Accuracy of dynamic contact thermography in the follow-up of breast cancer after surgery and radio-chemo-therapy

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Summary. Three hundred eighty patients, treated with conservative (186/380) or non conservative therapy (194/380), have been examined with contact thermography (C.T.). The most important engagement of C.T. is the follow-up of the breast cancers treated with conservative therapy. In most cases C.T. information are more useful than those provided by mammography and echography, this according to the relationship between thermogenesis and growth rate of the tumour. In the non conservative treatments (radical mastectomy) the C.T. information are useful in order to confirm the clinical suspicion of recurrences or metastases.

Key words: breast cancer follow-up; dynamic angio-thermography.

A) INTRODUCTION

After the treatment of breast cancer, both conservative or not, the periodical follow-up is mandatory, in order to confirm the favorable result or to detect local recurrence or metastatic spread of the tumour. The association of Physical Examination (P.E.) and Thermography (T.) has demonstrated a good reliability in the local follow-up.

The aims of P.E. and T. periodical follow-up are dependent on the type of treatment.

1. In the patients who underwent medical or surgical **conservative treatment,** the P.E. and T. follow-up establishes:

a) the *efficacy of the* treatment(radiotherapy; conservative surgery associated with radiotherapy; hormono-chemo-therapy), confirming the sterilization or the complete extirpation of the tumour;

b) the *failure of the treatment,* demonstrating the persistence, the non complete sterilization or the fast growth of the tumour;

c) the *development of recurrences or metastases* in the preserved or controlateral breast after apparent clinical healing.

2. In the patients who underwent **radical surgical treatment** (mastectomy), the P.E. and T. follow-up establishes:

a) the *efficacy of the treatment; b)* the development of cicatrix *recurrences* or controlateral breast metastases.

B) METHOD

The periodic P.E. and T. follow-up has to control the preserved breast or the cicatrix and the controlateral breast.

The times of the follow-up were: for the 1st and 2nd yr, every 3 months; for the 3rd and 4th yr, every 6 months; for the following yrs, every 12 months. Other more sophysticated methods (mammography, xeromammography, nuclear medicine, ultrasound, biopsy, etc.), were utilized if advised from the P.E. and T. results.

C) RESULTS

From June 1976 to December 1980, 380 patients previously treated for breast cancer, were periodically followed with P.E. and T. controls. Conservative medical or surgical treatment was performed on 186/380 patients, radical mastectomy was performed on 194/380.

In the P.E. and T. positive controls, histology was performed in order to confirm the results, whenever possible.

1. In the patients recently treated with **radiotherapy alone or in association** with conservative surgery, the breast is greatly in-

flamed and oedematous. The C.T. pattern is that of an increased background hyperthermin, diffuse hypervascularisation and nipple hyperthermia, In this stage a reactive sclerosis of the breast follows; the C.T. pattern is that of a fragmentation of the peri-tumoral vessels and decreased of background hyperthermia with the disappearance of the localized hypcrthermic spots (Fig. I).

Starting now. the following evolutions can be observed

a) When the *complete* sterilization of the tu-

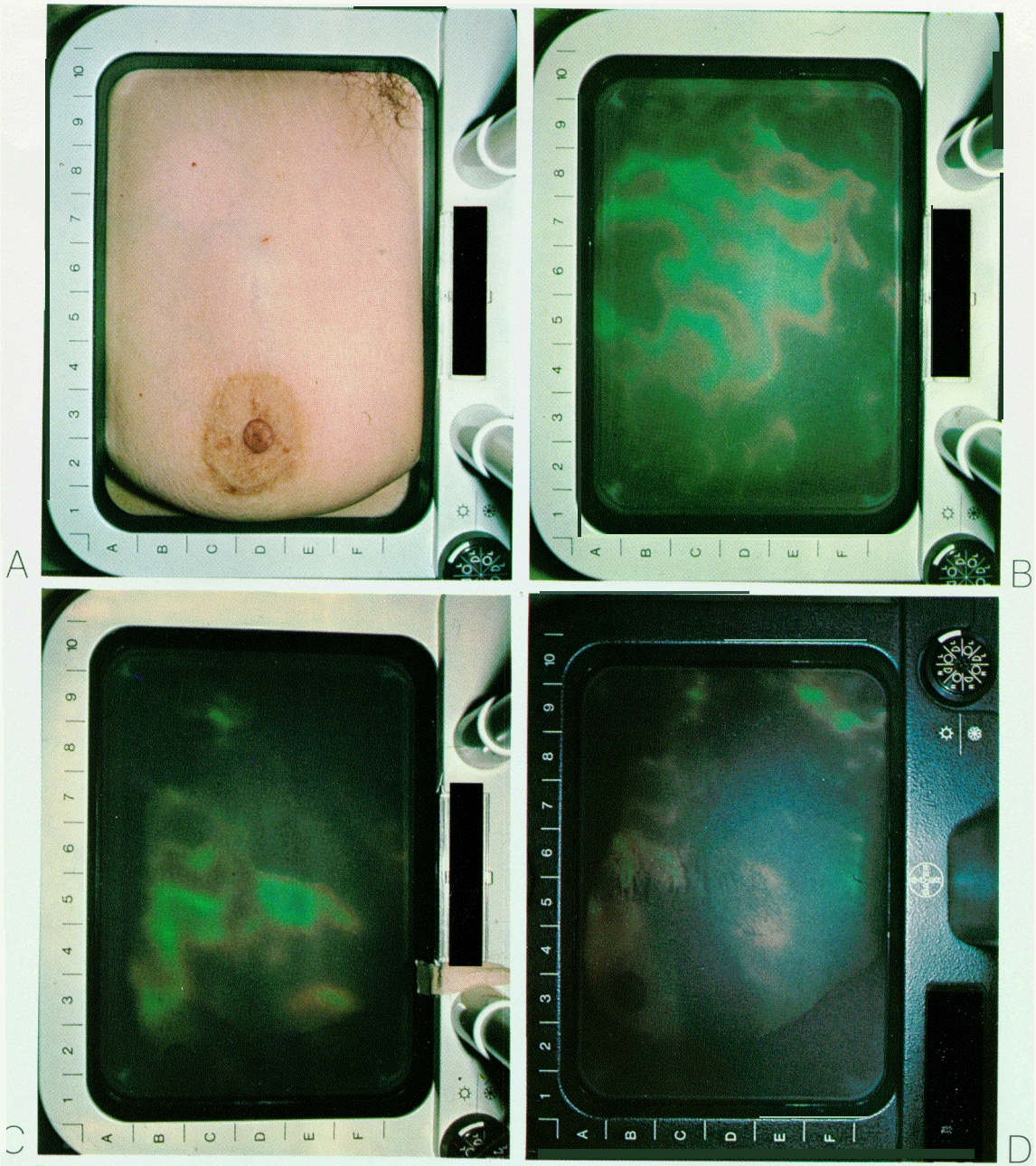

Fig. 1 A-C. A) Left breast cancer with nipple retraction. B) Hyperthermic background with abnormal and fragmentated vascularisation. C) 9 months after radiotherapy decrease of background hyperthermia and of the fragmentation of vascularisation. D) 16 months after radiotherapy. Success of radiotherapy with regression of hyperthermia and abnormal vascularisation.

mour is obtamed, the findings of C.T. consist of: a) *gradual decrease* of the background heat down to its disappearance within a 3 up 12 months period; β) *disappearance of the nipple* hyperthermia within 6 months; γ) *fragmentation of the vascular tree* around the tumoural side;

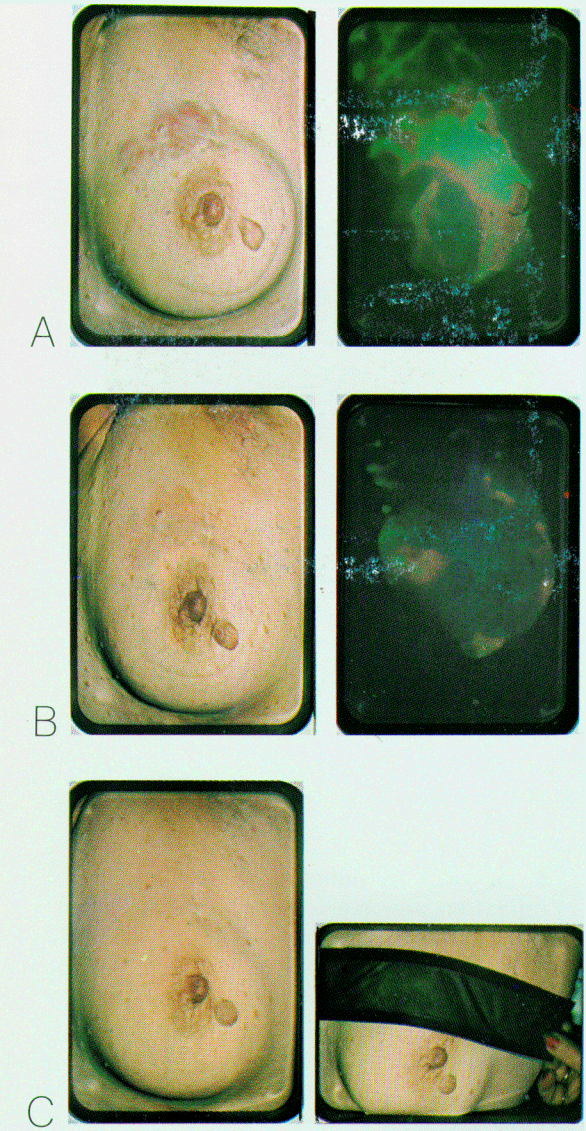

Fig. 2 A-C. A) Local recurrence after 3 months from conservative surgery (T1NO breast cancer in a 46 yr-old woman). C.T. examination demonstrates hyperthermic area on recurrence with « wheel-spoke » pattern. B) After 3 months chemotherapy partial clinical healing with reduction of hyperthermia and decrease of the vessels diameter. C) After 7 months chemotherapy complete clinical healing with normalisation of the C.T. pattern.

b) when the *incomplete sterilization* of the tumour occurs the findings of C.T. consist of: a) persistance of *mild focal hyperthermia,* after 18 months; β) the *persistance of the background hyperthermia,* with a «flou» pattern after 15 months.

c) When the treatment has completely failed, the findings of C.T. consist of: a) *the persistence of the background and nipple hyperthermia* after 9 to 12 months; β) the persistence of the *wheel-spoke hypervascularization;* γ) the development of a *hypothermic flow pattern,* caused by raising malignant oedema.

2. In the patients treated with **radical mastectomy** the aim of C.T. examination is the control of the surgical scar in order to demonstrate possible tumoural recurrence. Normally, the C.T. pattern of the surgical scar is absolutely hypothermic. Total or partial hyperthermia of the surgical scar and/or the abnormal increase of the vascular tree are typical signs of local recurrence (Fig. 2).

3. In the patients in which **recurrences** or **metastases** occur (indipendently of the kind of previous treatment) accuracy has been high: in fact, in 67/69 recurrences or metastases suspected by C.T., the bioptic examination confirmed C.T. findings (97.1%) (Fig. 3).

C.T. allows to control the efficacy of further therapies.

D) CONCLUSION

1. The most challenging question to the C.T. is referred to the control of the patients treated with **conservative therapy** whatever it may be. In these patients, the aim of C.T. follow-up is to demonstrate the lack of tumoural sterilization (radio-therapy alone or radio-chemo-therapy) or the recurrence of the tumour (conservative surgical treatment). In both eveniences the radical surgical treatment (mastectomy) is generally performed, but sometimes a further conservative treatment may be proposed and C.T. serial controls are performed in order to establish the good response to the treatment.

2. The C.T. follow-up of **non conservative treatment** is easier, because the

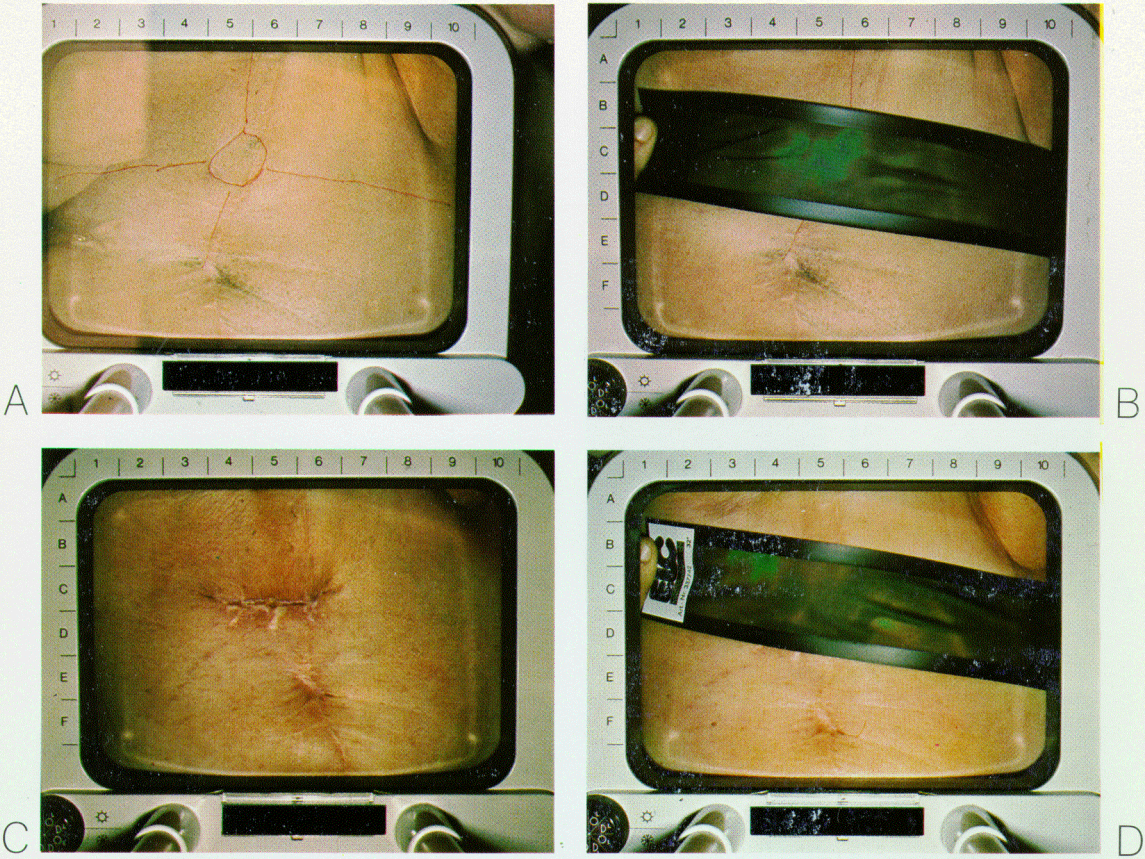

Fig. 3. Local recurrence after 2 yrs from radical mastectomy for T2NO breast cancer in a 47 yrs old woman. A) Nodule of 0,5 cm in diameter on the cicatrix. B) Star vessels pattern at nodule. C) 6 months after surgical excission of the nodule and radiotherapy. D) At C.T. scar is hyperthermic.

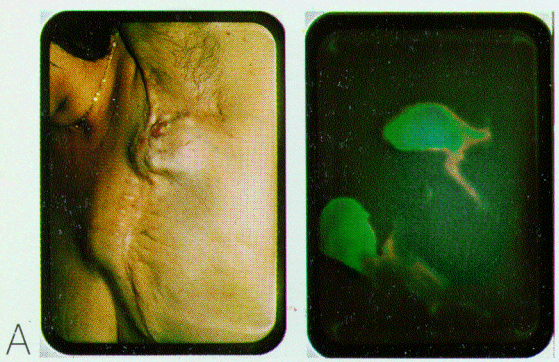

Fig. 4 A-B. A) Recurrence on the scar with sternal swelling after 3 months from radical mastectomy. B) Hyperthermic area with pathologic vessels around the recurrence and the sternal swelling.

aim is to demonstrate the possible appearance of recurrences or metastases. In these eveniences the conservative treatment (radio-chemotherapy) is generally performed, and further serial C.T. controls are required.

3. Opposite to radiological or ultrasound examination, which give morphological information, **C.T. information are only functional,** depending on the biological characterization of the tumour. This is very useful especially in the control of the breast cancers treated with radio-chemotherapy alone, in which the morphological modifications of the tumour are hardly evaluated with mammography or echography. On the contrary the C.T. examination is able to identify the biological modifications of the treated tumour, according to the relationship between tumoural growth and tumoural thermogenesis (Fig. 4).

Application of contact thermography in the examination of immune response with skin tests in neoplastic patients

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FREE COMMUNICATION

A) INTRODUCTION

In the last yrs several reports on immunodeficiencies in neoplastic patients have been published. Skin-tests (S.T.) for the immunological monitoring of neoplastic patients represent an easy, economical technique that also has the advantage of being carried out ((in vivo». Besides, in a previous study S.T. revealed some value in predicting the risk of septic post surgical complications. Currentely the response to cutaneous antigens is evaluated visually by the measurement of the principal diameters of any erythema and/or cutaneous induration. Since the S.T. findings are fairly subjective, it was decided to support the conventional readings with contact thermography (C.T.). C.T. is a useful technique in cancer diagnosis; it has also useful in non-neoplastic diagnosis. The aim of this study was to determine if C.T. examination could be considered a useful diagnostic technique in addition to visual reading in S.T. response evaluation.

B) MATERIAL AND METHODS

1. Fifteen **patients** were examined at the Out-patient Clinic of the Tumour Institute of Genoa. All were aged between 48 and 69 yrs (mean 55), and had previously been treated with chemoterapic drugs: all patients were taking part in the normal follow-up program and none showed any symptoms of relapse.

2. The following **antigens** were used: *a) PPD* (R) (SCLAVO) 10U in 0,1 ml; *b) Candida (R) dermathophitin o (R) (HollisterStier)* l/100 in 0,l ml; *c) varidare (R.) (Cynamid-Lederle)* SK 4OU, SD 1OU in 0,l ml.

0,l ml of bolus containing one of these antigens were injected I.D. on the volar surface of both forearms..

The delayed reactions were observed after *24-48* h.

3. The **visual evaluation** of the reaction was made according to the following parameters: *a) papula* (P); *b) erythema* (E); *c)* eventual *vesicular or necrotic reactions* as has been previously described. Each type of reaction (E,P) was evaluated by measuring the two greatest diameters.

4. The **contact thermographic evaluation** was made with a ELC Thermosystem Bayer unit. The plates 33-34 were employed, being more similar to the optical image. The exam was performed by direct contact of the plates to the volar surface of the forearms, at the point where the injection had been made. The 2 main diameters of the image were measured 48 h after the injection of antigens, the time interval which gave the more positive results. In order to correct possible mistakes, measurements were checked on the, slide. The dynamic test was not performed as it cools the skin surface to be examined. Evaluation of all tests was done following a double-blind protocol.

C) CONTACT THERMOGRAPHY RESULTS

1. The **contact thermography evaluation** was caracterized by: *a) localized image:* formed by a hyperthermic image ranging from dark green to blue, generally round-shaped. *b) Diffuse image*: ranging from light to dark green and, in some cases, to blue. Its shape and extension were variable. c) *Associated images;* in most cases the localized image was placed centrally in the diffuse one.

Tab. I. **Comparison between contact thermography and visual skin tests.**

Contact T. / Visual S.T.	Positive	Negative	Total
Positive	19	4	23
Negative	6	16	22
Total	25	20	Visual S.T. / Contact T.

2. The **results** obtained with the C.T. examination were compared with those of the visual evaluation as reference. In 41/45 S.T., the C.T. examination agreed with the visually obtained value when the 33 plate was employed and only in 4/45 when the 34 plate was employed.

In detailed way, it was observed (Tab. I): the visual reading 22/45 S.T. were negative; by C.T. examination 16 of these 22 S.T. were negative (73%) and 6 positive (27%) (false positives). Therefore the 2 techniques agreed in 16 of 22 cases (73%). On the other side, 23/45 S.T. were positive at the visual reading; 19 of these 23 S.T. were positive (83%) and 4 negative (17%) (false negatives) at C.T.. evaluation. Therefore, the 2 techniques agreed in 19/23 cases (83%).

Taking in consideration, at the visual reading, only the induration (excluding the erythema) the positive response was obtained in 19/45 S.T.; in these cases, also the C.T. examination was positive (19/19). On the contrary, in the 4 visual readings positivity due to the erythema, C.T. examination was negative in 4/4.

D) DISCUSSION

Since those results are preliminary, they can only lead to some subjective remarks. According to the results, visual reading is the best and more reliable means of S.T. evaluation. C.T. examination appears to be a useful complement to visual reading, specially in borderline cases, where visual appraisal cannot clearly distinguish positive from negative responses. According to the personal results, C.T. examination could be particularly useful in the erythematous response, where this method could distinguish responsive from non-responsive patients. There is no agreement about the significance of the erythema, which is considered positive by some people and negative by other. Patients with erythema only and positive C.T. response could be considered as responsive; patients, with erythema only but negative C.T. responses could be considered as non-responsive. Obviously, this is only a hypothesis because a higher number of studied cases is demanded. Moreover, the high degree of agreement- between visual and thermographic reading seems encouraging: 73% in cases negative to the visual reading, 83% in positive ones (by evaluating both erythema and cutaneous induration; 100% in positive cases excluding erythema).

E) CONCLUSION

The frequence of septic complications and second tumours is generally known to be far lower than would be expected from the evaluation of immuno-deficiencies in neoplastic patients. This suggests that the tests employed in the immune monitoring of neoplastic patients are too sensitive and in some cases immuno-deficiencies may have no correlation with clinical results. Therefore, new means are needed to distinguish the real hypoergic from anergic patients. «In vivo» monitoring by S.T. in visual reading non-responsive patients using C.T. examination could be useful to distinguish those patients.

Of course, all these hypotheses must be verified by evaluating a large and homogeneous number of patients, in order to obtain statistically significant data.