

## Breast thermography : identification of differential vascular patterns in breast carcinoma

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**SUMMARY.** Four new thermographic patterns of breast cancer described. These new signs are not only useful in making a differential diagnosis between benign and malignant disease but are also helpful in making a diagnosis of bilateral carcinoma or recurrent cancer in patients who have had a previous mastectomy. A combination of two or more signs can be present in the same breast with cancer. This heightens the suspicion of malignancy.

For symptomatic women and high risk women, clinical examination, thermography and mammography should all be performed. Thermography has proved to be much better than clinical examination alone. A combination of mammography and breast thermography gives a diagnostic accuracy of at least 94% in our experience.

**Key words:** breast thermography, breast carcinoma, benign breast disease, thermographic signs.

Since the initial application of thermography for the diagnosis of breast cancer, diagnostic emphasis has concentrated on comparing vasculature, background and areolar temperature, and contour of one breast to the other. Recently, we have identified four recognizable abnormal thermographic patterns in proven cases of cancer.

The purpose of this paper is to present these new thermographic signs of breast carcinoma and to discuss our experiences with thermography in the diagnosis of mammary cancer. A comparative study with proven benign disease is also presented.

### MATERIALS AND METHODS

This retrospective experience with breast thermography includes 10,063 cases from our Breast Cancer Demonstration Project Center. A Spectrotherm System 1000 and a System 2000 Thermographic Imager have been used

for all examinations. All patients disrobed to the waist and cooled for 10 minutes in the examining room at an ambient temperature of 20 to 21 °C. Thermograms were obtained with the patient in an erect position holding onto a movable bar which was suspended from the ceiling. The patient was inclined slightly forward so that the breasts assumed a natural dependency.

Three views were taken. A frontal view including the lower neck, both axilla and both breasts; and an oblique view of each breast at an angle of 30 to 45° to show the axilla in profile. Polaroid Type 107 film was initially used for recording the thermal image but recently Kodak SO 179 4" x 5" cut sheet film has been used. All films were taken in both black-hot and white-hot modes with a temperature range of approximately 5-10 °C. An automatic brightness control was used for the frontal view. A manual control was employed for the oblique views with higher temperature range than the temperature used for the frontal projection.

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## NORMAL BREAST THERMOGRAM (MAMMOTHERM)

The normal mammotherm should show relative symmetry of the vascular pattern; temperature, including vascular and non-vascular surface temperature (background temperature); areola; and breast contour. Thermographic vascular shadows are produced by superficial veins of the thorax. These vessels have a fan-shaped course and converge into one of three localized areas which are characterized by in-

There are five recognizable thermographic patterns on the normal mammotherm: an avascular type, a reticulated or mottled vascular type, a minimal linear vascular type, a moderate linear vascular type, and a marked linear vascular type.

## NEW THERMOGRAPHIC SIGNS OF BREAST CARCINOMA

Local or diffuse heat and contour abnormalities have been previously reported as the

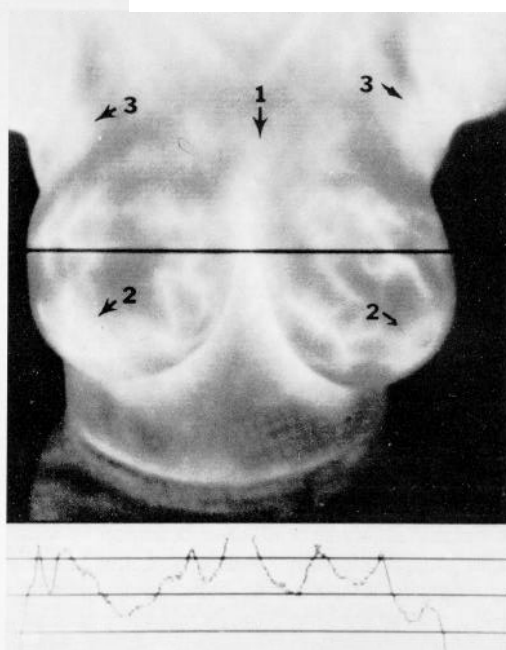
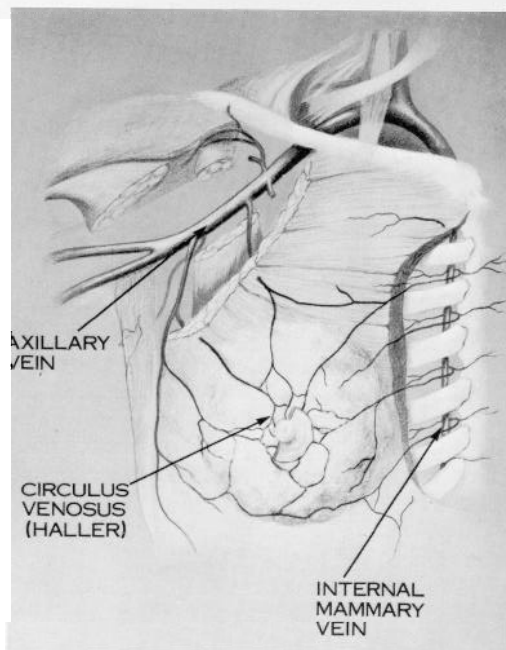


Fig. 1 A-B. (A) Diagram for normal venous drainage of the breast. (B) Normal frontal breast thermogram. 1. Internal mammary vein drainage area. 2. Circulus venosus. 3. Axillary vein drainage area.

creased heat on the normal mammotherm (Fig. 1, A-B). These three areas include the internal mammary vein drainage area in the lower midline of the thorax; the anastomotic venous circle around the base of the areolar, called by Haller the circulus venosus; and the axillary vein drainage into each axilla. The warmest area in the normal breast is usually over the internal mammary venous drainage. More vessels are recognized in the upper half of the breast.

thermographic signs of breast cancer 1, 2 However these signs are non-specific and can be associated with benign lesions of the breast. Recently we have noticed four recognizable abnormal thermographic vascular patterns which were only present in cases of proven breast carcinoma.

### 1. « Belaying » sign (Fig. 2, A-B)

Abnormally dilated, hot vessel or vessels connect two of the three major venous drainage

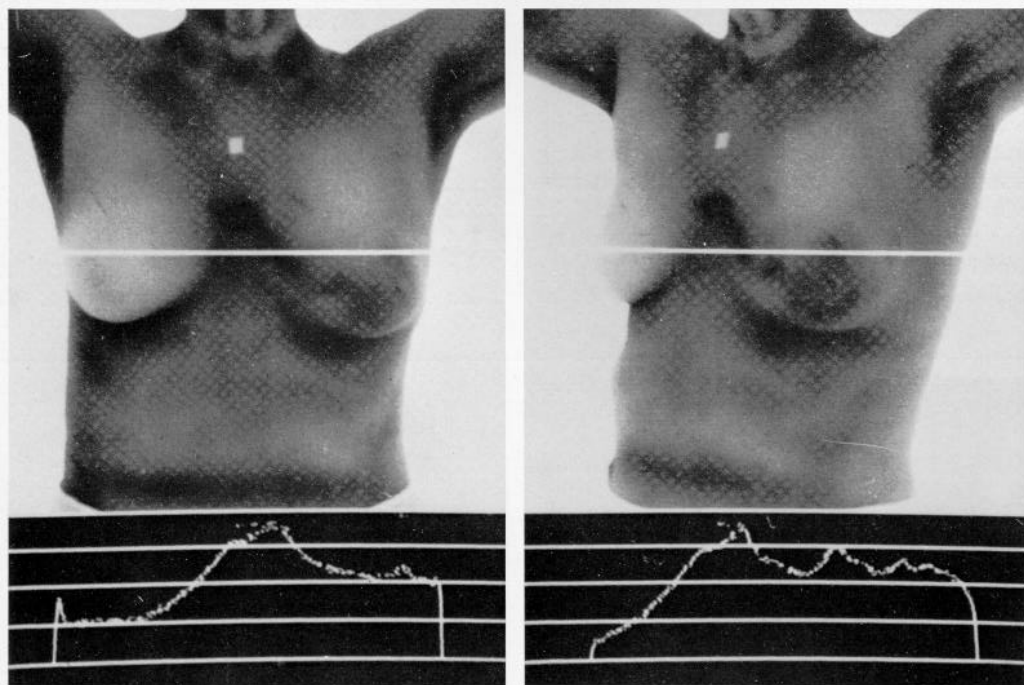


Fig. 2 A-B. (A) Frontal and (B) left oblique breast thermogram showing a positive «Belaying» sign extending from the left areolar drainage area to the right mammary area.

area: namely, the internal mammary-areola area, the axillary-areola area, or the internal mammary-axillary area. *There must be increased focal temperature at the point of venous drainage.* Occasionally a single or a few dilated veins can be seen running between the venous drainage areas without increased temperature. This does not indicate a positive «Belaying» sign. This sign was positive in 12 of 56 thermographically positive carcinomas.

## 2. «Supraclavicular extension» sign (Fig. 3)

A vessel or vessels extend abnormally beyond the supraclavicular region. The supraclavicular extension of vessels is frequently seen in normal mammothems, especially the breast with a predominantly longitudinal vein pattern. Normal vessels, however, run in a fan-shaped pattern and converge into the near midline of the neck or over the shoulders. When a rather straight vessel (or vessels) runs vertically and extends beyond the mid portion of the clavicle, it is indicative of a positive extension sign. This sign was positive in 6 of

56 thermographically positive cancers and is frequently associated with the other signs of cancer.

## 3. «Caret» sign (Fig. 4)

Two or more abnormally dilated, rather straight vessels converge together and form an apex pointing toward one of the three major drainage areas. One can occasionally see caret-like vessels on the mammothems of non-cancer patients. However the location of the apex in these cases is not pointing towards one of the three major venous drainage areas. This sign was noted in 7 of 56 thermographically positive cancers.

## 4. «Moya-Moya» sign (Fig. 5)

Bizarre focal heat is demonstrated between poorly defined dilated vessels, similar to what is seen in the angiographic pattern of Moya-Moya disease of the brain. This sign is different from focal increased heat and careful distinction is necessary. This sign was found in 10 of 56 thermographically positive cancers.

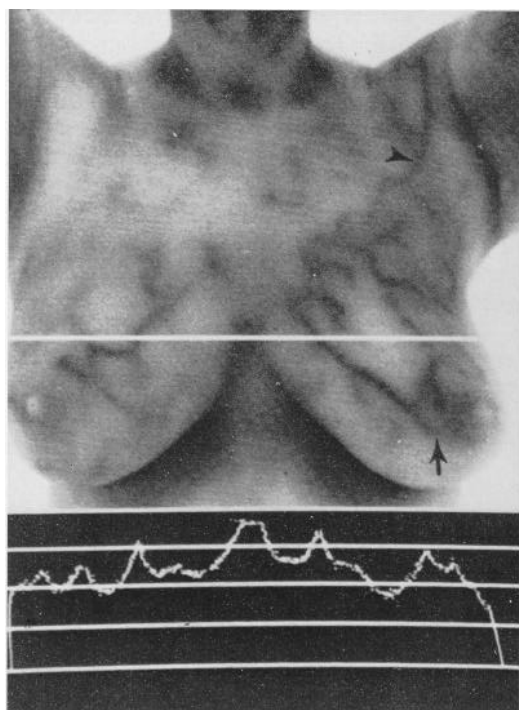


Fig. 3. Frontal breast thermogram showing a positive «Supraclavicular Extension» sign (arrowhead) in a case of left breast carcinoma. Positive «Caret» sign is also seen with its apex pointing toward the areola (arrow).

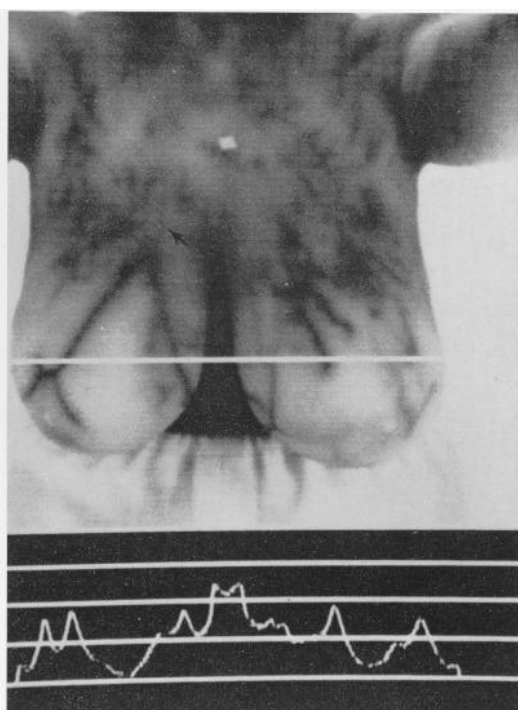


Fig. 4. Frontal breast thermogram showing a positive «Caret» sign in the case of right breast cancer with its apex pointing toward the internal mammary venous drainage area (arrow).

## DISCUSSION

There were 166 biopsy proven benign lesions in our series (Tab. I). One hundred cases (60%) of this group showed a normal mammotherm. Sixty-six patients (40%) showed an abnormal thermogram pattern but none of these benign lesions demonstrated any

of the new thermographic signs of breast cancer.

In this series, 75 asymptomatic patients had proven breast carcinoma. Thirty-nine patients had left breast cancer, 32 had cancer in the right breast and 5 cases had synchronous bilateral cancer. Thus 80 cancers were present in our series. Fifty-six cancers (70%) revealed an abnormal mammotherm.

There were 12 cases of mammographically obvious cancer which failed to show any thermographic abnormality. All but 2 of these patients had relatively small cancers, less than 1.5 cm in greatest diameter; and only 2 patients had axillary lymph nodes metastases at surgery. However, there were 5 cancer patients with a positive mammotherm who failed to show any mammographic abnormality. In fact, the thermographic abnormalities were present 7 to 12 months prior to the diagnosis of breast cancer. All 5 of these patients had dense dysplastic breasts.

Tab. I. Benign diseases (Biopsy proven).

Fibrocystic (or dysplastic) disease	101
Lymph node hyperplasia (intraparenchymal)	3
Fibroadenomas	13
Lipomas	13
Intraductal papillomatosis	18
Sclerosing adenosis	9
Normal breast tissue with no lesion	4
Fat necrosis	2
Benign calcifications	3
Total	166

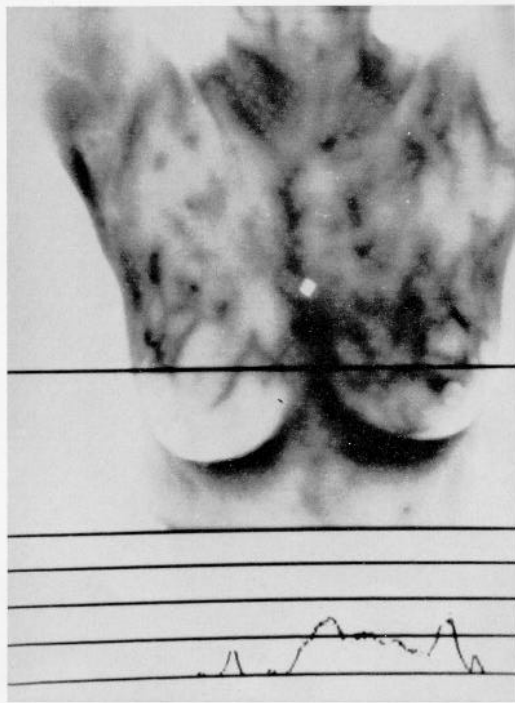


Fig. 5. Frontal breast thermogram showing a positive «Moya-Moya» sign in a proven left breast cancer.

There were 9 proven breast cancers with microcalcifications without obvious mass on the mammograms. Six cases of this group failed to show any thermographic abnormality. However, 3 cases of microcalcifications without mass did have an abnormal mammotherm.

In 4 patients the thermographic abnormality presented in the contralateral breast (so-called «cold cancer»). The location of thermographic abnormalities does not always correspond with the anatomical location of the cancer. Only 28 cases (50%) showed close agreement

between the mammotherm and the anatomical location of the cancer.

One hundred and fifty seven of 166 biopsy proven benign cases (95%) showed a temperature elevation; but less than 2 °C. Forty of 47 cases with cancer (85%), excluding 5 cases 01 postmastectomy and 4 bilateral cancers, exhibited a temperature elevation of more than 2 °C. The remaining 7 patients had 1.5 °C elevation. There were only 4 cases of cancer showing more than a 3 °C elevation.

Comparative diagnostic accuracy by different methods of examination in our series is summarized in Tab. II.

**Tab. II. Comparative diagnostic accuracy in 80 proven breast cancers.**

Method	Correct No.	diagnosis Percent
Thermography	56	(70 %)
Mammography	70	(87.5 %)
Clinical examination *	23	(29%)
Thermography + Mammography	75	(94%)
Thermography + Clinical examination *	61	(76%)

\* Performed by trained nurses.

## REFERENCES

1. ISARD H. J., OSTRUM B. J.: Breast thermography - the mammotherm. *Rad. Clin. N. Amer.*, 12, 167-188, 1974.
2. LAPAYOWKER M. S., BARASH I., BYRNE R., CHANG CH. J., DODD G., FARRELL C., HABERMAN J. D., ISARD H. J., THREATT B.: Criteria for obtaining and interpreting breast thermograms. *Cancer*, 38, 1931-1935, 1976.

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