Differences in accuracy detecting breast cancer between mammography and stress thermography as determined by breast biopsy

by Bridget Sue Bradshaw

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER IN NURSING
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Abstract:
To determine whether any difference existed in accuracy between mammography and stress thermography in the detection of breast cancer in symptomatic women was the purpose of this study. Therefore, a retrospective review was conducted of 780 records of women who had the stress thermography procedure. This review yielded 72 women with biopsy confirmation of their breast disease. Twenty-four of the subjects had breast malignancies while 48 had benign breast disease.

The mammography procedure performed on 54 subjects yielded 75% sensitivity and 87% specificity to breast cancer with an overall accuracy of 85%. Mammography, tended to be less accurate in detecting cancer in young women. The stress thermography procedure performed on 66 subjects produced a sensitivity of 88%, a specificity of 52% to breast cancer, and an overall accuracy of 65%.

In the subjects with cancer, three out of 24 were negative with the stress thermography while four of 16 were negative with mammography. One cancer was missed by both procedures; the combined procedure specificity was 94%. In the subjects with benign breast disease, five had positive mammograms while 20 had positive stress thermograms. Two subjects were false-positive with both procedures.

The results suggested that neither stress thermography nor mammography discriminated sufficiently to replace biopsy as a diagnostic modality in a disease of so serious a nature with such consequences as breast cancer. Given the retrospective nature of the data, the small sample size, and the current lack of follow-up data on each subject, these results were to be interpreted cautiously.

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Date 7 August 1981

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ABSTRACT

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Chapter 1

INTRODUCTION

Breast cancer is among the most dreaded of diseases. Not only is it the major cause of cancer death for women, but the crude incidence rate of cancer of the breast far exceeds that for any other type found in either sex (Cooperman & Esselstyn, 1978; Feig, 1979). In the United States, cancer of the breast is the most frequent malignancy in females with 100,700 new cases and 35,000 deaths annually. Among women who are between 25 and 74 years of age, breast cancer is the leading cause of death from cancer; and in women between 40 and 44 years of age it is the leading cause of all deaths (Graphic Stress Telethermometry System, 1980; Maharry, 1980). Statistics in 1980 indicate that one out of every 11 women, or about 9%, will develop breast cancer in her lifetime (Townsend, 1980).

Over 90% of breast cancer is detected initially by the woman herself (Breast Cancer Digest, 1980; Cooperman & Esselstyn, 1978). A large portion of these women are subjected to further diagnostic examinations before biopsy or mastectomy. Current available methods for aiding in diagnosis are physical examination of the breast, mammography, infrared thermography, and, more recently, stress telethermography. None of these methods, including breast biopsy, are 100% accurate given the nature of the disease.

The use of mammography as a diagnostic technique in evaluating patients with signs and symptoms of breast disease is well established. At present, mammography is believed to be of benefit in women over the age of 50; but its value in young women is controversial (Azzopardi, 1979; Breast Cancer Digest, 1980; Shapiro, 1977). Mammography is able to detect nonpalpable cancers less than 1 cm. in diameter including about 17% of the clinically occult cancers, but this is primarily restricted to post-menopausal women rather than premenopausal women with denser, more glandular breasts (Cooperman & Esselstyn, 1978; Dodd, 1977; Hicks, Davis, Layton, & Present, 1979; Shapiro, 1977). Fewer occult carcinomas are detected in young age groups (Azzopardi, 1979). A question of radiation hazard to the breast during mammography also exists. Although no direct evidence is available that the low dose of radiation currently used in mammography increases the incidence of breast cancer (Moskowitz, Gartside, Gardilla, de Groot, & Guenther, 1977),* current concerns are based on extrapolation from data on the carcinogenic effects of high doses of radiation. These dose-response relationships are derived from studies which show an increased incidence of breast carcinoma in women who received repeated chest fluoroscopies in tuberculosis clinics, those treated by radiation for post-partum mastitis and other non-neoplastic conditions of the breast, and from atomic bomb survival data (Azzopardi, 1979; Cooperman & Esselstyn, 1978; Dodd, 1977; Feig, 1979; Stark & Way, 1974; Townsend, 1980). The question of radiation hazard to the breast during mammography is an emotive one and currently the topic of much discussion. The radiation dose required to obtain a good image is greater in younger women than in women over 50, and the sensitivity of the breasts of younger women to radiation may be greater. Since the effects of radiation are cumulative over the years, current guidelines recommend that mammography be used only in patients under 50 years of age who are symptomatic or at high risk of cancer (Breast Cancer Digest, 1980; Cooperman & Esselstyn, 1978; Seidman, 1977; Townsend, 1980).

Thermography of the breast is a newer procedure than mammography and must be developed further before its full potential can be realized. Thermography cannot be considered an adequate prescreening technique to obviate further diagnostic procedures as was once anticipated. Although quantification of thermographic images has been performed, the interpretation depends on subjective analysis of an image and is only as accurate as the degree of expertise of the examiner. Thermographic diagnosis of malignancy has been based on venous pattern and regional temperature variations. Although the constancy and symmetry of the thermal pattern of the breasts has been found to be unchanging over several years (Isard, 1980a, 1980b), it is easily affected by biologically active, but benign, processes such as fibroadenomas, mastitis, medications, stage in ovulatory cycle, and pregnancy. The thermogram also is influenced by the growth rate of a tumor. Early cancer and rapid-growing cancers may give rise to strong hyperthermias, whereas advanced carcinomas or small carcinomas with unfavorable heat transfer conditions from the tumor to the skin do not give rise to thermographic abnormalities (Gautherie, 1980). As a result, conventional thermography has a false-positive rate of 20-25% and a false-negative rate of 20-30% (Jurist & Myers, 1980). Thermography has fallen into disfavor with the Breast Cancer Detection Demonstration Projects, and the current recommendation for its use is in conjunction with physical examination and mammography to reinforce diagnosis (Dodd, 1977), as a prognostic indicator (women with cancer who have normal thermograms have higher survival rates than those with abnormal thermograms), and as an interim screening tool in young women. Even though thermography is an entirely safe, noninvasive method, its current limitations preclude its use as an isolated diagnostic technique.

Stress thermography, or Graphic Stress Telethermometry (GST), is a variant of thermography which has been under investigation since 1975; but few published studies of this technique are available. No published long-term studies of this procedure and no repetitive studies of the test to determine whether changes in the scores indicate changes in breast pathology exist. Stress thermography is based on two principles. First, increased thermal emission occurs when blood vessels are located near the body surface and when certain organs have a significant vascularity near the body surface. It also occurs over areas of high metabolic activity such as is found with malignant tumors, infection, or injury which exceeds that of the surrounding normal tissue. Second, temperature measurements after a generalized vasoconstrictive (ice water) stress show that abnormal areas, such as in cancer, do not exhibit the same reduction in temperature from vasoconstriction as do normal areas. This observation presumably is a result of the vessels in the tumor not constricting to the same degree as those in normal tissue in response to the same vasoconstriction stimulus (Snyder, Watson, & Cruz, 1979). The use of the ice-water stress is thought to increase diagnostic sensitivity and specificity. Snyder et al. (1979) report 37% false-positives and 7% false-negatives, and Jurist and Myers (1980) report a false-positive rate of 28% and a false-negative rate of 10%.

To note that several factors can affect results such as the ambient room temperature, relaxation of the patient, as well as those variables mentioned under thermography, is important. One researcher even reports that a full bladder can alter the readings (Snyder et al., 1979). Hopefully, however, the physiological contrast between pre- and post-vasoconstrictive stress as well as the objective evaluation offered by computer analysis will more than offset these problems.

The continued evaluation of stress thermography as a diagnostic procedure in breast cancer is essential since it is noninvasive, does not use ionizing radiation, and "offers the advantages of an objective thermography reading and the potential discriminatory factor of insensitivity of tumor vessels to normal thermo-regulatory mechanisms" (Snyder et al., 1979, p. 201). The problem centers around the fact that no current diagnostic test exists that is 100% reliable in indicating either "cancer" or "no cancer."

Review of the Literature

Normal human breasts are composed of three types of body tissue: connective, epithelial, and fat. Arranged within each breast are 15-20 lobes or segments which converge on the nipple in a radial fashion. These lobes are subdivided into lobules and end in milk-producing bulbs called acini (ductals). The lobes, lobules, and acini are connected to the nipple by a complex network of ducts that enlarge as they enter the nipple. These enlargements are called the lactiferous sinuses. Though no externally visible or palpable anatomical separation of the segments exists, their ductal and lobular systems are distinct (Azzopardi, 1979; Breast Cancer Digest, 1980).

The lobules are composed of dense glandular tissue and are held together by connective tissues, blood vessels, and by the lactiferous ductules which unite to form the main duct. The lobes are covered and loosely connected by fibrous tissue, but the intervals between lobes are occupied by fatty tissue. A subcutaneous layer of fatty tissue envelops the breast except under the nipple and areola (Merrill, 1975). Figure 1 shows the anatomical parts of the breast.

Breast cancer begins with neoplastic proliferation of cells in the mammary ducts.

> Breast cancer is a disease of the mammary epithelium. The entirety of the mammary system is embryologically derived from ectodermal down growths into the mammary fat pad, thus the ducts and their terminal expansions are . . . epithelial surface (Gallagher, 1980, p. 905).

Carcinoma may affect any part of the ductal system, but evidence shows that the smaller ducts are more often involved than the larger ducts. Lobules also may be affected by either carcinoma or epitheliosis, but more commonly by carcinoma (Azzopardi, 1979). Figure 2, page 9, illustrates the sites affected by breast disease.

Cancers are classified by the specific tissue from which they originate. Most breast cancers arise in the glandular tissue and are called adenocarcinomas; <u>adeno</u> refers to glandular tissue; carcinomas arise from epithelial tissue. The earliest recognizable breast cancers are noninvasive intraductal carcinoma and lobular carcinoma in situ. Once neoplastic transformation is established, growth proceeds within the epithelium of origin. As the neoplastic cells proliferate in the lumen of the ducts, they tend to break through the basement membrane and invade periductal tissues where they incite a proliferation reaction (Brennan, 1973). To this point the evolution of breast carcinoma is a fairly uniform process. Little is known about

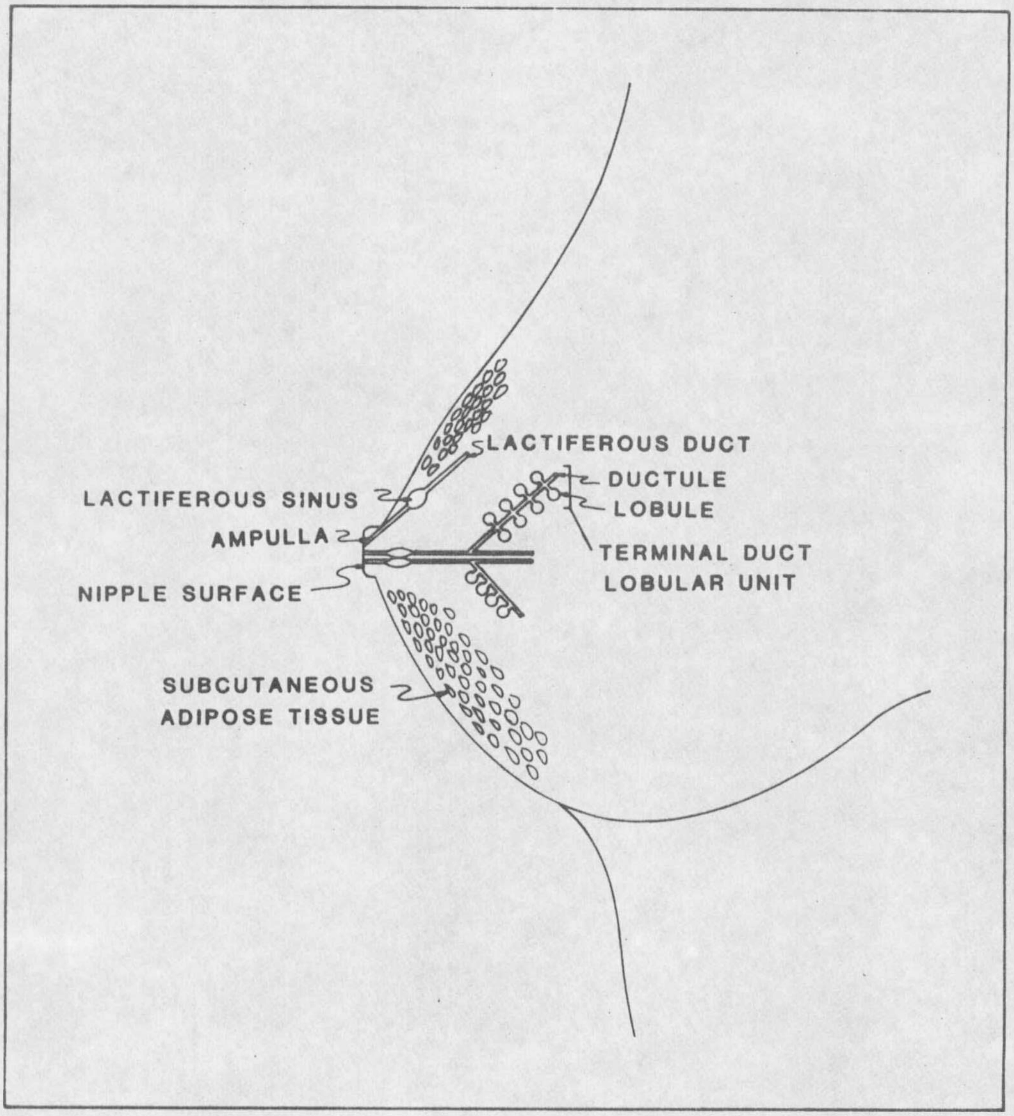

Figure 1. Anatomical parts of the breast. (Adapted from Azzopardi, 1979, p. 9).