Thermographic prognosis of treated breast cancers

by D. GROS, M. GAUTHERIE, F. WARTER

Breast Centre, Strasbourg (France)

SUMMARY. Mammary thermography is an examination which is absolutely necessary for assessing pre-therapeutic prognosis, or carrying out the follow-up of breast cancers treated by exclusive radiotherapy. However, the interpretation of thermographic images during the follow-up requires a knowledge of data provided by other senological investigations. Before treatment, thermography gives evidence of the cancer growth rate and contributes to the therapeutic choice. After treatment, it indicates the success of sterilization or the suspicion of a possible recurrence or radio-resistance.

Key words: pre-therapeutic thermographic prognosis, exclusive irradiation of breast cancer, post-therapeutic thermographic prognosis.

The increasing significance of conservative treatment has given thermography a prime place in the pre-therapeutic prognosis and the follow-up of irradiated breast cancers. But this preponderance requires constant comparison with other techniques i.e. senological, clinical, diaphanoscopical, radiological, or xerographical, echographic and cytological investigations.

This prognosis which presides over the choice of therapeutic modalities and follow-up which determines secondary mastectomy, must increase in accuracy and reliability. Indeed, the conservation of the breast sets numerous psychological problems to cancerous women. At one time, women were afraid simply because their breast had not been removed. At other times, women suffered, and thinking that the disease was progressing requested mastectomy. Lastly, before post-radiotherapy treatment, some women preferred amputation rather than lengthy follow-up for the histological analysis to show a complete remission.

PRE-THERAPEUTIC THERMOGRAPHIC PROGNOSIS

1. Tbermo-pathology and tumours kinetics

The speed of growth in small epitheliomas and their metabolic thermogenesis are connected in a univocal way: the doubling time of the tumour volume is in inverse ratio to the quantity of heat generated by the cancerous tissue by unit of volume and time.

These two parameters (specific heat producing power and doubling time) have been determined during the spontaneous growth of 69 epitheliomas; the diameter of the radiolbgical tumour opacity was set between 0,9 cm and 3,7 cm. The measurements have been performed in situ by thermometry and intra and peri-tumours fluvography with needle-probes placed under radiographic control. The specific thermogenic power of the cancerous tissue has been reckoned by computer from mathematical models taking into account the cancer geometry, thermal measurement and the tumour hypervascularization phenomena.

2. Thermography and pre-therapeutic prognosis

Correlations exist between the cutaneous hyperthermias connected with the cancer and survival. The rate of 5year survival is weaker, more especially since cutaneous hyperthermias are more severe, extended and with a more irregular topography.

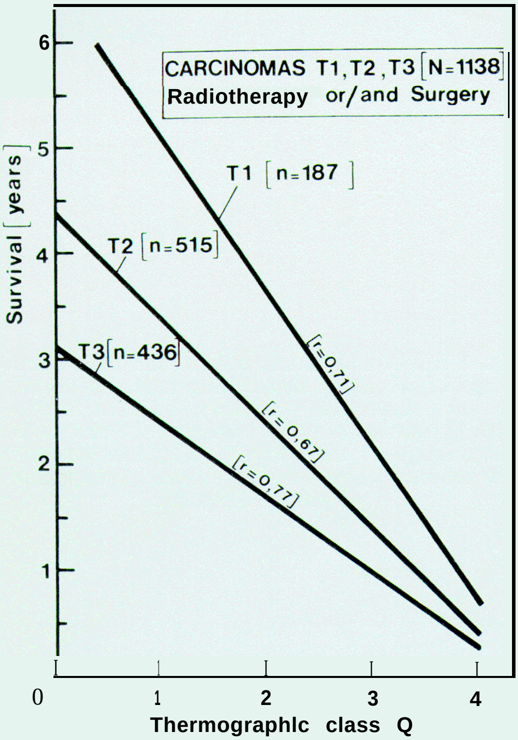
Statistical analysis has been realized on a population of 1,138 cancers (Tl, T2, T3) treated by radiotherapy and/or surgery, then regularly controlled over more than 5 years. The cancers have been divided following the international clinical TNM classification and the 2 prognostic thermographic classifications.

The hyperthermias have been characterized on the thermograms obtained with the help of infra-ted cameras equipped with a system of quantitative analysis and sheets of cholesteric micro-encapsuled liquid crystals.

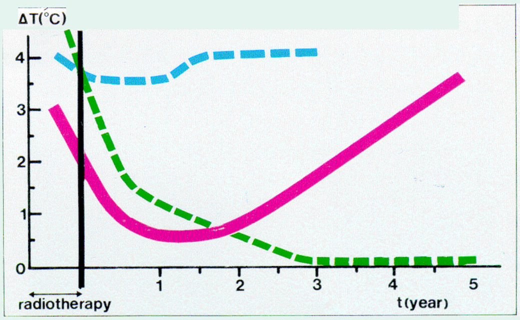
Regarding the classification TO, the study of 97 cases indicates little correlation between survival and thermographic grade. The scattering is relatively large in each thermographic grade. A number of TO classified QO and Ql have a **survival of** less than 3 years.

This failure of thermography for **TO** classified tumours is linked to the fact that a non palpable cancer is not necessarily small. The spreading (comedo-carcinollla), the localization (deep scirrhus). the consistency (soft cancer) may be some of the many factors which make a cancer non palpable while the **six** of lesions at.: important.

In the T4 grade, the study of 145 cases has shown that there were a number of T4 classified QO and Q I, the survival of which was less than 3 years. Indeed, in oedematous cancers, the oedema **is** an impediment for the transmis-



Graph 1, Correlation between the thermographic prognostic grade and survival.



Graph. 2. Thermographic evolution after radiotherapy. Blu=Non sterilization. Green=Sterilization. Red=Recurrence.

sio of cancerous hyperthermia towards the skin.

In the grade Tl, T2 and 7'3, strong statistical correlations exist between the thermographic prognostic grade and survival (Graph 1). Graph 1 shows that cancers classified Q3 and Q4 have generally less than a 2-year survival, especially the T2 and T3. Most of QO and Ql have a survival of at least three years, whatcver the size of the tumour.

POST-THERAPEUTIC PROGNOSIS

Thermography enables irradiation efficacy to be assessed. The comparative analysis of clinical, radiographic and thermal evolution has shown :

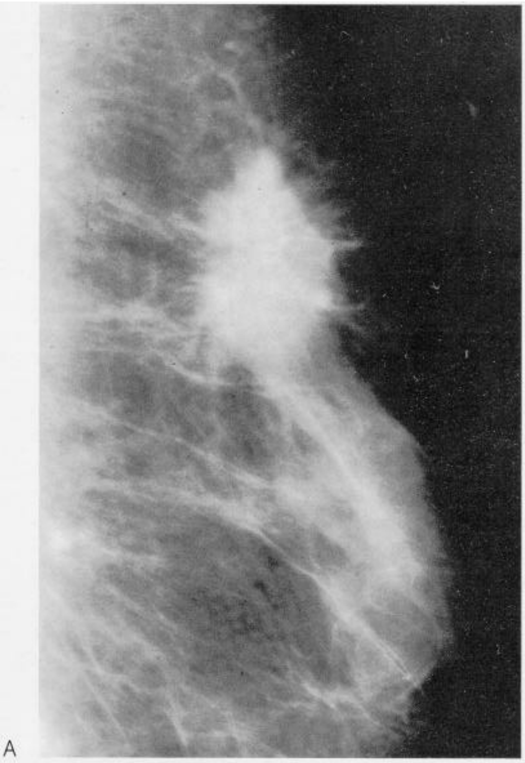
U. the long-term agreement between the loco-regional results of radiotherapy and the development of associated cutaneous hyperthermias.

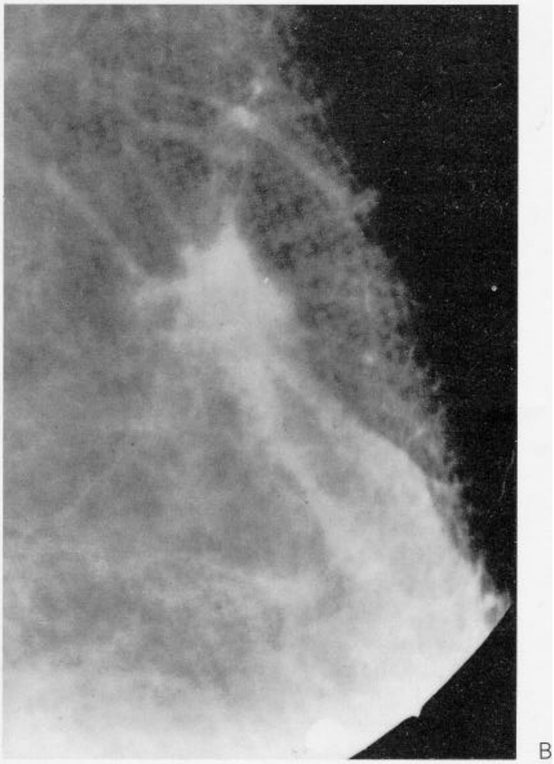
b. the early thermal indication of the regression or tumour recurrence compared to the corresponding clinical and radiographic signs.

There are three types of thermal increase characterized by the normalization, the regression, then the repeat, and the persistance of the malignant cutaneous hyperthermias and corresponding to clinical notions of sterilization, recurrence and non-sterilization.

Graph 2 shows the scheme of hyperthermia **increase** after radiotherapy: only local skin hyperthermia is shown.

Thermography is a particularly valuable element every time a radiological post-therapeutic opacity persists. Indeed, some cancers





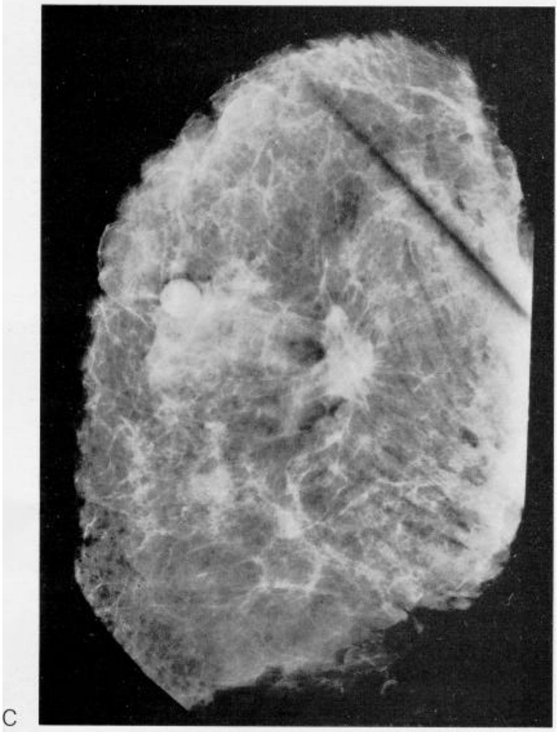


Fig. 1 A-B-C. (A) corresponds to the radiological image of a cancer before treatment. (B) shows the same cancer one year and a half alter irradiation: it remains a residual opacity. (C) shows the X-ray image of the operative site; histologically, the residual image of this cancer corresponded to simple fibrosis.

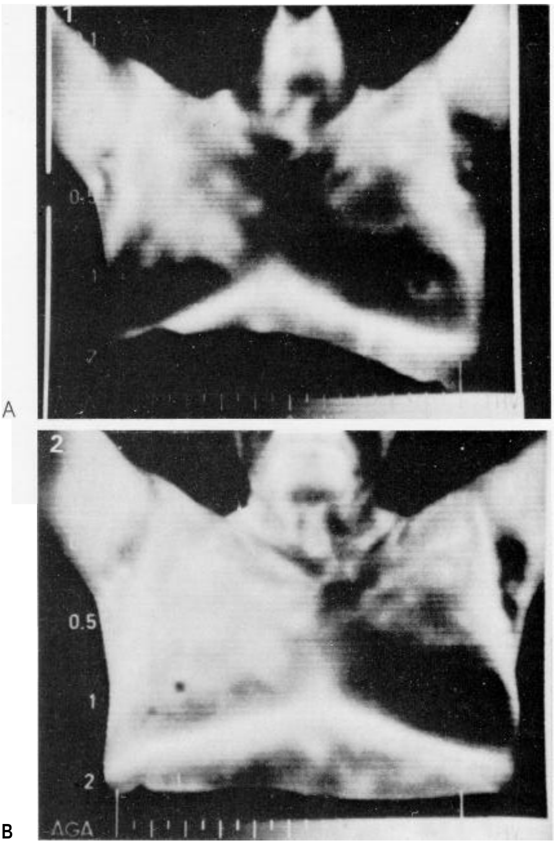


Fig. 2 A-B. (A) **Before** radiotherapy. (B) 6 months after radiotherapy (post-radiotherapic hyperthermias).

- completely sterilized - show a persistent radiological image corresponding to fibrous after effects, but which pose the problem of a possible non - sterilization. These radiological images persist often one year after treatment, sometimes indefinitely. That is the reason why - when the rest of the senological assessment is normal - and when a residual radiological opacity persists, we do not decide on mastectomy before one year. In these particular cases, the normalization of hyperthermias suggests that the residual radiological image corresponds to a fibrous processus (Fig. 1).

The reading of a mammary thermogram after irradiation cannot be dissociated from the knowledge of the pre-therapeutic assessment of the mammary gland (volume, structures) and the cancer (size, radiological, cytological aspect...); on the other hand, it is essential to know all the modalities of treatment (dose distribution in intervals and time: irradiation fields, overdose, spreading, fractioning); finally, it is necessary to know the clinical, and localization, corresponding to the thermogram. Indeed, a number of local or total, systematic or aleatory hyperthermias may be related to the mammary glands characteristics in a given patient, or to the cancer itself or lastly to therapeutic modalities.

1. Systematic hyperthermias

In most cases and in the course of treatment, hyperthermia appears, the topography of which corresponds approximately to the irradiation fields; their intensity varyng from one patient to another, in spite of similar treatment conditions.

The regression of these hyperthermias is fairly fast, but generally slower than that of erythema.

Due to these systematic post-radiotherapic hyperthermias, periodic thermographic examination for follow-up is not performed before the 6th month following treatment (Fig. 2).

2. Casual hyperthermias

These hyperthermias are formed only in certain cases and are due to, either glandular or cutaneous irradiation sequelae (sclero-oedematous spread masses, telangiectasia . . .) or morphological changes (local or complete hallows, retractions of the breast).

As often as not, these hyperthermias are very intensive and persist, even indefinitely; sometimes, they are located in the same area of the breast as the malignant hyperthermias seen before irradiation. The aetiology of these hyperthermias indicates that comparison between the thermographic images and clinical and radiological observations are necessary.

a. ***Sclero-oedematous heavy mass***

These are characterized by the sudden appearance of an intra-mammary painful mass, seated more often than not in an area of overdose of irradiation.

Diaphanoscopy: usually a diffuse veil, in the area of the clinical anomaly.

Thermography: local hyperthermias.

X-ray images: often not significant as the presence of oedema makes the intervention difficult.

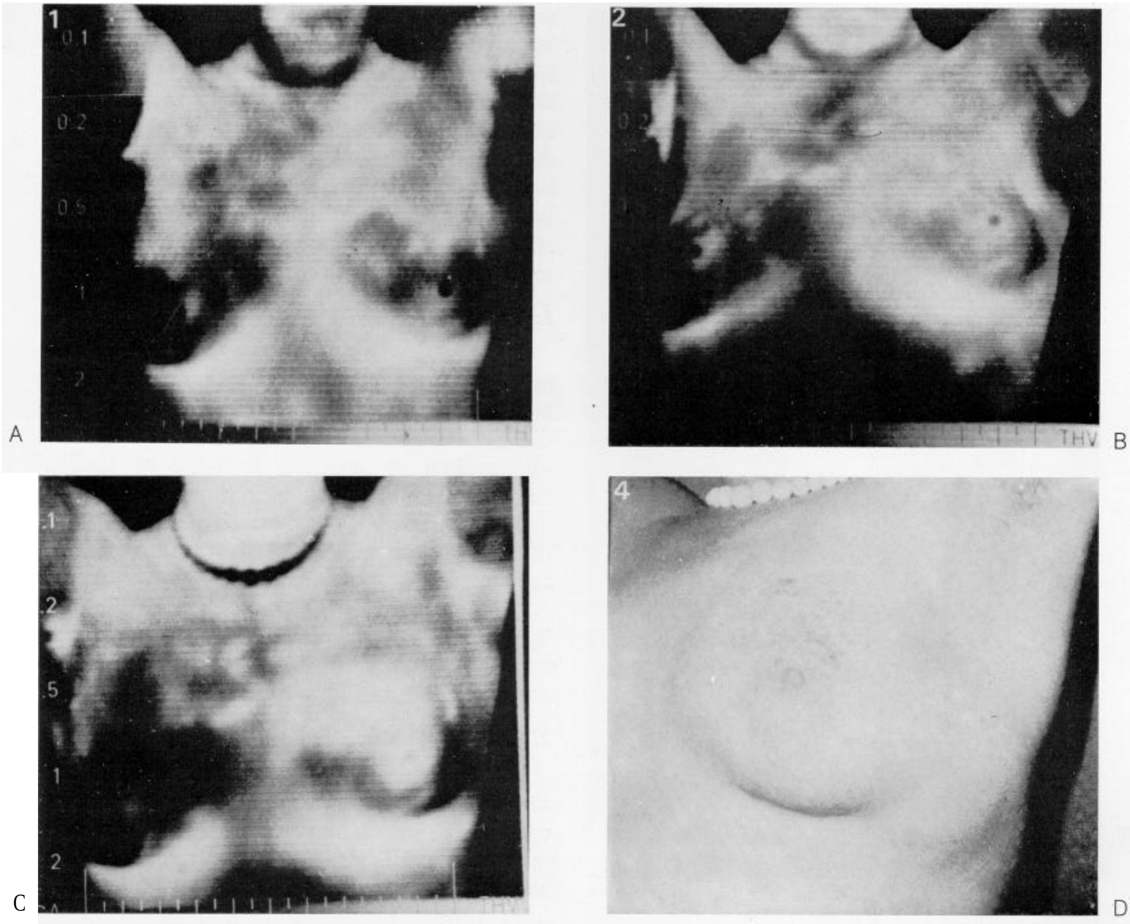


Fig. 3 A-B-C-D. Hyperthermias and telangiectasias. (A) Before radiotherapy. (B) 1 year after radiotherapy. (C) 3 years after radiotherapy: intense localized hyperthermias in connection with telangiectasias (D).

Echography: without anomaly.

In these particular cases, the use of an anti-oedematous therapy for one or two months leads to progressive regression of the clinical symptoms.

b. ***Telangiectasias***

The appearance of telangiectasias after irradiation is accompanied by intensive and persistant localized hyperthermias. Only examination of the patient permits accurate diagnosis (Fig. 3).

c. Retractions

Local retractions, seated in the area of an epithelioma give localized hyperthermias. The total retractions due to therapy in whole produces gross hyperthermia. Generally speaking, cutaneous concave zones are relatively hyperthermal due to a reduction of heat loss by radiation, and by convection between the skin and surroundings. Total retractions lead to some phenomena of hyperthermia for the same reasons of reduced heat loss between the skin and the surroundings.

d. ***Irradiated breast***

In a small percentage of cases < 3%), hyperthermia remission occurs becoming stable later on at a mean level higher than the initial

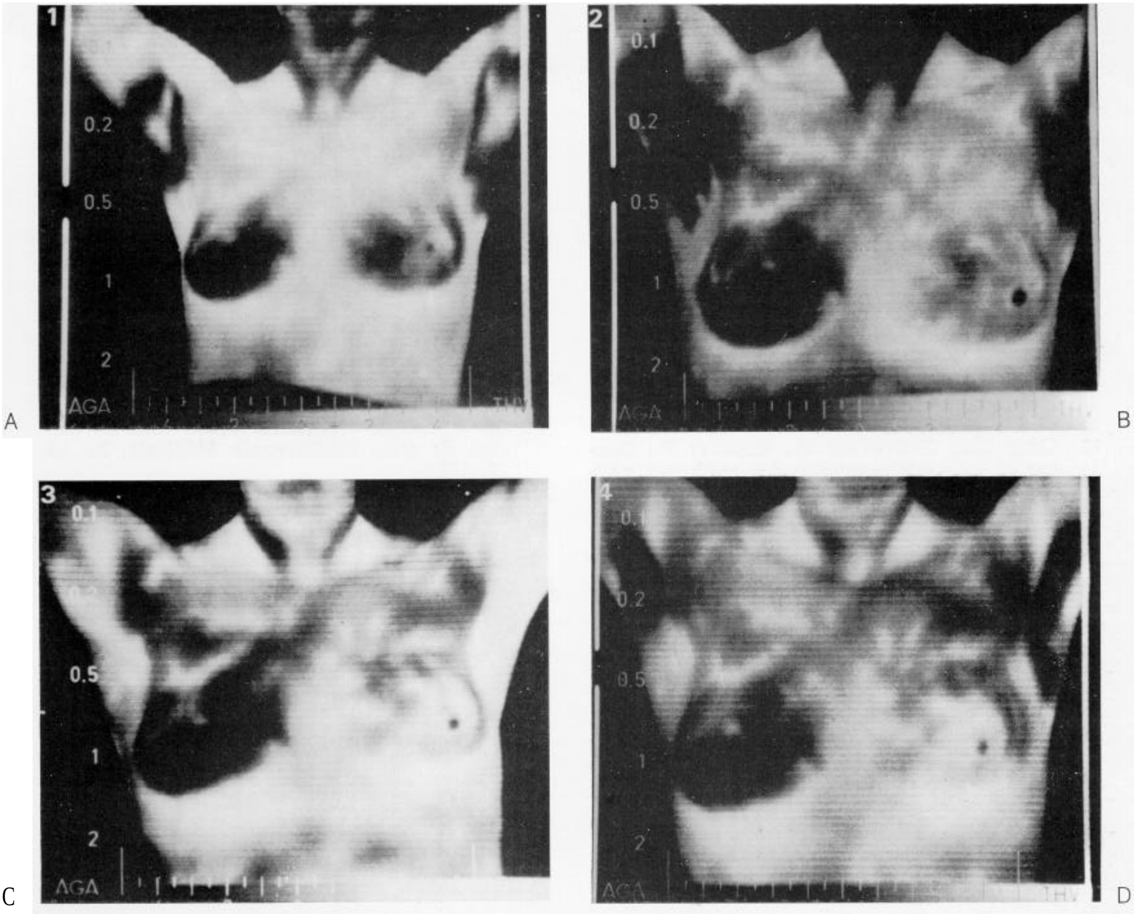


Fig. 4 A-B-C-D. Radiotherapic breast. (A) Before radiotherapy. (B) 1 year after radiotherapy. (C) 1 year and a half after radiotherapy. (D) 3 years after radiotherapy.

level before treatment. The appearance of these anomalies in a perfectly sterilized breast may lead to the same confusion (Fig. 4).

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