SOME EXPERIENCES WITH MAMMOGRAPHY*

WITH A BRIEF REVIEW ON RECENT TRENDS AND NEW TECHNIQUES OF EXAMINATION OF THE BREAST

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INTRODUCTION

Mammography or mastography is plain X-ray examination of the breast, is not new. Early investigations came from Europe. Interest in America was aroused following a report on mammography by Warren in 1930 (38). Enthusiasm soon waned owing to inability of various workers to produce uniform mammographs of satisfactory quality. Nevertheless, the work of subsequent investigators, notably Gershon-Cohen (16), Leborgne (24), and Egan (9), placed mammography on a firm footing and after 1960 mammography has gradually come to be recognised as an invaluable if not essential aid in the detection of mammary tumours. Much of the success could be attributed to standardisation of the X-ray technique. Other specialised X-ray techniques include contrast mammography and arteriography of the breast. Good historical accounts of mammography are given by Egan and by Gershon-Cohen (11, 16).

Mammography was attempted in the Outram Road General Hospital about three to four years ago, but no serious start was made till October 1967. This paper is to present our experience based on 39 patients seen from October 1967 to March 1968. Our purpose is to show that mammography is useful locally, as well as to draw the attention of clinicians and pathologists to its efficacy in the detection of tumours of the breast.

RADIOGRAPHIC TECHNIQUE

We routinely employ the three standard views as advocated by Egan (11). They are the cranio-caudad view (Fig. 1) and medio-lateral view (Fig. 2), which combination serves to cover the entire breast in two planes at right angles to each other; and the axillary view (Fig. 3) for showing the soft tissue contents of the axilla as well as the tail end of the breast. It is essential to radiograph both breasts for purposes of comparison. Besides, clinically unsuspected pathology may at times be found in the contralateral breast.

A cylindrical 4 inch cone is used. This serves not only to cut down unnecessary radiation to patient, but also improves contrast and detail in the mammogram. We utilise three films of different speeds in a pack as we find this gives satisfactory results, because it is difficult to obtain a uniform exposure on one film alone. Currently we employ Gevaert-Agfa films, namely, Industrial D4 and D7, and non-screen Osray films. It is essential that the breast be placed as close to the film pack as possible, and that the nipple be visualised in profile. The retromammary layer of fat should also be well outlined in the medio-lateral film. Our film-target distance is 36 inches. The kilovoltage used is around 26 to 40, and about, 1,000 - 1,200 mA sec. is needed for an average exposure. Added tube filtration is removed to enhance contrast. All mammograms are hand-developed under standard temperature technique.

X-RAY INTERPRETATION

An intimate understanding of the normal radiological anatomy of the breast is essential for proper interpretation of mammograms as there is a wide range in the size, shape and density of breasts of different subjects. Furthermore, considerable variations in appearance may occur in the same breast under normal physiological states and in the various periods of life. Our experience shows that the relatively smaller breasts of the local population are homogeneously dense, and which therefore tend to obscure the presence of tumours (Fig. 4). Fortunately, the majority of tumours in the young are benign tumours and cysts. However, the glandular portions of breasts atrophy in later life and concomitantly there is an increase of mammary fat. Under these altered circumstances, the presence of even tiny tumours can be easily detected in mammograms of the elderly patient. We therefore find that mammography is equally as useful a method in the detection of carcinoma as in Western countries.

NORMAL ROENTGEN ANATOMY OF THE BREAST

The main structures to note in a normal mammogram is firstly the skin which should appear as an opaque linear shadow of about 1 to 2 mm. in thick-

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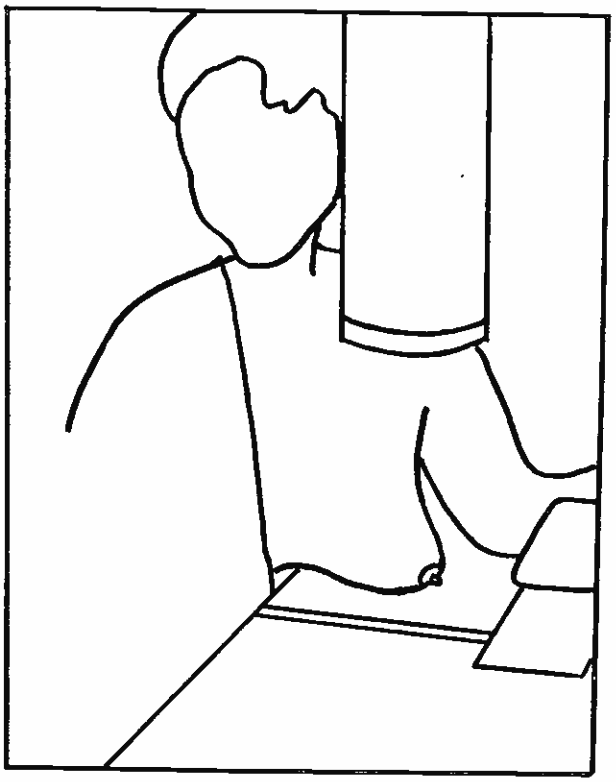

Fig. 1 Sketch of patient in position for the craniocaudad mammogram (modified after Egan). The patient is in the upright position for this view. It is important that the breast be laid at rest and spread out directly over the film pack with the nipple in profile. The edge of the film pack should be placed close to the chest wall to ensure that as much of the breast as possible be visualised in the mammogram.

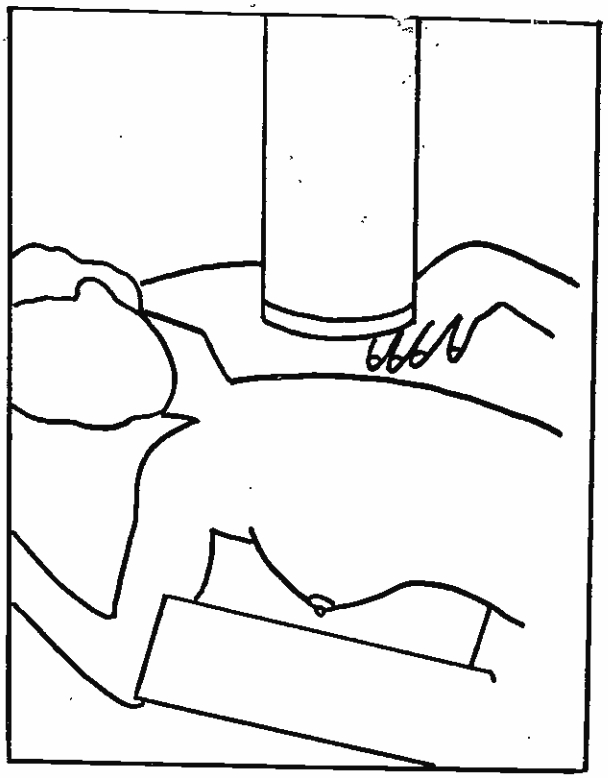

Fig. 2. Sketch of patient in position for the mediolateral mammogram (modified after Egan). The patient lies supine with the contralateral side elevated. The breast to be examined must be allowed to rest as close as possible to the film pack with the nipple in profile. If required, the patient can assist in pulling the contralateral breast away from the X-ray beam with the hand of the same side.

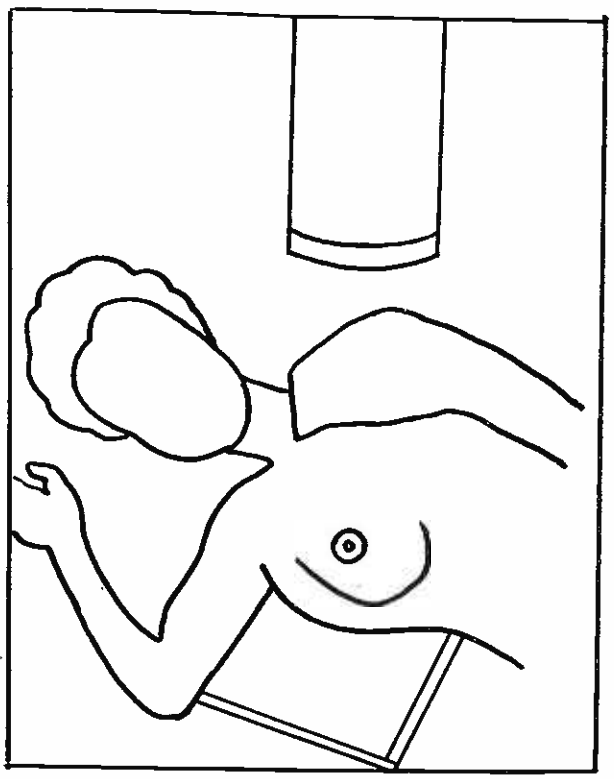

Fig. 3. Sketch of patient in position for the axillary mammogram (modified after Egan). The patient lies supine with about 20° to 25° elevation of the contralateral side. The central ray is directed about 5 cm. below the apex of the axilla and about 5 cm. medially.

Fig. 4. Y.Y.L., female 33 years. Left breast, mediolateral mammogram. The breast is of medium size with much dense glandular tissue which obscures the presence of any underlying abnormality. Pathologic diagnosis: Fibroadenosis. Note: Mammography is least effective in this type of breast. No radiologic diagnosis could be made in this case. Relatively small breasts with dense glandular tissue is commonly met with in the young in this part of the world. This renders mammographic demonstration of fibroadenosis and fibroadenoma difficult, if not impossible.

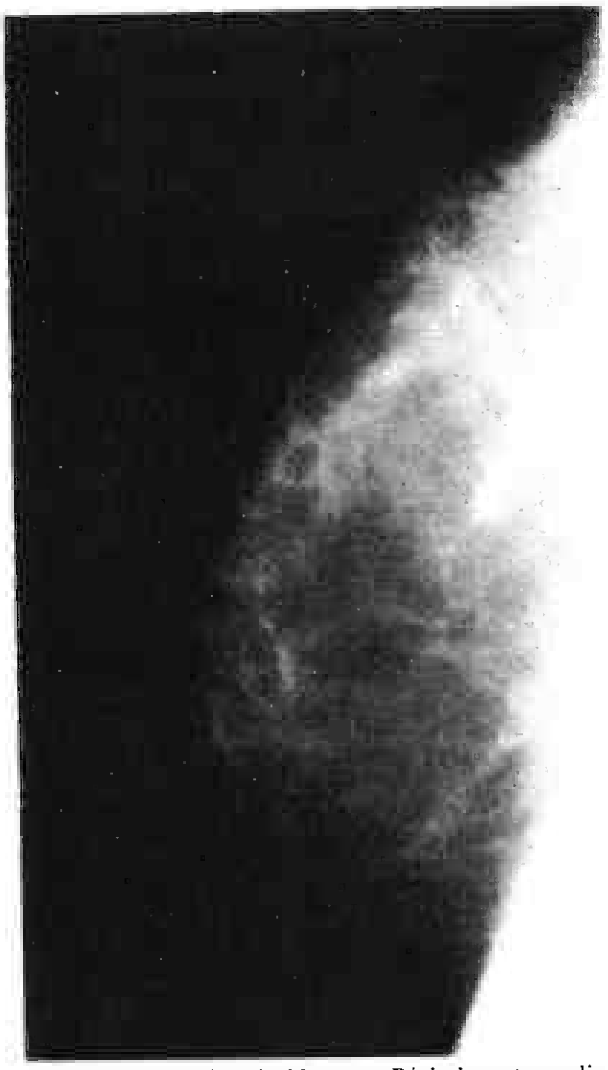

Fig. 5. L.Y.M., female 38 years. Right breast, mediolateral mammogram. This shows increased and thickened striations with nodulations in the upper part of the breast, a picture characteristic of fibroadenosis. Pathologic diagnosis: Mammary dysplasia. Note: This is the characteristic picture of fibroadenosis.

Fig. 6. T.L., female 28 years. Right breast, mediolateral mammogram. The breast is somewhat enlarged and distended due to the presence of a faintly outlined ovoid mass of homogeneous consistency within it, size about 7 to 8 cm. in diameter, consistent with a large blue dome cyst. Pathologic diagnosis: Increased fibrosis, with areas of adenosis and distended ducts with cyst formation.

ness, and beneath which is the subcutaneous fat. The latter varies considerably in thickness from a few mm. to over 2 cm. Suspensory or Cooper's ligaments and sometimes veins can be seen coursing through the subcutaneous fat as linear or spiculated opacities. The nipple lies at the summit of the breast and the areola around it appears as a dense disc-shaped structure. Beneath the nipple are the main ducts of varying calibres in different subjects and which run inwards for about 1 to 3 cm. before dividing and ending in the main glandular portion of the breast. The latter is rather homogeneously opaque in the young. In later life the glandular elements atrophy and the breast appears rather translucent because of concomitant increase of fat. The islands of fibrous tissue then appear as opaque shadows of varying sizes connected by ducts to the areola and nipple. Veins are prominent and easily seen in atrophic breasts as linear opacities. The retromammary fat should appear as a well defined linear radiolucent shadow beneath the breast and running up to the axilla. A normal axilla should show clearly some of the muscle boundaries.

RADIOLOGICAL FEATURES OF TUMOURS

Tumours appear as opaque shadows. Benign tumours or cysts are usually well defined and tend to be round or oval in shape, and of varying sizes, sometimes even occupying the greater part of the breast. Malignant tumours are usually indistinct as they tend to invade or infiltrate into the surrounding tissues; they therefore tend to possess hazy and spiculated borders, which may end in a tail on one or both sides. A good differential point is that a malignant tumour usually appears smaller in a mammogram when compared to the size found on palpation (11).

However, it may not be easy at times to differentiate a benign from a malignant tumour just on the appearance of the tumour alone. In such cases, the presence of so-called secondary X-ray signs should be looked for (11).

A most useful secondary sign is calcification in carcinoma (Figs 9 and 10), a point stressed by Leborgne (24) and first noted by Salomon in 1913. Calcification in carcinoma is usually described as fine, irregular and confined to the tumour. However, calcification may also occur in fibroadenomas, but these are said to be coarser in type. Some small carcinomas with ill-defined borders had been diagnosed on the basis of calcification alone (11).

The other important sign of carcinoma is increase of trabeculation or spiculation around the tumour (Fig. 9), the so-called tail of the comet or the mare's tail (11, 32). Increase of vascularity around a tumour may also be in favour of malignancy. A very useful sign is thickening of the overlying skin (Figs. 9 and 10) which may occur even when a carcinoma is at some distance from the skin. The skin thickening may involve the entire breast and may amount to 2 cm. A feature is that skin thickening even of a moderate degree may not be detected clinically (11). Another less helpful sign is retraction of the nipple, but this may occur in other non-neoplastic conditions.

DISEASES COMMONLY ENCOUNTERED IN MAMMOGRAPHY

Mammography is primarily employed for the detection of tumours, particularly in the differentiation between benign and malignant tumours. In practice, the commonly encountered diseases are three, namely: fibroadenosis, fibroadenoma and carcinoma.

FIBROADENOSIS

There is still disagreement in aetiology and definition for this group. The term chronic cystic mastitis has now been discarded by most authors. Synonyms include mammary dysplasia, mazoplasia and fibrocystic disease. There are three components in this disease, namely increase of glandular or of stromal elements, and cyst formation. The radiological features are coarse striations, with beading or small opacities corresponding to foci of adenosis. Small cysts may present a similar appearance; larger cysts are usually rounded or oval with smooth outlines, but differentiation from fibroadenoma or carcinoma may be impossible in some cases. An extremely large cyst is termed a blue-dome cyst of Bloodgood (Fig. 6). Fibroadenosis may involve one or often both breasts, and is common in the older age group. A typical case shows heavy striations with innumerable small rounded opacities (Fig. 5). Such changes may not be evident in the firm breast of the young (Fig. 4).

FIBROADENOMA

Fibroadenoma may be single; but is often multiple. They vary greatly in size. They usually are well defined, and may have a notched border (Fig. 8). They tend to displace and compress neighbouring structures, and if surrounded by a layer of fat may characteristically possess a radiolucent rim or halo (Fig. 7). Calcification may occur in fibroadenoma; this may be coarse grain-like or even massive in older tumours. As fibroadenomas usually occur in the young, their detection may be difficult in mammograms. Palpable breast nodules which cannot be visualised in mammograms is said to be characteristic of fibroadenomas (11).

CARCINOMA

By far the commonest histologic type of tumour is the adenocarcinoma. Variants include medullary or encephaloid carcinoma, intraductal and comedo carcinomas. The word scirrhous is applied to highly infiltrative growths. The main feature distinguishing carcinoma from benign tumours is the presence of

an ill-defined tumour (Fig. 9); this must be carefully looked for as haziness of outline may be confined only to one small part of a tumour. (11). A malignant tumour is usually denser than a benign one. The presence of fine sand-like calcifications is said to be pathognomonic of carcinoma (Figs. 9 and 10). Calcification is said to be common in intraductal carcinoma. The detection of carcinoma is rendered easier as it usually occurs in the elderly when breasts appear more translucent due to atrophy of glandular tissue (Fig. 9 and 10). In fact, it is not unusual to have tumours of around 5 mm. detected in mammograms based mainly on the presence of calcification (11). It is obvious that such small tumours may remain undetected clinically for months or years until they have grown appreciably in size.

MATERIAL STUDIED

Mammography was performed on 39 patients in the Outram Road General Hospital from October 1967 to April 1968. Our present analysis is confined only to 25 cases with histological verification. There were 8 instances of fibroadenosis, 7 fibroadenomas, 9 carcinomas and one epidermal cyst.

FIBROADENOSIS

There were eight patients with proven fibroadenosis. The patients ranged from 20 to 50 years of age, with a majority (five cases) in the third decade of life.

Two patients had small breasts and the remainder had medium-sized breasts. It was impossible to

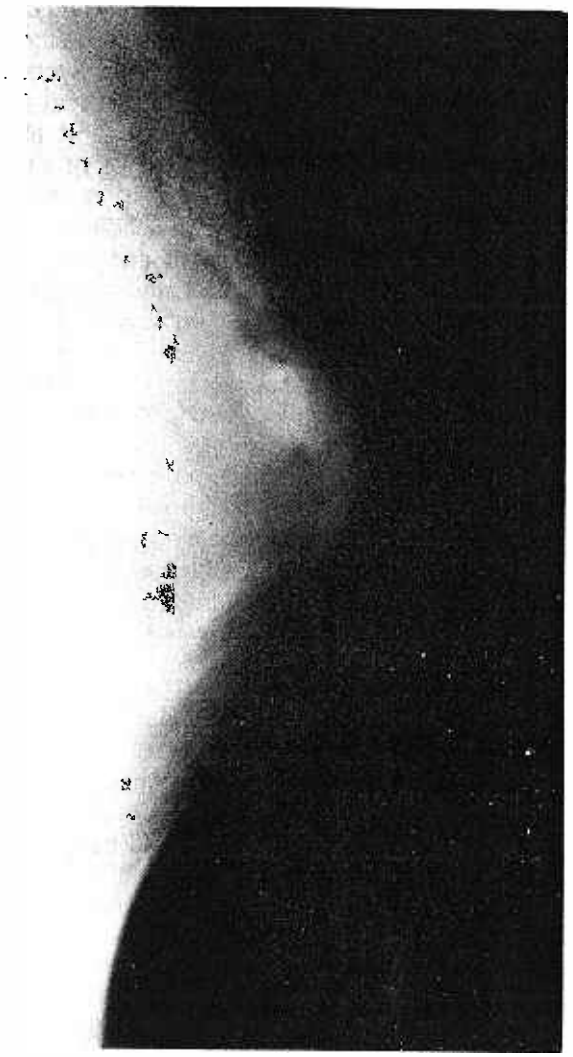

Fig. 7. C.Y.T., female 27 years. Left breast, mediolateral mammogram. Two small masses of average density are seen in upper part of the breast, one of 1.3 by 1.5 cm. just above the nipple, and another rounded one of 1.3 cm. in diameter higher up. Both these masses can be differentiated from the normal dense glandular tissue by a wide radiolucent rim of surrounding fat, the so-called "halo sign", which is characteristic of a benign condition like fibroadenoma. Pathologic diagnosis: Fibroadenoma. Note: Most fibroadenomas occurring in dense breasts of the young cannot be delineated owing to lack of a rim of surrounding fat.

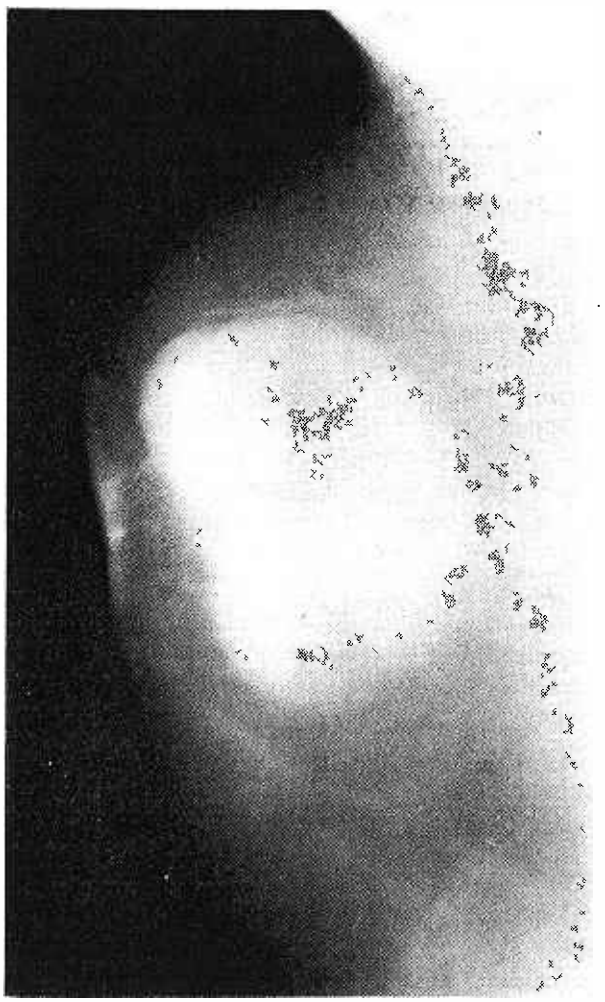

Fig. 8. T.K., female 64 years. Left breast, mediolateral mammogram. There is a medium-sized dense bean-shaped mass of 3.5 by 3.7 by 5.6 cm. in the central part of the breast. It is quite well defined and its anterior border is somewhat concave. There are a fair number of coarse trabeculations around this mass and some of the adjacent veins are enlarged. Pathologic diagnosis: Fibroadenoma. Note: The X-ray diagnosis was carcinoma; in retrospect, the umbilicated appearance would suggest fibroadenoma.

establish a diagnosis by mammography in the two patients with small breasts and one with medium-sized breasts owing to the presence of dense glandular tissue. The X-ray diagnosis was incorrect in four cases (mistaken for fibroadenomas) and it was not possible to make an X-ray diagnosis in another case, because of dense breasts (Fig. 4). The radiological diagnosis could only confidently be made when there was presence of the typical signs of heavy trabeculations with nodularity along them (Fig. 5). The condition appeared to be bilateral in 5 patients. One case had a blue-dome cyst (Fig. 6). There was no calcification in any instance.

FIBROADENOMAS

There were seven cases of histologically verified fibroadenomas. The ages of the patients ranged from 14 to 64. The majority of cases (five) were in the third decade of life. The youngest patient had small breasts; the remaining patients had medium-sized breasts. Only vague opacities were seen in the mammograms in the 3 youngest patients and it was therefore impossible to establish a diagnosis of fibroadenomas in them. Two cases had radiolucent borders around the tumours and their diagnoses could be made with a fair degree of certainty (Fig. 7). One case showed a moderately well-defined tumour. The final case presented a medium-sized dense umbilicated tumour with increased vascularity which was mistaken for carcinoma (Fig. 8). There was no calcification in any instance.

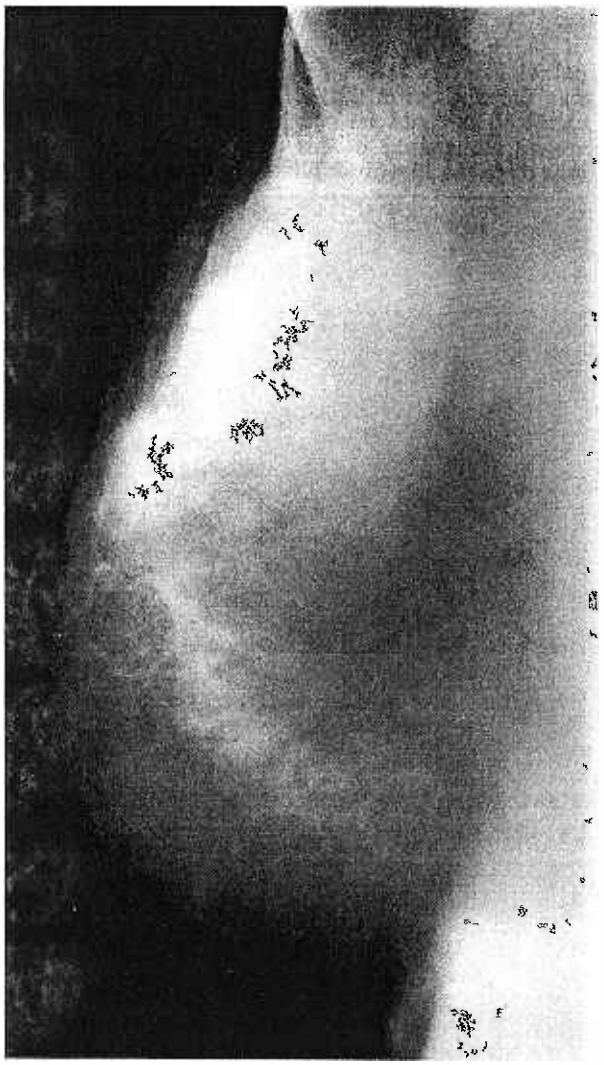

Fig. 9 (a). N.A.M., female 68 years. Right breast, medio-lateral mammogram. There is a medium-sized poorly defined mass of 3.5 by 3.7 by 4.0 cm. with hazy borders in the upper part of breast. There is a spot of calcification of 1 by 2 mm. in the centre of the mass. Coarse trabeculations are seen connected with the tumour. Part of the overlying skin is thickened to about 4 to 5 mm. The X-ray diagnosis was carcinoma. Pathologic diagnosis: Fibrous tissue with islands of medullary carcinoma. Note: This tumour exhibits many of the mammographic features of malignancy. Our limited experience shows that although calcification does occur in carcinomas, it is usually sparse.

CARCINOMA OF BREAST

Nine cases were analysed. Of these, eight were proven histologically. The ninth case had a medullary carcinoma of the right breast removed a year previously; a small tumour in the opposite breast was detected by mammography and this was confirmed clinically by rapid growth and other signs of malignancy subsequently.

The ages ranged from 35 to 70 and 4 patients were in the 6th decade of life. There were 7 instances of medullary carcinoma, one of scirrhous adenocarcinoma and one of poorly differentiated carcinoma. Six cases were in the Chinese, two of whom had small breasts. The tumours were well visualised in all cases except in one in whom the breast was small. The radiological diagnosis could therefore be established with confidence in the majority of cases.

Fig. 9 (b). Contact print of tumour showing the calcification as a dark spot in the centre of the tumour.

Fig. 10(a). T.A.S., female 57 years. A. Left breast, craniocaudad mammogram. There is an oval somewhat lobulated dense mass in infero-medial part of breast of 4.0 by 6.0 by 6.5 cm. Its edges are quite well defined except for thick trabeculations connected with its anterior and posterior surfaces. The overlying skin is slightly thickened, about 2 to 3 mm. The X-ray diagnosis was darcinoma. Pathologic diagnosis: Medullary carcinoma.

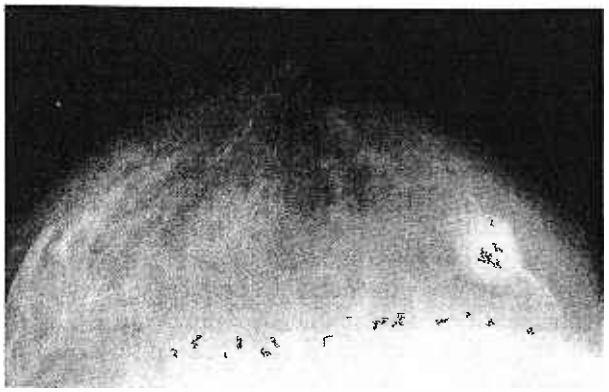

Fig. 10(b). Right breast, cranio-caudad mammogram. There is a small somewhat oval moderately dense mass of about 1.3 by 1.5 by 1.8 cm. seen in infero-lateral part of breast. It is sharply defined and contains two small spots of calcification of 1 by 2 mm. and 1 by 3 mm. within it. This illustrates the ease of visualisation of a small mass in a post-menopausal breast with atrophy of glandular tissue and abundant fatty stroma. No pathologic verification as the presence of the mass was unsuspected clinically. However, the presence of calcification could be considered as diagnostic of a second malignancy in this contralateral breast. This case therefore illustrates bilateral carcinoma.

Fig. 10(c). Contact print of the nodule in the right breast showing the two specks of calcifications as two dark spots.

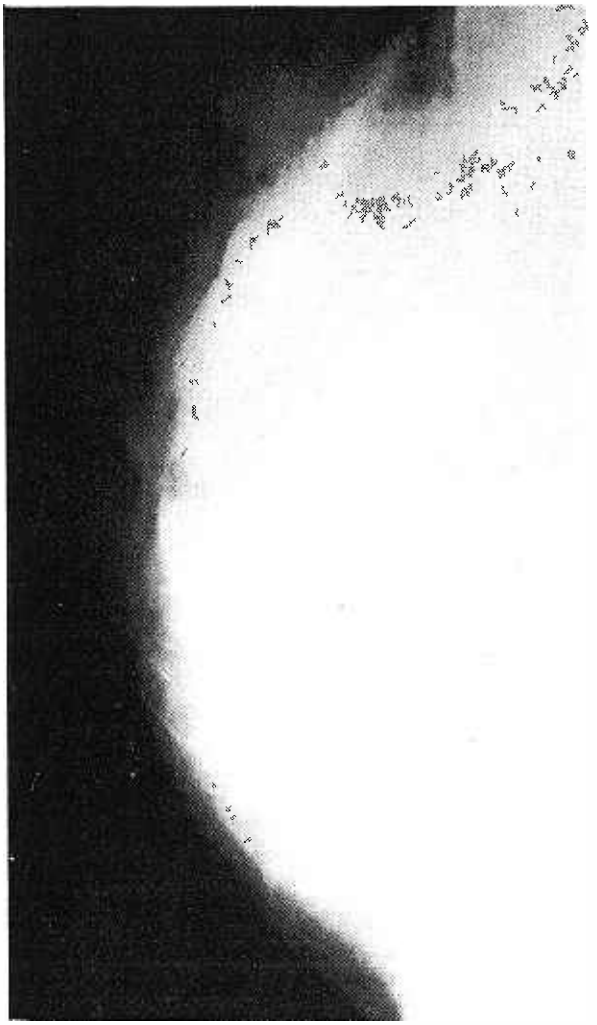

Fig. 11. S.H.K. female 50 years. Right breast, mediolateral mammogram. There is a large ill-defined dense mass of 6 by 10 by 11 cm. occupying greater part of breast. The skin of the upper breast is prominent and irregular due to ulceration. The changes are consistent with carcinoma. Pathologic diagnosis: Poorly differentiated carcinoma with inflammation.

One case of fungating tumour was fairly large in size (Fig. 11). Most of the tumours were of medium size and some were small. Most of the tumours were of moderate or fairly marked density. The majority of the tumours were fairly well defined; a few had shaggy borders. However, spiculations of slight or moderate degree were present in most cases (Figs. 9 and 10).

Calcifications were present in 4 tumours usually in the form of one or two tiny specks (Figs. 9 and 10). Slight streaky calcifications were suspected in another instance. No calcification was seen in 6 other tumours.

The skin was slightly thickened, ranging from two to three mm. in three breasts (Figs. 9 and 10). The skin was ulcerated in one tumour (Fig. 11).

It is of interest to note that mammography showed the presence of a tumour in the contralateral breast in 3 of 9 cases, making an instance of 30 per cent of bilateral breast tumours.

TOPICS OF INTEREST

It would be appropriate, at this juncture, to discuss some recent views pertaining to carcinoma of the breast, trends in mammography and the use of other newer techniques in breast diagnosis.

INCIDENCE OF BREAST CARCINOMA

In the U.S.A: Alcorn and O'Donnell (2) state that carcinoma of the breast, like that of the lung, is increasing. Breast carcinoma is now the commonest tumour in American women, occurring in about one out of every 19 persons. Dodd and associates (6) note that there are over 60,000 new cases of carcinoma of the breast each year and that 50 per cent of these will be dead in five years. MacDonald (25) says that the death rate is 24-35/100,000 since 1930. Thus, despite considerable advances in surgery, the survival rate of carcinoma of the breast has not shown any change for the past 40 years.

In Singapore: Tan (37) reports that 2,000 new cancer cases are met with each year, in the following order of frequency : Uterine cervix, nasopharynx, stomach, lung, oesophagus, liver, breast, skin, rectum, colon, larynx and lastly ovary. Breast carcinoma therefore stands sixth in order of frequency, and for women, comes second after the uterine cervix. Shanmugaratnam (33) says that for the period 1950-1961, there were 317 cases of breast carcinoma, constituting 9·6 per cent of all histologically proven carcinomas. He also finds that from 1960 - 1964, there were 335 cases of carcinoma of the breast as against 2,858 cases of all cancers, i.e., an incidence of 11.7 per cent. However, our impression is that the incidence of carcinoma of the breast is on the increase judging from the referrals to the Radiotherapy Department.

MAMMOGRAPHY

Technical considerations: The availability of slow fine grain industrial X-ray films has made it possible for roentgenologists to obtain the very fine soft tissue details needed in mammograms. But to have films of adequate contrast and density, the kilovoltage must be low and the milliampere seconds high (26-40 kVp and 600-1,200 milliampere seconds). The X-ray tube must be of high capacity with a fine focal spot, preferably 1 mm. or less. The inherent tube filtration should be around 0·5 mm. Al. Cones must be used; these may be variously shaped and be capable of compression work (8,11). In practice, it has been found advantageous to use a pack of two to four films of varying speeds to obtain mammograms of different densities for satisfactory visualisation of all structures from the skin to the deepest portion of the breast.

Radiation dosage: The skin dose is about 2·5 to 5·0 r with the use of industrial films, and the gonadal dose about 1 mr per mammogram. Most authorities consider this as within safe limits (35), even with six-monthly examinations. Besides, most patients needing repeated examinations are past the child-bearing age. Gershon-Cohen (16), on the other hand, advocates the use of only non-screen film to cut down radiation dosage to one-third and also to reduce movement blurring. However, the majority of investigators feel that the advantages of fine details obtained from industrial X-ray films outweigh all other objections. We feel that fine details are essential for accurate interpretation of films.

Contrast mammography: Injection of contrast medium may be useful in the delineation of some types of pathology, like intraductal papillomas (20, 24). This is not an innocuous procedure, for infection may follow injection (30). However, attempts are being made to provide safer contrast media (15). We feel that one objection in contrast examination is the identification of ducts, let alone the correct one, for injection.

Arteriography: Recently, Feldman and associates (12) report encouraging results from an examination of 12 patients with brachial or axillary artery puncture for visualisation of the mammary circulation. They feel that their route is superior to injection of the internal mammary artery as advocated by Arner and co-workers (3). Feldman and associates state that arteriography is more accurate than mammography in the differentiation between benign and malignant tumours. They also list other advantages, but feel that a more extensive experience would be needed before a proper appraisal of arteriography can be arrived at.

Calcification in Carcinoma: Egan (11) states that calcification can be seen in carcinoma of breast in 35-45 per cent of good mammograms, and that this figure should be doubled in excised specimens. Wolfe's (39) figure of 75 percent is a rather high one.

However, most observers (6, 32) give a figure of around 30 per cent. Dodd and associates (6) state that sand-like calcification is most important and when equivocal may be accepted as proof of carcinoma. They then consider biopsy mandatory even in a breast completely normal from the clinical standpoint. Our limited experience shows that the incidence of calcification in carcinoma is about the same as elsewhere, except that such calcifications are usually few in number.

Bilateral Carcinoma of Breast: Egan (11) has discussed in detail the problem of bilateral carcinoma of the breasts. Mammography is found superior in the detection of bilateral tumours as the surgeon is unable to detect a proportion of small tumours and the pathologist is dependent on bits of tissue for biopsy. Egan states that the diagnosis of a second primary carcinoma of the breast can be made with confidence on the radiologic appearances alone. Also, simultaneously appearing growths may have different histologic characteristics. Mammography can be used for identification of secondary tumours of the opposite breast based on the appearance of a diffuse carcinoma without any discrete mass or dominant nodule. Of 278 cases of radical mastectomy for proven carcinomas, Egan found that 28 cases or 10 per cent has a carcinoma of the opposite breast during follow-up periods from one month to 16 years. Of these, eight patients or 3 per cent were considered to be metastatic carcinomas, and the other twenty patients or 7 per cent were regarded as primary carcinomas.

Gershon-Cohen and associates (19) found 3 cases of bilateral carcinomas out of 35 cases detected from mass mammography, an incidence of approximately 10 per cent.

Chavanne (4), on the other hand, found 19 cases of proven malignancy of the opposite breast out of 2,000 patients, making an incidence of approximately 1 per cent.

In our limited series, we found 4 instances of bilateral carcinomas out of 9 patients.

Prognosis of Carcinoma of Breast: It is generally acknowledged that despite modern surgical advances, the mortality rate for carcinoma of the breast has remained practically unchanged the past 30-40 years (14, 25). The radiographic appearance of a carcinoma generally corresponds to the naked eye appearance and therefore provides a prognostic guide (22). A circumscribed carcinoma would therefore appear to offer a better prognosis than an infiltrating one.

Freundlich and associates (14) state that patients without axillary nodes at operation have a greater chance of survival, and that lesions discovered by mammograms, especially those too small to be detected by palpation, have a lower incidence of lymph node metastasis. Shapiro and Gershon-Cohen and their associates (7, 19, 34) note an improved mortality rate in patients with small growths picked up in screening by mammography.

Mammography in Textbooks: Gershon-Cohen and associates (19) mentioned that although mammography had been practised for over 50 years, it was only during the last few years that its potential was significantly recognised. In the United Kingdom (8), it is felt that general acceptance of mammography lags behind American and Continental radiologists, and that surgical resistance is probably due to unfamiliarity with the method. Mammography is mentioned in only one surgical text in the United Kingdom (32) while the latest edition of one popular text (29) makes no mention of mammography. An account of mammography can be found in a well known surgical textbook in the U.S.A. (25). Attention is paid to mammography in some textbooks on cancer (1,5, 26). There are now some excellent monographs on mammography (11, 39).

Accuracy of Mammography: Samuel and Young (32) cite nine groups of investigators who claim accuracies in X-ray diagnosis ranging from 80 to 98 per cent with an average of around 90 per cent. They compare this with the success of 3 groups of surgeons with accuracy ranging from 62 to 75 per cent, average 70 per cent. Another source (8) says the accuracy of mammography ranges from 78 to 92 per cent, which is comparable to the accuracy of barium meal examination. Dodd and associates (6) state that with accumulating experience, the correct figure for accuracy attained by mammography would be approximately 85 per cent. This still exceeds the accuracy of any form of examination currently available with the exception of excision biopsy. They also state that the greatest of error in mammography lies in the evaluation of dense breasts, especially in premenstrual patients, as these contain a large amount of glandular tissue. The percentage of false positive reports in mammography is about 10 to 15 per cent.

MacDonald (25) states that mammograms can show on occasion a mass too small for palpation. The smallest mass a surgeon can detect on palpation is about 1 cm. With painstaking attention to technical details, it is possible for an experienced radiologist to differentiate between a benign and a malignant mass. However, the absence of radiologic signs of malignancy should be given the same consideration as the negative report of a needle biopsy.

Gershon-Cohen and co-workers (19) state that combined clinical examination and mammography should yield an accuracy of 94 per cent in the detection of all malignant lesions of the breast.

Fitts (13) recognises the value of mammography, but sounds a note of warning that total dependency on negative mammographic reports may lead to delayed treatment of some early cases of breast carcinoma.

Egan (11) stresses the advantage of mammography over other methods of examination in pinpointing the exact location of a suspected area to

enable the surgeon to make an effective biopsy. Mammography may also be of use to indicate to the pathologist the particular region of an excised specimen where histologic examination can be gainfully made. Team work is essential for getting the best diagnostic results.

Mass Survey and Periodic Mammography: The high incidence of carcinoma of the breast coupled with the unchanged survival rate for decades in the U.S.A. have prompted radiologists to consider mass screening with mammography in the hope of uncovering growths at an earlier stage which may lend themselves to total extirpation and thereby improving the survival rate.

Gershon-Cohen and associates (19) state that a woman who discovers a lump through self examination usually has a mass averaging 3·5 cm. or over in size, and that 65 per cent of such cases have axillary metastases, and the hope of a 5-year survival is approximately 45 per cent. They conducted a pilot screening mammographic survey of 1,120 healthy females over 35 years of age from 1956 to 1965, at 6-month intervals. They discovered 33 unilateral carcinomas of breast and 3 bilateral growths. The tumours ranged from 0·4 to 3·5 cm. in sizes. The average diameter of the growth was less than 1·1 cm. and axillary metastases occurred in 30 per cent of these cases. The survival rate of these patients was about 80 cent, which was appreciably higher than the 45 per cent for patients who discovered their own growths.

Alcorn (2) observes that the widespread screening of asymptomatic patients is disappointing, but says that the method could be profitably employed for certain categories of subjects over 50 years of age considering that many unexamined women have detectable and surgically amenable lesions.

Fitts and co-workers (13) state that the precise value of screening still has to be evaluated. They find that some surveys of asymptomatic patients reported a yield of as high as 0·5 carcinoma per 1,000 patients.

Most authorities, including Egan, feel that mass mammography is not feasible because of expense, the time consuming technique and inadequacy of technical personnel to undertake such a formidable project. However, the concensus of opinion (6, 8, 10, 11) is that periodic mammography would be justified for the following categories of patients:

1. Following mastectomy. It is known that in such cases the contralateral breast is much more prone to develop malignancy than normally.
2. Family history of breast carcinoma.
3. A breast difficult to examine clinically.
4. Adenocarcinoma elsewhere, primary site undertermined. In this way, mammograms, if positive, may save unnecessary examinations of other systems of the body.
5. Fibroadenosis or multinodular breast.
6. Nipple discharge or recent inversion of nipple.
7. Pain in the breast.
8. Cancerophobia.

Recently, Strax and Oppenheim (36) introduced mass mammographic screening with photofluorography using 70 mm. film. However, only the craniocaudad view was taken, thus enabling a total of up to 25 patients to be examined per hour. These authors reported a considerable savings in film cost and reduction of radiation dose to patients. They claimed a high degree of accuracy and recommended that suspected cases should be studied with conventional mammography. However, we feel that this method suffers a handicap because of lack of the very useful medio-lateral view.

SOME NEWER TECHNIQUES IN THE EXAMINATION OF THE BREAST

The tremendous advances made in other fields of technology have resulted in the employment of thermography, ultrasonics and xerography for breast diagnosis. Of these, thermography appears to hold great promise as a screening agent for breast carcinoma.

Thermography: Freundlich and co-workers (14) credit Lawson (23) as being the first to employ thermography in the detection of breast tumours.

Gershon-Cohen and associates (17) trace in detail the development of thermography. Man emits infra-red radiation in the range of 3-20 microns, and if the human eye could perceive this part of the electro-magnetic spectrum, every human being would show an uneven incandescent glow corresponding to various heat levels of the body. However, due to the minute elevation of temperature in affected areas, a sensitive apparatus called the thermograph is needed to register temperature variations, and such a record is called a thermogram. Inflammation and malignant tumours can cause localised elevation of temperature. Thermography is rapidly performed but the patient must first remain naked inside the examination room maintained at around 70°-72°F for 10-15 minutes. In a series of 100 cases of carcinoma, Gershon-Cohen and associates are able to detect 7 cases unsuspected by other means. However, 4 cases had no appreciable temperature elevation. Temperature elevation may occur in some benign conditions, as well as during pregnancy. The concensus of opinion is that thermography may eventually be used for preliminary screening of large groups of asymptomatic females for breast carcinoma at a greatly reduced cost. Positive cases can then be studied by mammography.

Freundlich and colleagues (14) found 1 non-palpable carcinoma of breast out of 467 patients screened by thermography. Several other tumours were also detected by thermography in this series,

but all were palpable tumours. They advocate that positive cases shown by thermography should have complete mammographic examinations. They also found thermography useful in patients whose mammograms were difficult to interpret. Because thermography is rapidly performed and interpreted, these authors also feel that thermography is suitable for mass screening.

Ultrasonics: Howry (21) traces the development of ultrasonics. It is found that sound frequencies from 100 kilocycles/sec. to 20 megacycles/sec. take on properties more akin to light which can be confined to a narrow beam and focused with ultrasonic lenses to produce powerful focal effects, or be projected into long, linear, pencil-like beams for diagnostic purposes. The 1-2 megacycle range is commonly used in medical diagnosis. The author had considered the possibility of using ultrasonics for diagnostic purposes as early as 1947. A somagram obtained by pulse-echo focused B-scan technique or focused compound scan technique is found useful for diagnostic examination of the breast. The author presents results of somagrams of 25 cases of carcinoma of breast and 100 cases of other conditions of the breast and finds the method useful for the detection and differentiation of various types of tumours.

Xeroradiography: Ruzicka and co-workers (31) state that the xerographic process has been known for over 25 years, and is based upon the electrical characteristics of certain semi-conductors such as selenium which, although normally good insulators, become charged conductors under the action of light or ionising radiation. A metal plate coated with such material can be used as a substitute for the conventional photographic emulsion, and a radiographic image can be obtained and is then photographed. Subsequent work by O'Mara and associates (27, 28) indicate that the advantages of a xeromammograph are many. Firstly, the skin dose is only one-third of that of the conventional mammograph. Secondly, the ability of the xeromammograph to register all structures in a single image. Thirdly, there is a sharp delineation of all structures. These authors feel that the diagnostic accuracy of xeromammography is similar to mammography. They note that the present difficulties are of a technical nature, but feel that improvements can be expected in the future.

SUMMARY

1. Our experience with 39 cases of mammography is briefly described.
2. The results show that mammography is as effective in the demonstration of breast pathology, including carcinoma, as in Western countries.
3. Another objective of this presentation is to draw the attention of surgeons and pathologists to the important role mammography can play in the detection as well as localisation of tumours of the breast.
4. Recent trends relating to breast carcinoma and to mammography are touched upon.
5. Attention is drawn to some newer methods of examination of the breast, namely: thermography, ultrasonics and xeroradiography.
6. Recent observations indicate that thermography, in conjunction with mammography, may play an important role in the screening of breast carcinoma.

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