Determination of thyroid nodules malignancy with combined techniques

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SUMMARY. The author recommends a combined exploration of the thyroid by 3 methods: scintigraphy (131 cesium), ultrasound (mode A) and thermography (infrared) always with a physical examination.
The thermographic criteria retained are: configuration of thyroid body, symmetrical or asymmetrical pattern of vessels and a thermal rise equal or superior to 1 °C.
Of 33 cancers verified histologically, 16% had a local increase in temperature inferior to 1 °C while scintigraphy alone produced 7% of false-negatives.
Furthermore 108 hypofixing nodules (benign or malignant), 3,7% only had in thermography a local temperature rise above 1 °C.
The combination of these 3 methods provides an accurate diagnosis (in 100% of cases).

Key words: infrared thermography, thyroid, cancer, hypofixing nodules.

The evaluation of cancer risk in the nodular disease of the thyroid gland presents a problem. It is necessary to eliminate unnecessary surgery and often, a radical thyroidectomy, in cases of benign pathology.

There are certain essential aspects of thyroid pathology. The morbidity difference between the sexes contrasts with the small discrepancy in the mortality figures. The female/male ratio for death from cancer of the thyroid is 1: 1.5 in the U.S. while in the same country the morbidity rate is three times greater in women; although more frequent than in men it has a less malignant biological character and therefore gives lower mortality figures, nearer to those for men.

Thyroid metastatic tumours are found in breast, lung, kidney, rectum and sigmoidal colon cancers, reticulum cell sarcoma and lymphosarcoma.

Cancer of the breast has the most common metastatic lesion in the thyroid, as it has been found at autopsy in 30 per cent of patients who died of breast cancer. Not infrequently, cancer of the lung, usually of the bronchogenic type, metastatizes in the thyroid.

Malignant tumours derived from follicular epithelium may be differentiated or undifferentiated. The first type (differentiated tumour) is multifocal, encapsulated, invades veins, rarely involves lymph nodes and, less frequently, metastatizes in the bones.

The papillary carcinoma is used as the first type. Follicular carcinoma has high incidence in a goitrous area and papillary carcinoma is high in areas with a high dietary iodine.

Anaplastic carcinoma of the thyroid is a tumour with an extremely rapid growth. The differentiated papillary and follicular carcinomas have about a five-year survival rate.

A minority, (between 5% to 10%) of the thyroid carcinomas are derived from the parafollicular cells.

In the evaluation of high-risk groups, relative to thyroid cancer, it is necessary to evaluate these factors: endemic goiter, malignant transformation of the thyroid adenoma, ionizing radiation and hormone dependence.

Each group is well known.

The hypothesis for malignant transformation of thyroid adenoma

The following observations can be made:

1. that in many cases of carcinoma the patients have had a nodule or a thyroid struma for years or even decades.
2. that in certain endemic goiter areas, thyroid cancer is more frequent than in non endemic areas.
3. histological records exist of cases in which areas of cancerisation were present in thyroid adenoma.

Ionizing radiation can be an initiating factor in the onset of cancer

1. small doses of Ir^{131} (l-5 μ c) lead to formation of thyroid tumours.
2. optimal doses of radiation can act either as mutagenic agents or as a stimulus inducing a greater incretion of TSH following the partial destruction of the thyroid.

The hypothesis of hormonal dependence of the thyroid cancer depends

1. on higher incidence in geographical areas with endemic goiter.
2. the increase in cells with thyrotropic secretion in the hypophysis of patients with thyroid cancer.
3. stimulation of this increase by induction of a hypothyroid state in patients with thyroid cancer.

Carcinoma of the thyroid in Hashimoto's disease

Of all the various pathogenetic hypotheses, the most likely is the one which attributes the most important carcinogenic role to the excessive stimulation of TSH on the little thyroid epithelium present.

How can a benign nodule be distinguished from a malignant one?

The theory that thyroid cancer occurs more frequently in areas with endemic goiter has been demonstrated, although many observations do not favour this theory.

The nodule is more commonly observed in the thyroid when pathological. It can be single or multinodular.

Scintigraphy was used originally for thyroid pathology. The radium isotope most employed now is I^{131}; although this isotope gets fixed generally in normal tissue, it is not able to define exactly the limits of a tumour.

The thyroid cancers, including the most differentiated forms, have not the capacity of fixing the iodine, and for this reason, neoplastic tissue generally appears as a cool or less fixing area.

The introduction of cancer-marking radioisotope improved the possibility of the diagnosis of cancer: the tumour shows an increased fixing area, but also in these cases, there can be faults (Tab. I).

Tab. I. **Causes of misinterpretation by using Cs^{131}.**

False negative:
Too small lesion.
Less fixing of Cs^{131} for slow growth tissue.
Necrosis.
Antitumour drug or ionizing radiation.
False positive:
Recent cicatrix.
Traumatic or benign lesion.
Flogosis.

The radio isotope, used more frequently in our Nuclear Centre, is Cesium 131. In summary, thyroid scintigraphy clearly has limitations.

Echography has proved to be of increasing interest in recent years. The introduction of the Grey Scale System has permitted diagnosis by ultrasonics. The Grey Scale System is the most sophisticated and produces displays with an enormous amount of tissue structure information. It gives a Grey Scale display where the echo intensity is represented by various shades of grey on the screen. We propose a classification according to type of echoes and characteristics of the nodule (Tab. II).

Thermography is the most recent instrumental technique. The value of thermography has been demonstrated by many authors.

It is necessary to recall the thyroid anatomy in order to establish the limits and the possibilities of this method. The normal thyroid gland is almost always asymmetrical. The right lobe may be even twice as large as the left one. A pyramidal lobe is present in at least 15% of the population. When the isth-

Tab. II. Classification of thyroid ultrasonic tomography.

Structural features	*Echoes of distal wall*	*Echoes of deep tissues*	*Type of lesion*	*Class*
Nodules with liquid content Area of acoustic vacuum No echoes also at hight amplification Marked marginal delimitation	*Strengthened*	*Amplified*	*Thyroid cysts* *Cystic strumal abscess*	1st
Nodules with mixed content *Semisolid structure* Transonic area of acoustic blank, which is not total. Scant, isolated echoes.	*Strengthened* Possible lateral acoustic shadows	*Amplified*	*Cystic or haemorrhagic strumal phlegmons*	2nd
Nodules with homogeneous solid content Well delimited transonic area Uniformly distributed echoes not much numerous, regular also at average amplification	*Regular* Possible lateral acoustic shadows	*Present*	*Simple strumal adenomas*	3rd
Nodules with dishomogeneous solid content Not well delimited transonic area	*Absent or reduced*	*Disappeared Reduced*	*Carcinomas*	
Rough, disordered echoes, confluent into spots, with alternation of hyperreflecting and blank zones	Presence of median acoustic shadow		*Ligneous Thyroiditis*	4th

mus fails to fuse, the medical aspect of lateral lobes may be tumour-like.

The sternocleidomastoideal muscles may, in part, cover the thyroid lobes. The lateral regions are crossed by a hot line which corresponds to the external jugular vein. Thermographic patterns can present asymmetrical vascularization for compression from the thyroid nodule.

There are three criteria for interpreting thyroid thermograms (Tab. III). There are four suspicious signs and malignancy criteria in the thyroid cancer (Tab. IV). Vascularization is less important in the thyroid area, compared for example with that of the breast but an abnormal vascularization (Tab. V) can clarify the thermographic diagnosis. The combination of three methods provides a diagnostic combination (Tab. VI). Echography also permits

Tab. III. Criteria for interpreting thyroid thermograms.

1) Examination form of the thyroid
2) Examination of vascular patterns
3) $\Delta T \geq 1$ °C.

Tab. IV. **Suspicious signs and malignancy criteria in the thyroid tumour.**

Lobular At > 1 “C.
Abnormal vascularization.
Whole thyroid hyperthermia.
At of the lymphatic node lesions.

Tab. V. Abnormal vascularization.

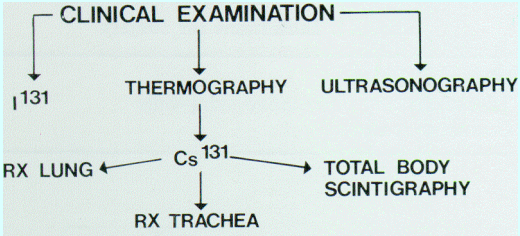
Whole increase.
Asymmetric.
Stenosis and irregular tract.

Tab. VI. **Triple examination by scintigraphy, echography and thermography.**

	Examination		
	Scintigraphy	*Echography*	*Thermography*
Morphologic	●●	●●●	
Functional	●●		●●●
Structural	●	●●	●

the determination of distances. The procedure cannot be conducted without a clinical examination (Graph 1).

The clinical examination is very important. The character of the nodule permits us to observe some elements, useful for a correct diagnosis (Tab. VII). During this time, we have examined 1,433 thyroid nodules and have studied the same by various methods (Graph 2).

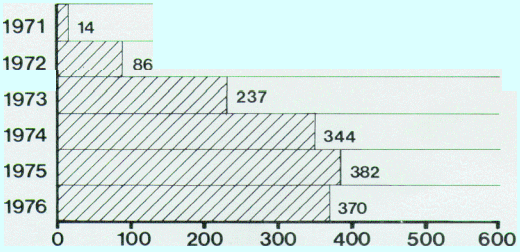


Graph 1. Combined diagnosis of thyroid tumours.

Tab. VII **Thyroid cancer symptoms in physical examination.**

Hardness
Irregular surface
Infiltration
Rapid growth
Possible lesions of the recurrcnt nerve
Possible adenopathies

The comparison between hyperfixing cesium cases and thermography in benign lesions has provided these results: (Tab. VIII). False posi-



Graph 2. Cases of thyroid nodules screened in scintigraphy. echography and thermography.

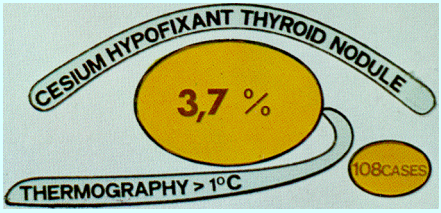


Fig. 1. Comparison between ceaium hypofixation and thermography.

Tab. VIII **Comparison between cesium hypertixation and thermography in benign lesions.**

Hystological type	*cases*	*Thermography*		
		0°-0,6 °C	0,8°-1 °C	1 °C
Colloid cyst goiter	88	53	I?	12
Adenomas	68	31	25	25
Cyst	33	27	2	4
Thyroiditis	4	2	1	I
total	193	113	43	42

tive results occur in colloid cyst goiter. It is useful to recall that only 3.7% of hypofixing cesium cases have demonstrated a T difference greater than 1 °C (Fig. 1). The delta T in thyroid cancer has produced 16% of false negative results out of 33 cases, histologically verified and only 7% by cesium scintigraphy. The delta 2 can be observed in some cases of thyroid cancer by thermography (Tab. IX).

Tab. IX. **Thermal gradients of 33 thyroidal cancers verified histologically.**

AT	% of cases
< 1 °C	16.1
= 1°C	6.4
> 1 °C	77.5

In conclusion, none of these techniques alone guarantees completely a perfect diagnosis in 100% of cases, but the combination of various techniques greatly decreases the percentage of likely errors. The determination of cancer risk in thyroid nodules can be shown (Tab. X). The indications for surgery can be reduced with the same methods (Tab. XI), Only by this procedure we can guarantee a better diagnosis.

Tab. **X. Evaluation cancer risk in thyroid pathology.**

Low risk	*Moderate risk*	*High risk*
Cs^{131} Hypofixant	Cs^{131} Isofixant or hyperfixant	Cs^{131} Hyperfixant
Echo 1^{st}-2^{nd} class	Echo 2^{nd}-3^{th} class	Echo 3^{th}-4^{th} class
Th Negative	Th $\Delta T = 0{,}8°$-1 °C, or vascular, irreg.	Th $\Delta T > 1$ °C

Tab. XI. **Indications for surgery.**

High risk index
To correct any obstructive symptoms
Cosmetic reasons