Thermography of thyroid body. Technique, semiology and classification of thermographic images

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SUMMARY. The joint study carried out by 9 French Cancer Centres is based on thermography in hypo- or non fixing scintigraphically and solid echographically thyroidal tumefactions. It only covers cases confirmed histologically.

It defines a tbermographic technique and produces a semiology of thermographic images, Finally, the various signs are gathered in a classification which takes into account their respective value in order to obtain 5 classes from THl to TH5, which became increasingly suspect, in the carcinological field,

Key words: thyroidal thermography, technical data, hypofixing nodules, thyroidal cancer, thermographic semiology.

From the beginnings of thermography, it was clear that this technique would find an important place in thyroid pathology and confirm the publications from the Strasbourg (Pr. Gros) and Tours Groups (Pr, Planiol). Indeed, the thyroid is a symmetrical organ, superficial enough to enable, through the skin, thermal emissions to be easily detected; and the function or pathology should be interpreted into significant thermograms.

Thyroid thermography has not made such great strides as mammary thermography. First of all, this is due to technical conditions which make the interpretation of images harder: shortening of the organ, difficulty in isolating it entirely from other cervical structures, and changeableness of the vascularization etc. It is also due to the fact that the number of examinations is less which makes the statistics less significant. For example, at the Nantes Cancer Centre, in 2 years (1975-1976), we have performed 2210 mammary thermograms and only 285 thyroidal thermograms.

As in any statistical study, we can only take into account cases proven histologically; we find ourselves again with modest figures (out of the 285 thyroidal thermograms, 100 only having had a histological confirmation). The idea of gathering statistics from several Centres enable us to reach more significant figures. But for this, we must speak the same language, that is:

1. define the limits of the study: we have chosen the scintigraphically hypofixing and full echographically thyroidal tumours (since it is in those tumours that cancers are recruited).
2. use a standardized thermographic technique.
3. adopt a perfectly univocal classification of images in order to permit the assembly of results. This was done by thermographers from 9 French Cancer Centres and the results of that joint study are described.

TECHNIQUE

The patient, neck exposed, undergoes a cooling of about 10 minut,es in the thermography room. Cooling may be completed by a ventilation on the neck but is not essential. The examination field is delimited by 3 reference markings placed on the protrusion of thyroid cartilage; the two others on the sterno-clavicular joints horizontally at 2 or 3 cm below the suprasternal notch. The thyroid being practically in the middle of this triangle, we can limit examination to the area thus defined.

The first part of the examination is a *mor-*

phological study in black and white. We usually take front views, except for very large lateral tumours where we can also take oblique or profile views. We personally use, by analogy with the breast, the inverted image (that is warm in black, cold in white) but this choice is left open.

The second part of the thermographic study is a *quantitative coded study*. Usually, a colour slide with the scale in degrees is sufficient but more frequently we specify an image on a half-degree negative with isotherms in black or in colour.

The thermographic examination of a thyroid tumour includes a third stage: *the reference marking* of *the tumour*. The periphery of the nodule is individualized on a special slide with a wire or a circle with metallic reference marking in order to make it visible. The reference slide marking is performed at the end of the examination to avoid disturbance by a undue palpation or a too bulky and objective disturbance of the thermal equilibrium of the area.

NORMAL THERMOGRAPHIC IMAGES

A first rule is to be established; the normal parenchyme is functionally and morphologically indicated in relation to the surrounding area by an obvious thermal difference, the normal thyroid has no thermographic image.

It is localized in an area where some bulging structures show if they are cold (for example: the laryngeal bulging, the light stripes of Sterno-mastoideals and where some hollows appear in dark by a wash-basin appearance; sub-sternal and clavicular hollows).

There are in the area, large venous vessels which show *vascular images* in the form of hyperthermal sulcuses: they are mainly the external jugular, internal jugular along the Sterno-cleido mastoid and more rarely the anterior jugular. But there are important individual changes in normal vascularization. The vascular sulcuses are generally not very pronounced in women, principally in old women. On the contrary, they are very marked in young men, particularly in sportsmen. Perfect symmetry is rare. It occurs frequently that an internal jugular can be well visible on one side and not obvious at all on the other side. Sometimes, the vascular thermal pattern spreads out in patches, at other times, the vessel is broken down.

Therefore, we will have to be very definitive to confirm simple hypervascularization, that is for vessels having normal topography (Fig. **1).**

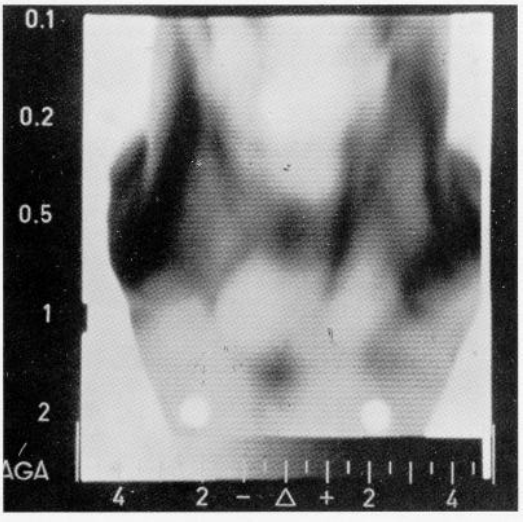


Fig. 1. Normal thyroidal thermography. The thyroidal area is not the centre of a notable hyperthermia. External jugulars are visible and also partially the left internal jugular.

ABNORMAL THERMOGRAPHIC IMAGES

As always in thermography, they are of two types: a focus of hyperthermal images and abnormal vascular images.

I) Focalized hyperthermias

They translate the localized or non-localized increase in the metabolism by physiological (hyperthyroiditis) or tumour, benign or malignant alterations.

1. *Morphological study*

This involves the form and dimensions of the hyperthermal area compared to the tumefaction.

Whether that hyperthermal areas and tumefaction (reference marked with circling) coincide (Fig. 2).

Or that a part of the tumefaction is hyperthermal which is very frequent.

Or, on the contrary, that a warm area ex-

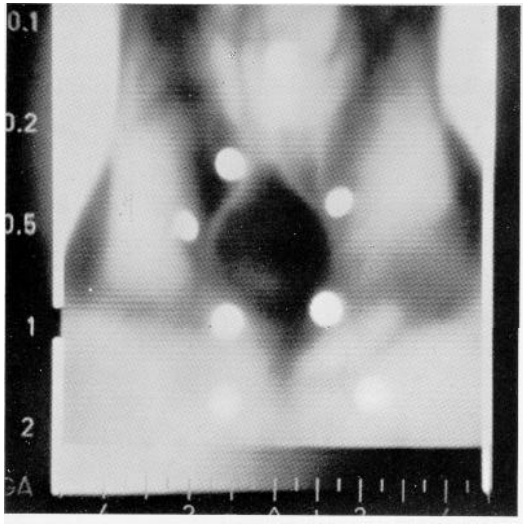


Fig. 2. Focalizcd hyperthermia extending to the tuniefaction.

ceeds widely the limits of the tumefaction and diffuses to the whole thyroid and even to a part of the cervical area.

2. Quantitative study

By analogy with mammary thermography, we should theorically contemplate several criteria:

Δ1: thermal difference between the hottest spot of the tumefaction and the healthy thyroid

Δ2: thermal difference between the hottest spot of the tumefaction and the symmetrical thyroid point

Δ3: thermal difference between the hottest spot of the tumefaction and extra-thyroidal reference marked point.

In fact, Δ1 and Δ2 seem difficult to measure separately: as the thyroid is a too exiguous organ taking into account the definition of colour isotherms - for the tumefactions are often median or too big not to exceed the median line - as the thermal difference between Δ1 and Δ2 is most of time small.

We have thus resigned ourselves to a joint criterion Δ1-2 that we call Δ1 to simplify.

The Δ3 extra thyroidal reference point has been chosen at the sternum level at 3 cm above the notch, that is practically between the two lower reference marking, then easily seen on the colour thermographic slide.

II) Abnormal vascular images

We discovered that cervical vascularization was capricious in its importance and symmetry and that we had to be very careful to assert a hypervascularization when the vessels had a normal topography. The anarchic hypervascularization alone can be noticed, that is when the vessels have not the usual course; the realized patterns may then be changeable - striated - in sunbeams -

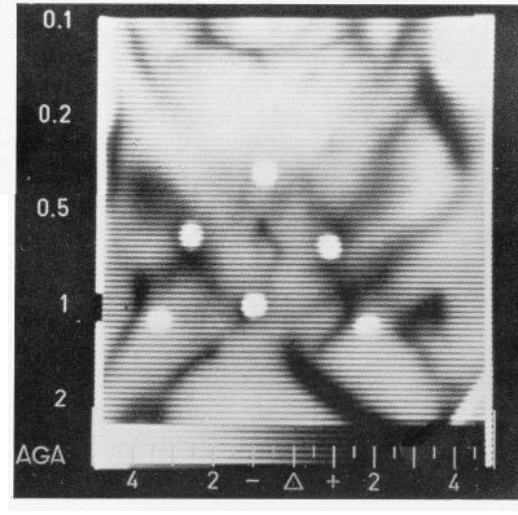


Fig. 3. Abnormal vascular images. Vessels converging towards the tumefaction.

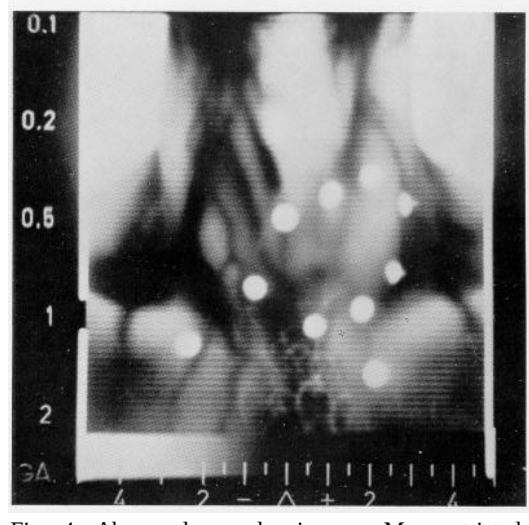


Fig. 4. Abnormal vascular images. Many striated vessels heading to the infero-internal pole of the tumefaction.

in medusa head. Sometimes, the pattern is that of a hyperthermal stripe around the tumefaction; this hyperthermal crown can be related to a wash-basin appearance, but sometimes also to peritumorous vascular phenomena, and this image has appeared to us to have some diagnostic importance for it is often observed in cancers (Figs. 3 and 4).

CLASSIFICATION OF THERMOGRAPHIC THYROIDAL IMAGES

As almost always in thermography and in particular in mammary thermography, the classification that we have tried to settle is a classification into 5 figures from THl to TH5. What is the relative importance of the various criteria? As for the breast, let us contemplate the focalized hyperthermias and the vascular images:

I). Localized hyperthermias - value of coded data - value of A 1

In a study carried out in Nantes, 2 years ago, based on 70 histologically confirmed tumefactions, the following is the ratio of cancers in terms of Δ1 (Tab. I).

Then, when the tumefaction is isotherm,

Tab. I. 70 histologically verified tumefactions - Percentage of cancers in terms of A **1.**

	Verified tumefactions	*Cancer*	*%*
Δ1 <1 °C	31	2	4
Δ1 between 1 and 3°C	31	11	35
Δ1 >3 °C	8	8	100
In total	70	21	30%

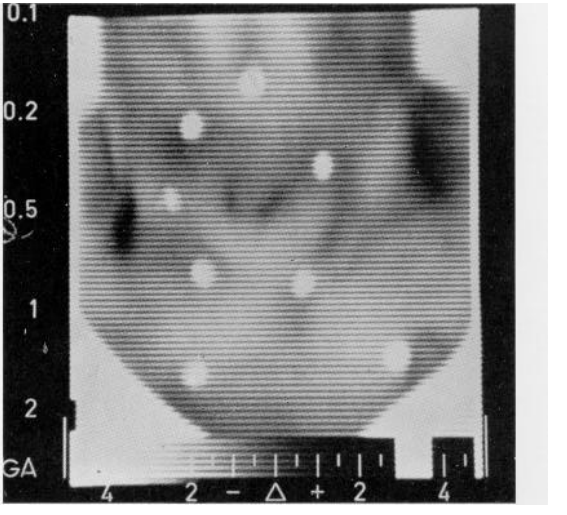
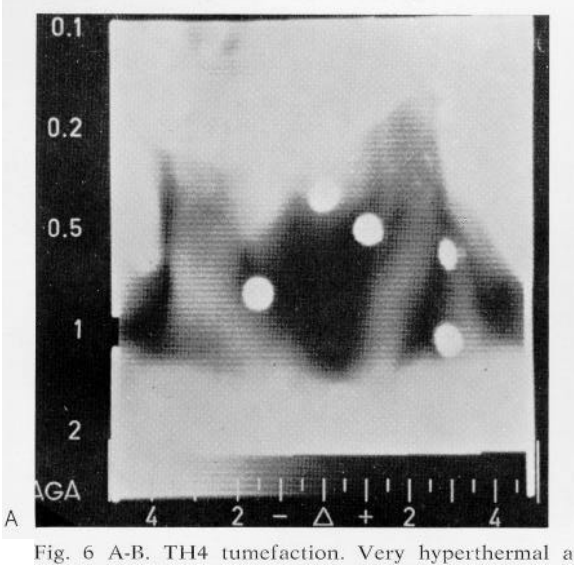
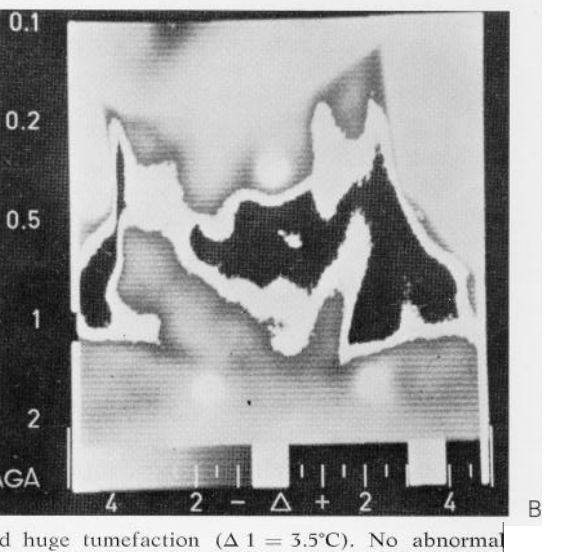


Fig. 5. TW1 tumefaction. No hyperthermia of the tumefnction. Any abnormal vascular image.

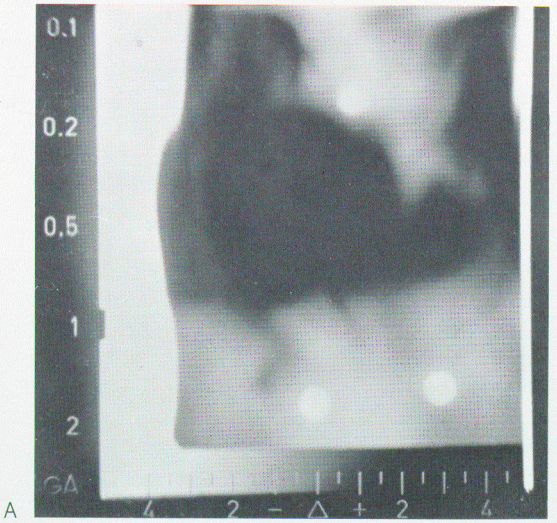


A



B

Fig. 6 A-B. TH4 tumefaction. Very hyperthermal and huge tumefaction (Δ 1 = 3.5°C). No abnormal vascular image.



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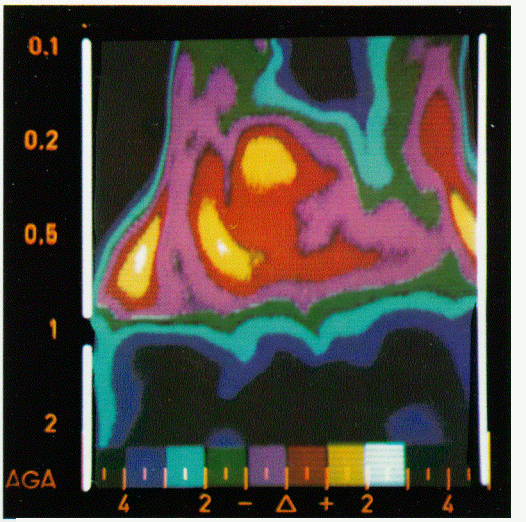

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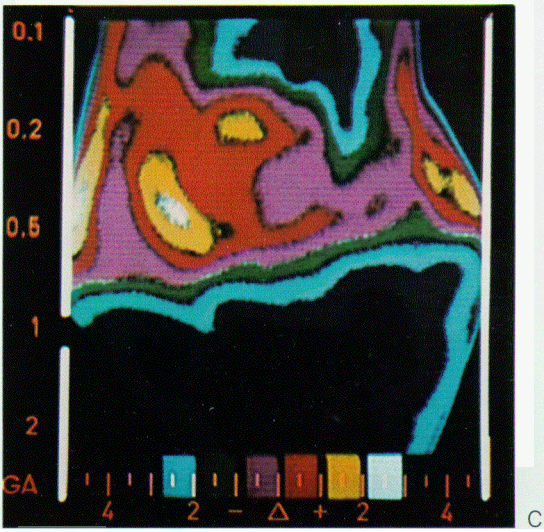

C

Fig. 7 A-B-C. TH5 tumefaction. Very hyperthermal and large tumefaction: $\Delta 1 = 4\,°C$ $\Delta 3 = 6\,°C$. Small abnormal vascular images.

it has few chances to be a cancer (4%).

When the thermal difference between the tumefaction and the healthy tissues is superior to 3 °C, it has all chances to be a cancer.

Between 1 and 3 °C, we may conclude.

But, of course, we can only set one criterion into action. Which is the value of $\Delta 3$?

$\Delta 3$ value

From a study carried out by Laurent and Naja, on some fifty normal individuals, it is clear out that $\Delta 3$ is always inferior to 3 °C. Above 3 °C, $\Delta 3$ may be contemplated as pathological.

II) Abnormal vascular images (AVI)

We would have lilted to allot them the same value as mammary thermography, but we have already said that due to the frequency of vascular asymmetries in a normal state, we could not consider the vascular anarchy as abnormal that is when vascular images had an unusual topography.

What is the frequency - the value - of

these vascular images with an abnormal topography?

In the Nantes statistics, we counted: 141 hypofixing, full, confirmed nodules, 42 of which were cancers.

Out of these 141, 47 had vascular abnormal images with 30 cancers and 17 adenomas.

We may conclude from this that AVI are quite frequent: 1 out of 3 examinations (47 out of 141); show that 2 cancers out of 3 show abnormal vascular images (30 out of 42) and that in the presence of such images, we have 2 chances out of 3 that it involves a cancer (30 out of 47).

CLUSTERING OF VARIOUS CRITERIA

We have tried to gather these 3 criteria in the classification: Δ1 - Δ3 and AVI taking into account their respective value and the diagram which has been taken up follows. To each criteria some figure is alloted:

When Δ1 is inferior to 1 °C, the figure alloted is 1

When Δ1 is between 1 and 3 °C, the figure alloted is 2

When Δ1 is superior to 3 °C, the figure alloted is 3.

When Δ3 is inferior to 3 °C, the figure alloted is 0

When Δ3 is superior to 3 °C, the figure alloted is 1.

AVI

When there is no AVI, the figure alloted is 0

When there are AVI, the figure olloted is 1.

The addition of the figures (Δ1+Δ3+AVI) gives the figure of the TH classification.

For example:

Δ1 hyperthermal tumefaction 2.5 °C

Δ3 hyperthermal tumefaction 2.5 °C

and including abnormal vascular images = TH3 (Figs, 5, 6, 7).

CONCLUSION

In the preamble to Dr. Naja's report, we have thus defined successively:

- the area of our study
- the thyroidal tumefaction translated scintigraphically by a lacunar image corresponding to a hypo- or afixation of the solid consistency tracer to echography and then verified surgically
- the thermographic' technique used
- the thermographic normal or abnormal image
- a classification taking into account the various thermographic signs and their relative importance.

Now, there remains the outcome of this study and the inferences which may be drawn from the value and interest of the method. This will form the subject of the second report.

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