The role of thermography in ORL neck lesions*

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SUMMARY. **The normal thermographic pattern of the neck is described in the lateral and frontal views. The various areas are characterized by hot, warm, and cool values.**
A characteristic thermogram of the neck is defined. Different lesions can modify the normal thermographic pattern by increasing or decreasing temperatures. The parotid, supra-hyoid, sub-hyoid, and laterocervical regions are described with their pathologic changes: special attention is given to the diseases of the salivary glands. Finally, the role of thermography in the diagnosis of diseases of the neck is discussed.

Key words: normal neck thermogram; neck lesions; salivary glands diseases.

The detection of skin areas temperature by means of a thermograph permitted the advance of a new technique for investigating different body lesions [1].

Skin temperature is closely related to the anatomical (vascular) and functional (metabolic) situation of the region: this relationship is the background of the different thermal patterns which are represented in the thermograms.

Several lesions modify the thermal patterns of the involved areas and, in some instances, those of the surrounding ones; modifications correspond to an increase (hyperthermia) or to a decrease (hypothermia) of the skin temperature. A quantitative evaluation is necessary for distinguishing two levels of a same temperature modification (e.g. hyperthermal changes). The thermal gradient (Δt) between two body areas permits the evaluation of the temperature differences existing between symmetric or adjacent regions. The thermal gradient is particularly important when a lesion modifies the normal thermal pattern of an area, the At value being related to some typical lesions, such as inflammatory diseases, benign versus malignant tumours, congenital abnormalities, etc.

The ORL diseases of the neck represent a kind of lesions suitable for thermographic investigation as they are localized in a region easily explored by means of thermography, they give a characteristic thermogram, and they involve deep structures (vessels, glands, etc.) which give superficial thermal manifestations.

THERMOGRAPHIC ANATOMY

The normal neck thermogram has not yet been established [3]. Therefore, the possibility of comparing pathological thermograms to a standard one is not yet possible. We tried to define a normal thermogram which would take into account individual variations and which could be suitable for these comparaisons.

The normal temperature distribution is represented in figure 1 where the main thermal areas of the neck are shown, each of them characterized by temperature values defined according to three different levels (hot, warm, and cool).

The *normal thermogram* has been based on two standard views:

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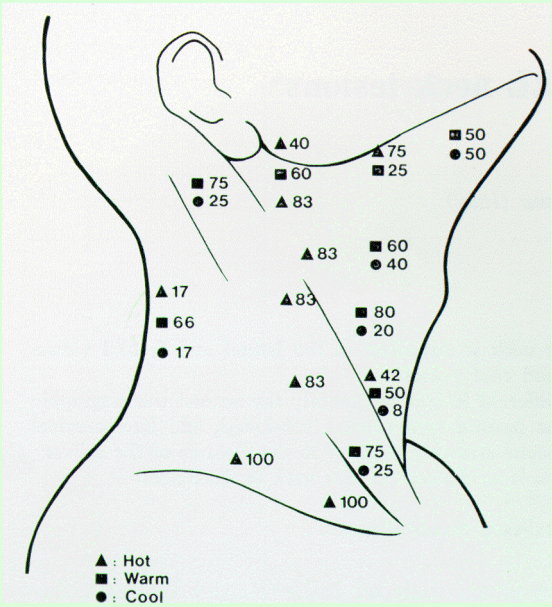

Fig. 1. Normal thermal distribution in the diffc-rent areas of the neck. Numbers indicate the percentage of occurence of cool. warm, and hot values.

1. lateral oblique with slightly extended head;
2. frontal, with hyperextended head.

1. In the lateral view the following areas are identified (Fig. 2):

a) Parotid area: the region has a thermo graphic pattern which is constantly warm or hot became of the superficial situation of the parotid gland and of the vascular structure5 (external jugular vein and external carotid artery) which pass through the gland.

A part of the parotid gland is covered by the masseter muscle and therefore it appears cool; on the other hand this part of the gland does not really belong to the neck but to the facial area.

b) **Supra and sub-hyoid areas**: these two region5 arc represented on a small surface when investigated on the lateral view. Their thermal characteristics arc described in the frontal view.

c) Sternocleidomastoid area: the correspondence of this region to the sternocleidomastoid muscle explains the cxtension of warm values. The region is crossed by an hot line directed downwards and posteriorly and which corresponds to the external jugular vein.

d) Supra-clavicular area: it reprcsents the

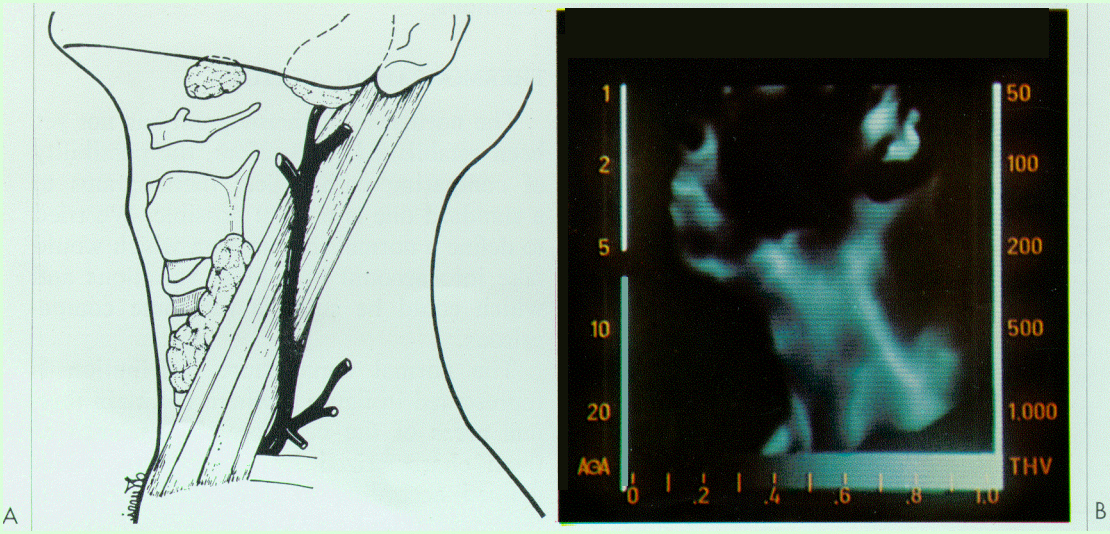

Fig. 2. Lateral vicw. A) Anatomic illustration of the rcgions cxplorcd by thcrmography. B) Normal thermogram.

posterior part of the neck, corresponding to scalenes and trapezium muscles. It has almost always warm and uniform values. In its inferior part there is an hot spot which corresponds to vascular structures irradiating from this zone.

e) Vascular lines: they have very hot values and reach the supraclavicular hyperthermal region coming down from the region of the mandibular angle and surrounding the posterior aspect of the sternocleidomastoid muscle.

2. The frontal view permits the identification of the following regions (Fig. 3):

a) **Supra-hyoid area:** the normal thermographic pattern of this region is constantly characterized by warm or cool values. Nevertheless, on both sides of the midline just below the jaw in the *sub-maxillary region,* an area presenting hot or warm values is constantly recognizable. It could correspond, in its posterior aspect, to the submaxillary gland and, in its anterior aspect, to a branch of the facial artery crossing the platisma and reaching the subcutaneous tissues. Anterior jugular veins which lie on both sides of the midline in the superficial planes do not give a constant thermographically valuable pattern.

b) **Sub-hyoid area:** this region is characterized by warm or cool values whose pattern is not homogeneous, the thermal values progressively increasing from above downwards. The superior third of the region is normally cool (larynx and thyroid cartilage), while the inferior two/thirds are usually warm (thyroid gland).

c) Sternocleidomastoid area: this region is well examined - in the frontal view - only in the inferior two thirds, its upper part being situated in the lateral aspect of the neck. The vascular line is easily recognizable in this view, too.

d) **Supra-clavicular area:** a very limited part of this region is recognizable in the frontal view and it has always a hyperthermal pattern. This is due to the inferior tract of the external jugular vein and to several small venous branches which are superficial at this point of the area.

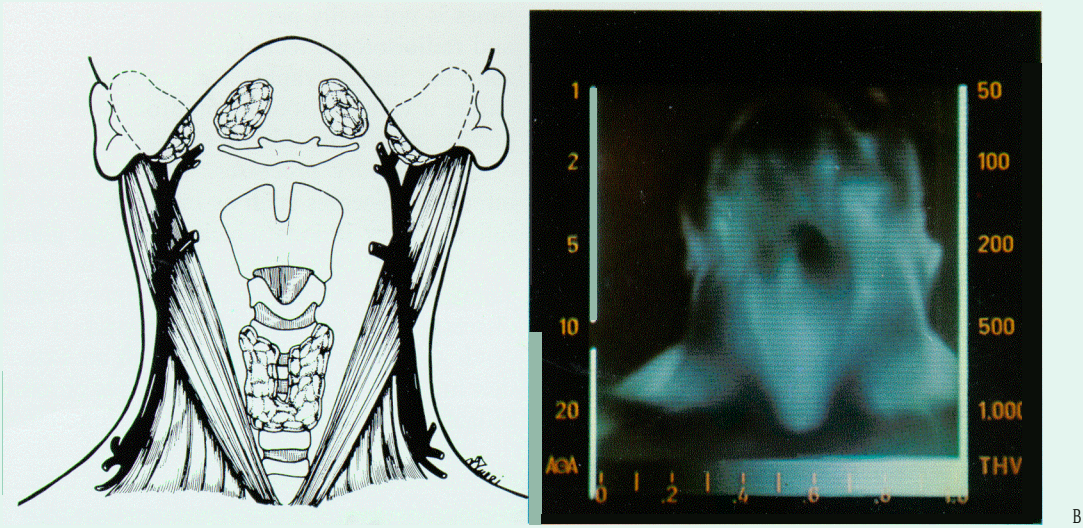

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Fig. 3. Frontal view. A) Anatomic illustration of the regions explored by thermography. B) Normal thermogram.

e) Parotid area: this region is seldom identified in the frontal view. It appears on upper external zones of the neck when parotid glands are enlarged.

The description of the neck thermograms **reveals** that the differences which normally exist among the neck temperatures are mainly due to anatomical reasons, such as the site and the level of vascular structures. Nevertheless, some differences are due to the functional activity of very particular regions, such as the parotid and thyroid glands.

THERMOGRAPHIC PATTERNS IN ORL NECK LESIONS

The lesions of the neck structures may present different thermographic patterns, which are similar to other regions, that is: lesions with increased temperature (hyperthermia); lesions with decreased temperature (hypothermia); lesions with no variations of the temperature (normothermia).

The temperature variations may be isolated to a single region of the neck or to be widespread to several regions which are contemporarly attained.

The description takes into account the thermal modifications which can be encountered in the different neck regions. For an easier description sternocleidomastoid and supra-clavicular areas will be named latero-cervical region.

Parotid region. It is attained by many lesions with some very typical thermographic patterns. The diagnostic of this region sometimes is not easily performed by sialographic and radioisotopic techniques [2]. For these reasons the thermographic technique may constitute a valuable tool for improving the diagnostic results in this area.

Inflammatory processes. They are due to infectious diseases such as in parotitis, or to inflammatory lesions which reach the gland by an ascending route (sialodochitis and sialoadenitis). In both cases a hyperthermia characterizes the inflammation and it exceeds the limits of the gland with an extended hot spot (Fig. 4a). In some cases chronic inflammatory lesions result in a functional

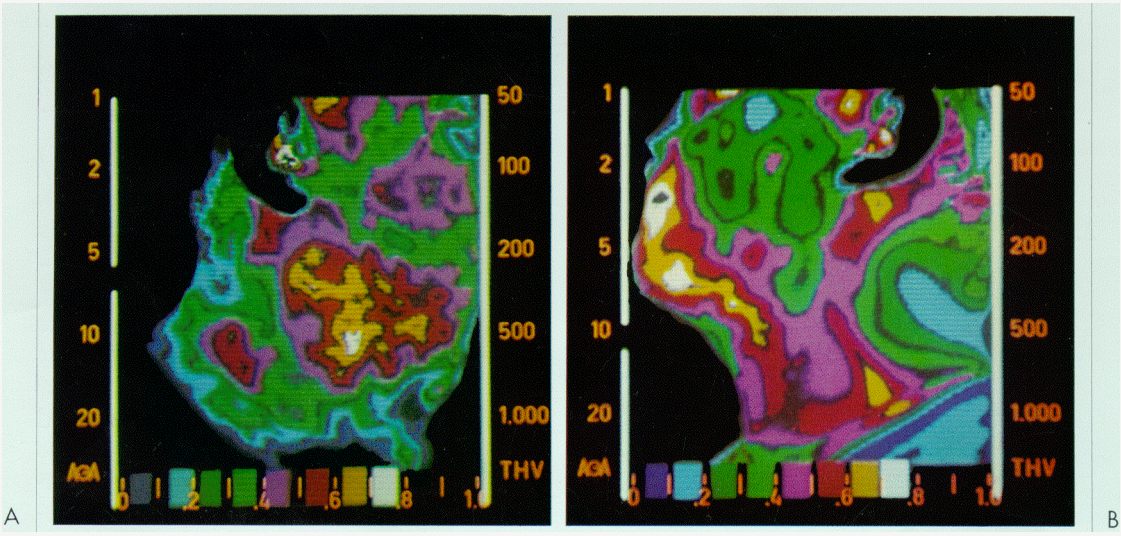
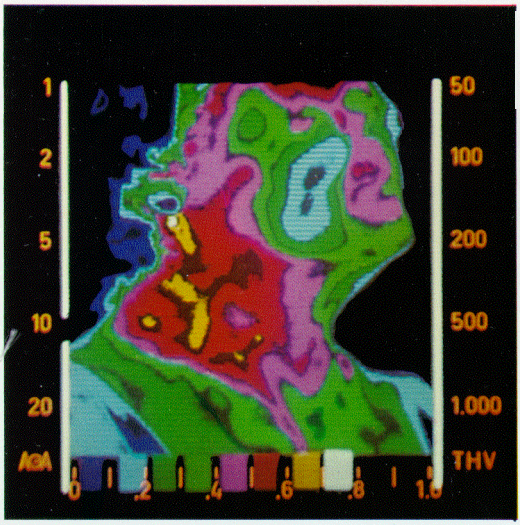


Fig. 4. A) Acute parotitis: lateral thermogram showing a hyperthermal area extended to the right pre-auricolar, retro-mandibular and sub-mandibular regions. B) Chronic parotitis: lateral thermogram showing the unusual hypothermia extended to the parotid region and to the mandibular angle.



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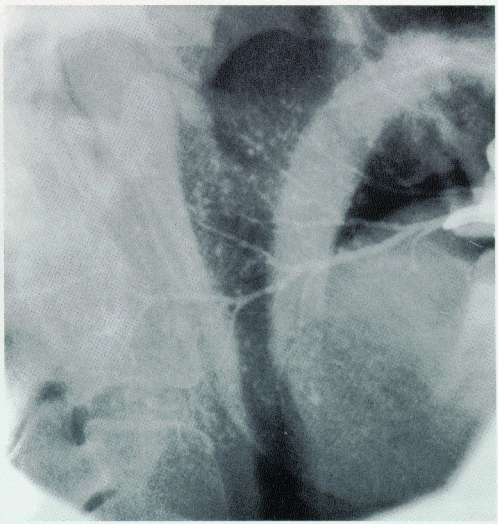

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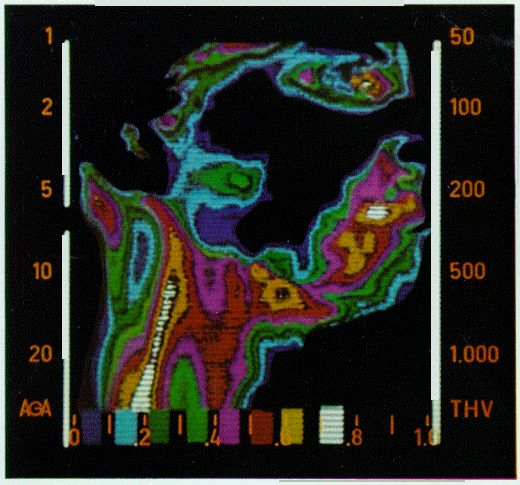
Fig. 5. Sclerodermia. A) Lateral thermogram showing a diffuse hyperthermia extended to the parotid and to the sub-maxillary regions. B) Sialographic pattern denoting a typical inflammatory phase with several, small, rounded opacities (sialectasies).



A

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Fig. 6. Sjögren disease. A) Lateral thermogram showing the extension of the hypothermia to the parotid and to the sub-maxillary regions. B) Sialographic appearance of the right parotid gland in the samc subject: ducts are lacking and short..

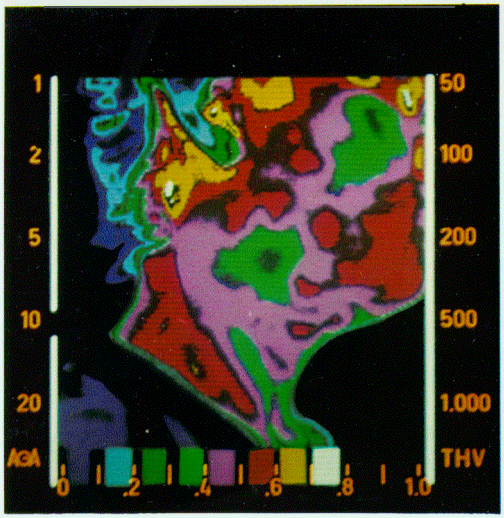
death of the parotid gland which appears on the thermogram as a hypothermal area, in spite of existing inflammatory modifications of the parotid ducts (Fig. 4b).

Collagenous *lesions*. The participation of salivary glands to several collagenous diseases has been widely investigated and sialographic manifestations are extensively descri-

bed in the literature. Thermographic manifestations of these diseases in the parotid area arc often recognized. The temperature modification may be detected as an increase of thermal values when the gland is still in the early or intermediate inflammatory phases (fig. 5). The late phases of many collagenous diseases conduct towards an atrophic stade of the salivary glands and this situation is thermographically detected as an extended cool pattern of the whole parotid area (Fig. 6).

For these reasons it should be possible to check by thermography the progression of the collagenous involvement in salivary glands related to different temperature values encountered in the corresponding regions (parotid and submaxillary areas).

Benign masses. They are difficult to be clinically differentiated from the mixed tumours which are among the most common masses of the region. Sometimes sialography shows the parotid gland integrity, but in some instances the intraglandular ducts are displaced as in mixed tumours and sialography is not consistent. Benign masses are characterized by warm or normal thermographic values as in the salivary cysts or by cool values as in the lypomatous disease of the gland.



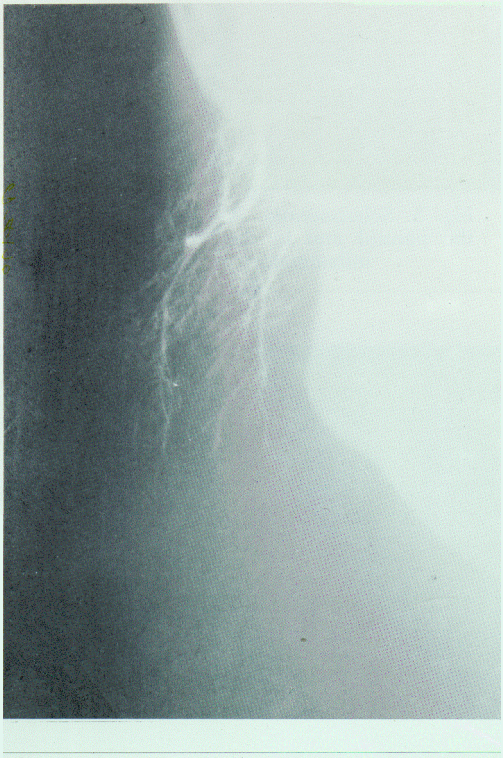


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Fig. 7. Dysontogenetic cyst. A) On the lateral thermogram, a large hypothermal area is localized at the mandibular angle, just below the inferior aspect of the parotid area. B) Sialographic appearance of the displaced parotid gland which is not involved by the cyst.

A case of an enormous dysontogenetic cyst with necrotic phenomena, situated at the mandibular angle and displacing outwards the inferior aspect of the parotid gland, appeared very cool, probably due to the avascular mass with necrosis (Fig. 7).

Mixed or malignant masses. The description of mixed and malignant tumours together derives from the fact that they are all characterized by hyperthermal values on the thermogram. Nevertheless the hyperthermal modification due to a mixed tumour (Fig. 8)

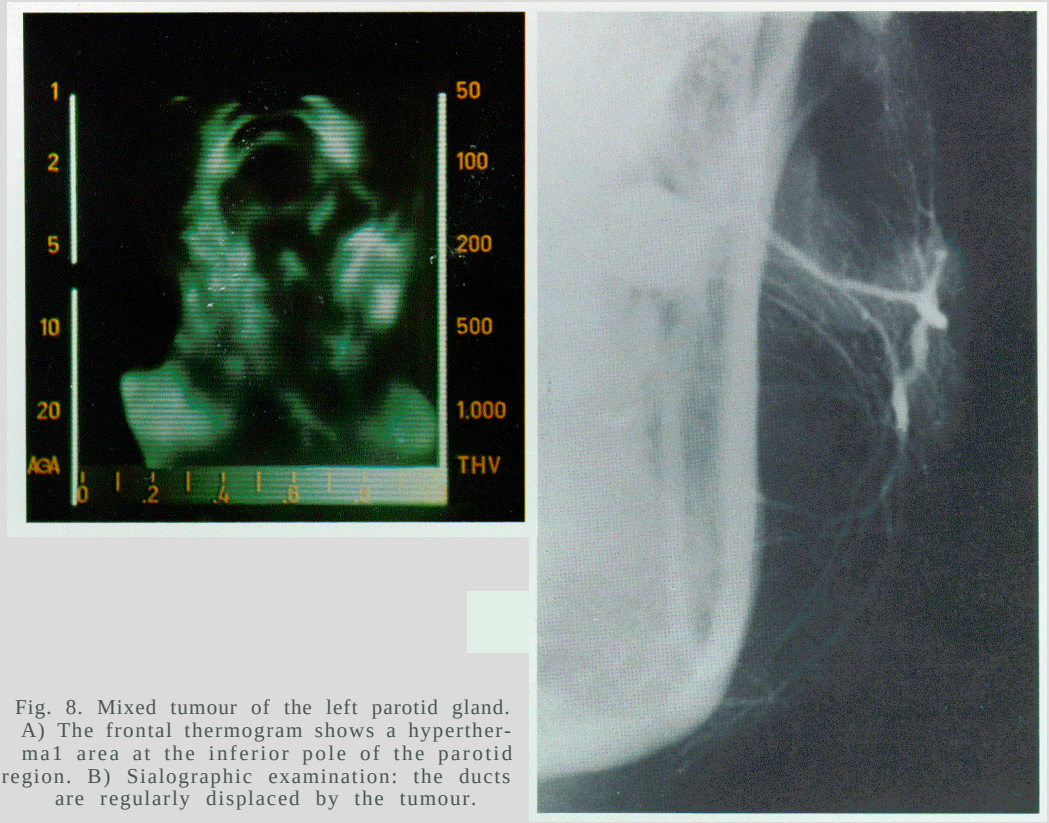

Fig. 8. Mixed tumour of the left parotid gland. A) The frontal thermogram shows a hyperthermal area at the inferior pole of the parotid region. B) Sialographic examination: the ducts are regularly displaced by the tumour.

is generally less noticeable and more limited than that of other malignancies, where the spread of the hot temperature outside the parotid region signifies the extensive involvement of the surrounding structures (Fig. 9). This latter thermographical pattern may be also encountered when primary tumours situated outside the parotid region spread into it during their growth.

Supra-hyoid region. The thermographic importance of this region is due to the submaxillary glands contained, the lesions of which may give characteristic temperature modifications. Moreover, the superficial projection of these glands being very limited, regional abnormalities can be easily detected.

Lithiasis. The lesion is the most common disease affecting the sub-maxillary glands. In general it does not give important modifications on the thermogram: temperature values may be in the range or below the normal ones (Fig. 10a).

Consistent temperature modifications are encountered when *inflammatory lesions* are superimposed on a lithiasis. In these cases the thermographic pattern is analogous to the modification of sialoadenitis where the hot values characterize the disease (Fig. l0b).

In some instances the inflammatory lesion does not originate from the submaxillary gland. The whole supra-hyoid region may be invaded by a very hot area with extension to the adjacent sub-hyoid region when phlegmon infections are localized to the mouth floor.

Sub-hyoid region. The importance of this region in thermography is related to thyroid

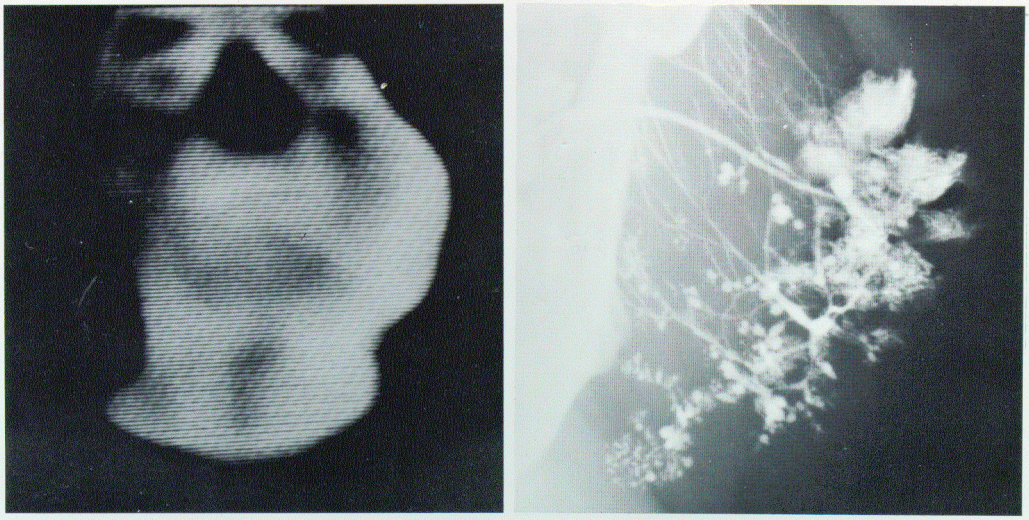

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Fig. 9. Reticulum cell sarcoma of the left parotid gland. A) The frontal thermogram shows an extended hyperthermal area corresponding to the mass involving the parotid structures. B) Sialographic examination: enlarged parotid gland, with distorted ducts and irregular contrast medium opacities.

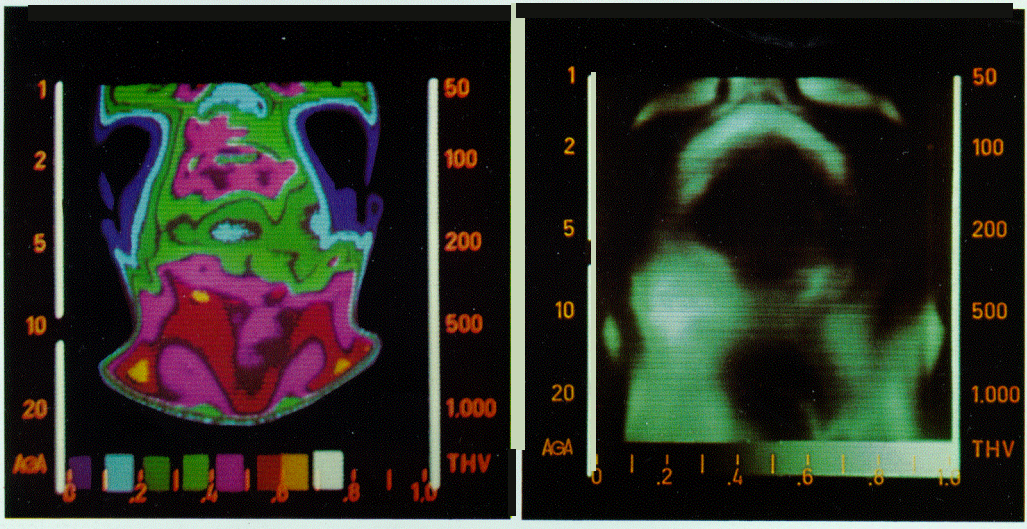

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Fig. 10. A) Left sub-maxillary lithiasis: frontal thermogram showing cool temperatute values in the sub-maxillary arca. B) Right sub-maxillary sialoadcnitis: the frontal thermogram reveals a marked hyperthermia in the sub-maxillary area.

diseases. Nevertheless some other abnormalities may present a thermographic modification of this region.

Larynx and pharynx tumours. The hyperthermal modification which laryngeal and pharyngeal malignancies may present, is not easily conducible to a schematic rcpresentation. When hyperthermia is evident it has generally a very extended pattern and it does not correspond closely to the anatomic le-

sions. This may be due to the relatively deep structures involved in these tumours (Fig. I la). Nevertheless the identification of the most affected side is possible and this fact permits one to study adequately the treatment planning: the importance of this study is evidently due to the frequent coexistence of metastatic nodes. The detection and localization of the metastatic secondary nodes is very important from the laryngological point of view. Laryngeal cancer may be accompanied by metastatic nodes in the neck region. On the other hand, recurrences of operated laryngeal cancers are almost exclusively localized to these regions. Figure 11 b shows the dishomogeneous. hyperthermal pattern of a patient operated by laryngectomy, having an extended recurrence affecting the laterocervical lymphatic nodes. In many other cases it was possible to detect the invasion of lymphatic nodes by carcinomatous metastasis originating from the parotid, the larynx or the pharynx.

Laterocervical region. The region comprises the two anatomical areas formarly described as stcrnocleidotnastoid and supraclavicular areas. The opportunity of describing them together as a single region derives from the distribution of pathological lesions which affect indeffcrcntely one or both areas and by the fact that thermal modifications may be widespread in the whole regional surface.

Vascular abnormalities. When increased vascularity occurs, the best situation for thermographic modifications is realized. Vascular changes in the artero-venous fistulas of the neck are easily detectcd by thermography, appearing as an hot spot in the area of the more superficial vascular involvement. Sometimes the vascular involvement is clinically evident as a well limited, palpable, pulsating mass in the laterocervical region, with an extended hyperthermia on the thermogram. In the case of figure 12, the operation demonstrated the presence of chemodectoma originating from the carotid bifurcation and greatly extended upwards.

Vascular modifications constantly occur when radiation theraphy is performed. The thermographic detection of these changes in the laterocervical area is a good method for evaluating the tissue response to the absor-

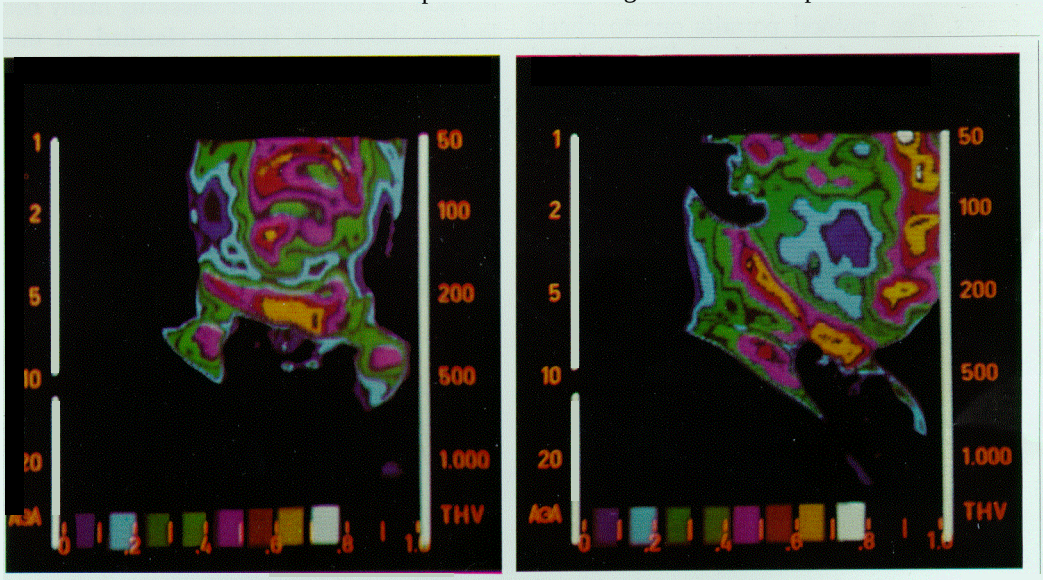

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Fig. 1 1. A) Laryngeal cancer. Thermogram in frontal view, showing a hyperthermal area situated in the midline of the sub-hyoid region. B) Operated laryngeal cancer: lateral thermograms showing an extended hypertherma l involving both the laterocervical lymphatic chains, and the supra-sub-hyoid regions.

bed doses. Some Authors' proposc the thertnographic evaluation of the temperature changes in the latcrocervical area following preoperative radiotherapy, as a tool for proposing the most opportune time in head and neck cancer surgery.

CONCLUSIONS

The role of thermography in neck lesions is not yet sufficientely defined. Almost all lesions affecting neck structures give a thermographic evidence of their cxistcnce.

The thermographic modifications are mainly hyperthermal. but hypothermal patterns are not unusual. Moreover thermal characteristics are often identical in many diseases. Hyperthermia, for example, is evident in malignancies and in mixed tumours of the parotid gland.

The At evaluation in many instance5 permits the differentiation of primary tumour hypcrthermia (At = 3° C) from the mixed tumour changes (At = 1.5°-2° C).

In addition, thermography is a usefull method for evaluating the evolution of many diseases. The method permits one to check the vascular or functional modification5 of some regions, either in chronic conditions as in collagenous and tumoral lesions, or in acute manifestations as in inflammatory diseases.

The validity of thermography in ORL neck lesions seems to be consistent with the-SC points:

- Salivary glands lesion5 are easily recognizablc because of the superficial position of these structure. Moreover the temperature modifications have almost always a good concordance with the lesion nature.

- Pharynx and larynx lesions arc scarcely detectable because the involvement of these structure5 must bc greatly extended before the temperature modification reaches the superficial planes.

- Lymphatic node lesions do not present characteristic features permitting an accurate diagnosis of their localization in the neck, except for the hyperthermal values which characterize the carcinomatous origin.

- Vascular abnormalities have a good chance to be detected because of the high increase of temperature they cause.

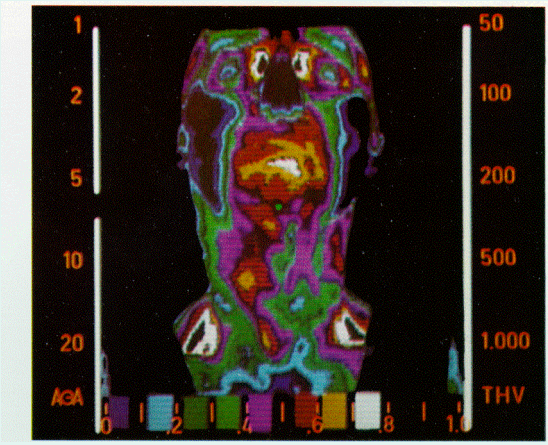

Fig. 12. Chemodectoma of the right carotid bifurcation. Frontal thermogram showing an extended hyperthermal area situated outside the carotid axis. just medially to the sternocleidomastoid muscle.

The role of thermography as a bloodless method for detecting or checking many neck lesions should be further clarified. It must be stressed that thermography alone is not sufficient for an exact definition of the nature of the Icsions.

Thermography should be linked to other diagnostic examinations such as sialography, radioisotopic studies, tomography, etc. In this role it has certainly good chances for improving its value.

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