BREAST THERMOGRAPHY

THESIS

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OF THE MASTER DEGREE IN

RADIO-DIAGNOSIS

BY

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INTRODUCTION

Various methods are now available for clinical exploration of the breast. The most commonly used methods provide information essentially on morphology and structure, including macroscopic data. (Palpation, radiography, echography) and microscopic data (cytology, histology). By contrast, the thermal methods, among them skin thermography using infrared scanners or liquid crystals films, offer the advantage of giving information on thermophysiology. The superficial thermal pattern of the breast is in fact related to metabolism and vascularization within the underlying tissues. It may therefore be changed significantly as a result of normal phenomena (e.g., the menstrual cycle or pregnancy) or pathological processes. As cancers vary so widely, not only in their histologic features but also in their physiological properties, it is important to study the thermological dimension, which is related to the various properties of cancer.

Lawson introduced infrared thermography for the evaluation of breast lesions in 1956 **(Gautherie, 1983)**. Infrared thermography is performed with the use of remote-sensing scanners which analyze thermal radiation from the skin in the infrared range of electromagnetic spectrum **(Gautherie et al., 1972)**.

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In the last 10 years, the development of systems in which thermosensitive liquid crystal films are used has resulted in renewed interest in this modality.

In liquid crystal thermography, thermosensitive cholesteric liquid crystals deposited on special films are used. Plates containing these films are brought into contact with the skin and provide direct observation of the cutaneous thermal pattern as a coloured map. Dramatic improvements in this technology have occurred, particularly in the areas of thermal and spatial resolution.

The interpretation of breast thermograms should not depend upon subjective feelings but should use a certain objective scheme which takes into consideration both the absolute temperature differences between both breasts and changes in the thermovascular patterns. Numerical scores can now be assigned to each abnormality and the sum of these single scores can be related to the ultimate thermal class assigned **(Gautherie, 1983)**.

The aim of this work is to spotlight the possible role of liquid crystal thermography as a tool in the diagnosis of breast lesions not to replace but to complement the widely used well known methods of breast investigations.

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PHYSICAL CONSIDERATIONS

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PHYSICAL CONSIDERATIONS

Thermography is the procedure by which the heat naturally emitted by the body is detected, measured and imaged. The resultant image -the thermogram- is a visualization of the distribution of the heat patterns of the body surface. This heat is naturally emitted as a result of either normal body function or disease or injury **(Gautherie, 1983).**

Two methods of thermal imaging are presently available for routine thermographic assessment of breast health, infrared thermography and liquid crystal thermography. Although both are non invasive, they are totally different in their underlying physical principles and technology **(Gautherie, 1973).**

Infrared Thermography

Infrared thermography is performed with the use of remote-sensing scanners which analyze thermal radiation from the skin in the infrared range of the electromagnetic spectrum **(Gautherie et al., 1972).** Electronic devices coupled to the scanner and fitted with microprocessors allow real-time display of images which represent the temperature distribution over a large part of the body.

These machines are accurate, reliable and can be used for thermographic studies in a variety of pathologic circumstances. However, their relative high cost has limi-

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ted their utility to specialized departments, mostly in hospitals **(Gautherie, 1983).**

Infrared radiation is an electromagnetic radiation. Thus it shares the characteristics of wave motions and specifically those of electromagnetic radiations. It is part of the same wide spectrum of wave like radiations that include radio and light waves, ultraviolet rays, x-rays, and cosmic rays. Infrared lies just beyond the red end of the visible spectrum of light, and thus has somewhat longer wavelength and lower energy than light rays. Infrared energy or heat radiation, is emitted as a function of local temperature **(Gautherie et al., 1972).** All objects in nature seek to acquire or remain in thermal equilibrium with their surroundings. Thus areas of the skin that are warmer than the surroundings will radiate more infrared rays. Metabolism generates heat. Local metabolism is often increased in areas of malignant tumour, inflammation, or injury. Circulation and some other body mechanisms contribute to the maintenance of human thermal equilibrium. In the course of these processes, some areas of the skin will be warmer and others cooler. Although invesible, this spontaneously emitted radiant energy, which is fundamental to all nature, is the physical basis for thermography **(Evans and Gravelle, 1973).**

Apparatus and Principles Employed

There are a number of machines commercially

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The EMI Thermoscan

This scanner allows an easy change from a two-dimensional to a single line scan. The horizontal and vertical fields are scanned by means of rotating plane mirrors(Evans and Gravelle, 1973).

The Pyroscan

The pyroscan was the first British apparatus to be developed for medical thermography. The detection unit uses an indium antimonide cell cooled with liquid nitrogen. The infrared radiation is focused by mirrors on to a sensitive indium antimonide cell. A change in conductance in the cell is converted into an equivalent voltage to produce a black and white picture on a special type of paper (Evans and Gravelle, 1973).

The Barnes Medical Thromograph

This equipment uses a thermistor detector and has a scanning time of about 3 minutes. The thermistor cell needs no cooling and has a wide spectrum of response to infrared radiation (Evans and Gravelle, 1973).

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Liquid Crystal Thermography

Liquid crystal thermography a new modality of thermography uses certain chemical substances which are cholesterol derivatives that selectively reflect polarized light in a spectrum of narrow wave lengths. They have strong molecular rotatory power and specific colour temperature responses that are utilized in colour thermography **(Crissy et al., 1970).** The adaptation of liquid crystals to thermography in previous years was hampered by the necessity of skin preparation with black, water-based paint in the form of a spray prior to the actual application of liquid crystals to the skin **(Pochaczevsky and Meyers, 1979).** Rigid plastic plates subsequently skin preparation and spraying, but the unyielding plates precludes uniform contact between the liquid crystals and the skin, particularly when applied to the spine or extremeties. The resultant thermograms were, therefore, inadequate. A new contact thermographic technique using liquid crystals embeded in elastometric Flexi-Therm was first adapted clinically for breast thermography. The method was further refined for use with the extremities by mounting the elastic sheets, which had been impregnated with liquid crystals, on inflatable frames or boxes. The resultant liquid crystal "air pillows" could then be closely contoured to any shape

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or body surface. Six or more "air pillow" boxes are used and progressively numbered from 24 to 35 to correspond to the medium celsius temperature ranges of the incorporated liquid crystal Flexi-Therm sheets. Liquid crystals have accurate and reliable colour responses to specific temperature changes. The lowest temperature in the liquid crystal thermal gradient is displayed as dark brown. As temperature rises, the colour changes from dark brown to tan, reddish brown, yellow, green, light blue, and then dark blue. The highest temperature (hyperthermia) is indicated by a dark blue colour and the lowest **temperature**, hypothermia, by a dark brown colour **(Pochaczevsky et al., 1982).**

The Thermographic Examination

Patients are prepared by disrobing and waiting in an air-conditioned, draft-free room for 15 minutes. The "air pillow" selected is the one with the widest display for the patient's skin temperature. A 30 °C box is initially used. If brown colours seem to predominate, skin temperature is too cold for that particular box, since brown represents the lowest temperature on the liquid crystal colour scale. A 28 °C box is then substituted. If blue colours predominate with the 30 °C box, the skin temperature is too warm, since blue indicates the highest temperature on the liquid crystal colour scale. A 32 °C box is then used. The appropriate box is then firmly pressed against the patient's skin. A coloured image promptly appears on

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