great value both in the follow up of primitive and metastatic bone tumours, and in the precocious, preradiologic diagnosis of metastasis. Even if thermography is not absolutely specific, like scintigraphy it is a particularly easy and economic procedure in this field.

A. TOTI (Ferrara, Italy)

### Closing remarks

The point of this Round Table is to emphasize that the application of thermography is continually expanding, confirming its interdisciplinary nature. It is also notable now that the more significant results are obtained in skin tumours. This is due to the fact that melanotic tumours are hyperthermic while epithelial tumours are more or less hypothermic. Hopefully, technological progress will give us more precise instruments in the near future which will give better definition and an increased thermic discrimination even for deep lesions. It is necessary to underline the fact that many tumours escape thermographic diagnosis (false negatives). In spite of this, thermography is capable of demonstrating tumours where all of the other methods have failed, particularly in bones. This permits a precocious, prognostic grading, even before a histologic study, as in lymphomas, and thyroid and parathyroid tumours. One must therefore consider both the qualitative and quantitative data together. The problem that now emerges, is that of standardization. All of the thecnical and methodologic parameters must be organized to a very high degree so as to allow, for example, the construction of maps with precise numerical indications of the various levels of temperature emission, not only superficially but from the deeper levels. Standardization will permit reproductability and therefore greater possibility for early and effective therapy. It must be underlined that thermography might concentrate even more on the principles of complementarity, multidisciplinarity and universality (Gautherie, Cohen, et al.). Perhaps only in a small part we forced ourselves to remain faithful to these principles, trying to speak a common language. At least in this way, every « rapporteur » forced himself to use clear and concise language, stimulating the critical enthusiasm of all, and including the greatest possible number of participants in this interdisciplinary work. Much time, and much work awaits us in our attempt to better the diagnostic and prognostic value of thermography. But the results will be worth the battle because it will tend to bring medicine from the present state of art to that of science.

## IInd Round Table: *Thermography in breast tumours*

Moderator: C. VALDACNI (Trento, Italy)

#### INTRODUCTION

The agreement, during the preparation of this Congress, was to ask, through a questionaire, to foreign Institutes and Colleagues, that use thermography as a screening method, their data and their opinion on the rôle of thermography in a survey for breast cancer detection. Indeed, the opinions we find in current literature, do not agree on the value we should give to thermography as an instrument for early diagnosis. Of the twenty or more questionaires we sent, we received only a few answers (about one third, see table I). The result is quite modest; however,

Tab. I.

| Name and Institute | Method of screening | | | | Age groups | Number of unselected (annualy) | % of women as being at risk | % of women with clinical symptoms |
|---|---|---|---|---|---|---|---|---|
| | Clinical exam | thermography | mammography | others | | | | |
| Greening W. P.<br>Royal Marsden Hospital<br>London (England) | yes | yes | yes | — | 20-75 years | 8,000 | 50 | 30 |
| Strax P.<br>Guttman Institute<br>New York (U.S.A.) | yes | yes | yes | yes | — | 50,000 | - | 20 |
| Isard H. J.<br>The Albert Einstein<br>Medical Center<br>Philadelphia (U.S.A.) | yes | yes | yes | — | — | 10,055 | - | 56.31 |
| Ghys Ii.<br>Laboratoire Radio Medical<br>Montreal (Canada) | yes | yes | yes | - | - | - | - | 57 |
| Stark A. M.<br>Queen Elizabeth Hospital<br>Gateshead (England) | yes | yes | yes | - | | - | | |
| Lapayowker M. S.<br>Health Sciences Center<br>Philadelphia (U.S.A.) | - | yes | - | - | 35-75 years | 5,000 | - | - |
| Jakobsson S.<br>Karolinska Sjukhuset<br>Stockholm (Sweden) | yes | yes | yes | - | 35-75 years | 8,167 | - | - |

it will help us to examine and interpret this problem more precisely, just the same. Personally I think that: 1) the role of thermography as a mass screening method is not well defined in many centers, around the world. Probably, this generates a certain uneasiness in aswering our questionaire and may also be one of the main reasons why we did not receive replies to all the questionaires we sent. 2) The answers we received seem to « support » point 1) and in a certain way justify it because the data given to us by Ghys, Strax, Isard, Lapayowker, Jakobsson, and Stark, whom I thank very much for their courtesy, are discordant. For the same reason we can not draw a well defined conclusion from these data. Current literature, as I have already mentioned, and the papers presented at the recent International Congress on Prevention and Detection of Cancer held in New York (April 27th, 1976) seem to give further support to this idea. A work on this subject will soon be published in « Acta Thermographica ». From a panoramic review of these opinions and data we may say that almost all the authors (with the exception of the french group) give to thermography a secondary role in early breast cancer detection, whereas, mainly in the IJ.S.A., mammography is the most important test in the physician's hands. For some time, I was also of this opinion. The high number of false positives means that thermography is uncertain and absolutely non-specific. In our histories, for example, among 15,000 examined women, 4,905 of them had abnormal thermograms which means about one third of the entire population examined! For this reason, after a few years when we had introduced this method in our Tumour Center, I was personally oriented in considering it, may be quite superficially, valid mainly because it was accepted quite favourably by the women and it was also a more effective psycologycal tool in recalling the female population to our Center than the simple anamnestic or clinical exam. Now, after almost eight years of thermographic practice, I reexamined our results with the greatest care, specially from a statistical point of view. My conclusion is that we are now in the position of defining more precisely the role of thermography in a breast cancer screening. In my opinion this

| *Women with clinical symptoms* | | | *Women without clinical symptoms* | | | *Cases without follow-up* | *Th+ %* | *Th− %* | *False positive %* | *False negative %* | *Notes* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *abnormal Th %* | *equivocal Th %* | *normal Th %* | *abnormal Th %* | *equivocal Th %* | *normal Th %* | | | | | | |
| 9 | 14 | 77 | 6 | 12 | 82 | 1/3 | - | - | - | - | - |
| 60 | - | 40 | 20 | - | 80 | - | - | - | - | - | - |
| 36 | - | 64 | 23 | - | 77 | - | 30.31 | 69.68 | 27.5 | 28.75 | accuracy 75% |
| — | — | — | — | — | — | — | — | - | 0.3 | 4.5 | - |
| - | - | - | - | - | _ | _ | _ | - | 13.6 | 21 | - |
| - | - | - | - | - | - | - | 16 | 84 | 2.25 | 0.14 | - |
| - | - | - | - | - | _ | _ | _ | - | - | - | - |

definition passes through an exact evaluation of the type of information thermography may give us. The knowledge of the precise questions to put will make us understand what we may and may not expect. At this moment, in Italy, there are a few centers sufficiently experienced in Milan, Cesena, Busto Arsizio and Trento. To the speakers, chosen among these centers, we will now ask their opinion on the rôle thermography plays in a breast cancer screening.

B. PERANI (Trento, Italy)

1) In our screening center we use thermography not as a « stand-alone » exam but integrated with other exams: history for risk evaluation, clinical exam, mammography, cythological exam, and eventually biopsy.

2) The women who come to our center are: a) spontaneous arrivals or b) sent by physicians who already have suspected a pathological breast situation. We consider very carefully the risk factor. Among 17,000 women we visited, 6,230 of them were subject to high risk (36.6%); and 128 of these had cancer (2.05% of 6,230). This is 56.14% of all the 228 cancers we found. Among the women that did not present any particular risk factor, 10,770 (63.4%) we found 100 cancers (0.93% of this group and 43.85% of all the cancers). The women that have only the anamnestic exam positive and all the others negative are visited every 6 months. The women subject to high risk with a normal thermogram and positive clinic, or with an abnormal thermogram and a negative clinical exam are sent to mammography and eventually to other exams.

3) Comparative results.

a) Thermography

false positives = 5,901 (34.7% on the 17,000 patients)
false negatives = 34 (14.9% on the 228 cancers)

b) Clinical exam

false positive = 3,339 (19.6% on the 17,000 patients)
false negative = 38 (16.6% on the 228 cancers). The women sent to mammography after the evaluation of the three preceeding exams (thermography, family history, and clinical exam) were 6,590.

c) Mammography

false positive = 3 (0.04% on the 6,590 patients) false negatives = 7 (3.1% on the 288 cancers). The follow-ups for 652 women with abnormal thermograms, but all the other factors negative, showed the presence of 5 cancers.

4) Our screening done with the 3 exams gives good results. Thermography alone would detect 85.10% of all cancers, the clinical exam 83.33% and high risk 56.14%. A cross examination with the three methods gives us the highest possible precision. In our opinion the main interest of a screening, once it's medical precision is established, is to extend it to the highest number of women. To do this it is necessary to educate with booklets, conferences, etc. all the female population, and to organize some mobile screening units so they may reach even the most distant towns. Computerizing the family history and lectures on clinical findings would give to the whole system a very high flexibility and speed.

P. L. CARNAGHI (Busto Arsizio, Italy)

We have been clinically detecting breast cancer for some years. In case of doubt or suspicion after clinical examination, we carry out mammography, cytological exam of secretion, and biopsy. When our center had the possibility of having at its disposal a thermography unit, we hoped we would carry out clinical and thermographycal screening delaying the other examinations. It has not been possible because of lack of room, time, medical, and paramedical staff. Therefore we used thermography only on patients recommended by doctors for clinical anomalies or women who had risk factors in family history or in clinical instrumental exams. Thus we used thermography on preselected people at « high risk ». Anyway no patient was submitted to biopsy without previously carrying out thermography. At first we noticed that thermography is not so rapid as many persons state. In our opinion five minutes are not enough for a good exam consisting of cooling, taking thermographic pictures from various angle-shots, exact use of isotherm views, evaluation of termal gradients, accurate visit, and recording all data. This is another reason which has persuaded us to use preselected patients. Five groups of thermograms are recognized on the basis of the Amalric classification. In consequence of the above mentioned reasons we saw thermographically only some (3176) of the women that came to be visited, from April 1975 to February 1976. The false negatives prove to be 11%. For evaluating the patients with doubtful or positive thermography, we expressly have considered the TH3 cases together TH4 and TH5 cases because we wished to know the number of patients that needed further thermography checks in a short time, even if they had negative clinical, instrumental, and cytological exams. The false positives were about 16.5%. Therefore if we should organize a screening concerning 1000 women, 15000 exams should be performed in one year, owing to the necessary checks (2-4 times a years) required by doubtful clinical cases (3-6 months), most of which are due to false positive thermographic cases. Considering this experience in thermogram interpretation, we believe that the realization of a thermographic survey in a fairly difficult task. Another consideration from this survey deals with the most frequent thermographic aspects in comparison with stage TNM. We noticed that in T3 a, T3 b, T4 a, T4 b, T4 c either a wide iperthermic area or a dilated asymetrical vessel are more frequent; while in Tl s, Tl, T2 a hot-spot or simple vessel increase in a breast are the most frequent characteristics. In conclusion: 1) Examining our data it seems that the use of thermography is hard as a survey method, while good results can be obtained utilizing thermography only on people exposed to risk. 2) We must pay attention to the above mentioned thermographic aspects relating to the fact that the women coming to our center are in initial stages.

L. ROCCHI (Cesena, Italy)

We may synthesize the advantages and disadvantages of thermography in a screening for early breast cancer detection as follows:

*Advantages:* 1) low running costs, 2) rapidity, 3) repeatability, 4) good diagnostic results, 5) well accepted by women.

*Disadvantages:* 1) high cost of instrument, 2) need of an experienced operator, 3) low room temperature, 4) tiring of operator.

The average time needed for a thermographic observation is 6/7 minutes. We classified thermographic findings in 5 classes according to Spitalier and Amalric. We found a false negative rate of 9.65%. The false positives were mainly fibrocystic masthopathies. The histologically accertained cancers have been 195, in the proportion of 1 every 300 thermographies done.

M. PIETROJUSTI (Milan, Italy)

We always associate thermography with the clinical exam in each visit of the patient. Mammography is considered as a more through diagnostic investigation and is used in the cases we notice or suspect of breast tumour. We invite to our center, by letter, all the female population of more than 35 years of age. We consider more carefully women bound to risk and we examine them more frequently. The percentage corrisponding to this group is about 30%.

*Results*

| | |
|---|---|
| Positive to our exam | 62 |
| Cases of unknown istological exam: | 6 |
| False positives (i.e. cases that did not evidence *till* now any malignancy) | 3 |
| Cases with histologically ascertained tumours: | 53 |

At the first visit, among the 53 ascertained cancers we found 25 (47%) of them, the others presented at the first visit these results:

| | |
|---|---|
| normal | 9 |
| libroadenoma | 2 |
| cystic diseases | 4 |
| mastopathy | 6 |
| nipple secretion | 1 |
| suspect | 6 |

Almost all these cases evidenced malignancy after a period longer than six months.

Only among the suspect cases has this period been shorter.