Augmentation mammoplasty: effect on diagnosis of breast cancer

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Summary  Breast augmentation for cosmetic purposes is an increasingly common procedure in the USA and UK. In the USA in 2003, a total of 254,140 breast augmentation procedures were carried out [American Society of Plastic Surgeons, http://www.plasticsurgery.org/news_room/Procedural-Statistics-Press-Kit-Index.cfm9-1-2005; 2006.1]. It has been previously estimated that between 1 and 1.5 million women in the USA have prosthetic breast implants [Cook RR, Delongchamp RR, Woodbury M, et al. The prevalence of women with breast implants in the United States, 1989. J Clin Epidemiol 1995;48:519–25.2]. The UK National Breast Implant Registry has recorded a rise in the numbers of women receiving breast implants, with over 13,000 procedures registered in 2001; an estimated 77% of these were for cosmetic purposes.

No association has been found between the presence of breast implants in a breast and an increased risk of breast cancer, and this subject has been comprehensively reviewed elsewhere [Hoshaw SJ, Klein PJ, Clark BD, et al. Breast implants and cancer: causation, delayed detection, and survival. Plast Reconstr Surg 2001;107:1393–407.3]. However, as the population of women with breast implants ages, an increasing number of them will develop breast cancer; a reflection of the fact that the incidence of the disease increases with increasing age. Debate continues on the effect of breast implants on the efficacy of mammography in diagnosing breast cancer, and the role of other imaging techniques for this purpose, as well as the limitations that the presence of implants place on percutaneous biopsy techniques.

We review the literature on the radiological and tissue diagnosis of breast cancer in women with a history of previous augmentation mammoplasty.

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Breast implants and mammography

The effect of augmentation mammoplasty on subsequent mammography was initially discussed by Rintala and Srin-huvud in 1974. They examined 20 women with prosthetic implants, and reported that ‘the prosthesis did not impair the technical performance of the examination in a single case’. In fact, they felt that mammography was made easier in women with severe hypoplasia, as the glandular tissue became more protuberant after augmentation. They found that, because of its radio-opacity, a prosthesis did obscure parts of the breast, but that the glandular tissue per se was usually clearly visible anterior to the implant.

These findings were subsequently contradicted in several small studies. All concluded that breast implants obscured a significant proportion of the breast tissue during mammography, potentially reducing the reliability of the technique. Gumucio et al. confirmed this finding, using mammography phantoms to show that silicone or saline-filled implants could obscure simulated radiological abnormalities.

Furthermore, in addition to preventing visualisation of glandular tissue, breast implants may also provoke changes that adversely affect the diagnosis of breast cancer. It has been reported that implants may cause compression of native breast tissue, hindering the identification of architectural distortion that may be a mammographic sign of malignancy. The capsule that inevitably forms around an implant may become calcified and mimic malignant microcalcification. Finally, irregularities or diverticulae of the capsule or implant may present as a palpable lump.

For all of these reasons, it is clearly important that mammographic imaging of the augmented breast is optimised to allow maximum visualisation. To this end, Ekland et al. described a technique for modified imaging of the augmented breast with standard mammography. They displaced the implant posteriorly against the chest wall, pulling the breast tissue over and in front of the implant, observing a moderate to marked improvement in the amount of breast tissue visualised using this technique in 99% of cases. In addition, all cases were felt to show improved image detail. To fully visualise the most posterior breast tissue, it was necessary to carry out standard craniocaudal and mediolateral oblique projections in addition to the modified compression views. This doubles the radiation exposure of the breast and increases the workload of the radiographer carrying out the examination. Furthermore, in 15–20% of women, significant capsular contracture meant that the technique was of limited value, and was often painful where capsular contracture was severe.

Silverstein et al. showed that, by using Ekland et al.’s displacement technique, the amount of breast tissue visible mammographically increased in the presence of implants. This finding was consistent for both subglandular and submuscular implants. Problems with capsule formation were once again reported, limiting the use of displacement views. A further report from Silverstein et al. confirmed this finding, with six of 62 women unable to have a full set of displacement views carried out because of painful capsular contracture. In addition to these problems, the authors reported that, although the measured area of visualisation was reduced, the actual volume of tissue might not be (i.e. a similar volume of tissue as pre-augmentation was present, but was compressed into a smaller area). The consequences of this might be superimposition of structures and poorer image quality, which can result in the concealment of mammographic abnormalities. Furthermore, intraparenchymal scarring and reduced intrammary contrast were found in women with subglandular implants, which made interpretation more difficult. Therefore, although the use of displacement views does increase the amount of tissue visible on the mammograms of women who had undergone breast augmentation, significant problems remain with mammography in this patient group.

Miglioretti et al. conducted the largest study to date on breast cancer in women who had undergone breast augmentation. They set out to determine whether mammographic accuracy and tumour characteristics are different in women with and without augmentation. Prospective cohorts of 137 women with augmentation and 685 women without augmentation were compared. The women with augmentation and breast cancer were matched with women without augmentation for age, race and ethnic origin, previous screening and geographical region at a ratio of one woman with cancer to five without. However, although women with implants were more likely to have dense breasts, a family history of breast cancer and to be premenopausal or taking hormone replacement therapy, women were not matched for these variables because of missing data in 13–24% of cases. Mammography was carried out between 1995 and 2002, and the authors state that displacement views were the technique of choice during this period.

Miglioretti et al. evaluated the sensitivity of mammography as a screening tool in symptomatic women. The raw sensitivity of screening mammography was estimated as 45% in the women receiving augmentation and 67% in women not receiving augmentation. After adjustment for age, breast density, geographical region and first compared with subsequent mammograms, this difference remained significant (46% vs. 67%). In symptomatic women, mammographic sensitivity was lower in the augmented than non-augmented group (73% vs. 81%), although this difference did not reach statistical significance.

Miglioretti et al. found that screening mammography was more specific in women with previous breast augmentation, and that this increase in specificity reached statistical significance. Thus, symptomatic women with implants were less likely than women in control groups to have a false-positive examination. Despite the likelihood of calcification developing in the implant capsule, this does not seem to increase the likelihood of having a false-positive mammogram, nor to mimic the appearances of malignancy. The authors conclude that such women can be reassured that their implants will not increase their likelihood of being recalled for further investigation.

However, this study has some flaws. The number of participants, although larger than previous studies, remains small when subdivided into screening and symptomatic populations. More pertinently, the overall sensitivity of screening mammography is extremely low in this study, missing 55% of cancers in women who had received...
augmentation and 33% in women of the same age who had not received augmentation. The authors argue that this is partly a result of their definition of a positive mammogram, using the end result of all imaging (thus reducing sensitivity, as some of those mammograms initially reported as equivocal will ‘become’ negative as a result of further investigation). Furthermore, they argue that the sensitivity of mammography is low in this study, as women with augmentation tend to be younger than a general screening population and thus have denser breast tissue, which reduces the sensitivity of mammography.16–18 Because women who had not received augmentation were matched for age, the authors argue that they are younger than the general screening population and thus mammography will also be less sensitive in this population. Data are not presented on the age distribution of women in the ‘screen-detected’ cancer group. However, looking at the age distribution in all 137 women with previous augmentation and breast cancer, only 5% are less than 40 years old and only 42% are less than 50 years old, the age at which routine screening starts in the UK.

Insufficient information is available in the study by Miglioretti et al.14 on the implant types used and their placement, as both these factors have been shown to influence the diagnostic accuracy of mammography.9,12 In addition, information on possible confounding variables such as hormone replacement use and breast density was missing in up to 24% of cases. Taking these potential sources of bias into account, however, the authors conclude that screening mammography is less sensitive (although more specific) in women who have undergone previous breast augmentation.

Skinner et al.19 also evaluated mammographic sensitivity in women who had undergone breast augmentation, and reviewed a prospectively gathered database of breast cancers diagnosed over a 20-year period. Mammography was abnormal in 66% of women who had undergone augmentation, and in 95% of women without implants. Implant position did not affect mammographic sensitivity in this study compared with previous findings.12

Skinner et al.19 also assessed the sensitivity of mammography in symptomatic women. Where a palpable lesion was found in the presence of implants, mammography was abnormal in only 63% of cases, compared with 93% of women who had not undergone breast augmentation. The authors comment that palpable tumours in the women who had undergone augmentation were less likely to be detected on mammography regardless of lesion size, and, only once tumours exceeded 5 cm, was mammography positive in over 70% of cases.

There are some difficulties with the study by Skinner et al.19 First, data collection began in 1980. Until 1988, mammography in women who had undergone breast augmentation was carried out as standard two-view mammography. In 1988, displacement views (as described by Eklund et al.11) became standard practice, and, on the basis of previous published data, might be expected to improve the sensitivity of mammography.12 Second, the mean age of the woman with breast augmentation was 46 years, compared with 53 years in women who had not received augmentation. As discussed previously, mammography has been shown to be less sensitive in younger women; a potential source of bias that the authors failed to address.

Mammographic sensitivity in women with previous augmentation mammoplasty have been reported in several additional studies as ranging from 5–100%.20–28 However, these are mostly small, retrospective studies. The patient groups are heterogeneous in terms of age and augmentation type and position. Furthermore, not all patients underwent preoperative imaging, and there are wide disparities between the imaging techniques used. These factors mean that the results of these studies must be interpreted with caution, and few firm conclusions may be drawn from them.

However, there seems little doubt on the basis of such limited evidence that standard two-view mammography is inadequate for imaging the augmented breast, and will almost certainly fail to detect abnormalities in a proportion of women. Although displacement views may improve the sensitivity of mammography, they must be carried out in conjunction with standard views (and capsular contracture may prevent displacement views being carried out).

The implications of this are an increased workload for radiographers carrying out imaging, particularly when screening. Colville et al.,29 in assessing the effect of women with previous augmentation on breast unit workload, reported that women with implants require 15 mins for screening rather than the standard 5-min appointment allocated. Furthermore, the required facilities are not always available in mobile screening units. The authors observed that the number of such women is currently small, but is increasing in a linear fashion. Although this has no adverse effect on personnel and finance, this may change if the increase in cosmetic breast augmentation in the UK continues with the present upward trend. Of interest, in a 1995 telephone survey of 23 breast units, only four routinely employed displacement views.30

Breast implants and non-mammographic imaging modalities in the diagnosis of breast cancer

In recent years, the use of other imaging modalities, such as ultrasound and magnetic resonance imaging in addition to mammography in the diagnosis of breast cancer, has increased. Few data are available on the use of these techniques in the presence of breast implants, although both have been described.

Ultrasound of the breast is of proven value in the diagnosis of breast cancer, and has several important indications,31 including the assessment of breast implant integrity.32,33 Less information is available, however, on its use in the detection of breast cancer in women with breast implants. Rosenbaum et al.34 in 1981 described the use of ultrasound in four women with previous breast augmentation. The authors found that the efficacy of ultrasound was dependent on the augmentation type, and that silicone implants did not appear to limit the usefulness of the examination as the ultrasound beam readily penetrated the prosthesis. Leibman and Kruse32 also described the use of ultrasound in addition to mammography in the women who had undergone breast augmentation with breast cancer. Ultrasound was carried out in five out of 11 women with implants and breast cancer, and gave useful additional
information in three of these cases, including one case in which mammography was negative. A further report by the same authors gives a sensitivity of 88% for the combination of mammography and ultrasound in the detection of breast cancer in a study of 25 women. This included two women with normal mammograms, who were subsequently found to have a mass lesion on ultrasound. These findings suggest an important adjunctive role for targeted ultrasound in the detection of breast cancer in women who have undergone breast augmentation. However, ultrasound is not a useful technique in the screening of asymptomatic women who have not undergone breast augmentation, and no evidence supports its use for this in women with breast implants.

Magnetic resonance imaging of the breast was first described in the mid-1980s, and is increasingly used in breast imaging. Sensitivity rates of between 88 and 100% have been reported. Its limitations include cost, availability, claustrophobia and unsuitability in patients with indwelling metallic implants. In women who have had previous breast augmentation, it has been well described as a tool for assessing implant integrity, and indeed is superior to mammography and ultrasound in an animal model. However, little information is available regarding the use of magnetic resonance imaging in the diagnosis of breast cancer in women with breast implants.

**Tissue diagnosis in the presence of breast implants**

Tissue diagnosis in women with a palpable or radiological abnormality in the breast is usually obtained by percutaneous biopsy. There has been a certain reluctance to undertake this in women with breast implants because of concern about damaging the implant. Numerous techniques for the percutaneous biopsy of breast lesions have been described. Fine needle aspiration (FNA) cytology can be used to achieve a cytological diagnosis of breast lesions. However, this technique requires experience on the part of both the operator and the cytologist to obtain a correct and accurate diagnosis. Although reported to have a false-negative rate as low as 1.4%, it may not be possible to achieve a diagnosis in up to 30% of patients. The Radiologic Diagnostic Oncology Group 5 multicentre trial was designed to compare the relative accuracy of FNA with large needle core biopsy, and the FNA arm of the study was terminated early due to a high rate (34%) of insufficient samples.

Large needle core biopsy is now an increasingly used diagnostic technique, carried out either freehand or under image guidance. False negative rates for freehand core biopsy have been reported as ranging from 0−36%, with inadequate sampling in up to 10%. It has been shown that the false-negative biopsy rate can be reduced to 0−2% by the use of imaging in these patients. A more recent development is the use of vacuum-assisted techniques for outpatient breast biopsy. This allows the removal of larger specimens, with no increase in complications, and may be used under either ultrasound guidance or stereotaxis.

Although these techniques have previously been described, few reports of breast biopsy in women with previous augmentation mammoplasty have been published. Two studies have reported experience of image-guided needle localisation in these women, followed by open surgical biopsy. Mitnick et al. described a technique of needle localisation that used Eklund displacement views. The authors reported the successful removal of two fibroadenomas and two silicone granulomata without complication.

Similarly, few reports of techniques for percutaneous biopsy in women with implants have been published. These techniques have a definite risk of damaging the implants in this scenario. Mitnick et al. studied women with previous breast augmentation and a palpable mass. FNA was carried out in the women without image guidance, while palpably displacing the mass lesions away from the implants. A further report from the same institution described stereotactic FNA for cytology in 15 women with silicone implants and impalpable breast lesions. No cases of inadequate sampling were reported, nor were there any instances of damage to implants. Fornage et al. reported a retrospective study of ultrasound-guided FNA for cytology in lesions in breasts either augmented or reconstructed using a silicone gel-filled prosthesis. Twenty-two women were included in the study; four with reconstructed breasts and 18 with previous augmentation; in only one case was it not possible to reach a diagnosis on the basis of cytology. The use of cytology for the diagnosis of breast cancer has certain limitations. In addition to the relatively high false negative and insufficiency rates, it is not possible to distinguish in situ from invasive malignancy, which presents dilemmas relating to axillary node management. For these reasons, many breast units now use either large core needle biopsy or vacuum-assisted devices for preoperative histological diagnosis. Jackmann and Lamm reported 31 women with silicone implants who underwent stereotactic biopsy for the diagnosis of radiologically detected lesions. A large bore needle core biopsy was carried out in 13 women, and a vacuum-assisted device used in the remaining 18 women.

Lesions in the augmented breasts comprised both microcalcifications (68%) and mass lesions (32%). Implants were subglandular in 21 women and subpectoral in 10 women. Positioning difficulties were encountered in 10 women who had undergone augmentation, but these problems did not prevent biopsy being undertaken in this series. Lesions in the study group were significantly more likely to only be visible on a single mammographic view compared with lesions in women without implants. The rate of inadequate tissue sampling was 10%. Significant positioning problems occurred in two cases, and in all cases the biopsies had been taken using 14G needles rather than the 11G vacuum-assisted device. No instances were recorded of implant rupture, infection or haematoma requiring surgical drainage.

**Discussion**

There is little doubt that the problems discussed above will become more evident as the number of breast cancers occurring in women with previous augmentation mammoplasty increases. It is important for women who are...
undergoing breast augmentation to consider the implications of this surgery for their future breast health.

The evidence that exists would tend to suggest that the presence of gel-filled implants in the breast does reduce the sensitivity of mammography as a diagnostic test, although this can be partly mitigated by the use of displacement views to improve the volume of visualised tissue. Mammographic sensitivity may be less of an issue in symptomatic women with a palpable breast abnormality, as non-mammographic imaging modalities may be used in combination with mammography, with an improved combined sensitivity. However, the presence of breast implants certainly seems to curtail the usefulness of mammography as a screening tool for breast cancer, significantly reducing the sensitivity of the examination. It may be of some relevance to these women that the presence of implants does not increase their likelihood of being recalled for further assessment and investigation of radiological abnormalities.

The second issue arising from the literature is the effect of the presence of breast implants on the feasibility of achieving a tissue diagnosis on screen-detected or symptomatic breast lesions. Few data are available on which to base decisions, but it would seem that the standard techniques of percutaneous breast biopsy are all applicable in this setting. However, image guidance should be considered mandatory in the presence of implants, even for biopsy of palpable lesions, in order to minimise the risk of damage to the underlying implant.

In summary, the following conclusions may be drawn from a review of the published evidence: (1) women should be carefully counselled before augmentation mammoplasty about the reduced sensitivity of mammography in the presence of silicone implants; (2) women should be made aware that the presence of silicone implants may impair the ability of screening mammography to detect impalpable breast cancer; (3) women at high risk of developing breast cancer (e.g. family history) should be carefully counselled about the potential problems with screening, and, if necessary, advised against augmentation mammoplasty; (4) no published evidence supports the practice of routine preoperative mammography before augmentation mammoplasty. This may be of limited value as women are often younger, and the sensitivity of mammography is reduced; (5) the potential effect of women undergoing breast augmentation on the resources available to the NHS Breast Screening Programme should be considered, particularly as the number of women with implants increases and as this population ages towards the screening age group; (6) FNA of palpable and impalpable lesions appears to be safe and feasible on the basis of the limited data available; (7) both percutaneous core and vacuum-assisted biopsy can be safely carried out in these patients, with no increased complication rate compared with the normal population; (8) percutaneous biopsy should be carried out under image guidance to reduce the risk of implant injury.

References


