Value and interest of dynamic telethermography in detection of breast cancer

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SUMMARY. The authors have studied over than 3,000 microscopically proven breast tumours. From this material of study, they have verified the reliability of their classification into 5 categories. It shows that the rate of false-negatives (9%) and false-positives (9%) is acceptable.
Besides, telethermography used in a combined diagnosis outline (with physical examination, X-ray and cytology) enables to detect 9% of clinically or radiologically benign cancers, 9% of isotherm cancers with a good prognosis and 11% of fast growth cancers, the latter being of a very poor prognosis.

Key words: infra-red thermography, breast diseases, false-negative, false-positive, cancer detection.

To define the value of Dynamic Telethermography (D.T.T.) in breast diseases, we should first make a selection of the *objective measurable parameters* (Table I). It is then necessary to classify the mammary thermograms into categories of *growing diagnostic value* (Table II).

Table **I. Suspicious signs and malignancy criteria.**

Parameters	*Suspicious signs*	*Criteria of malignancy*
Hypervascularization	Asymmetric	Anarchic
Hot spot	***2,5 °C***	***2 3 °C***
Whole breast hyperthermia	2 °C	***>2°C***
Edge sign	Localized	**Extended**

Our usual examination technique is as follows: the patient is unclothed to the waist, raised arms supported by straps avoiding a usuless tiredness. Thorax and axilla and sub-clavicular sulcus are atomized with a cooling liquid which is evaporated in front of a fan for 10 minutes. As usual, one frontal and two left and right oblique views are taken in order to have the outer quadrants and the connection of the mammary skin to the thorax and the axillary sulcus well drawn.

Table **II. Classification of mammary thermograms (Ref. 1, 2, 3 and 4).**

TH1	Normal thermogram
TH2	Thermogram of a benign type
TH3	Suspicious or doubtful thermogram (with one sign of suspicion)
TH4	Thermogram with one malignancy criterion
TH5	Thermogram with several malignancy criteria

In a first analytical time, 4 parameters are considered: the vascularization, the gradient of the local thermal rise (hot spot), the one of the whole breast temperature (full hyperthermia) and, lastly, the regularity or not of the thermal outlines of the breast (edge sign).

According to the importance of the registered abnormalities at these parameters level, we have described 4 *suspicion signs and 4 malignancy criteria* which are exhibited in Table I.

1) The four suspicion signs are:

the vascular asymmetry, that is either an asymmetry of the vascular distribution at

Fig. 1. Isolated hypervascularization of an anarchic type (disturbed vessels, thick caliber). Category *TH4* (adenocarcinoma).

Fig. 2. Stiffness of the inferior thermal outline of the left breast. Extended *edge sign. Category TH4* (carcinoma of a scirrhus type).

the breast level (the vascularization was clearly more marked on one side) or a caliber vessel asymmetry. The caliber was thick on one side (Fig. 5).

the hot spot (of less than 5 cm² area), the thermal gradient of which compared to the symmetric area being equal to 2.5°C. We have selected 2,5°C as a *significant themal threshold* for it is exactly the average and the median of our 1,000 first mammary carcinomas thermal rises (gradients measured and compared to the surrounding healthy tissues or AT).

the whole breast hyperthermia, that is a diffuse hyperthcrmia covering the whole breast by +2°C.

the localized edge sign, not extending the quadrant.[5]

2) The four malignancy signs are:

an anarchic hypervascularization, that is disturbed, disorganized and not systematized (Fig. 1).

- a hot spot by 3°C or above (Fig. 6).

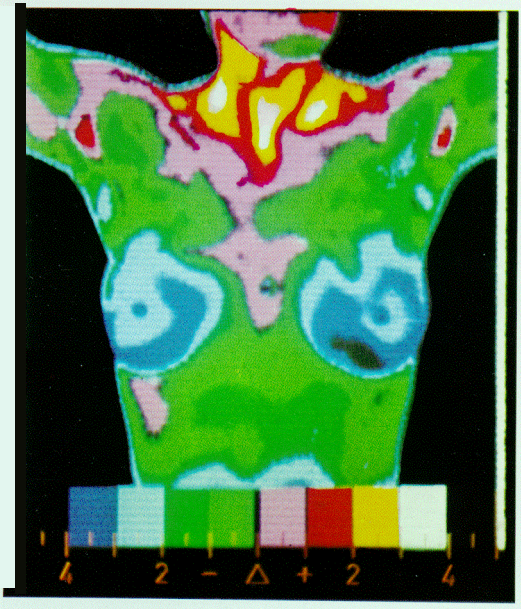

Fig. 3. Thermogram of a normal type. Cold. isothermal breasts, without any vascularization. Category *TH1.*

Fig. 4. Thermogram of a benign type. Bilateral and symmetrical hypervascularization without abnormal thermal emission. Category ***TH2*** (bilatcral mastosis in this instance).

- a whole hyperthermia of a breast by +2°C.

- an extended edge sign covering more than one quadrant (Fig. 2). There is evidence that the edge sign is an indirect thermographic sign but it is often better seen on the thermogram than at physical examination.

In a second synthetical time, we classify the thermovisual mammary images into five categories (Table II and figures from 3 to 8).

Our current experience is supported by 25.000 mammary thermograms, 3097 of which being carried out for tumors which have been *confirmed rnicroscopically,* later on. Amongst those, we count 1878 *cancers,* all having had previously a physical examination, an X-ray film, besides thermography and microscopic examination. It is the result of this *quadruple confrontation* which forms the subject of the present report.

We specify that a systematic screening is not involved here but a continuous series of 1878 women bearing a breast cancer. The

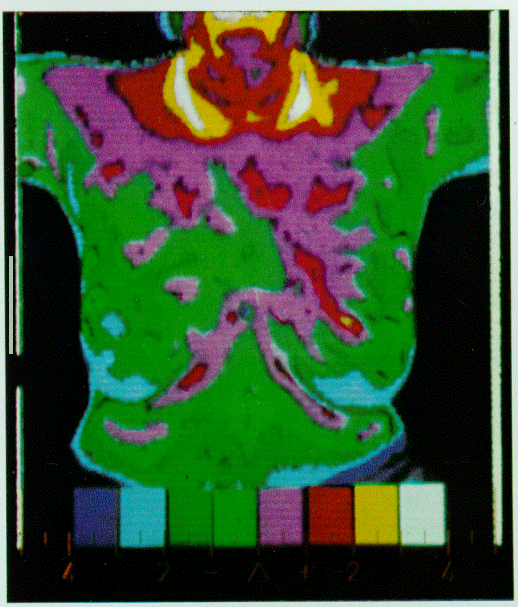

Fig. 5. *Suspicious* thermogram. Unilateral, asymmetric hypervascularization. *Category TH3* (adenocarcinoma in this case).

Fig. 6. Thermogram with one malignancy sign only: a hot spot of 4 °C on the left. *Category TH4* (confirmed adenocarcinoma).

Fig. 7. Thermogram with several criteria of malignancy; hot area of 5 °C with an anarchic vascularization. *Category TH5* (adenocarcinoma).

Fig. 8. Fast growing cancer of the right breast, in evolutivc phase, hyperthermia ot 8 °C, exceeding the breast limits; *Category TH5* PEV.

consultation was justified due to a mammary functional and/or physical sign.

The study of these 1878 cancers distribution, according to our classification, shows that there were 9% of all the cases which appeared under falsely normal or falsely benign thermovisual pattern (THl or TH2). These are the telethermography *false negatives.*

Opposite to it, there were one or several thermal malignancy criteria (TH4 or TH5) in 71% of the studied cancers; these are the actual positives (Table I I I).

Hetween these two clearly divided groups, we find in 20% of cases thermograms of a *TH3 category* being only suspicious or doubtful. We have searched for the real *meaning* of this image type: out of 644 palpable tumors, showing a thermal suspicion sign, a microscopical verification has evidenced 376 existing cancers, i.e. 58% of cases. In these terms, we can say that more than once out of *two,* a *palpable* tumor showing a TH3 image is a cancer; therefore, we cannot neglect this category of thermograms.

Table **111. Distribution of 1878 mammary carcinomas according to their tbermovisual category.**

	N. cases	*%*	
THl	15	<1%	= 9% of false-negatives
TH2	151	8%	
TH3	376	*20%*	=20% of suspicious or doubtful
TH4	*626*	33%	=71% of real positives
TH5	710	38	
	1878	100%	

This distribution of cancers in 5 thermovisual categories varies considerably, depending on the *clinical extension* of the examined cancer.

Indeed, if we consider all the cases, the abnormal thermographic rate (TH3 + TH4 + TH5) is 91% (Table IV). If we only look at the advanced cases of the International Union Against Cancer, T3 and T4 categories, this rate reaches 97 to 99%. If we apply to cases a little advanced of T2 categories (between 2 and 5 cm in diameter), this same rate is 90% and, lastly, for the Tl category (up to 2 cm in diameter), it falls to 71% only. This means that we can have up to *29% of false negatives of telethermography in small size cancers* and this notion has to be kept in mind for the mass screening tests.

Table IV. **Distribution of tbermovisual categories in terms of the examined cancers clinical extension.**

	I. U. A. C.				
	T1	T2	T3	T4	
TH1 +TH2	45	103	16	2	166
TH3+TH4+TH5	113	904	504	191	1712
	158	1007	520	163	1878
TV>0	71%	90%	97%	99%	91%

After the false-negatives, we have systematically searched for the falsely positive results of telethermography owing to the microscopical verification of the quasi-totality (96%) of cases showing one or several thermal malignancy criteria.

Out of 1473 controlled images TH4 and TH5, the *false-positive total rate is 9%* (Table V); it reaches 15% when there was only one malignancy criterion (category TH4) and it falls to 4% when there were several malignancy criteria (category TH5).

To get rid of these false-positive and false-negatives of telethermography, it is absolutely necessary to use this method, solely in the *combined diagnosis outline,* besides the clinical examination (essential) and the X-ray (with molybdenum anode).

Which is the place of telethermography in the balance of a mammary disease?

For us, telethermography takes place immediately after the interrogatory examination: it is followed in all cases by an X-ray film (localized on the eventual thermal abnormalities, reference marked on the skin).

Table V. **False-positive rate of telethermography.**

	Positive fhermography	***False-positive***	***Rate***
	1473	137	9%
One malignancy criterion TH4	733	107	15%
Several criteria TH5	740	30	4%

A complete, methodical, physical examination is then performed after having enquired into the thermographic and radiographic images.

Finally, when a palpable tumor is found, we make a needle aspiration biopsy and if it involves a cyst, a pneumo-cystography to

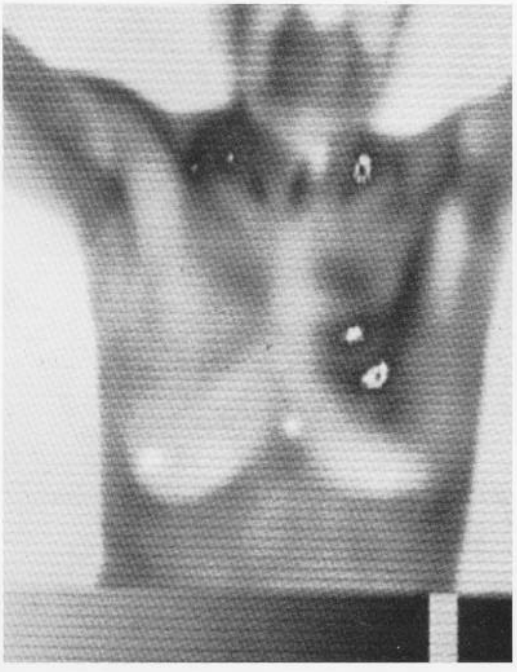

Fig. 9. Bifocal mammary carcinoma with 2 well apart hot spots at the level of 2 palpable nodes (confirmed microscopically).

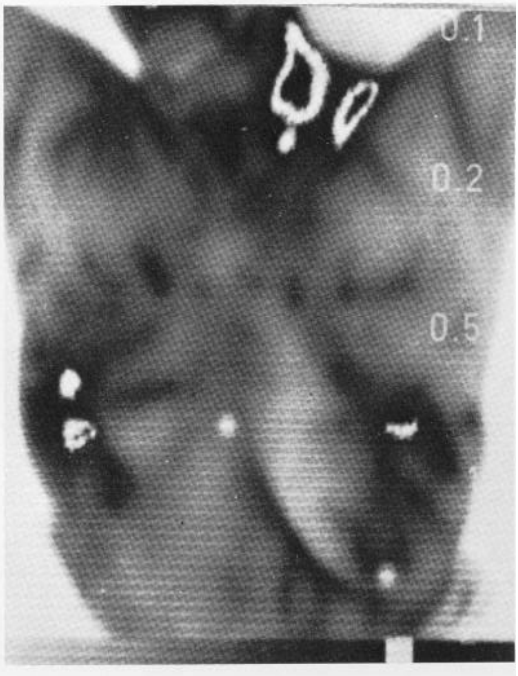

Fig. 10. ***Synchronous bilateral mammary carcinoma.*** Clinically obvious on the right, subclinical on the left. (Positive microscopic verification on both sides).

verify the regularity of the internal walls.

The advantage of this *quadruple diagnosis* (« Tétrade ») is triple:

1. All these non-bloody examinations may be performed in 2-3 hours in a specialized medical department (Senology Unit) with no need to resort to surgery in every case.
2. The reliability of this quadruple examination reaches 99%, each method being able to avoid the plus or minus errors of the others.
3. This systematic quadruple confrontation has afforded us to evidence owing to *infrareds* ***176*** *sub-clinical or occult cancers.*

Indeed, out of our 1878 mammary carcinomas, we count:

- 2 1 non palpable microcarcinomas
- 75 clinically benign cancers
- 80 radiologically benign cancers, that is 9% of our cancers (176/1878).

All these cancers showed thermal abnormalities sufficiently evocative to formally indicate an excisional biopsy.

- Our *21 non palpable carcinomas* with 3-5 mm in diameter have been evidenced owing to a wide wedge resection centered on the thermographic data and then by an X-ray film of the operative part.
- Our 155 *occult cancer,* with an average diameter of 10 mm, have been localized, due to an apposite abnormal thermal emission; once out of two, they were localized amongst other really benign nodes, palpable or visible on the X-ray film.

In all these small size mammary carcinomas, thermography may bring an original alert and encourage their accurate radiosurgical tracking for their histological identification.

Besides the detection of breast cancers themselves, telethermography may bring information of importance regarding the detection of *their real extension and evolutive potential.*

As a matter of fact, in our statistics, the infra-reds have shown:

- a plurifocality of lesions in the same breast, in 42% of cases (Fig. 9); by plurifocality, we mean: no several separate spots or hot areas well individualized inside a same breast.
- a synchronous bilateral cancer at the first examination in 4% of cases (Fig. 10).
- a metastatic lymph node in 30% of axillas;
- finally, at distance metastases, at the first balance, in 5% of cases.

We could evidence these last ones owing to telethermography of the whole body (at 6 meters distance or at 3 meters with a normal 15" lens by taking successively the upper half, then the lower half of the subject). This « total body thermography » has even shown us quite a few numbers of subclinical, cutaneous, sub-cutaneous or bone metastases; it can also evidence secondary, pleural, mediastinal, choroidian or hepatic localizations.

But it is mainly in the *fast growing cancer detection* that telethermography may be the most helpful. We know that a lot of mammary carcinomas (10 to 20% according to the statistics) may show growths or « evolutive phases » and that, in these cases, any at once surgical action may come along with early local recurrences and be exceeded by a fast generalization (Fig. 8).

We may suspect the existence of such evolutive growths, during the interrogatory (when a tumor increases in volume rapidly) or during the physical examination (breast oedema with pink skin or carcinomatous mastitis in the extreme cases).

But telethermography allows to make them appear by showing a very extended hot area (covering the whole breast or even exceeding it, while the palpable tumor is relatively limited) with a very high thermal rise (from 4 to 14°C).

Differences in temperature which may appear unbelievable have been verified with absolute temperature measurements. However, it has to be specified that the opposite normal breast was often very cold explaining partly that such high gradients could be obtained; that is what we call the « too hot » cancers (Fig. 8). We have met 11% of them in our statistics and 17% of these fast growing cancers had no clinical translation.*

The identification of these cancers in evolutive phase, before any treatment, is essential for the choice of therapeutics and prognosis. Effectively, since Llyod-William's studies,' we know that there is a *thermal prognosis of breast cancer,* the five-year survival rate being inversely proportional to the thermal rise importance.

Table VI. Thermal prognosis.

Cancers	*N. cases*	*Failure at 3 years*	*Alive*
Hyperhot: 4°C and over (fast growing cancers)	25	19=76%	24%
Cold cancers: 0 to 2°C (false negatives)	20	4=20%	SO%

Very lately, Jones et Al.6 has shown that the 3 years-survival of breast cancers (Stages II and III) with thermal abnormalities was clearly inferior to those of cancers at the same stage with normal thermogram (61% against 84%).

This difference increases considerably if we compare as we have done (Table VI),

the cold cancers and the hyperhot cancers (Stages II and III gathered).

- the « cold » cancers are the false-negatives of telethermography, their thermal rise is no more than 2°C and their prognosis is good: 80% of 3 years - survival.
- the « *too hot* » cancers (4°C and above) are the fast growing forms and their prognosis is very poor: 24% of 3 years survival.

In the *positive diagnosis* of breast cancers, thermography gives between 9 and 29% of false-negatives and in another connection 9% of false-positives. We must be fully aware of this method limits which may misknow a palpable cancer or, on the opposite, see a non palpable cancer...

Thermography should not be used alone, it must enter a combined diagnosis outline where the mutual diagnosis safety is ensured, each method having different error causes.

At this price, the errors, before any histological control, are reduced to less than 1% and telethermography may give all its measure beyond the positive diagnosis; indeed, on our 1878 confirmed cancers:

- 9% could not be identified, neither by physical examination, nor by X-ray: they have been detected or localized owing to infra-reds only.
- 11% had an excessive thermogenesis which constitutes an alert often original in fast growing cancers and a prognostic touch independent to the volume (poor prognosis).
- 9% had no cutaneous thermal manifestations (potential good prognosis).
- 5 % , finally, showed on at distant metastasis on the first examination, evidenced by the corporeal thermography.

In total, Dynamic Telethermography provides original data in 3 cases *out* of *10* (34%).

Functional test, thermography will still ask the physicians more work, carefulness and imagination. Through its cutaneous thermographic manifestations, the cancer betrays a reflexion of its thermo-kinetic behaviour.

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