Proceedings of the 26th Annual International Conference of the IEEE EMBS
San Francisco, CA, USA • September 1-5, 2004

A Comparative Study of Thermal Texture Mapping in Benign and Malignant Breast Diseases

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Abstract **The aim is to investigate differences of Thermal Texture Mapping (TTM) between benign and malignant breast diseases. After receiving TTM, 100 patients were categorized into three groups in normal patient, benign change and malignant lesion. TTM demonstrated that the malignant lesion mostly appeared thermal features and deeper layer position with surrounding or penetrating vessels, and irregular thermal spread pattern with spinal margin in breast; there also appeared deeper layer abnormal thermal source in axilla and abnormal thermal pattern with circular, asteroid and agaric-like shape fixed near the left side of Angle of Louise of the sternum, which was irrelative to abnormal thermo-radiation and lesion position in breast. Therefore, the difference of TTM appearance definitely exists between benign and malignant breast diseases.**

Keywords **Breast Diseases, Thermal Imaging, Malignant Lesion, Thermal Texture Mapping, TTM**

I. MATERIAL AND METHODS

Patients The study population comprised 100 female patients with uncomfortable complaint in breasts from December 2003 to February 2004. Thermal Texture Mapping (TTM) was consecutively performed in all patients. 51(51%) out of these patients were in premenopause (≤ 45 years), 28 (28%) patients in perimenopause (46-54 years) and 22 (22%) patients in postmenopause (≥55 years) including 5 (5%) patients of 71-80 years

Method All TTM was performed with TSI-21M Thermal Scanner Imaging System (Beijing Bioyear Group Inc. TTM System used as software for data processing) at room temperature of 24°C. The patients were required no cloth on upper body and stood in front of the Scanner with two hands holding the head, keeping balance for 5-10 minutes. TTM imaging of the body above the line of iliac spine were obtained from the anteroposterior, bilateral-oblique and posteroanterior position. The stored imaging underwent tomography and analysis. All patients simultaneously received Near-Infrared Imaging (NIR) test in both breasts.

Evaluation The results of TTM were reviewed and evaluated based on clinical manifestation, results of NIR, cytology of tumor fine needle aspiration and surgical pathology as well as follow-up results.

Statistics The Qi-square was calculated by Microsoft EXCEL software. It had significant difference as P value < 0.05.

II. RESULTS

Among 100 patients with TTM test, seven out of these patients were normal, 13 patients had breast cancer and 80 patients had benign breast diseases. Their appearance on TTM imaging was shown as follows:

A. Breast

1. Abnormal thermo-radiation: We defined the local appearance of temperature in breast inconsistent with that in peripheral tissue on TTM as the abnormal thermo-radiation. The referral area was located in the region of body between the medial sides of proximal part of both forearms. It was called the increased thermo-radiation when its temperature in the foci was higher than that in referral area; by contraries, the decreased thermo-radiation. Table I indicated the local breast thermo-radiation in various patients.

As shown in Table I, there was higher rate of no abnormal thermo-radiation in normal patients* and benign group than that in malignant group (P<0.05). Among the group of benign breast diseases, five (62.5%) patients with decreased thermo-radiation were accessory breast; two patients with breast cyst and six ones with breast hypo-degeneration (66.67%) did not present abnormal thermo-radiation.

TABLE I
LOCAL THERMO-RADIATION STATUS IN THE PATIENTS WITH VARIOUS BREAST DISEASES

	No abnormal thermo-radiation (n=20)	Abnormal thermo-radiation (n=80)	
		Increased (n=71)	Decreased (n=9)
Normal (n=7)	7 (100%)*	-	-
Malignant (n=13)	1 (7.69%)	11 (84.62%)	1 (7.69%)
Benign (n=80)	12 (15%)	6 0 (75%)	8 (10%)

2. The depth and spread pattern of abnormal thermo-radiation and vascular appearance: The abnormal thermo-radiation gradually spread into deeper layers immediately after it appeared. The number of layers varying from homogeneous spread to abrupt enlargement was called the depth of abnormal thermo-radiation [1]. The morphologic pattern of abnormal thermo-radiation could be regular ones with well defined round or oval shape; or irregular ones with the coarse rim. There also appeared vessels surrounding or penetrating the abnormal thermo-radiation area. The depth and spread pattern of abnormal thermo-radiation and vessel appearance in various breast cases were shown in Table II.

The vessel appearance in benign changes was larger, coarse and vague, and could rapidly spread; it mainly located in superolateral quadrant or areola of nipple in both breasts, rarely penetrated the foci. The isolated vessel without local abnormal thermo-radiation was observed in one of the patients with breast hypo-degeneration, and in subsequent follow-up.

B. Axilla

The axillary thermal source is usually located in the middle point of axilla, subsequently, extended into both sides along the fold of axilla linearly, or confluent back to the middle point. The number of layer should be counted from the position where several axllary thermal sources appeared. Table III summarized the axillary condition in various breast disease cases.

TABLE II
THE DEPTH AND SPREAD PATTERN OF THERMO-RADIATION AND THE VASCULAR APPEARANCE IN BENIGN AND MALIGNANT BREAST DISEASES

	Deep (≥3 layers)	Irregular	Vascular	All three appeared
Malignant (n=12)	8 (66.67%)	10 (83.33%)	9 (75%)	8 (66.67%)*
Benign (n=68)	35 (51.47%)	17 (25%)	27 (39.71%)	6 (8.82%)

TABLE III
AXILLARY STATUS IN VARIOUS BREAST DIEASE CASES

	No abnormal thermo-source	Abnormal thermo-source	
		Deep (≥4 layers)	Superficial (1-3 layers)
Normal (n=7)	3 (42.86%)	4 (57.14%)	-
Malignant (n=13)	3 (23.08%)	9 (69.23%)*	1 (7.69%)
Benign (n=80)	42 (52.5%)	18 (22.5%)	20 (25%)

C. Occipital-Cervical-Thoracic-Abdominal Region

Our studies found that there was abnormal thermo-radiation in occipital- cervical-thoracic-abdominal region in some patients as shown in Table IV. The isolated increased thermo-radiation was frequently noted in cervical and occipital region, whereas circular, asteroid and agaric-like appearance in thoracic region, and finger-like one in abdominal region below costal arch.

Among the patients with benign changes, six cases had thoracic abnormal thermo-radiation, five with breast hyperplasia and one patient with breast cyst, all showed bilateral symmetric pattern. However, thoracic abnormal thermo-radiation in malignant patients mainly focused on the left side of sternum.

III. DISCUSSION

The breast diseases greatly disturbed the women in their life and work, and the breast cancer further harmed human health directly. There are many methods to detect the breast diseases such as NIR, Doppler Color Ultrasonography and mammography as well as CT. But these methods could only examine the breast in partial, or had side effect of radiation on human body or high medical cost. TTM could examine both breast local change and general condition with different emphasis. It explored the function in different organs and systems and evaluated the various physical conditions of the tested patients via the principle of receiving thermo-radiation signal from cell metabolism in different part of body. It integrated the technology of computed tomography into infrared thermo-radiation scanning receiver, so that it not only detected the position of the abnormal thermo-radiation, but also measured its depth and understood its morphologic pattern and further localized the lesion accurately. Furthermore, TTM passively absorbed thermo-radiation from human body, which had no injury to body, no harmfulness to health and no pollution to environment. TTM could be performed easily, repeatedly and economically, also could monitor the pathologic changes dynamically. It had great preponderance in screening and diagnosing breast diseases

Our findings on TTM showed that the isolated increased abnormal thermo-radiation with coarse rim, irregular pattern and deeper layer position as well as with surrounding or penetrating vessels in breast raised high suspicion in breast cancer. The accompanying abnormal dot thermal source in deeper axilla further supported the diagnosis of malignancy. The features of TTM imaging were highly consistent with the malignant characteristics such as invasive growth, hyperactivity of cell division, hypervascularity in tissue and easier axillary lymphatic metastasis. The evaluated results of TTM were further proven in the subsequent follow-up, examination and therapy of the tested patients.

TABLE IV
ABNORMAL THERMO-RADIATION CONDITION IN OCCIPITAL-CERVICAL-THORACIC-ABDOMINAL REGION IN DIFFERENT BREAST DISEASE CASES

	Cervical	Thoracic	Abdominal	Occipital	≥3 regions presented
Normal (n=7)	4 (57.14%)	-	-	4 (57.14%)	-
Malignant (n=13)	9 (63.23%)	7 (53.85%)*	2 (15.38%)	10 (76.92%)	6 (46.15%)*
Benign (n=80)	43 (53.75%)	6 (7.5%)	18 (22.5%)	29 (36.25%)	4 (5%)

We have shown that the patients with breast cancer mostly had the specific features of abnormal thermo-radiation on TTM imaging in occipital-cervical-thoracic-abdominal region, which was particularly different from other test methods. The similar imaging was also observed in the patients with malignancy in other organs. We believed that these regions were corresponding to the area that aggregated numerous neuroendocrine tissues such as central nerve system, major sympathetic ganglion, hypothalamus and thyroid gland as well as pancreas. The cancer elicited the specific and non-specific immune reaction, then via the activation of cellular factor and tumor antigen and dual the feedback network of neural-endocrine-immune system, induced hyperactivity of those neuroendocrine tissues and finally demonstrated the increased abnormal thermo-radiation on TTM imaging.

The accurate diagnosis of breast diseases would be further benefited from combination of local appearance in breast lesions with specific finding in whole body scanning. The aged patients had lower metabolic rate, poor response to diseases and repression of immune system [2], and could not show local and systemic specific features occasionally. So history and physical examination should be referred in interpreting TTM imaging.

IV. CONCLUSION

In summary, TTM can provide the value information in diagnosis of breast diseases per via combination of general functional condition in body with local appearance in breast. It can be performed easily, economically and practically, no injury and harmfulness to human body and no pollution to environment. TTM has great potential for screening and diagnosing breast diseases.

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