Mammography:

An Aid in the Treatment of Carcinoma of the Breast

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The indications and contraindications for mammography are reviewed in a study of 182 patients with breast biopsy or mastectomy. The mammographic signs seen in breast carcinoma are presented. In the group studied, a correct diagnosis was made in 80.2% of the cases, with a false positive diagnosis in 13.1% and a false negative in 6.6%. The concept of "minimal breast cancer" is defined. A method of localizing nonpalpable breast masses, injection mammography, is described. Surgical management continues to be the best means of lowering the mortality of breast cancer.

CARCINOMA OF THE BREAST occurs in 30% of American females and is the most frequent cause of death in women between the ages of 40 and 46.[4,6] There has been no improvement in the mortality statistics of this disease in recent years.[14,25]

Mammography has been used for 50 years, sporadically at first but more frequently and with better results in the past few years. The introduction of more specialized radiographic equipment, which provides exceptional contrast and fine details in films,[14] has made mammography an excellent addition to the armamentarium for the diagnosis of breast disease. The indications and contraindications for its use have been defined, and it has become axiomatic that close cooperation is essential between the surgeon, radiologist and pathologist if the best use is to be made of mammography.

Indications for Mammography

The remaining breast, after contralateral mastectomy for carcinoma, should be evaluated by x-rays annually and more frequently if symptoms appear. Breast carcinoma is multicentric and a metachronous carcinoma will occur in 7% to 10% of such patients.[5,24]

Fibrocystic disease in a lumpy breast may obscure a small carcinoma and should be screened by mammography.

Large breasts may contain a neoplastic mass that cannot be palpated and should be screened.

Patients with strong family history of breast carcinoma will develop a neoplasm 2 to 7 times as frequently as the general population[24] and should be x-rayed periodically.

Patients with nipple discharge, whether or not a palpable mass is present, should have mammography in search of neoplasm as the cause of the discharge.

Detection of a second primary breast carcinoma, whether ipselateral or contralateral, can best be found by mammography (Table 1).

Contraindications for Mammography

X-rays of the breasts below the age of 30 years are unproductive due to the denseness of young breast tissue.[5,21,25] Even masses occurring in the young breasts will not be seen on films as a rule.[21] In such patients physical examination is more helpful. Between the ages of 30 and 40 years mammograms may be helpful, but the breasts of patients 40 and older have greater fat content and therefore greater contrast and detail. In addition, this is the age group in which breast pathology occurs more frequently.

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TABLE 1. *Indications for Mammography*

1.	Remaining breast after contralateral mastectomy for carcinoma.
2.	The "lumpy" breast.
3.	The large breast.
4.	Strong family history of breast carcinoma.
5.	Nipple discharge:
	With palpable mass
	Without palpable mass
6.	Detection of second primary breast carcinoma:
	Ipselateral
	Contralateral

Mammography as a Screening Procedure

Screening of asymptomatic women an even of patients referred by their physicians gives a yield of 2.7 to 4.11 carcinomas per 1,000 patients[22,25,26] the first year, and on subsequent screening years the number of carcinomas found dropped precipitously. Mammography as a Public Health screening measure does not justify the manpower and cost of such a program.

Mammographic Signs

A dense or dominant mass is seen which is usually single. It may be spiculated with areas of invasion that give it a starlike outline. Extension of the tumor into contiguous tissue may give the appearance of a dominant mass and a trailing tail called the comet sign.[1,5,10,15,17,19,26]

Fine calcific stippling in a localized area appears in approximately ⅓ of the nonpalpable carcinomas and appears as fine stippling best seen with a magnifying glass. As few as three flecks of calcium may be seen, and it is usually agreed that the larger the number of flecks, the more pathognomonic the finding. This should not be confused with dystrophic calcification, which is larger and is more common in duct stasis, papillomatosis or comedocarcinoma.

There is a loss of mammographic symmetry of the breasts due to the neoplastic changes.

The mass when palpated feels larger than it appears on the radiograph.

TABLE 2. *Mammographic Signs*

1.	Dominant mass:
	Dense shadow
	Crab sign
	Comet sign
	Lobulation
2.	Fine calcific stippling.
	Varigated stippling in a localized area.
3.	Loss of mammographic symmetry.
4.	Mass feels larger to palpation than it appears on radiographs.
5.	Localized skin thickening.
6.	Unilateral increased vascularity.
7.	Change from previous films.

Localized skin thickening often appears near the dominant mass or the thickening may be the only abnormality seen.

Increased vascularity may appear in the affected breast due to the increased demand for nourishment for the rapidly growing tumor.

If the patient has previous mammograms on file there will be a change from the previous films (Table 2).

Accuracy of Mammography

The accuracy of mammography has been reported from 68% to 89%.[4,9,21,24] False positive radiologic diagnosis is not a problem as the lesion incorrectly diagnosed as carcinoma is due to benign breast disease. False negative diagnosis should be weighed by the surgeon, and if he has any doubt about the mammographic diagnosis biopsy is indicated, as 20% of breast carcinomas show no radiologic signs.[4] False negative readings vary from 6% to 20%.[3,21,22,24]

A two-year study from April 1, 1971 to April 1, 1973 was made of mammography at St. Joseph's Infirmary. All films were made using a special radiographic apparatus specifically designed to produce x-rays optimal for soft tissue radiography. The films were developed in a 90-second film processor. During this two-year period 724 sets of mammograms were made. Our study was limited by discarding all patients lost to followup or those whose records were incomplete. Only the 182 patients subjected to biopsy and/or mastectomy were studied. Of this number 59 patients had histologically proven carcinoma (32.4%). A correct positive diagnosis was given in 47 patients and correct negative in 99, a total of 146, which is an accuracy rate of 80.2% in the 182 patients undergoing biopsy and/or surgery. False positive diagnosis was made in 24 patients (13.1%), all of which had some type of benign breast pathology, fibrocystic disease, fibroadenoma, papilloma or galactocoele. False negative diagnosis was made in 12 patients (6.6%).

Mammography is not a substitute for biopsy.[11,12]

Minimal Breast Cancer

A new concept has appeared in the surgical literature in the past few years; minimal breast cancer.[1,2,7,8,13,17,19,20] This should be distinguished from early breast cancer, meaning a small cancer, which, by inference, has been present only a short time, and from occult breast cancer, meaning a cancer which cannot be palpated. By definition, minimal breast cancer is a malignant lesion no larger than .5 cm in diameter and which is usually a lobular carcinoma with or without microinvasion or intraductal carcinoma with or without microinvasion.[1,7,8] The most common radiologic sign of minimal breast can-

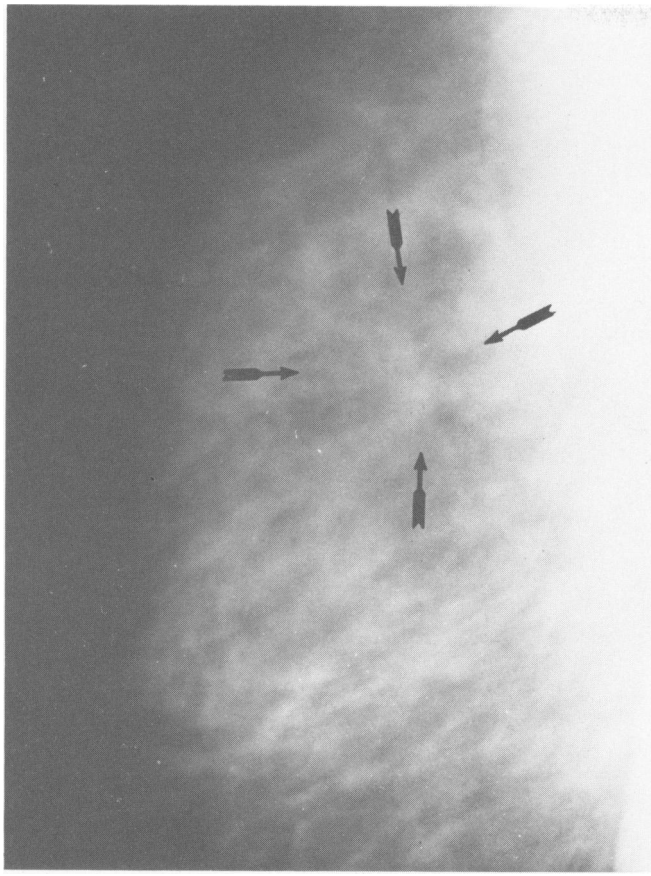

FIG. 1a. A.C., F, age 47: Lateral mammogram showing small, spiculated, dominant mass deep in a large breast. Carcinoma.

FIG. 2a. A.C.: Lateral view of injection mammogram of the same breast. Arrows delineate the mass. Note dye to the left (superficial to the mass).

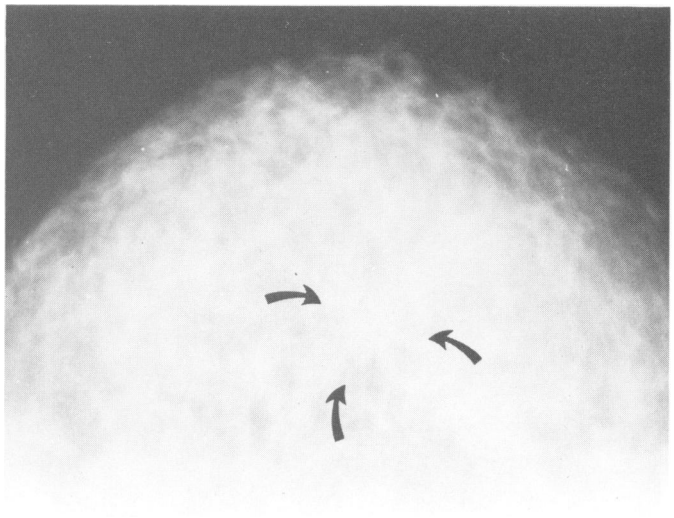

FIG. 1b. A.C.: Craniocaudad mammogram of the same breast.

FIG. 2b, A.C.: Craniocaudad mammogram of the same breast. Arrows delineate the mass. Note dye superficial to the mass.

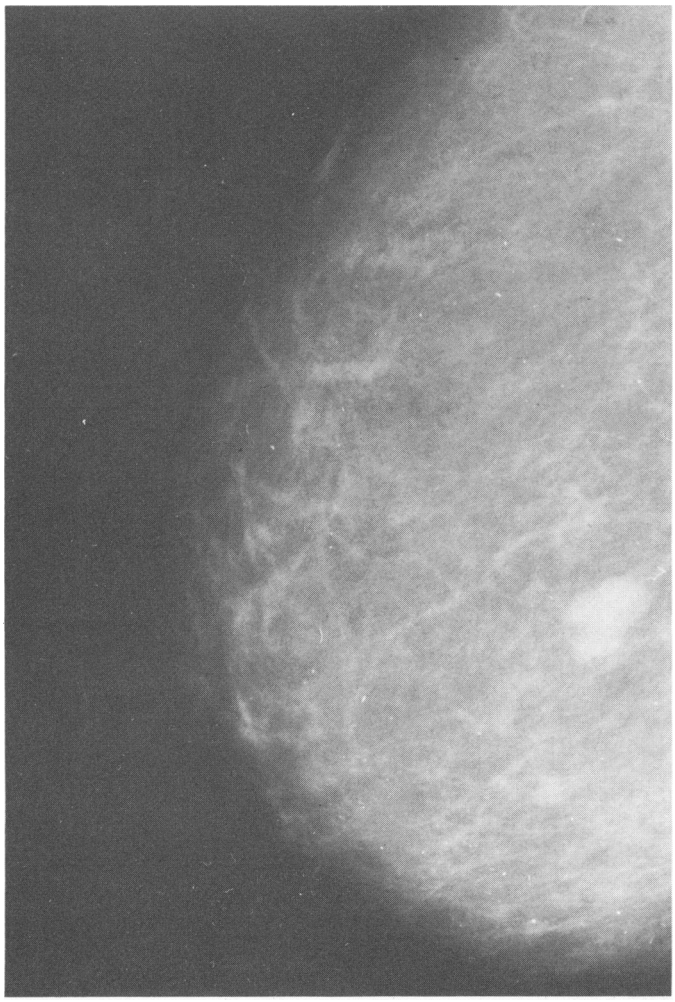

FIG. 3a. D.D., F, age 56: Lateral mammogram of a large breast showing a deeply located, nonpalpable, dominant mass. Hyalinized fibroadenoma.

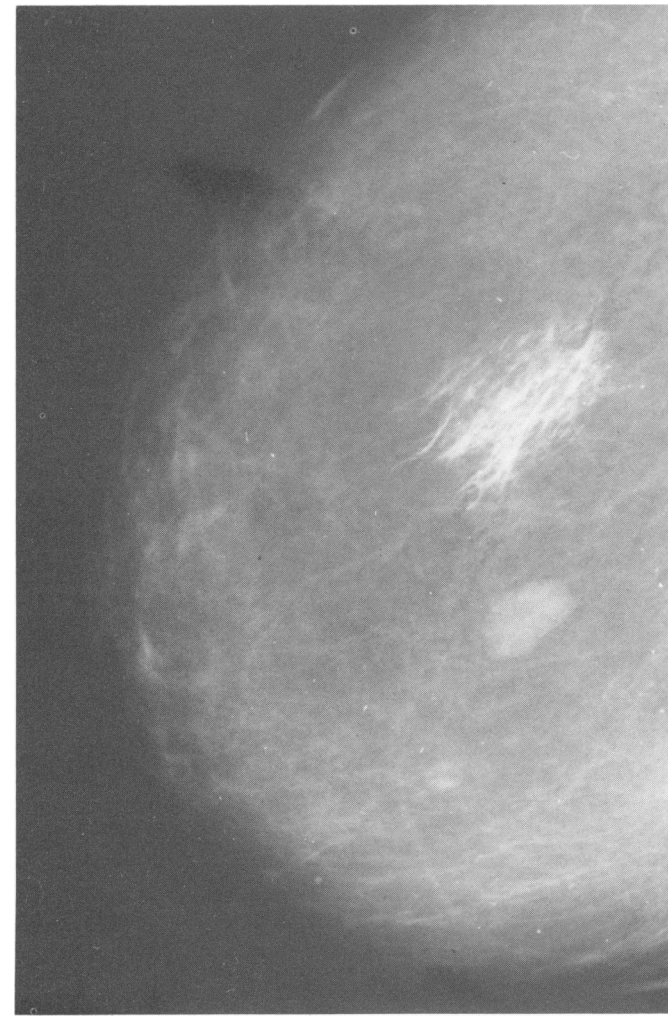

FIG. 4a. D.D.: Lateral view of injection mammogram of the same breast. Dye was deposited 2 cm. superior to mass.

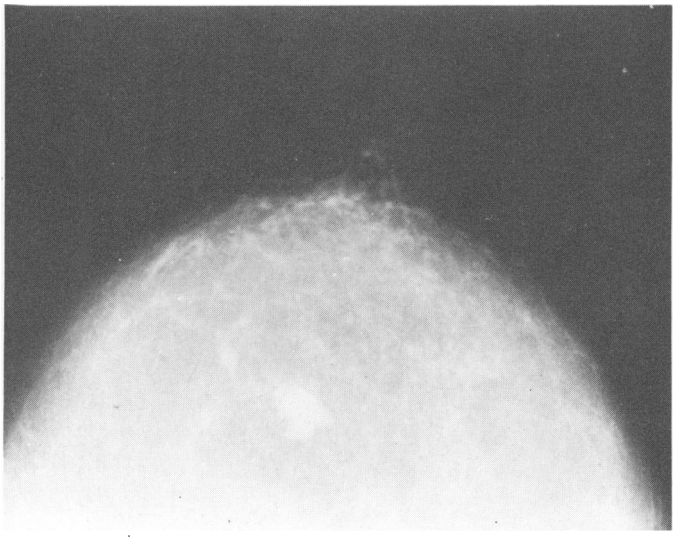

FIG. 3b. D.D.: Craniocaudad mammogram of the same breast.

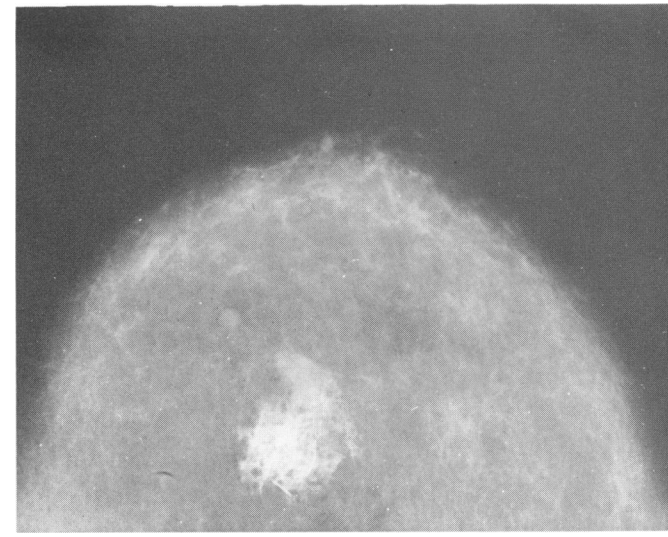

FIG. 4b. D.D.: Craniocaudad view of injection mammogram of the same breast. Dye was deep to the mass.

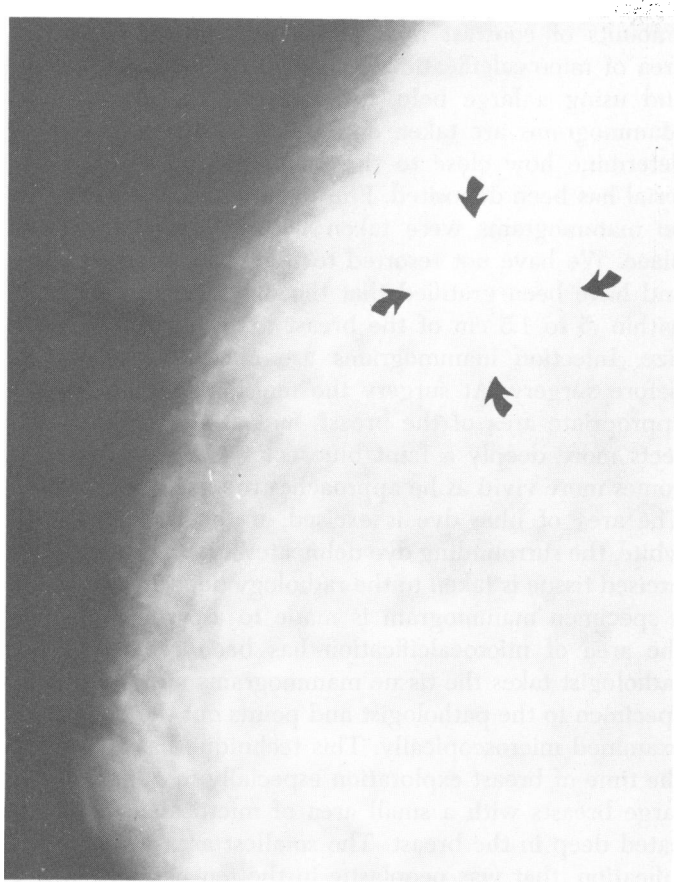

FIG. 5a. M.R., F, age 47: Lateral mammogram reveals nonpalpable, smooth, dominant mass at the 11 o'clock position deep in breast. Fibrocystic disease.

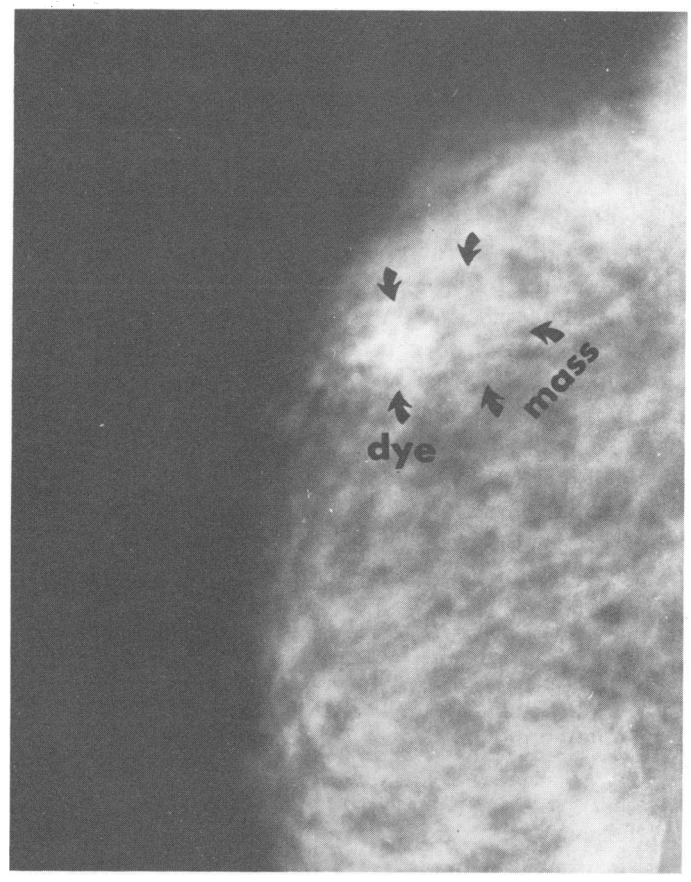

FIG. 6a. M.R.: Lateral view of injection mammogram superficial to the mass.

FIG. 5b. M. R.: Craniocaudad mammogram of the same breast. The mass was seen on mammograms one year before but the mass has enlarged and is denser than on previous films.

FIG. 6b, M.R.: Craniocaudad view of injection mammogram with dye superficial to the mass.

cer is microcalcific stippling.[1,2,9,10,13,15,17,19] These lesions rarely have spread or metastasized to the regional lymph nodes and have a better prognosis even with a less radical extirpation.[2,7] It is difficult and time-consuming to find and excise a lesion of this size especially in a large breast. Cases are reported in which the surgeon removed an area of breast that did not contain the tumor or where the tumor plus surrounding breast was removed and the pathologist took sections of an area other than the small malignancy. Elaborate, tedious and time-consuming methods have been used to eliminate these errors. Quadrant or half quadrant mastectomies have been done leaving a grossly deformed breast. The excised breast tissue is "bread loafed" in slices with a lead marker attached to each; the slices are x-rayed in search for the carcinoma and when found, the area is examined by the pathologist.[1,8,9,13,15,23] Some use lead markers on the breast at the time of mammography.[9] Others make diagrams on clear film of craniocaudad and lateral mammograms and use them as a guide to these small lesions.[2,23] Price and Butler[16] have taken stereographic paired films of the breasts and claim a limit of accuracy of 3 mm.

Mammograms are taken in the sitting position; on the operating table the breasts fall laterally and caudad especially if they are large. This vitiates lead markers on the breasts at mammography, skin marking with dye or drawings made from mammograms as an accurate localization of minute breast masses.

Injection Mammography

This term is used to differentiate this procedure from radiologic mammography. Simon *et al.*[20] described an injection technique for localizing small breast lesions in 1972. We have used a modification of their technique in 12 patients with successful localization of masses measuring 4 mm to 1.5 cm in 10 patients.

One failure was due to the use of Methylene blue as a marker. The second failure showed no tissue dye at surgery and the cause is unexplained. The protocol for injection mammography is as follows. In consultation with the radiologist the craniocaudad and lateral mammograms are reviwed and the small area of calcification localized on the films. With the patient sitting in the mammography chair a wheal of local anesthetic is made in the skin at the appropriate location; a #23 gauge, spinal anesthesia needle is inserted through the wheal in the direction and to the depth that will bring the tip of the needle as near the lesion as possible. The stylet is withdrawn and using a tuberculin syringe .06 ml (1 drop) of Megulmine Diatrizoate and Sodium Diatrizoate mixed with .06 ml (1 drop) of Evans Blue dye are injected. The tuberculin syringe is detached, filled with air, reattached and the air is injected to clear the needle of the dye and radiopaque material. Care is taken not to inject larger amounts of contrast material as this may obscure the area of microcalcification. The blue dye diffuses readily and using a large bolus will stain too large an area. Mammograms are taken and the films are reviewed to determine how close to the mass the radiopaque material has been deposited. Fluoroscopy was not used and no mammograms were taken with the needle still in place. We have not resorted to reinjection of the breast and have been gratified that the dye has been injected within .5 to 1.5 cm of the breast mass regardless of its size. Injection mammograms are made the afternoon before surgery. At surgery the incision is made in the appropriate area of the breast, and as the surgeon dissects more deeply a faint blue color is seen which becomes more vivid as he approaches the mass in question. The area of blue dye is excised; if the tumor mass is white, the surrounding dye delineates it more clearly. The excised tissue is taken to the radiology department where a specimen mammogram is made to ascertain whether the area of microcalcification has been removed. The radiologist takes the tissue mammograms and the biopsy specimen to the pathologist and points out the area to be examined microscopically. This technique has shortened the time of breast exploration especially in patients with large breasts with a small area of microcalcification located deep in the breast. The smallest area of microcalcification, that was neoplastic in the ten patients, was 4 mm in diameter.

It is shown that malignant breast masses 5 mm or less in diameter very rarely have metastasized to the regional nodes and have a much better survival rate than palpable malignant breast masses.[2,7,8,18,22,26] It is believed that this is the best means of improving long term survival from breast cancer at the present time.

References

1. Barker, W. F., Sperling, L., Dowdy, A. H., Zeldis, L. J. and Longmire, W. P., Jr.: Management of Nonpalpable Breast Carcinoma Discovered by Mammography. Ann. Surg., **170**: 385, 1969.
2. Berger, S. M., Curio, Barbara M., Gershoncohen, J. and Isard, Harold J.: Mammographic Localization of Unsuspected Breast Cancer. Am. J. Roent., **96**:1046, 1966.
3. Clark, R. L., Copeland, M. M., Egan, R. L., Gallager, H. S., Geller, H., Lindsay, J. P., Robbins, L. C. and White, C. E.: Reproducibility of the Technic of Mammography (Egan) for Cancer of the Breast. Am. J. Surg., **109**:127, 1965.
4. Cohn, H.E.: Mammography in its Proper Prospective. (Editorial) Surg. Gynecol. Obstet., **134**:97, 1972.
5. Copeland, M. M. and Scott, W. G.: Mammography, A Progress Report. Am. J. Surg., **116**:57, 1968.
6. Egan, R. L.: Roles of Mammography in the Early Detection of Breast Cancer. Cancer, **24**:1197, 1969.
7. Galante, M.: Minimal Breast Cancer: A Surgeon's Dilemma. Cancer, **28**:1516, 1971.
8. Gallager, H. S. and Martin, J. E.: An Orientation to the Concepts of Minimal Breast Cancer. Cancer, **28**:1505, 1971.

9. Gershon-Cohen, J.: Medical and Legal Implication of Mammography. Surg. Gynecol. Obstet., **130**:347—Editorial, 1970.
10. Gershon-Cohen, J., Yiu, L. S. and Berger, S. M.: The Diagnostic Importance of Calcareous Patterns in Roentgenography of Breast Cancer. Am. J. Roent., **88**:1117, 1962.
11. Hayden, C. W.: A Surgeon Looks at Mammography. Arch. Surg., **93**:853, 1966.
12. McClow, M. V. and Williams, A. C.: Mammographic Examinations (4030): Ten Year Clinical Experience in a Community Medical Center. Ann. Surg., **177**:616, 1973.
13. Minagi, H. and Youker, J. E.: Roentgenography of Breast Specimens. Am. J. Surg., **115**:435, 1968.
14. Orloff, T. J.: The Senograph: New Tool for Cancer Detection. JAMA, **216**:681, 1971.
15. Patton, R. B., Poznenski, A. K. and Zylak, C. J.: Pathologic Examination of Specimens Containing Nonpalpable Breast Cancers Discovered by Radiography. Am. J. Clin. Path., **46**:330, 1966.
16. Price, J. L. and Butler, P. D.: Stereoscopic Measurement in Mammography. Br. J. Rad., **44**:901, 1971.
17. Rosen, P. Snyder, R. E., Foote, F. W. and Wallace, T.: Detection of Occult Carcinoma in the Apparently Benign Breast Biopsy Through Specimen Radiography. Cancer, **26**:944, 1970.
18. Schwartz, A. M. and Siegelman, S. S.: A Technique for Biopsy of Nonpalpable Breast Tumors. Surg. Gynecol. Obstet., **123**:1320, 1966.
19. Siegelman, S. S., Rubinstein, B. M. and Schwartz, A.: Elusive Carcinoma of the Breast. Am. J. Surg., **113**:401, 1967.
20. Simon, N., Lesnick, G. J., Lerer, W. N. and Bachman, A. L.: Roentgenographic Localization of Small Lesions of the Breast by the Spot Method. Surg. Gynecol. Obstet., **134**: 572, 1972.
21. Sokol, E. S., Walker, B., Terz, J. J. and Lawrence, W., Jr.: Role of Mammography With Palpable Breast Lesions. Surgery, **67**:748, 1970.
22. Stevens, G. M. and Weigan, J. F.: Mammography Survey for Breast Cancer Detection. Cancer, **19**:51, 1966.
23. Stevens, G. M. and Jamplis, R. W.: Mammographically Directed Biopsy of Nonpalpable Breast Lesions. Arch. Surg., **102**:292, 1971.
24. Stevens, G. M.: Survey Mammography as a Case Fnding Method for Routine and Postmastectomized Patients. Cancer, **24**:1201, 1969.
25. Strax, P., Venet, L., Shapiro, S. and Gross, S.: Mammography and Clinical Examination in Mass Screening for Cancer of the Breast. Cancer, **20**:2184, 1967.
26. Wolfe, J. N.: Mammography as a Screening Examination in Breast Cancer. Radiolology, **84**:703, 1965.

Discussion

Dr. Benjamin F. Byrd, Jr. (Nashville): It was most informative to hear described the ingenious fashion in which Dr. Shepard and his group have converted an x-ray technique into a clinical tool. It's a very interesting adaptation of the mammographic aid to detection and identification of breast tumors.

I was especially impressed with the emphasis which he places on the mammogram as a tool which can be used by the surgeon in identifying suspicious areas for biopsy, but not as a substitute for microscopic examination of clinically dominant lumps or of radiographically suspicious lesions. All this is especially important with the increasing use of mammography and thermography.

The Task Force for Breast Cancer Control of the American Cancer Society and the National Cancer Institute have now designated 20 centers across the United States, with the prospect of examining at each center 5000 women each year, with a pertinent history, physical, mammograms—either the conventional or xeroradiographic studies—thermography, and a followup. These are pilot projects, but of course have some epidemiologic impact. From these 100,000 women examined each year it is hoped that a valid technique for identifying high risk groups can be developed, and although the initial methods of examination are well outlined, it is probable that by the end of the fifth year of this five-year project new tests will be in use which may prove to be much more effective than those currently employed.

Early reports from these centers have just begun to come in. From the Gutman Institute, 23,824 patients were examined in a period of 10 months. Seventy-four cancers were found, and in 37 of these patients lymph node metastases were found at subsequent surgery.

At the University of Kansas Medical Center in the first month of operation 601 patients were seen, 35 biopsies recommended, and four cancers found. Essentially these same proportions have been the result of the operation at the University of Cincinnati, at the Virginia Mason Research Center at Seattle, and at the Health Sciences Center at the University of Oklahoma.

As patients have lesions that are found as the product of these efforts, the question of organized investigation of these lesions becomes increasingly important. Certainly, the injection of tissue dye and radiopaque material is an ingenious and effective answer to this part of their management. The question which must be answered in the laboratory is: Has the lesion seen on x-ray been removed?

The use of the Faxitron in the pathology lab and the preparation of a Polaroid radiograph is a gerat help, using the bread loaf technique which is described in the manuscript by Dr. Shepard. Still to be answered is the value of all this in justifying the use of limited surgery for invasive malignancies.

The earliest detectable invasive breast cancers have already spread to the axillary lymph nodes in at least 25% of the cases. This is a matter which one must equate in managing the patient with an early lesion. I would like to ask Dr. Shepard how the rise of mammography has affected the treatment of the patient with invasive breast cancer in his experience.

Dr. William W. Shingleton (Durham): I would like to support the concept of the use of this modality in early detection of breast cancer. As he stated, this is one of the most prevalent of all of the cancers; not only that, but it is increasing in frequency. It's estimated that there will be 60,000 new cases in this country this year, with 27,000 deaths. It's also estimated that one of every 17 female infants who are born is destined to develop breast cancer eventually. This means, of course, that with the increasing need for early detection, we are all interested in new ways of trying to accomplish this.

Now, I thought you might be interested in the study currently in progress in New York, which is supported by the National Cancer Institute. It's being conducted in the Greater Health Plan of New York, where they have divided two groups of women, 31,000 in each group, one group having physical examination alone for detection of breast cancer, the second group having physical examination plus a mammogram obtained.

Now, this study has already gone for six years. We have the data at the end of the first five years. The end point they are looking for is not how many cancers they find, but, rather, how many patients are dying of breast cancer in the two groups of patients; and one year ago, at the five-year followup level 64 patients who were in the group that had physical exam alone had died of breast cancer at the end of five years. The number who had died who had had the physical exam plus the mammogram was 40 patients. In other words, there was a reduction in deaths by one-third in those who had the mammogram obtained.