Applications of Microwave Radiometry in Diagnostic Suspicion of Mammary Pathology

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Abstract — **Paper present the theoretical basis of microwave radiometry, the specific problems, both theoretical and practical, during the detection of the thermal origin electromagnetic radiation and microwave frequency, comparing with the detection of infrared radiation.**

Paper will show the results obtained after an analysis upon a specific group, from which selected for our discussion only the cases in which the results obtained by classical methods are contradictory to the results obtained by microwave radiometry and IR thermography

I. Introduction

Microwave radiometry technique (MRT) comes with need of early and non-invasive detection of breast cancer in individuals with increased risk for this type of cancer. MRT measuring electromagnetic thermal radiation and infrared thermography (IRT) belong to functional investigations of breast activity. In the on used study both methods in order to observe the sensitivity of MRT over classical methods of breast investigation.

Recording of heat patterns- thermogram- rests upon recording of changes in blood circulation and metabolic reactions inside the pathology pattern. Tumoral angiogenesis and tumoral proliferation processes generating heat increase thermal gradient in the affected area [1].

Thermal regulation means preserving body temperature despite the changes in the environment. Thermal regulation is a complex function under the command of central nervous system specifically the hypothalamus. Body temperature results from losing and getting heat from intracellular chemical reactions and from muscle contractions and lose heat through skin spontaneously and this is increased by superficial vasodilatation, sweat and sweat evaporation [2].

Overwhelming thermal regulation mechanisms in pathologic situations represents the base for thermal imaging: infrared thermography and microwave radiometry.

II. Material and methods

Subjects were investigated through 2 types of functional methods: microwave radiometry and infrared thermography with infrared thermograph IR TVK-05 (images resulted from picking up infrared radiation sent by superficial skin surface) and with microwave radiometer RTM-01-RES (images resulted from picking up microwaves sent by skin and underskin surface) [3].

All had done breast ultrasound and subjects over 40 years had done mammography.

42 women were studied [4], 36 with no symptomatology and 8 patients with established diagnosis through punction biopsy or surgical biopsy. These 8 patients were also studied for the side effects of chemotherapy and radiotherapy and microwave radiometry role in recording them. A case was chosen to clarify the diagnosis suspicion.

In order to realize thermal image of the studied area – breast, all patients sit with thorax uncovered, placing hands on hips, 20 minutes to reach a thermal equilibrium with the environmental temperature of $(22–23)^0$C. Radiometric images were recorded in the same thermal ambient. Radiometric sensor was placed successively in all 10 areas of the breast as software indicated (fig.1) on both breasts: superior, inferior, internal, external, supero-interior, supero-exterior, infero-interior, infero-exterior, nipples area, axilary. Temperature of control points T1 and T2 in sternum area was also measured .

Temperature was measured starting with points T1,T2 followed by 0,1,2,3,4,5,6,7,8,9. In order to calculate thermal gradient from radiometric point of view breast diameter was considered as follows: subject in decubitus placing hands under head, starting measuring from point limit between supero-internal quadrant and infero-internal quadrant, over the nipple till point limit between supero-external quadrant and infero-external quadrant. Thermal and radiometric im-

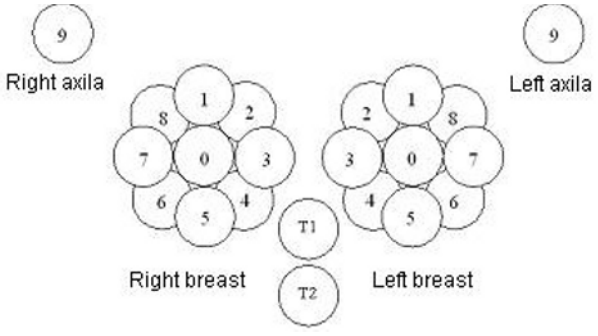

Fig.1 Disposal of temperature measured radiometric areas

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ages were taken at 3 minutes distance from one another in the same ambient temperature.

Working conditions during investigation were general conditions like environmental conditions and particular conditions specific to studied breast area.

General working conditions:

It is strictly necessary to respect ambient temperature in the closed space were investigation take place $(22\text{-}23)^0$C; there were 4 thermometers placed in the four corners of the room. No air currents at the investigation space. It is strictly necessary to respect the given time for the thermal change with the ambient 20 minutes as everywhere recommended. Without these conditions may appear false results.

Particular conditions for breast pathology:

- during thermal change recommended position is sitting with hands on hips, no skin contact;
- 24 hours prior to investigation no solar exposure;
- 24 hours prior to investigation no use of therapeutic gels.

Use of hormone products changes thermal image because increases temperature, acting on breast circulation- this aspect should be taken in consideration.

Investigation during menstruation could influence thermal image because of the hormone impact on breast circulation. Thats why it is recommended to investigate outside this period of month meaning between day 7 and day 21 of the menstrual cycle. Some recommend to investigate outside ovulatory peak also. It was no change in thermal image observed in this period.

Clinical exam before thermal imaging investigation is very important because all skin lesions may change the results. Apply radiometric sensor carefully on skin, avoid as possible skin folds because on skin folds thermal change is not satisfactory corresponding.

Both types of investigations should be done on the same period of time in order to correlate them and to build a correct functional image of the patient; different periods of time mean different functional moments of the patient.

III. Case study

L.D., femeale, 46 years old, no clinical symptomatology, a patient in the Cancerdet study [4], had done breast ultrasound, mammography, infrared thermography, microwave radiometry.

Breast ultrasound results: adipose structure both breasts.

Right breast at meeting point of superior quadrants, inside preglandular adipose tissue there is a hyperechoic image of 5/3mm; in the supero-internal quadrant, paraareolar, there is hyperechoic image of 18/11 mm inside preglandular adipose tissue (lipomas).

Left breast has no pathologic changes.

Axilary area present sclerolipomatosis of ganglions of 11 mm in left axila and 8 mm in right axila.

Fig. 2 Ecography of rigth breast

Mammography results:

Breasts with adipose homogenous structure, without expansive formations or malign micro calcifications.

The left breast presents a lipoma observation in the superior quadrants with a hyper transparent oval image, visible on LMLO.

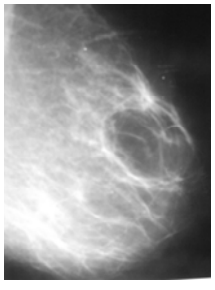

Fig. 3 Mammography of left breast

The results obtained through thermography in IR:

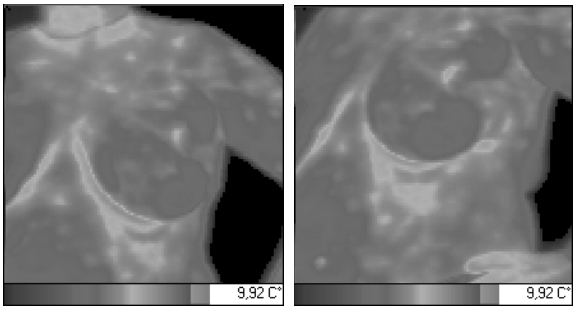

Fig. 4 Thermography in IR of left breast, front and profile

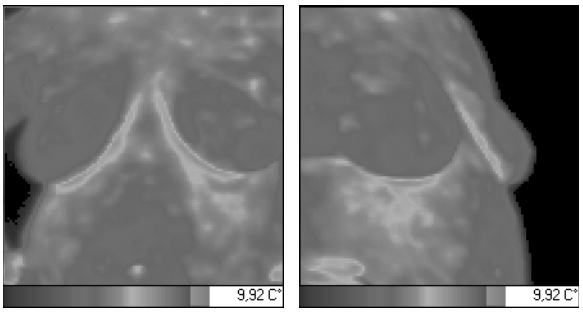

Fig. 5 Thermography in IR of right breast, front and profile

The images obtained through thermography in IR registers at the level of both breasts large regions of hypothermia, with the following localizations: at the level of the right breast it occupies almost all the quadrants but the mammilla zone. The left breast presents a zone of normothermia on the whole central portion of the breast.

The results obtained within this investigation sustain the results obtained through ecography and those obtain through mammography.

The image obtained through the **radiometric investigation**:

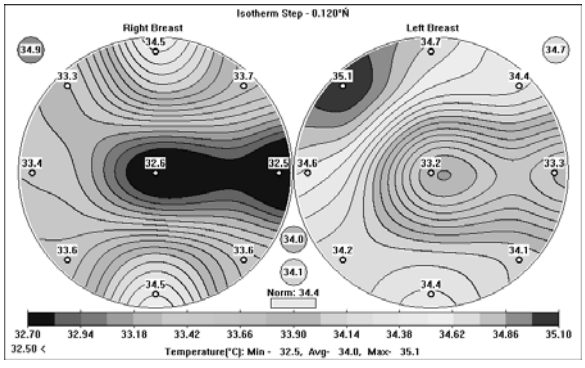

Fig. 6 Radiometric result

The radiometric image which represents the values of the temperature registered with the interior probe at the level of the mammary gland.

The asymmetries represent an image that presents the differences of temperature between the symmetric points at the level of both breasts.

The interpretation of the radiometric image: at the level of the right breast, a zone situated within the supero intern quadrant is observed with a temperature gradient much lower than the contralateral symmetric points. This aspect comes in sustaining the result obtained through ecography, fig 2 (observation: lipoma) because this type of formations has a low vascularity and consequently a lower temperature.

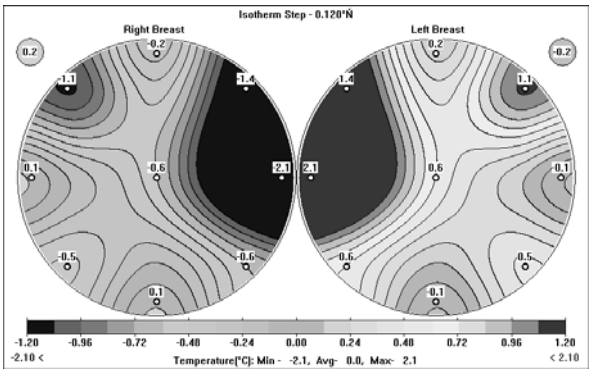

Fig. 7 Thermal asymetries

Also one can observe the similitude of the localization through ecography and through radiometry with microwaves.

The registration of a high thermal activity in the point 2 (according to the notes in fig. 1), in comparision with contralateral symmetric point, coincides as modification with the mammographic localization of the lipoma. One can observe in the case studied a general increase of the temperature, at the level of all the points investigated on the left breast[5].

IV. Discussions

In the case of this investigation one can observe that the mammography identifies a formation (lipoma) at the level of the left breast and the ecography describes the presence of more formations, including a lipoma, but at the level of the right breast. Both types of investigations identify the presence of some modifications but on different breasts.

The results obtained through thermography in IR concords with the results obtained through ecography and mammography, obtaining ranges of hypothermia in the regions identified with structural modifications. These zones of reducing the thermal gradient are larger as surface than the zones mentioned ecographic and mammographic because of the dispersion phenomenon of the temperature. In the zone considered pathological from the functional point of view, there is a minimum of the temperature registered, that through the phenomenon of dispersion cools the adjacent zone. Radiometry with microwaves registers this aspect of gradual increase of the temperature around the maximum affected zone.

Radiometry with microwaves captures a hypothermic aspect at the level of the left breast that cannot be seen from the point of the structural characteristics in the investigations made.

The correlation of just the thermography in IR with results obtained through ecography and mammography can be explained through the existence of a pathological neoplastic structure in evolution at the level of the left breast supero intern quadrant which presents at the super adjacent levels a lipoma type formation (that is with low vascularity and with lowering temperature in the given zone). In order that thermography in IR be a method of registration of the temperature at the surface of the body, it cannot register the modification of the thermal gradient registered through radiometry with microwaves at the inferior levels of the lipoma.

The subject was proposed for punction biopsy, this investigation being in course

V. Conclusions

Consequently to the achievement of the study through IR comparative radiometric and thermographic investigation, the following were observed:

The investigation method through thermal analysis of different structures of the human body made through radiometry and thermography in IR, is a **more sensitive method** from the investigational point of view, rendering evident the functional modifications at the level of the studied structures. From this point of view it is essential to survey the subjects for a certain period of time, variable according to the pathology pursued, in order to render evident the acute and transitory affections, of the chronic pathology of the subjects (rendered evident through the long- standing thermal modification at the studied levels).

The work conditions are essential in order to obtain correct results. By non respecting strictly the way of investigating, it leads to obtaining erronated results.

Correlating the results obtained through thermal investigation with the results obtained through classical methods (ecography, mammography), consider them relative because the IR thermography and microwave radiometry capture the functional profile whereas ecography, mammography give information about the structure of the breast. Thermal investigation can capture the subject in an initial phase in which the pathological structures are below the dimensional limit of their ecographic and mammographic finding but with a possible vascularity of developed neoangiogenesis. For this reason it is essential the survey of the subject in time, with the monitorization of the thermal activity at the studied level. At the moment of the ecographic or mammographic finding of some pathologies at the breast level, thermal investigation can bring essential information about the functionality of the structure.

The anamnesis of the subject is very important in order to interpret the thermal image; the possible associated pathologies (hypothyroid, hyperthyroid, acute infections etc), having impact on the body temperature and consequently on the results obtained.

Correlation of the two methods of thermal investigation is essential, radiometry presenting a stronger sensitivity than IR thermography.

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